Research Report
KTC-89-27

EARTHQUAKE HAZARD MITIGATION OF TRANSPORTATION FACILITIES FOR FULTON COUNTY

by

L. John Fleckenstein
Engineering Geologist

David L. Allen
Chief Research Engineer

and

Vincent P. Drnevich
Professor of Civil Engineering

Kentucky Transportation Center
College of Engineering
University of Kentucky
Lexington, Kentucky

in cooperation with
Transportation Cabinet
Commonwealth of Kentucky

and

Federal Highway Administration
U.S.Department of Transportation

June 1989

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
KTC-89-27		

4. Title and Subtitle

Earthquake Hazard Mitigation of Transportation Facilites for Fulton County

5. Report Date
June 1989

6. Performing Organization Code

7. Author(s)
L. J. Fleckenstein, David L. Allen, Vince P. Drnevich

8. Performing Organization Report No.6
KTC-89-27

9. Performing Organization Name and Address

Kentucky Transportation Center
College of Engineering
University of Kentucky
Lexington, KY 40506-0043

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
KYHPR-87-116

13. Type of Report and Period Covered

12. Sponsoring Agency Name and Address
Kentucky Transportation Cabinet
State Office Building
Frankfort, KY 40622

14. Sponsoring Agency Code

15. Supplementary Notes
Publication of this report was sponsored by the Kentucky Transportation Cabinet with the U.S. Department of Transportation, Federal Highway Administration

16. Abstract

Concern has grown in recent years over the seismic activity of the New Madrid seismic zone in Western Kentucky. Fulton County, Kentucky is located in this region. To permit emergency medical, supply, and equipment traffic into this area after an earthquake has occurred, the Kentucky Transportation Cabinet is interested in the possibility of keeping selected routes passable. This report lists the routes that have been investigated and recommended as being the routes in Fulton County that should be maintained in a passable condition. The recommended routes, US 45, KY 94, KY 125, and KY 166 have been visually surveyed and all seismically significant features cataloged. These features are logged by their location on strip maps contained in Appendix A and a detailed listing of all the potentially critical features is given in Appendix B.

17. Key Words	18. Distribution Statement
Earthquake Alluvium Seismic Analyses Modified Mercalli Scale Earthquake Mitigation	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	37	

Form DOT 1700.7 (8-72) Reproduction of completed page authorized

INTRODUCTION

An awareness of earthquakes and their possible effects upon the nation's infrastructure is critically important to the public, and in particular, to public officials. The nation's highway system is one of the most important components of the infrastructure. After the occurrence of an earthquake, the highway system is the primary mode of transporting emergency supplies and services into an affected area. Thus, it is important to catalog the important components of the highway system and attempt to anticipate the possible damage to these components from an earthquake.

Western Kentucky in general and Fulton County in particular are in a high risk earthquake zone. In 1811-1812, three of the most severe earthquakes in American history shook the country. The location of these quakes was not on the infamous San Andreas fault nor anywhere along the well-known fault laden Pacific coast but was near a small town on the Mississippi River where the states of Kentucky and Missouri share a border (Figure 1). It is this river town, New Madrid, Missouri, that is the namesake of a region now regarded by seismologists and disaster response planners as the most hazardous earthquake zone east of the Rocky Mountains -- the New Madrid seismic zone.

In addition to these three great earthquakes, there are several other well documented factors demonstrating the susceptibility of the New Madrid region to the recurrence of major earthquakes. Through a decade of extensive research, an ancient crustal rift has been found to underlie the relatively shallow sediments comprising the region's surface. This type of geologic structure is prone to seismic activity. The New Madrid rift has been identified as being of sufficient size to generate major earthquakes. Further evidence of the area's seismicity is the record of over 2,000 earthquakes detected in the zone since 1974. Though most have been of a magnitude below the threshold of human perception, their existence clearly indicates the high level of seismic activity occurring in the zone.

Seismologists have calculated the probabilities of recurrence of sizeable earthquakes in the New Madrid rift zone. The probability of a magnitude 6.3 earthquake (Richter scale) within 50 years is from 86 to 97 percent. The probability (1) of that same earthquake occurring within the next 15 years is from 40 to 63 percent. For comparison, the 1971 San Fernando earthquake (magnitude 6.6) killed 58 people and caused $480 million worth of damage. The 1988 Armenian earthquake of similar magnitude killed approximately 25,000 to 30,000 people.

The probability of a magnitude 7.6 earthquake occurring within 50 years is from 19 to 29 percent. The probability for this size earthquake occurring within 15 years drops to a range of 5.4 to 8.7 percent. On February 4, 1975, the Haicheng earthquake in China had a magnitude of 7.3 and destroyed or damaged about 90 percent of the structures in a city of 90,000 people.

When comparing historical earthquakes of similar magnitude, one must take into consideration

that death totals and damage estimates will vary greatly due to the geology, population density, types of building, and quality of construction.

For a given earthquake, effects at a given location are described by the Modified Mercalli Intensity (MMI) scale (2) which ranges from I (no damage and felt only by instruments) to XII (total destruction). Details of the MMI scale are given in Table 1. Values of MMI associated with the 1811-1812 earthquakes are shown in Figure 1. The potential for damage and destruction from earthquakes in the region is significant.

In 1982, the Governor's Task Force on Earthquake Hazards and Safety was created to evaluate Kentucky's earthquake risk and to make recommendations for responding to those risks. This task force recommended increased public awareness and education programs, improved emergency response planning and training, improved building codes and seismic restraint designs, evaluation of other mitigation measures, and participation in national and regional earthquake forums and funding programs.

In 1984, Governor Collins created the Governor's Earthquake Hazards and Safety Technical Advisory Panel (GEHSTAP) to analyze scientific and engineering data regarding seismic risks in Kentucky and to make specific recommendations on mitigation, public awareness, response planning, and policy development for public health and safety. The States are dependent on their highway systems for the movement of goods and services. Due to the possible adverse effects a major earthquake could have on this system, the Earthquake Stability and Transportation Subcommittee (ESTS) of GEHSTAP was formed.

ESTS has encouraged the Kentucky Transportation Cabinet to secure funding for generating and implementing an earthquake hazard mitigation plan in an attempt to safeguard the highway system against catastrophic earthquake failure. As a result, the Cabinet commissioned the Kentucky Transportation Center at the University of Kentucky to analyze and assess the possible effects of an earthquake on highway facilities. The study area includes the 26 western-most counties in Kentucky that are adjacent to the New Madrid seismic zone (Figure 1). To date, one of the results of that study has been the recommendation that over 1,000 miles of highways in the study area be utilized as emergency or "priority" routes. These would be the primary routes used for transporting emergency supplies and personnel after an earthquake. Also, it is anticipated that these would be the first routes repaired after an earthquake.

The initial task in identifying these priority routes was to decide where they should begin; that is, in the event of a major earthquake, the point at which the transport of goods and services would originate. Ideally, the city chosen should possess the following attributes:

1. Sufficient size to contain all necessary personnel, supplies, and facilities to respond quickly to a major emergency;

2. Proximity to the high hazard area to speed the relief effort but not so close as to suffer the same high risk potential;

3. Easy access from other major cities in the State; and

4. Sufficient routes to provide relatively direct access to all 26 high-risk counties.

The city best fitting these criteria is Bowling Green. Located at the eastern edge of the earthquake zone in Warren County, Bowling Green meets both the size criterion (population 40,450) and the accessibility criterion (Louisville and Nashville via I 65 and Lexington via the Bluegrass Parkway). Bowling Green provides access to the 26-county area via US 68/KY 80; this road was chosen as the main east-west artery because it crosses Lake Barkley and Kentucky Lake upstream from the dams impounding those bodies of water.

As a first step towards establishing an overall policy for earthquake hazard mitigation in the highway system, these priority routes have been visually surveyed and all natural and man-made features along these routes that are considered seismically significant were cataloged. With this information, a realistic and cost-effective plan for "hardening" these routes against earthquakes can be established. Such efforts are currently under way.

PRIORITY ROUTE IN FULTON COUNTY

The western end of Fulton County is located in New Madrid Seismic Zone. Figure 1 indicates that Fulton County is located in the XI, X, and the IX bands of the MMI scale. This indicates severe damage could occur in Fulton County in the event of a major earthquake.

US 45, KY 94, KY 125, and KY 166 have been designated as the priority routes for Fulton County. US 45 starts at City of Fulton and continues east for 1.20 miles, ending at the Fulton County-Hickman County line. KY 94 starts at the Fulton County-Hickman County line and continues west for 16.40 miles, ending in the City of Hickman. KY 125 starts at the City of Hickman and continues east for 4.0 miles, ending at the junction of KY 166. KY 166 starts at the junction of KY 125 and continues east for 12.80 miles, ending in the City of Fulton.

A number of features along the priority routes could potentially hamper rescue and relief efforts. These features included bridges, soil fills, gas pipelines, power lines, large trees, faults, water impoundments, a silo, and swamps. These features are logged by their location on strip maps contained in Appendix A and a detailed listing of all potentially critical features is given in Appendix B.

BRIDGES

Bridges are the most significant and important features on the priority route. With few exceptions, existing highway bridges in the study area have not been designed to resist motions and forces that may be generated by earthquakes. Bridges located within the seismic zone could possibly be damaged, thus reducing their load-carrying ability. In some cases, damage could be sufficiently great to cause complete collapse.

Several types of damage could occur:

1. A bridge could fail at the bearing which supports the main spans, causing the spans to fall from the bearings and possibly from the piers or abutments.

2. Failure could occur in the columns, piers, or footings which would reduce the load-carrying capacity of the bridge, if the bridge was still in place.

3. An abutment could tilt allowing the entire span to fall.

4. Soil movement or slumping could affect the bridge approach fills, damaging the abutments or piers, or making the bridge inaccessible.

There are six bridges on KY 94, and four bridges on KY 166 in Fulton County. The bridges are located at the following:

KY 94

1. Mud Creek,
2. Little Bayou De Chien OVF,
3. Big Mud Creek,
4. West Fork Of Bayou De Chien,
5. Little Bayou De Chien, and
6. Little Bayou De Chien.

KY 166

1. Mud Creek,
2. Bayou De Chien, and
3. Two bridges on the Purchase Parkway.

Research is currently under way studying the effects that an earthquake could have on these bridges and their approach fills.

FILLS

Highway fills are particularly important because of their tendency to fail from seismically induced motions. Fills fail in one of two major modes. The first is a generalized circular or wedge-shaped failure resulting in one or both traffic lanes moving down and out. If both lanes failed, this would certainly render the route impassable and immediate repairs would be necessary. The second mode of failure is a general slumping or settling of the embankment. The roadway would probably remain passable if settlement or slumping were not severe but reduced speed limits would be required for safety.

Large fills on priority routes in Fulton County are located as follows:

KY 94

1. Approach fills for the Mud Creek bridge,
2. Approach fills for the bridge over Little Bayou De Chien OVF,
3. Approach fills for the Big Mud Creek bridge,
4. Approach fills for the West Fork Bayou De Chien bridge, and
5. Approach fills for the two

Little Bayou De Chien bridges.

KY 166

1. Approach fills for the bridge over Mud Creek, and

2. Approach fills for the bridge over Bayou De Chien.

POWER LINES

High voltage power lines also were cataloged during the route surveys. The heights of the lines above the roadway were estimated visually. Power company officials speculated that a number of breaks along each power line would occur during a major earthquake. In most cases, fallen lines would not be transmitting power because power would be automatically cut off within a few seconds in the event of a break.

Additionally, power line support towers could potentially fall across a priority route.

Power lines cross priority routes at the following locations:

KY 94

1. 0.20 mile east of Fulton County High School, and

2. 1.30 miles west of the Fulton County-Hickman County line.

KY 125

1. 0.27 mile west of the junction of KY 1099, KY 94 bypass and KY 125.

GAS PIPELINES

Several gas pipelines cross under the priority routes in Fulton County. It is possible that pipelines could fail under or near a priority route causing a temporary closure. If a pipeline failed, an explosion might destroy a section of the priority route. Repair could be delayed by further gas leaks, fire, and/or additional explosions.

It appears that most of the pipelines in Fulton County were constructed with little or no seismic considerations. Gas pipelines cross under the priority routes at the following locations:

KY 94

1. At the junction of KY 1127 (south) and KY 94, and

2. 0.10 mile east of the junction of KY 1127 (south) and KY 94.

KY 166

1. 0.21 and 0.31 mile east of the Mud Creek bridge.

TREES

The behavior of trees during an earthquake depends upon many factors including their condition, type, height, and size. Local soil conditions, geometry of the ground surface, and characteristics of the earthquake can also be important. Violent ground motions accompanied by surface rupture and perhaps permanent displacement of the soil surface produce sudden surface accelerations of the ground which can snap and uproot large trees (3). Trees are so numerous that, if many of them fell, the priority routes in Fulton County could effectively be blocked for several hours or days before emergency crews could clear

the debris. Groups of large trees are located near the road at the following sites:

KY 94

1. 1.05, 1.75, 1.95, 2.85, 3.55, and 4.55 miles east of the Big Mud bridge,
2. 0.14 and 0.54 mile west of the bridge over the West Fork of Bayou De Chien,
3. 0.30, 0.65, 0.66, and 1.40 miles east of the junction of KY 781 (north) and KY 94,
4. 0.29, 0.50, 0.89, 1.69, and 2.20 miles east of the junction of KY 1125 (south) and KY 94, and
5. 0.60, 0.90, 1.10, 1.20, and 1.40 miles west of the Fulton County-Hickman County line.

KY 125

1. 0.66, 1.10, and 1.37 miles east of the junction of KY 166 (east) and KY 125, and
2. 1.07, 1.70, and 2.60 miles east of the junction of KY 1129 (east) and KY 125,

KY 166

1. 0.20, 0.80, and 1.50 miles east of the junction of KY 125 and KY 166,
2. 0.01, 0.41, 0.71, 1.41, 1.61, 2.31, and 2.71 miles east of the Mud Creek bridge,
3. 0.30, 1.00, 2.00, 2.60, and 2.70 miles east of the junction of KY 239 and KY 166,
4. 1.03, 0.83, and 0.33 miles west of Bayou De Chien, and
5. 0.17, 0.27, 0.77, 1.57, 1.87, and 2.47 miles east of Bayou De Chien.

US 45

1. 1.20 miles west of the Fulton County-Hickman County line.

GEOLOGIC FAULTS

There are numerous geologic faults (breaks in the bedrock where movement has occurred in the past) in the study area. The faults are seismically significant since a large earthquake could trigger additional movement along one or more old slip planes. There are no precautionary measures that can be taken to reduce hazards from faults except that construction of bridges and other facilities over or near such faults requires special consideration. The faults are included for informational purposes only. Faults are located at the following:

KY 94

1. 0.53 mile west of the Mud Creek bridge.

KY 125

1. 1.25 miles east of the junction of KY 1129 (east) and KY 166.

WATER IMPOUNDMENTS

Small impoundments such as large farm ponds could also be a problem area. Ponds which have large earthen dams that lie above the road surface could collapse during an earthquake and wash out a section of a priority route. Ponds which lie

below the road surface and are adjacent to the toe of the fill could cause failures in the fill during an earthquake due to the high moisture content. Several of the ponds were logged from geologic quadrangle maps, therefore they may not be visible from the priority route.

Impoundments are located as follows:

KY 45

1. 1.20 miles west of the Hickman County-Fulton County line.

KY 94

1. 1.70 miles west of the Fulton County-Hickman County line.

KY 166

1. 0.71 mile west of the Purchase Parkway.

SILO

A silo is adjacent to KY 94 at the 26.10 milepost. It is possible that the silo could fail during a major earthquake and temporarily block the priority route.

SWAMPS

KY 94 is constructed adjacent to and/or over swampy terrain at mileposts 25.35 and 24.40. Priority routes that are constructed over or adjacent to swamps will probably be damaged due to failures within the soil structure during an earthquake. The high water tables penetrate the underlying road bed and weaken the soil structure. During an earthquake, the structure will be further weakened and large vertical displacements in the road surface are likely to occur.

ALLUVIUM

Soil maps for Fulton County indicate that there are moderate to large amounts of alluvium present throughout the county. Alluvium is a loose, fine-grain soil which is deposited by flowing water such as creeks and rivers. Due to the nature of the alluvium, ground motions at the surface of the soil can be many times greater than those within the underlying bedrock and temporary liquefaction can occur (Figure 2). An alluvium map for Fulton County is shown in Figure 3.

CONCLUSIONS

In 1984, ESTS developed a fivefold plan of action for formulating and implementing a seismic mitigation policy for the western Kentucky seismic zone. To date, the Kentucky Transportation Center has established priority routes for all 26 counties in the western Kentucky seismic zone and developed seismic risk maps of all natural and man-made features that are susceptible to earthquake damage that could jeopardize the priority routes.

Current work is being conducted to analyze these features and make recommendations for hardening them against earthquake damage.

Future work involves training key personnel in the Transportation Cabinet in hazard mitigation and seismic safety; which includes bridge inspectors, district engineers, construction inspectors, designers, and maintenance personnel.

Following the education of key

personnel, the mitigation plan proposed by the Kentucky Transportation Center will be reviewed by the Kentucky Transportation Cabinet and a program will be established for implementation. The final step involves the use of relevant seismic codes for all new construction, repair, and maintenance.

REFERENCES

1. Johnson, Arch C., "A Brief Overview of the Geology, Seismicity and Seismic Hazard of the Central Mississippi Valley Area," Proceedings, A Regional Seminar on Earthquake Fundamentals for the Mississippi Valley, Earthquake Engineering Research Institute, Memphis, Tennessee, October 29, 1985.

2. Green, N. B., "Earthquake Resistant Building Design and Construction," Third Edition, Elsevier, 1987, Page No. 179-180.

3. Keller, Edward A., "Environmental Geology," Charles E. Merrill Publishing Company, A Bell and Howell Company, 1979, Page No. 157.

Additional Information

The Commonwealth of Kentucky has prepared a State Emergency Operations Procedures (State EOP) manual that is produced by the Division of Disaster and Emergency Services (DES), Department of Military Affairs, Frankfort, 40601. Annexes H. on Transportation and DD on Earthquakes give additional information on disaster preparedness and response.

A copy of the State EOP and information on local hazard mitigation activities and response preparedness are available from the AREA 1 Office of DES which is located in Mayfield. The phone numbers at this office are (502) 564-8601 and (502) 247-9712.

Additional information about the study discussed in this report should be directed to David L. Allen, Project Director, at the Kentucky Transportation Center, (606) 257-4513. Requests to be placed on the mailing list for updated information should be submitted on your company or agency letterhead to the Kentucky Transportation Center at the University of Kentucky, Lexington Kentucky 40506-0043.

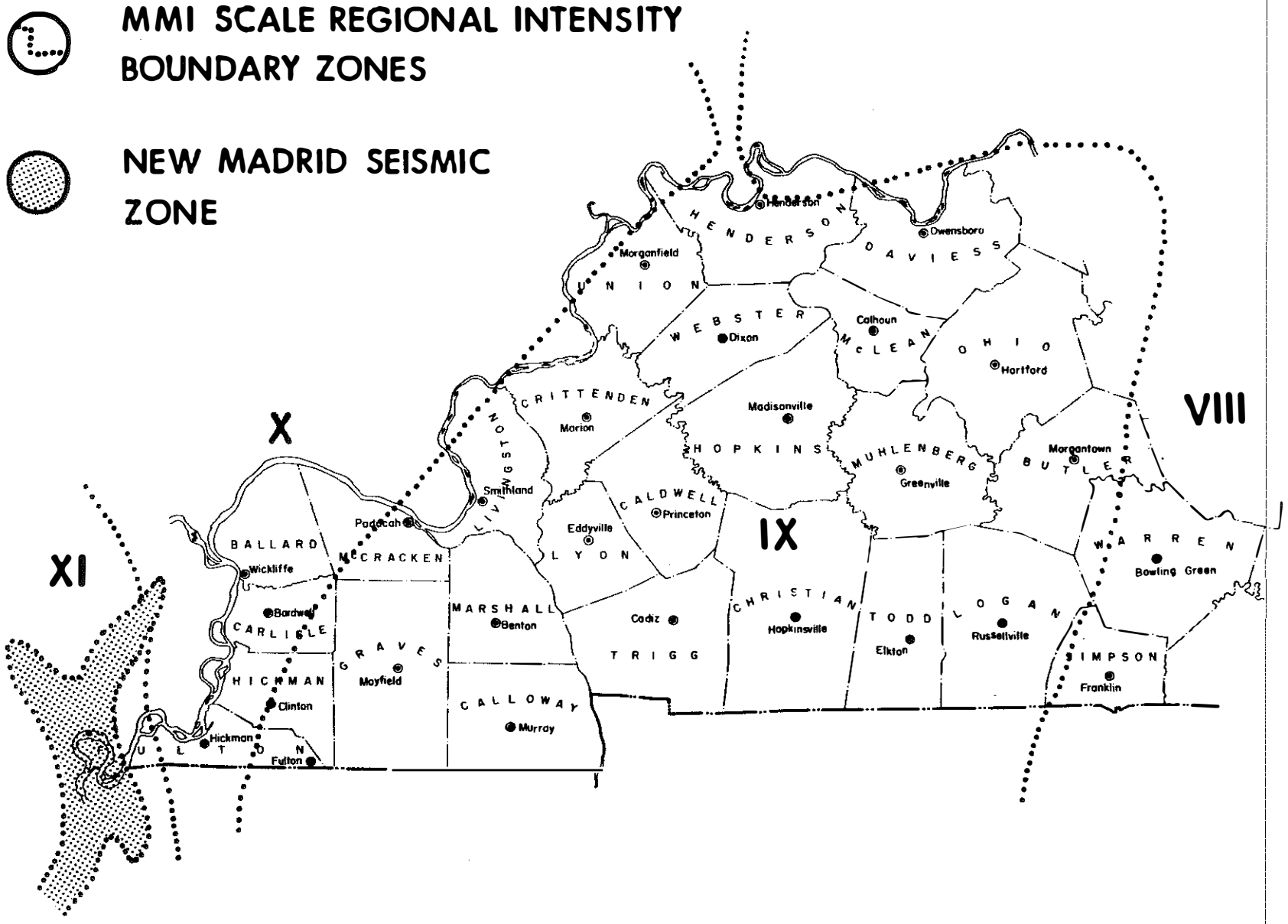


Figure 1: The twenty-six counties included in this study area.

Table 1: MODIFIED MERCALLI INTENSITY SCALE

Modified Mercalli Intensity Scale, 1956 Version

The following comments by Dr. Richter precede the published statement of the intensity scale:

...Each effect is named at the level of intensity at which it first appears frequently and characteristically. Each effect may be found less strongly, or in fewer instances, at the next lower grade of intensity; more strongly or more often at the next higher grade. A few effects are named at two successive levels to indicate a more radual increase.

Masonry A, B, C, D. To avoid ambiguity of language, the quality of masonry, brick or otherwise, is specified by the following lettering.

Masonry A. Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.

Masonry B. Good workmanship and mortar, reinforced by not designed in detail to resist lateral forces.

Masonry C. Ordinary workmanship and mortar; no extreme weakness like failing to tie corners, but neither reinforced nor designed against horizontal forces.

Masonry D. Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

The following list represents the twelve grades of the scale.

I. Not felt. Marginal and long-period effects of large earthquakes.

II. Felt by persons at rest, on upper floors, or favorable placed.

III. Felt indoors, Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.

IV. Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV wooden walls and frame creak.

V. Felt outdoors; direction estimated. Sleepers awakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.

VI. Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken, Knickknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken.

VII. Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices. Same cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.

VIII. Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundation if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.

IX. General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. Frame structures, if not bolted, shifted off foundations. Frames cracked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas sand and mud ejected, earthquake fountains, sand crater.

X. Most masonry and frame structures destroyed with their foundations. Some will-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large land slides. Water thrown on banks of canals, river, lakes, etc. Sand and mud shifted horizontally on beaches and flat lands. Rails bent slightly.

XI. Rails bent greatly. Underground pipelines completely out of service.

XII. Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown in the air.

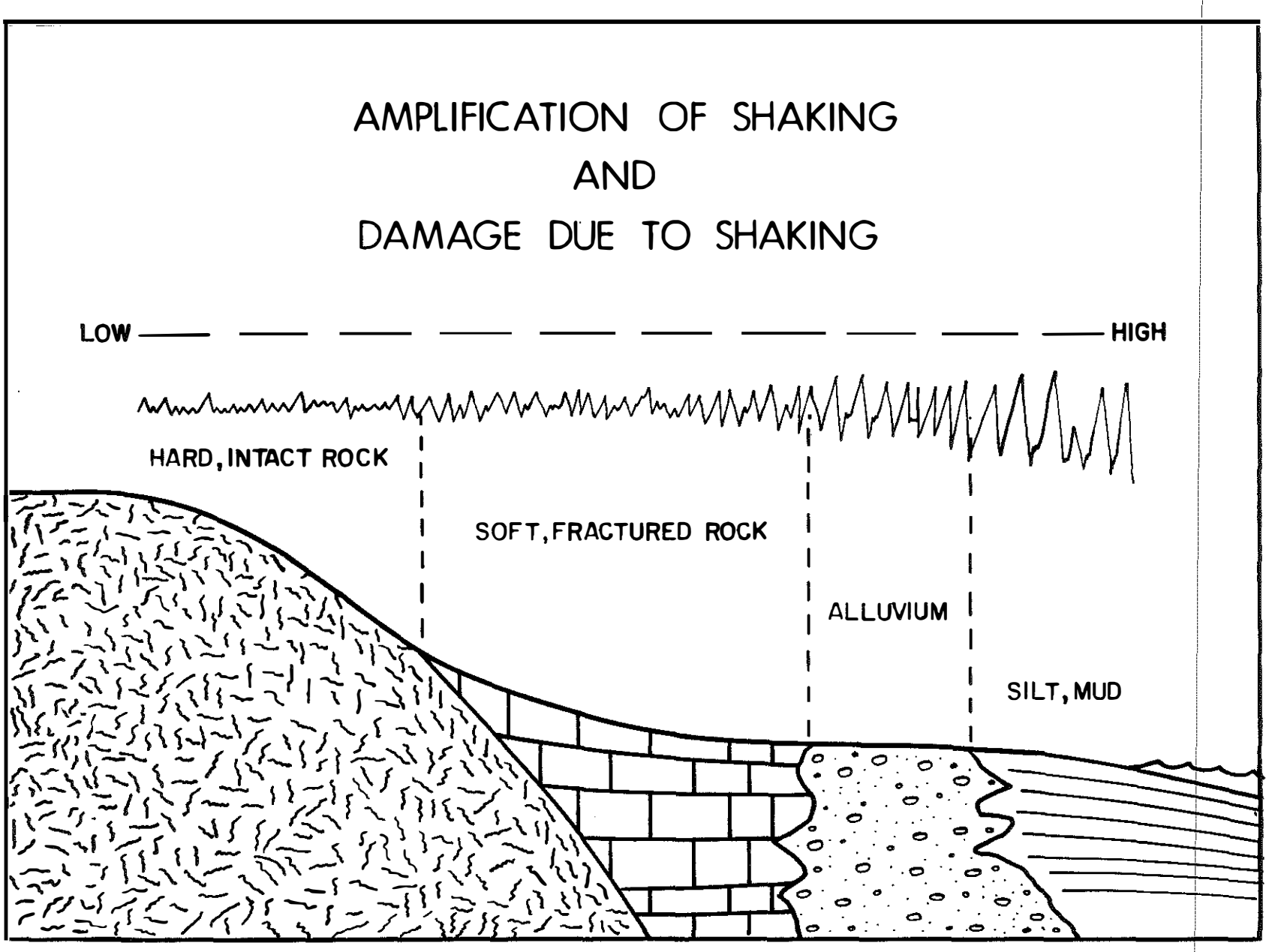
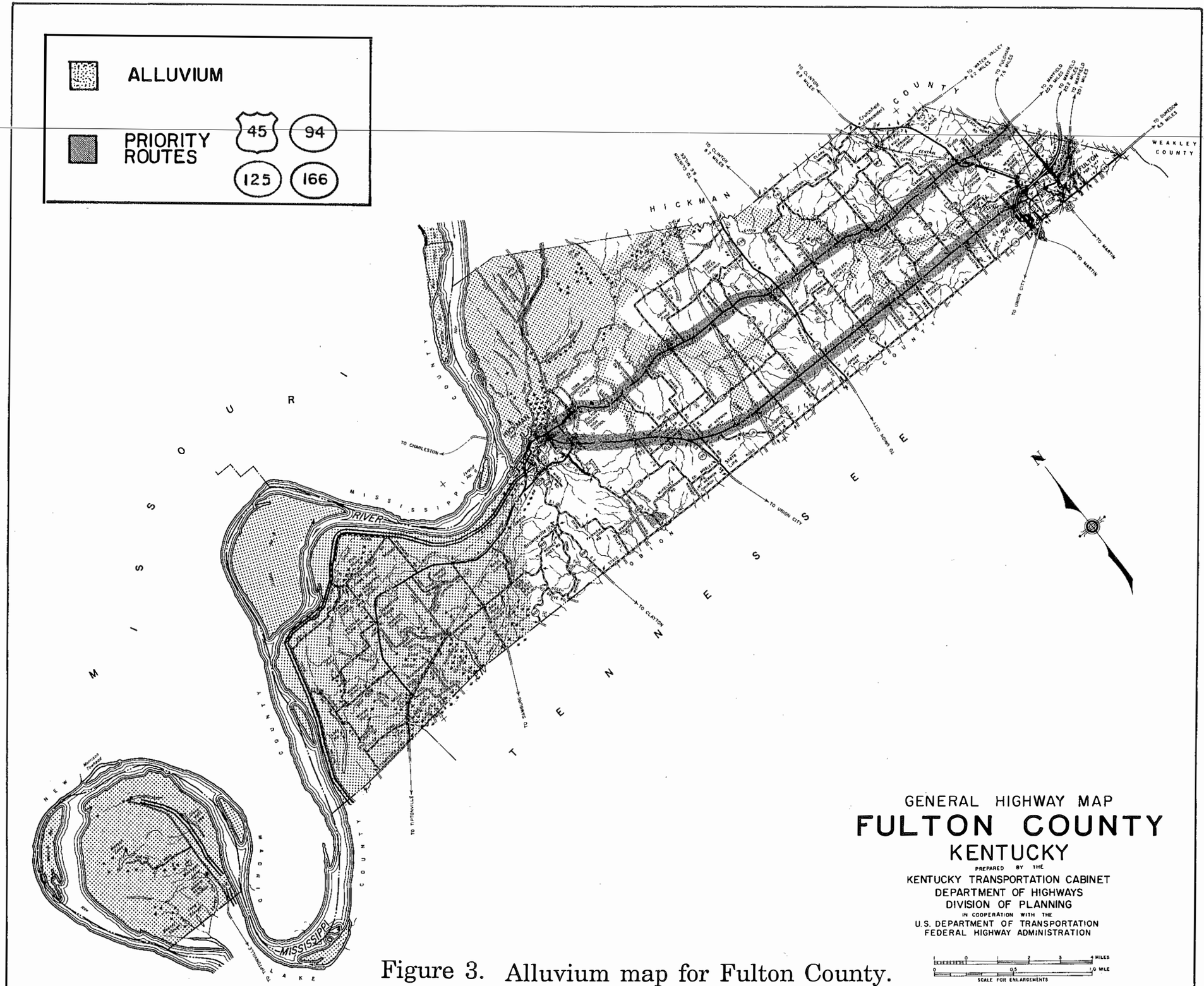


Figure 2 : Amplification of shaking in softer rock & soil during an earthquake.



GENERAL HIGHWAY MAP

FULTON COUNTY

KENTUCKY

PREPARED BY THE
KENTUCKY TRANSPORTATION CABINET
DEPARTMENT OF HIGHWAYS
DIVISION OF PLANNING
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

0 1 2 3 4 MILES
0 0.5 1.0 MILE
SCALE FOR ENLARGEMENTS

POLYCONIC PROJECTION

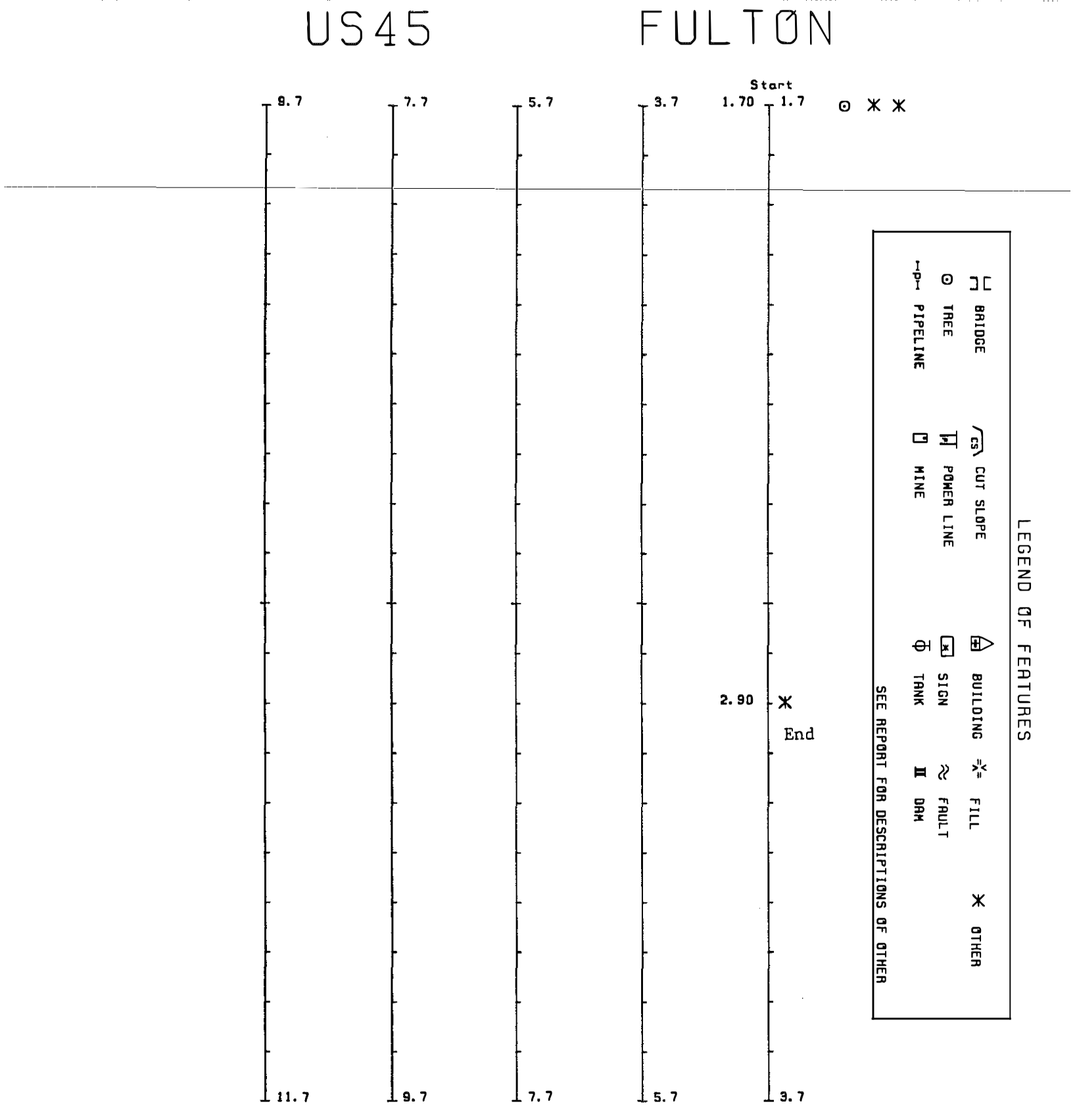
778

Figure 3. Alluvium map for Fulton County.

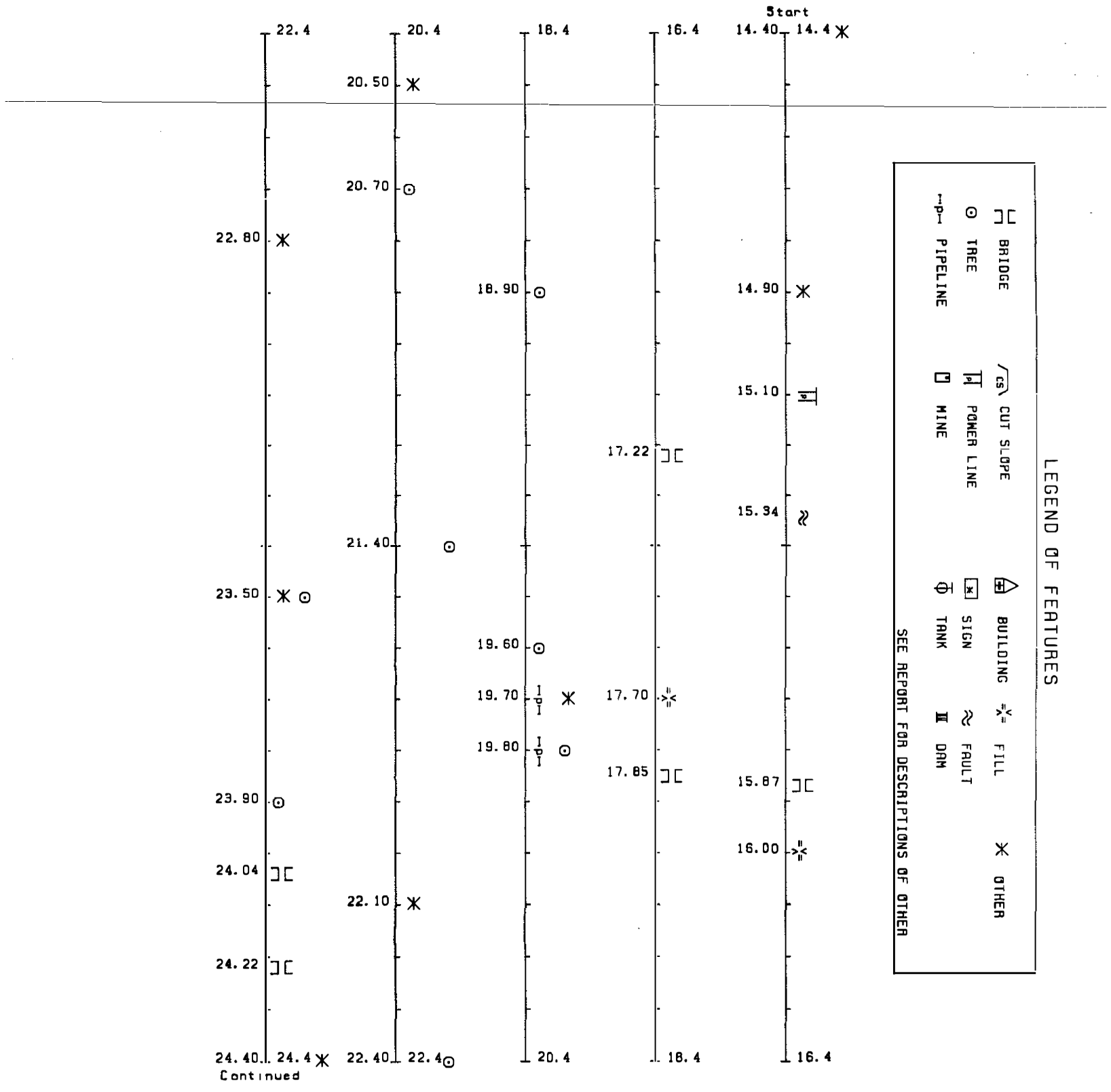
APPENDIX A

STRIP MAP FOR FULTON COUNTY

US 45, KY 94, KY 125, AND KY 166


US45
FULTON
Start
1.70
9.7
7.7
5.7
3.7
1.7
2.90
End
11.7
9.7
7.7
5.7
3.7
LEGEND OF FEATURES
BRIDGE
CUT SLOPE
BUILDING
TREE
POWER LINE
SIGN
FILL
OTHER
PIPELINE
MINE
TANK
FAULT
DAM
SEE REPORT FOR DESCRIPTIONS OF OTHER

KY94 FULTON

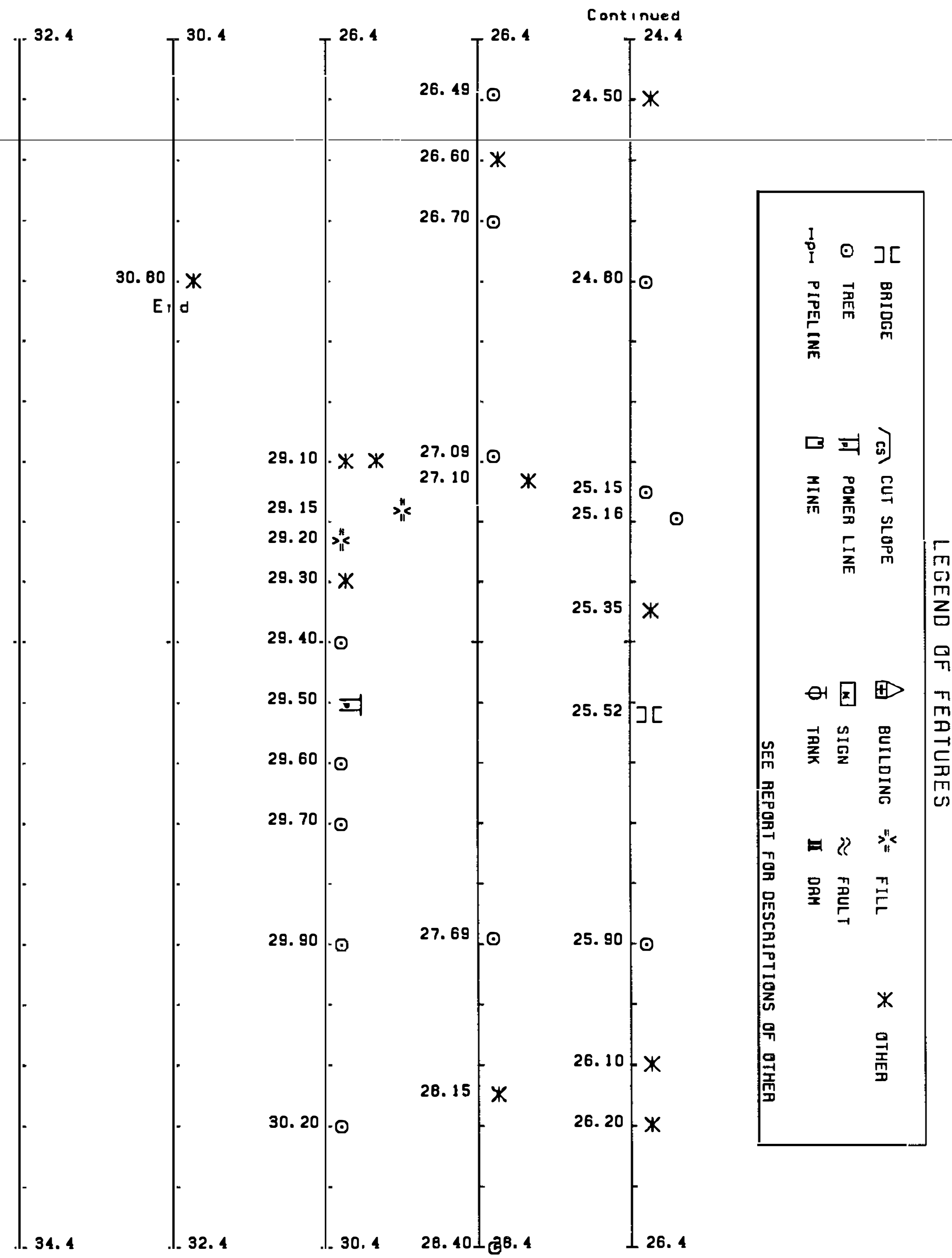


LEGEND OF FEATURES

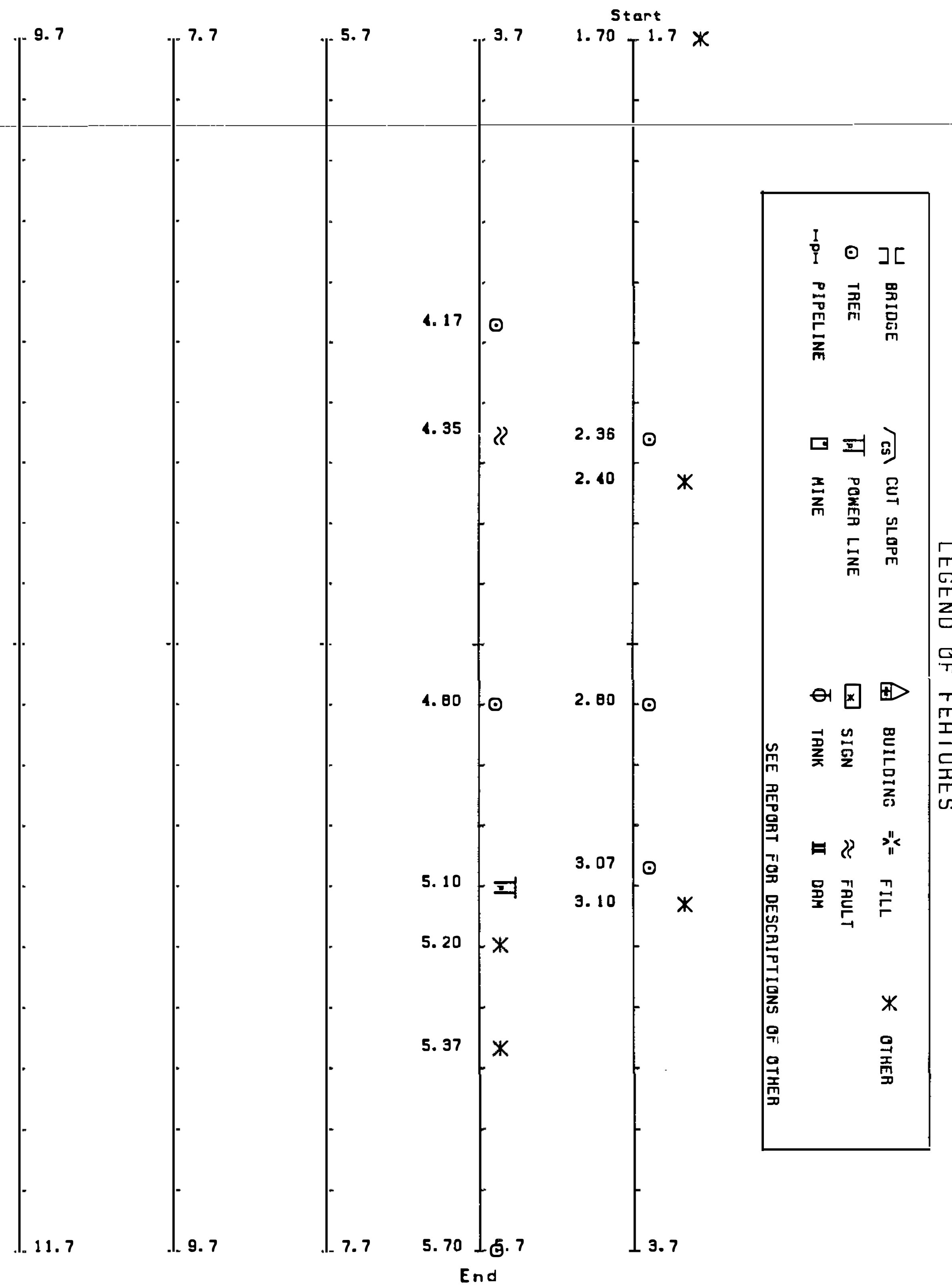
BRIDGE	CUT SLOPE	BUILDING	
TREE	POWER LINE	SIGN	FILL
PIPELINE	MINE	TANK	FAULT
			DAM
			OTHER

SEE REPORT FOR DESCRIPTIONS OF OTHER

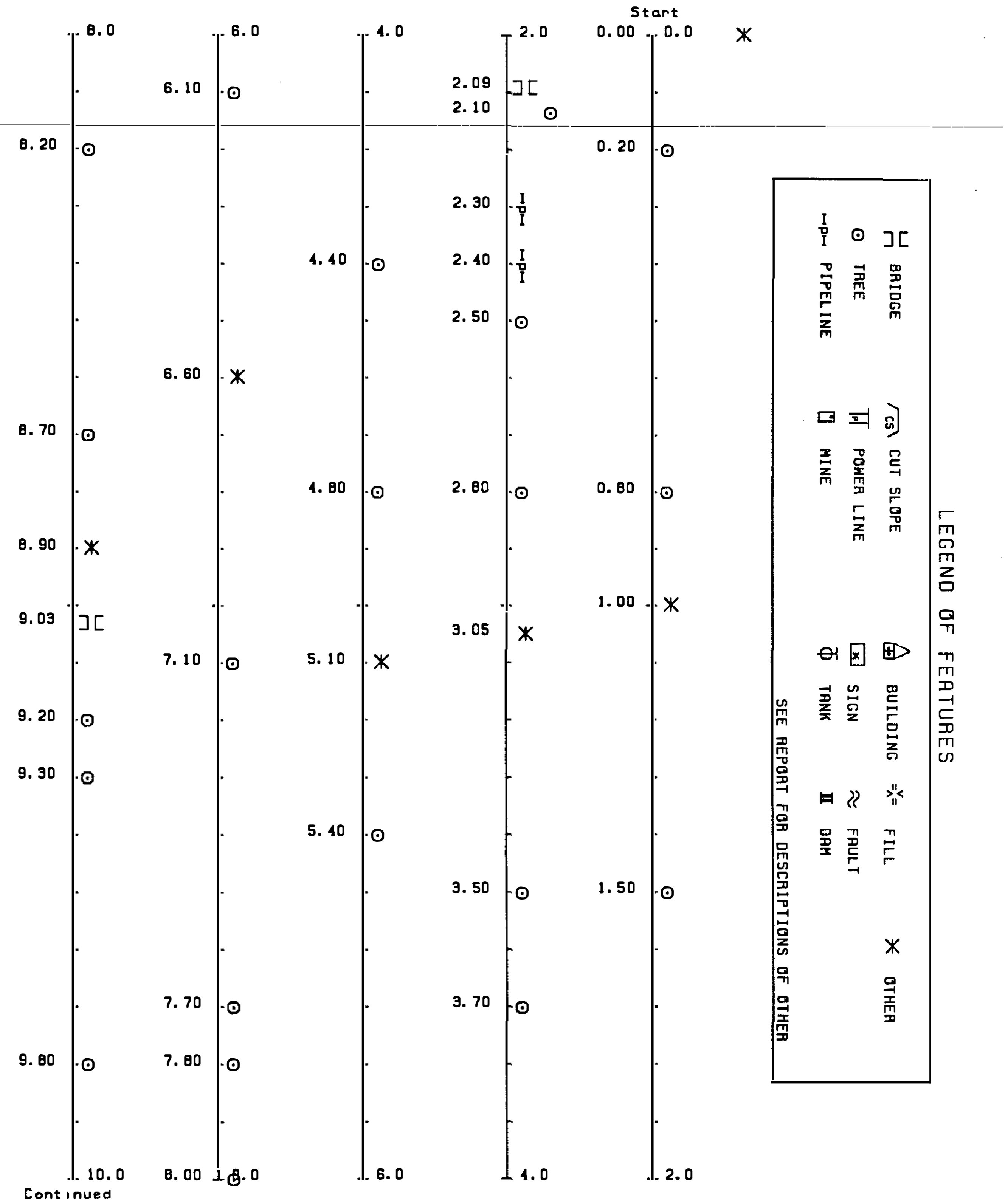
KY94 FULTON


Continued
32.4
30.4
26.4
26.4
24.4
26.49
24.50
26.60
26.70
30.80
End
24.80
29.10
27.09
27.10
25.15
29.15
25.16
29.20
29.30
25.35
29.40
29.50
25.52
29.60
29.70
29.90
27.69
25.90
26.10
28.15
30.20
26.20
34.4
32.4
30.4
28.40
28.4
26.4
LEGEND OF FEATURES
BRIDGE
TREE
PIPELINE
CUT SLOPE
POWER LINE
MINE
BUILDING
SIGN
TANK
FILL
FAULT
DAM
OTHER
SEE REPORT FOR DESCRIPTIONS OF OTHER

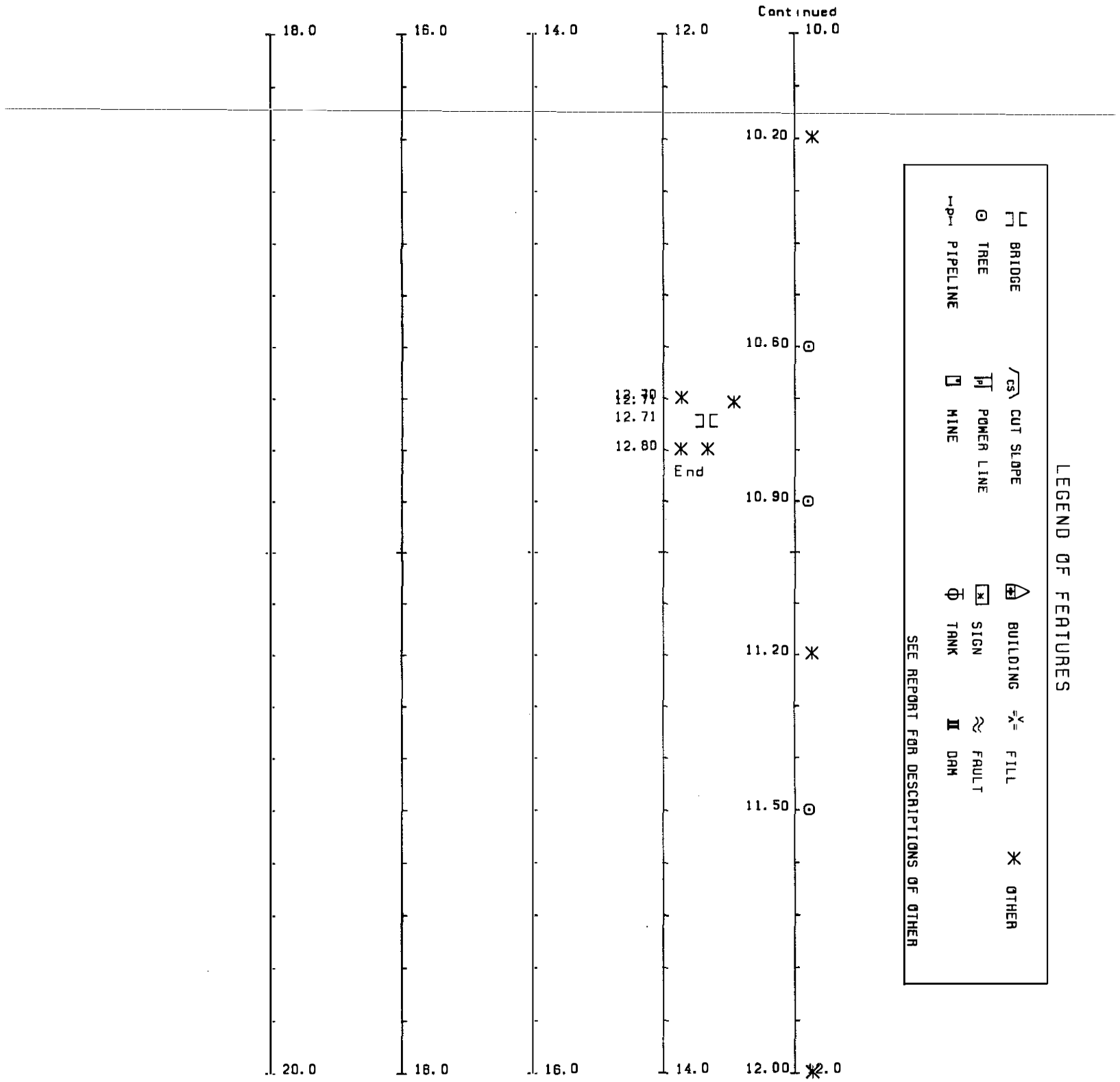
KY125 FULTON



KY166 FULTON



KY166 FULTON



LEGEND OF FEATURES

BRIDGE	CUT SLOPE	BUILDING	
TREE	POWER LINE	SIGN	
PIPELINE	MINE	TANK	
FILL		OTHER	
FAULT			
DAM			

SEE REPORT FOR DESCRIPTIONS OF OTHER

APPENDIX B

SEISMICALLY SIGNIFICANT FEATURES

Report by Road and Milepoint
for Fulton County - Kentucky
KY 94

Milepoint	Feature	Data
14.40	Other	City of Hickman Road Surface Type - Composite
14.90	Other	Fulton Co High School Road Surface Type - Composite
15.10	Power Line	Electrical Power Line 3 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Composite
15.34	Fault	Fault Road Surface Type - Flexible
15.87	Bridge	Number of Spans 1 Type Unknown Concrete T-Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 43 feet Width 19 feet Pier Type - Unknown SPC Rating - D Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
16.00	Fill	Material Type - Soil Height 15 feet Side slope 2:1 Length 750 feet Crest 40 feet Type Fill - Other Road Surface Type - Composite
17.22	Bridge	Number of Spans 1 Type Unknown Concrete Box Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 32 feet Width 25 feet Pier Type - Unknown SPC Rating - D Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown

Report by Road and Milepoint
for Fulton County - Kentucky
KY 94

Milepoint	Feature	Data
17.70	Fill	Material Type - Soil Height 15 feet Side slope 2:1 Length 4,500 feet Crest 40 feet Type Fill - Other Road Surface Type - Composite
17.85	Bridge	Number of Spans 2 Type Unknown Concrete T-Beam End 1 Fixed Pier 1 Fixed End 2 Fixed Deck Type - Concrete Length 106 feet Width 19 feet Pier Type - Unknown SPC Rating - D Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
18.90	Trees	Number of Trees 20 Height 45 feet Diameter 15 in. Ending Milepoint 19.10 Distance From Road 10 feet Road Surface Type - Composite
19.60	Trees	Number of Trees 20 Height 45 feet Diameter 15 in. Ending Milepoint 19.70 Distance From Road 10 feet Road Surface Type - Composite
19.70	Pipeline	Pipeline Type - Natural Gas Road Surface Type - Composite
19.70	Other	Junction KY 1127 Heading South Road Surface Type - Composite
19.80	Pipeline	Pipeline Type - Natural Gas Road Surface Type - Composite
19.80	Trees	Number of Trees 50 Height 45 feet Diameter 15 in. Ending Milepoint 20.30 Distance From Road 10 feet Road Surface Type - Composite

Report by Road and Milepoint
for Fulton County - Kentucky
KY 94

Milepoint	Feature	Data
20.50	Other	Junction KY 1212 Heading South Road Surface Type - Composite
20.70	Trees	Number of Trees 50 Height 45 feet Diameter 15 in. Ending Milepoint 20.90 Distance From Road 10 feet Road Surface Type - Composite
21.40	Trees	Number of Trees 100 Height 45 feet Diameter 15 in. Ending Milepoint 21.90 Distance From Road 10 feet Road Surface Type - Composite
22.10	Other	Junction KY 239 Heading North-South Road Surface Type - Composite
22.40	Trees	Number of Trees 90 Height 40 feet Diameter 15 in. Ending Milepoint 22.90 Distance From Road 10 feet Road Surface Type - Composite
22.80	Other	Junction KY 1907 Heading North Road Surface Type - Composite
23.50	Other	Junction KY 781 Heading South Road Surface Type - Composite
23.50	Trees	Number of Trees 50 Height 50 feet Diameter 18 in. Ending Milepoint 23.80 Distance From Road 10 feet Road Surface Type - Composite
23.90	Trees	Number of Trees 70 Height 40 feet Diameter 8 in. Ending Milepoint 24.40 Distance From Road 10 feet Road Surface Type - Composite

Report by Road and Milepoint
for Fulton County - Kentucky
KY 94

Milepoint	Feature	Data
24.04	Bridge	Number of Spans 1 Over Stream Concrete Box Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 73 feet Width 25 feet Pier Type - Solid SPC Rating - D Surface Type - Composite Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
24.22	Bridge	Number of Spans 1 Over Stream Concrete Box Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 64 feet Width 26 feet Pier Type - Solid SPC Rating - D Surface Type - Composite Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
24.40	Other	Swamp Road Surface Type - Composite
24.50	Other	Junction KY 781 Heading North Road Surface Type - Composite
24.80	Trees	Number of Trees 15 Height 45 feet Diameter 20 in. Ending Milepoint 25.10 Distance From Road 15 feet Road Surface Type - Composite
25.15	Trees	Number of Trees 3 Height 45 feet Diameter 12 in. Ending Milepoint 25.15 Distance From Road 15 feet Road Surface Type - Composite
25.16	Trees	Number of Trees 10 Height 40 feet Diameter 24 in. Ending Milepoint 25.20 Distance From Road 25 feet Road Surface Type - Composite

Report by Road and Milepoint
for Fulton County - Kentucky
KY 94

Milepoint	Feature	Data
25.35	Other	Swamp: 10 feet from Road, 250 feet along Road Road Surface Type - Flexible
25.52	Bridge	Number of Spans 1 Type Unknown Concrete T-Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 24 feet Width 20 feet Pier Type - Unknown SPC Rating - D Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
25.90	Trees	Number of Trees 2 Height 45 feet Diameter 30 in. Ending Milepoint 25.90 Distance From Road 15 feet Road Surface Type - Composite
26.10	Other	Silo Road Surface Type - Composite
26.20	Other	Junction KY 1125 Heading South Road Surface Type - Composite
26.49	Trees	Number of Trees 10 Height 45 feet Diameter 15 in. Ending Milepoint 26.55 Distance From Road 15 feet Road Surface Type - Composite
26.60	Other	Junction KY 1125 Heading North Road Surface Type - Composite
26.70	Trees	Number of Trees 15 Height 45 feet Diameter 24 in. Ending Milepoint 26.80 Distance From Road 15 feet Road Surface Type - Composite

Report by Road and Milepoint
for Fulton County - Kentucky
KY 94

Milepoint	Feature	Data
27.09	Trees	Number of Trees 10 Height 45 feet Diameter 15 in. Ending Milepoint 27.15 Distance From Road 15 feet Road Surface Type - Composite
27.10	Other	Junction KY 1706 Heading South Road Surface Type - Composite
27.89	Trees	Number of Trees 10 Height 45 feet Diameter 15 in. Ending Milepoint 27.95 Distance From Road 15 feet Road Surface Type - Composite
28.15	Other	Junction KY 1901 Heading South Road Surface Type - Composite
28.40	Trees	Number of Trees 100 Height 45 feet Diameter 15 in. Ending Milepoint 28.90 Distance From Road 15 feet Road Surface Type - Composite
29.10	Other	Pond Road Surface Type - Composite
29.10	Other	Junction US 51 Heading Northwest-Southeast Road Surface Type - Composite
29.15	Fill	Material Type - Soil Height 40 feet Side slope 2:1 Length 250 feet Crest 24 feet Type Fill - Other Road Surface Type - Flexible
29.20	Fill	Material Type - Soil Height 20 feet Side slope 2:1 Length 1,000 feet Crest 25 feet Type Fill - Other Road Surface Type - Composite

Report by Road and Milepoint
for Fulton County - Kentucky
KY 94

Milepoint	Feature	Data
29.30	Other	Railroad Tracks Road Surface Type - Composite
29.40	Trees	Number of Trees 5 Height 40 feet Diameter 24 in. Ending Milepoint 29.50 Distance From Road 10 feet Road Surface Type - Composite
29.50	Power Line	Electrical Power Line 3 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Composite
29.60	Trees	Number of Trees 5 Height 30 feet Diameter 8 in. Ending Milepoint 29.60 Distance From Road 10 feet Road Surface Type - Composite
29.70	Trees	Number of Trees 5 Height 50 feet Diameter 18 in. Ending Milepoint 29.70 Distance From Road 10 feet Road Surface Type - Composite
29.90	Trees	Number of Trees 5 Height 30 feet Diameter 8 in. Ending Milepoint 29.90 Distance From Road 10 feet Road Surface Type - Composite
30.20	Trees	Number of Trees 50 Height 50 feet Diameter 18 in. Ending Milepoint 30.80 Distance From Road 10 feet Road Surface Type - Composite
30.80	Other	Fulton Co - Hickman Co Boundary Road Surface Type - Composite

Report by Road and Milepoint
for Fulton County - Kentucky
KY 166

Milepoint	Feature	Data
0.00	Other	KY 125 Joins KY 166 (Begin KY 166) Road Surface Type - Flexible
0.20	Trees	Number of Trees 20 Height 35 feet Diameter 18 in. Ending Milepoint .24 Distance From Road 10 feet Road Surface Type - Flexible
0.80	Trees	Number of Trees 100 Height 35 feet Diameter 18 in. Ending Milepoint 1.10 Distance From Road 12 feet Road Surface Type - Flexible
1.00	Other	Junction KY 116 Heading South Road Surface Type - Flexible
1.50	Trees	Number of Trees 5 Height 40 feet Diameter 14 in. Ending Milepoint 2.10 Distance From Road 15 feet Road Surface Type - Flexible
2.09	Bridge	Number of Spans 3 Over Stream Concrete T-Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 100 feet Width 24 feet Pier Type - Solid SPC Rating - D Surface Type - Composite Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
2.10	Trees	Number of Trees 5 Height 40 feet Diameter 14 in. Ending Milepoint 2.10 Distance From Road 15 feet Road Surface Type - Flexible

Report by Road and Milepoint
for Fulton County - Kentucky
KY 166

Milepoint	Feature	Data
2.30	Pipeline	Pipeline Type - Natural Gas Road Surface Type - Composite
2.40	Pipeline	Pipeline Type - Petroleum Road Surface Type - Composite
2.50	Trees	Number of Trees 8 Height 50 feet Diameter 24 in. Ending Milepoint 2.51 Distance From Road 20 feet Road Surface Type - Composite
2.80	Trees	Number of Trees 12 Height 40 feet Diameter 20 in. Ending Milepoint 2.83 Distance From Road 15 feet Road Surface Type - Composite
3.05	Other	Junction KY 1127 Heading North-South Road Surface Type - Flexible
3.50	Trees	Number of Trees 3 Height 45 feet Diameter 24 in. Ending Milepoint 3.51 Distance From Road 15 feet Road Surface Type - Composite
3.70	Trees	Number of Trees 40 Height 40 feet Diameter 14 in. Ending Milepoint 3.90 Distance From Road 15 feet Road Surface Type - Flexible
4.40	Trees	Number of Trees 30 Height 40 feet Diameter 8 in. Ending Milepoint 4.60 Distance From Road 20 feet Road Surface Type - Composite
4.80	Trees	Number of Trees 1 Height 60 feet Diameter 18 in. Ending Milepoint 4.80 Distance From Road 10 feet Road Surface Type - Flexible

Report by Road and Milepoint
for Fulton County - Kentucky
KY 166

Milepoint	Feature	Data
5.10	Other	Junction KY 239 Heading North-South Road Surface Type - Flexible
5.40	Trees	Number of Trees 20 Height 45 feet Diameter 12 in. Ending Milepoint 5.50 Distance From Road 15 feet Road Surface Type - Flexible
6.10	Trees	Number of Trees 100 Height 50 feet Diameter 18 in. Ending Milepoint 6.70 Distance From Road 20 feet Road Surface Type - Composite
6.60	Other	Junction KY 781 Heading North-South Road Surface Type - Flexible
7.10	Trees	Number of Trees 2 Height 45 feet Diameter 30 in. Ending Milepoint 7.10 Distance From Road 20 feet Road Surface Type - Composite
7.70	Trees	Number of Trees 7 Height 45 feet Diameter 12 in. Ending Milepoint 7.71 Distance From Road 15 feet Road Surface Type - Flexible
7.80	Trees	Number of Trees 7 Height 45 feet Diameter 12 in. Ending Milepoint 7.81 Distance From Road 15 feet Road Surface Type - Flexible
8.00	Trees	Number of Trees 2 Height 50 feet Diameter 18 in. Ending Milepoint 8.00 Distance From Road 20 feet Road Surface Type - Flexible
8.20	Trees	Number of Trees 20 Height 35 feet Diameter 12 in. Ending Milepoint 8.30 Distance From Road 15 feet Road Surface Type - Flexible

Report by Road and Milepoint
for Fulton County - Kentucky
KY 166

Milepoint	Feature	Data
8.70	Trees	Number of Trees 70 Height 30 feet Diameter 18 in. Ending Milepoint 8.90 Distance From Road 15 feet Road Surface Type - Flexible
8.90	Other	Junction KY 1125 Heading North Road Surface Type - Flexible
9.03	Bridge	Number of Spans 3 Over Stream Concrete T-Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 99 feet Width 24 feet Pier Type - Open SPC Rating - D Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
9.20	Trees	Number of Trees 10 Height 50 feet Diameter 25 in. Ending Milepoint 9.20 Distance From Road 15 feet Road Surface Type - Flexible
9.30	Trees	Number of Trees 2 Height 50 feet Diameter 25 in. Ending Milepoint 9.30 Distance From Road 15 feet Road Surface Type - Flexible
9.80	Trees	Number of Trees 10 Height 70 feet Diameter 20 in. Ending Milepoint 10.00 Distance From Road 15 feet Road Surface Type - Flexible
10.20	Other	Junction KY 1706 Heading North Road Surface Type - Flexible

Report by Road and Milepoint
for Fulton County - Kentucky
KY 166

Milepoint	Feature	Data
10.60	Trees	Number of Trees 10 Height 50 feet Diameter 18 in. Ending Milepoint 10.70 Distance From Road 15 feet Road Surface Type - Flexible
10.90	Trees	Number of Trees 3 Height 50 feet Diameter 18 in. Ending Milepoint 10.91 Distance From Road 15 feet Road Surface Type - Flexible
11.20	Other	Junction KY 1909 Heading North Road Surface Type - Flexible
11.50	Trees	Number of Trees 10 Height 50 feet Diameter 18 in. Ending Milepoint 11.51 Distance From Road 15 feet Road Surface Type - Flexible
12.00	Other	Pond: (400 x 200) feet, 15 feet from Road Road Surface Type - Flexible
12.70	Other	Junction KY 2567 Heading North-South Road Surface Type - Flexible
12.71	Bridge	Number of Spans 3 Overpass Concrete I-Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 120 feet Width 40 feet Pier Type - Open SPC Rating - D Surface Type - Flexible Expansion Type - Sliding Plate End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
12.71	Other	Two Bridges at this Location Road Surface Type - Flexible

Report by Road and Milepoint
for Fulton County - Kentucky
KY 166

Milepoint	Feature	Data
12.80	Other	Junction KY 2568 Heading North-South Road Surface Type - Flexible
12.80	Other	City of Fulton Road Surface Type - Flexible

Report by Road and Milepoint
for Fulton County - Kentucky
KY 125

Milepoint	Feature	Data
1.70	Other	Junction KY 166 Heading East Road Surface Type - Flexible
2.36	Trees	Number of Trees 20 Height 45 feet Diameter 15 in. Ending Milepoint 2.40 Distance From Road 15 feet Road Surface Type - Flexible
2.40	Other	Junction KY 1128 Heading East-West Road Surface Type - Flexible
2.80	Trees	Number of Trees 2 Height 55 feet Diameter 18 in. Ending Milepoint 2.80 Distance From Road 15 feet Road Surface Type - Flexible
3.07	Trees	Number of Trees 10 Height 45 feet Diameter 15 in. Ending Milepoint 3.10 Distance From Road 15 feet Road Surface Type - Flexible
3.10	Other	Junction KY 1129 Heading East Road Surface Type - Flexible
4.17	Trees	Number of Trees 10 Height 50 feet Diameter 18 in. Ending Milepoint 4.20 Distance From Road 15 feet Road Surface Type - Flexible
4.35	Fault	Fault Road Surface Type - Flexible
4.80	Trees	Number of Trees 30 Height 45 feet Diameter 13 in. Ending Milepoint 5.00 Distance From Road 10 feet Road Surface Type - Flexible

Report by Road and Milepoint
for Fulton County - Kentucky
KY 125

Milepoint	Feature	Data
5.10	Power Line	Electrical Power Line 3 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
5.20	Other	City of Hickman Road Surface Type - Flexible
5.37	Other	Junction KY 1099 & Ky 94 Bypass Road Surface Type - Flexible
5.70	Trees	Number of Trees 30 Height 50 feet Diameter 12 in. Ending Milepoint 5.80 Distance From Road 10 feet Road Surface Type - Flexible

Report by Road and Milepoint
for Fulton County - Kentucky
US 45

Milepoint	Feature	Data
1.70	Trees	Number of Trees 500 Height 40 feet Diameter 24 in. Ending Milepoint 2.80 Distance From Road 12 feet Road Surface Type - Flexible
1.70	Other	Pond Road Surface Type - Flexible
1.70	Other	City of Fulton Road Surface Type - Flexible
2.90	Other	Fulton Co - Hickman Co Boundary Road Surface Type - Flexible