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KTC-89-18

EARTHQUAKE HAZARD MITIGATION OF TRANSPORTATION FACILITIES FOR LIVINGSTON COUNTY

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16. Abstract

Concern has grown in recent years over the seismic activity of the New Madrid seismic zone in Western Kentucky. Livingston 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 Livingston County that should be maintained in a passable condition. The recommended routes, US 62/US 641 and US 60 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

Earthquake
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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 Livingston 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 LIVINGSTON COUNTY

Livingston County is located approximately 61 miles northeast of the center of the New Madrid Seismic Zone. Figure 1 indicates that Livingston County is located in X and IX bands of the MMI scale. Approximately 85 percent of Livingston County is located in the IX band. This indicates considerable damage could occur in Livingston County in the event of a major earthquake.

US 62/US 641, and US 60 have been designated as the priority routes for Livingston County. US 62/US 641 starts at the Livingston County-Marshall County line and continues east for 2.80 miles, ending at Livingston County-Lyon County line. US 60 starts at the Livingston County-McCracken County line and continues north for 29.10 miles, ending at the Livingston County-Crittenden County line.

A number of features along the priority routes could potentially hamper rescue and relief efforts. These features included bridges, soil fills, rock cut slopes, power lines, large trees, underground or open pit mines, dams, water towers, and faults. 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 US 62/US 641, and five bridges on US 60 in Livingston County. The bridges are located over:

US 62/US 641

1. Tennessee River,

2. I.C.R.R.,

3. Reeds Haul Road and R.R.,

4. Two KY 453 bridges cross over US 62/US 641, and

5. Cumberland River.

US 60

1. Cumberland River,

2. Dyers Creek,

3. Mitchell Branch,

4. Sandy Creek, and

5. Dry Creek.

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 Livingston County are located as follows:

US 62/US 641

1. Approach fills for dam,

2. Approach fills for the bridge over Reeds Haul Road and R.R., and

3. Approach fills for the bridge over the Cumberland River.

US 60

1. Approach fills for the bridge over Cumberland River,

2. Approach fills for the bridge over Dyers Creek,

3. Approach fills for the bridge over Mitchell Branch,

4. Approach fills for the bridge over Sandy Creek, and

5. Approach fills for the Dry Creek bridge.

CUT SLOPES

Most cut slopes cataloged during surveys of priority routes in Livingston County were in rock and were less than 35 feet in height. Should any of these slopes fail, both lanes of the roadway probably would not be closed, thus permitting passage around the slide. Cut slopes that have a history of failure and those that have steep slopes should be considered as problem areas.
Cut slopes are located at the following:

US 60

1. 0.70 mile west of the junction of KY 137 (heading northwest) and US 60, and

2. 1.70 miles west of the junction of KY 763 (heading west) and US 60.

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:

US 62/US 641

1. 0.05 mile west of the junction of KY 453 (heading south) and US 62/US 641.

US 60

1. 2.05 and 0.95 miles west of the junction of CO 2238 (heading west) and US 60,

2. 0.25 and 0.95 mile east of the junction of CO 2238 (heading west) and US 60,

3. 1.40 miles west of the junction of CO 2238 (heading west) and US 60,

4. 1.23 miles east of the Cumberland River Bridge,

5. 0.66 mile west of the Dyers Creek bridge,

6. 0.54 and 0.84 mile east of the Dyers Creek bridge, and

7. 0.30 mile west of the junction of KY 133 (heading northwest) and US 60.

MINES

There are several types of mining-related activities in Livingston County that could affect priority routes during a major earthquake. A large earthquake could collapse roofs in underground limestone mines and cause rapid subsidence at the surface. Other potential hazards exist from highwall failures within open pit mines. Quarry's are located at the following:

US 62/US 641

1. 0.88 mile west of the Cumberland River bridge.

US 60

1. 0.38 mile west of the junction of KY 453 (heading southeast) and US 60,
2. 0.47 mile west of the junction of KY 137 (heading northwest) and US 60, and
3. 0.64 mile east of the Dyers Creek bridge.

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. Several faults cross under US 60 in Livingston County, and are listed below:

US 60

1. 0.30 and 0.87 mile west of the junction of CO 2238 (west) and US 60,
2. 0.30 mile east of the junction of CO 2238 (west) and US 60,
3. 0.01 mile west of the junction of CO 2238 (east) and US 60,
4. 0.08 mile east of the junction of CO 2238 (heading east) and US 60,
5. 1.46, 1.63, 1.71, 2.05, and 2.39 miles east of the junction of KY 937 (heading south) and US 60,
6. At the junction of KY 70 (heading east) and US 60,
7. 0.62 and 0.70 mile east of the Cumberland River bridge,
8. 0.30 mile west of the junction of KY 137 (heading northwest) and US 60,
9. 0.13 mile west of the Dyers Creek bridge,
10. 0.91 mile east of the Dyers Creek bridge,
11. 0.57, 1.25, 1.57, 1.63, 1.71, 1.86 and 1.97 miles west of the junction of KY 763 (heading west) and US 60,
12. 0.01 mile east of the junction of KY 1433 (east) and US 60,
13. 0.05 and 0.12 mile west of the Mitchell Branch bridge,

14. 1.73, and 2.01 miles east of the Mitchell Branch bridge,

15. 0.04, 0.63, 1.16, 1.20, 1.29 and 1.39 miles west of the Sandy Creek bridge, and

16. 0.51 and 0.81 mile east of the Sandy 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 Livingston 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:

US 60

1. 1.85, 2.38 and 3.40 miles east of the Livingston County-McCracken County line,

2. 0.31 mile west of the junction of CO 2238 (east) and US 60,

3. 1.46 and 2.36 miles east of the junction of KY 937 (south) and US 60,

4. 0.18 mile west of the Cumberland River bridge,

5. 1.73 miles east of the Cumberland River bridge,

6. 0.86 and 1.16 miles west of the Dyers Creek bridge,

7. 1.24 miles east of the Dyers Creek bridge,

8. 0.40 mile east of the junction of KY 763 (west) and US 60,

9. 0.31 mile west of the Mitchell Branch bridge,

10. 0.90, 0.99, 1.89 and 3.09 miles east of the Mitchell Branch bridge, and

11. 0.10 mile east of the junction of KY 723 and US 60.

WATER IMPOUNDMENTS

A section of US 62/US 641 is constructed over Kentucky Dam and another section of US 62/US 641 is constructed downstream from Barkley Dam. US 60 is downstream from both Barkley Dam and Kentucky Dam. If either of these dams failed during a major earthquake, it is likely that sections of both US 62/US 641 and US 60 could be destroyed and/or flooded for a considerable period.

Water Tower

A water tower is approximately 60 feet from US 60 at milepost 6.75. It is possible that the tower could fail during a major earthquake and temporarily block the priority route.

ALLUVIUM

Soil maps for Livingston County indicate there are moderate amounts of alluvium present in the central and northern part of 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 Livingston 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

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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 2 Office of DES which is located in Hopkinsville. The phone numbers at this office are (502) 564-8602 and (502) 885-7100.

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.

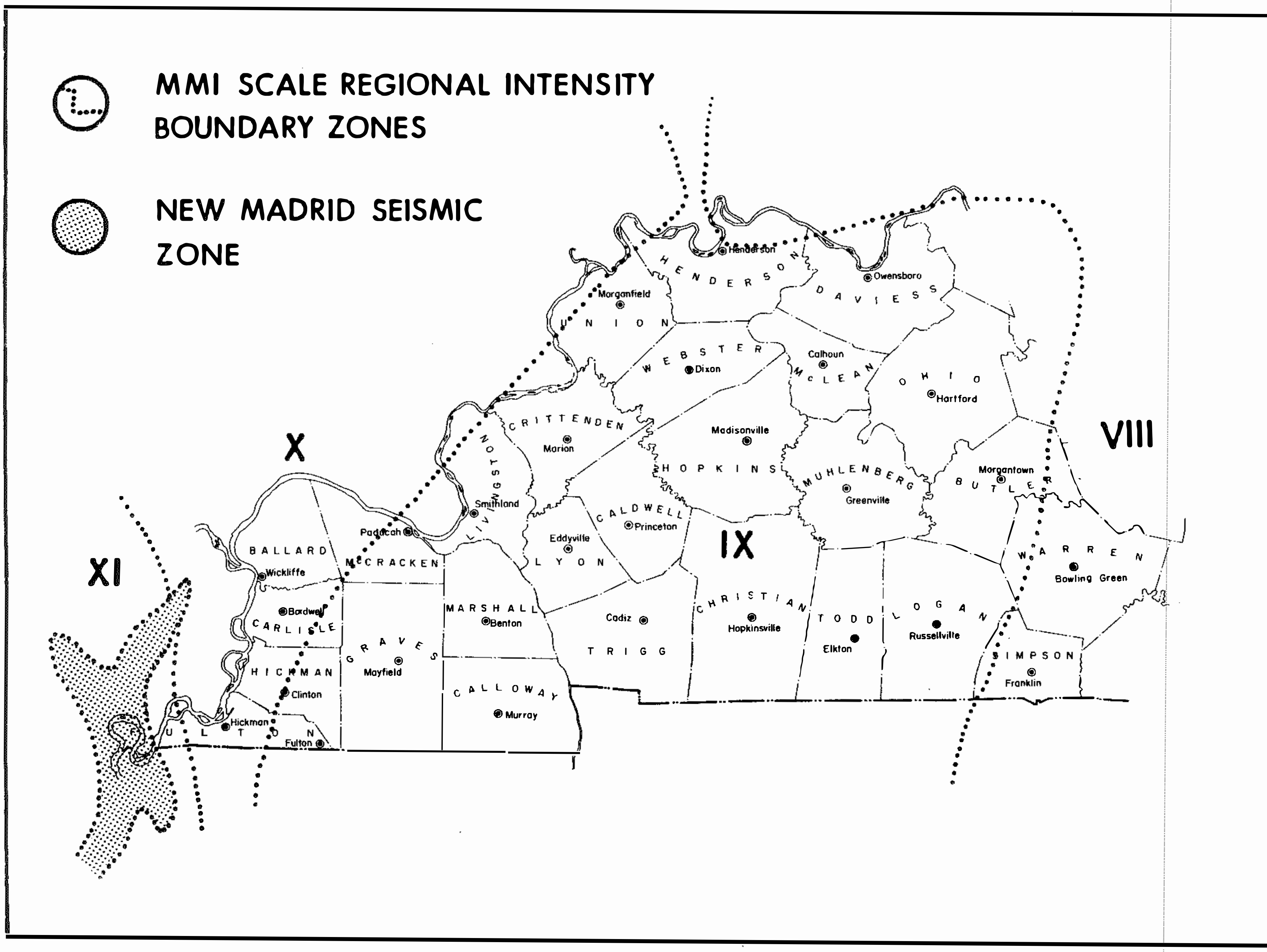


Figure 1: The twenty-six counties included in this study area.

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 gradual 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. Smal 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.

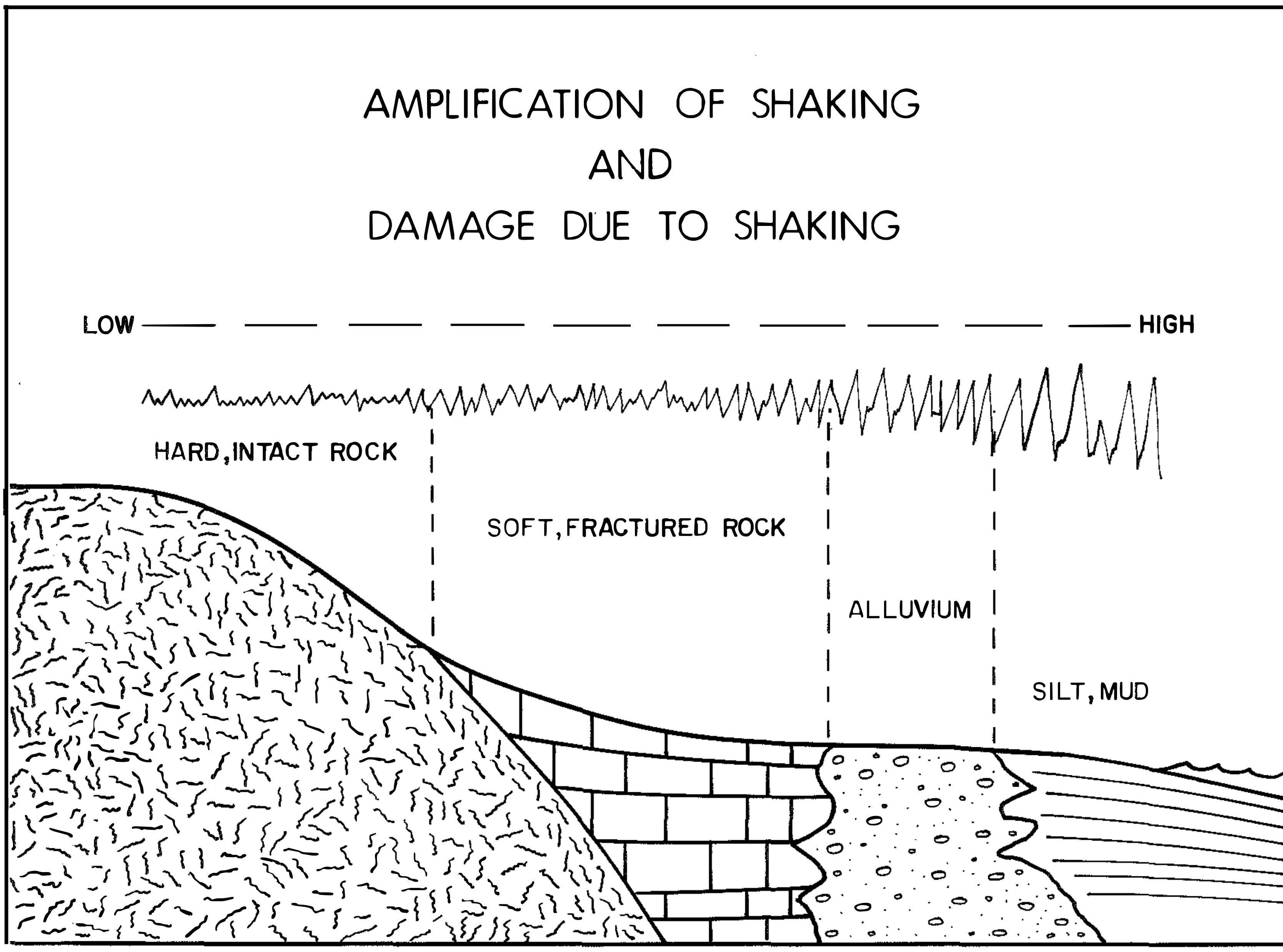


Figure 2 : Amplification of shaking in softer rock & soil during an earthquake.

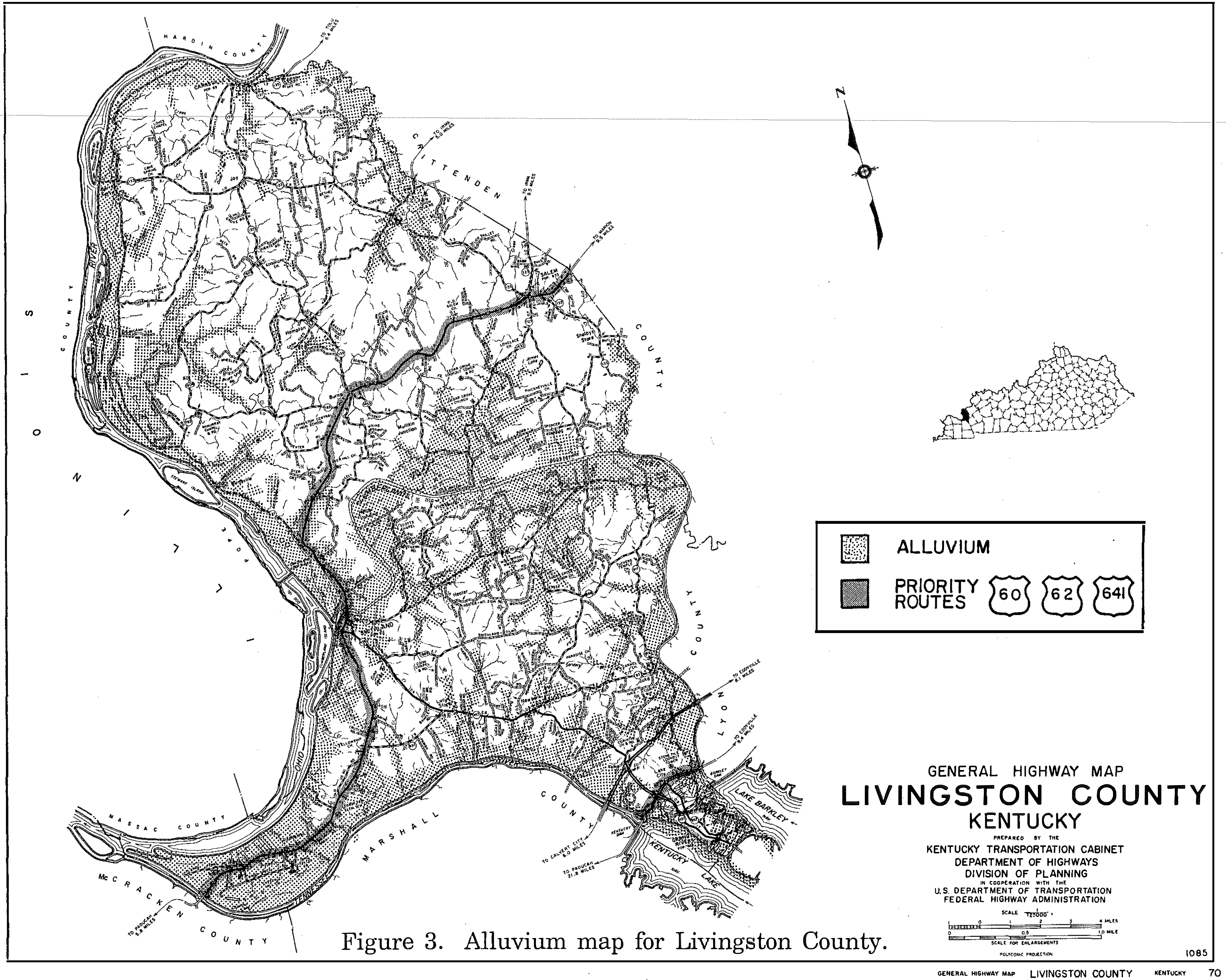


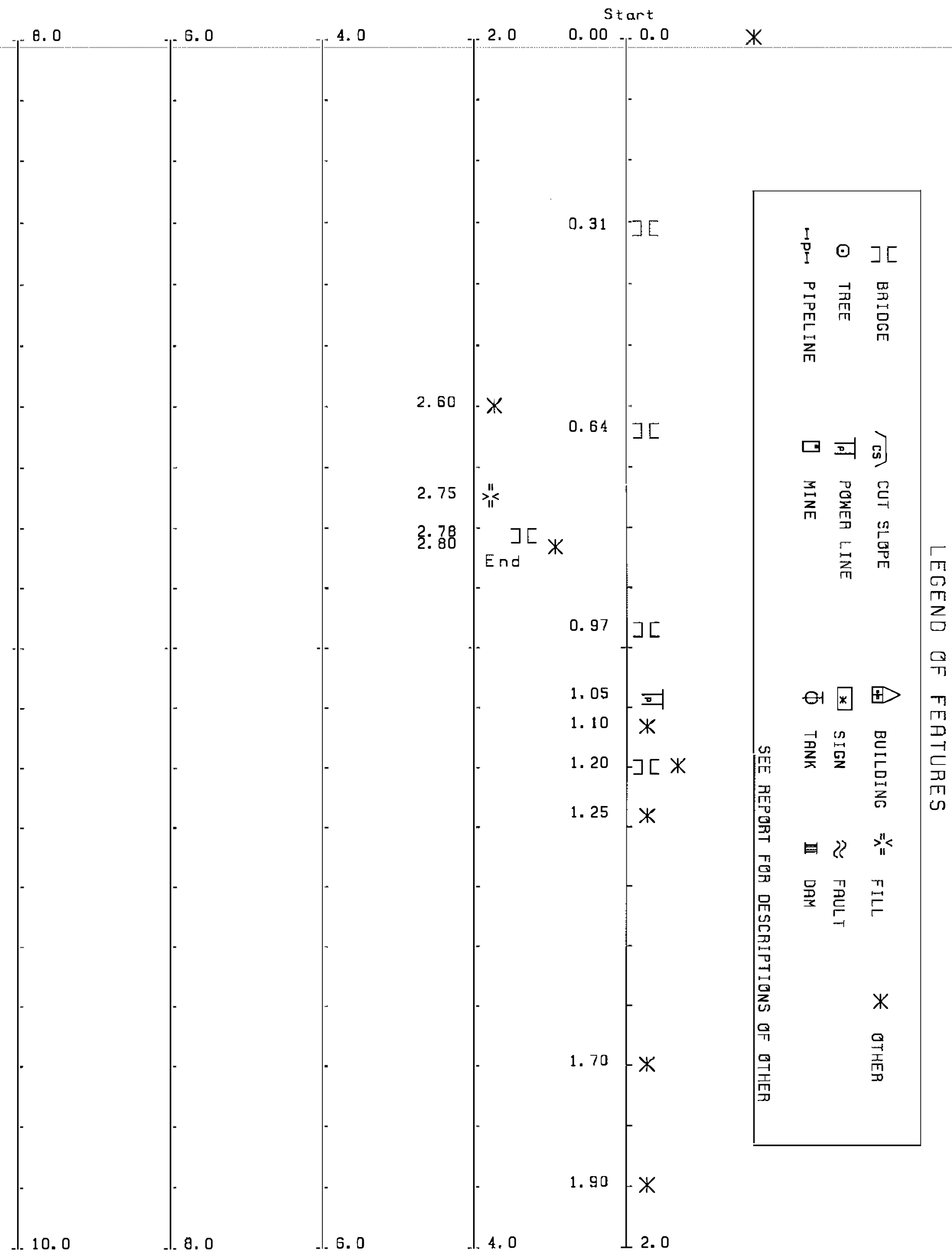
Figure 3. Alluvium map for Livingston County.

APPENDIX A

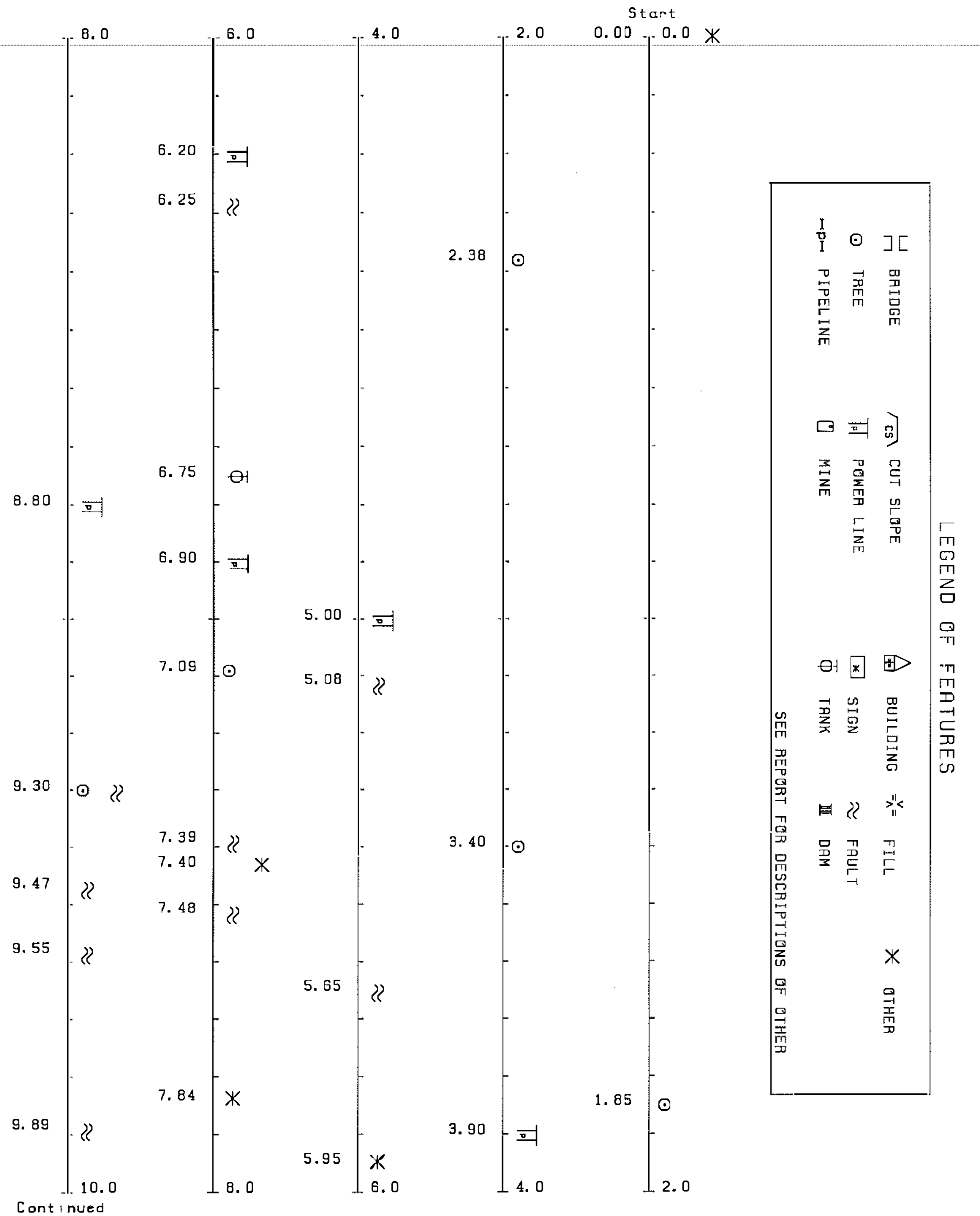
STRIP MAPS FOR LIVINGSTON COUNTY

US 62/US 641 and US 60

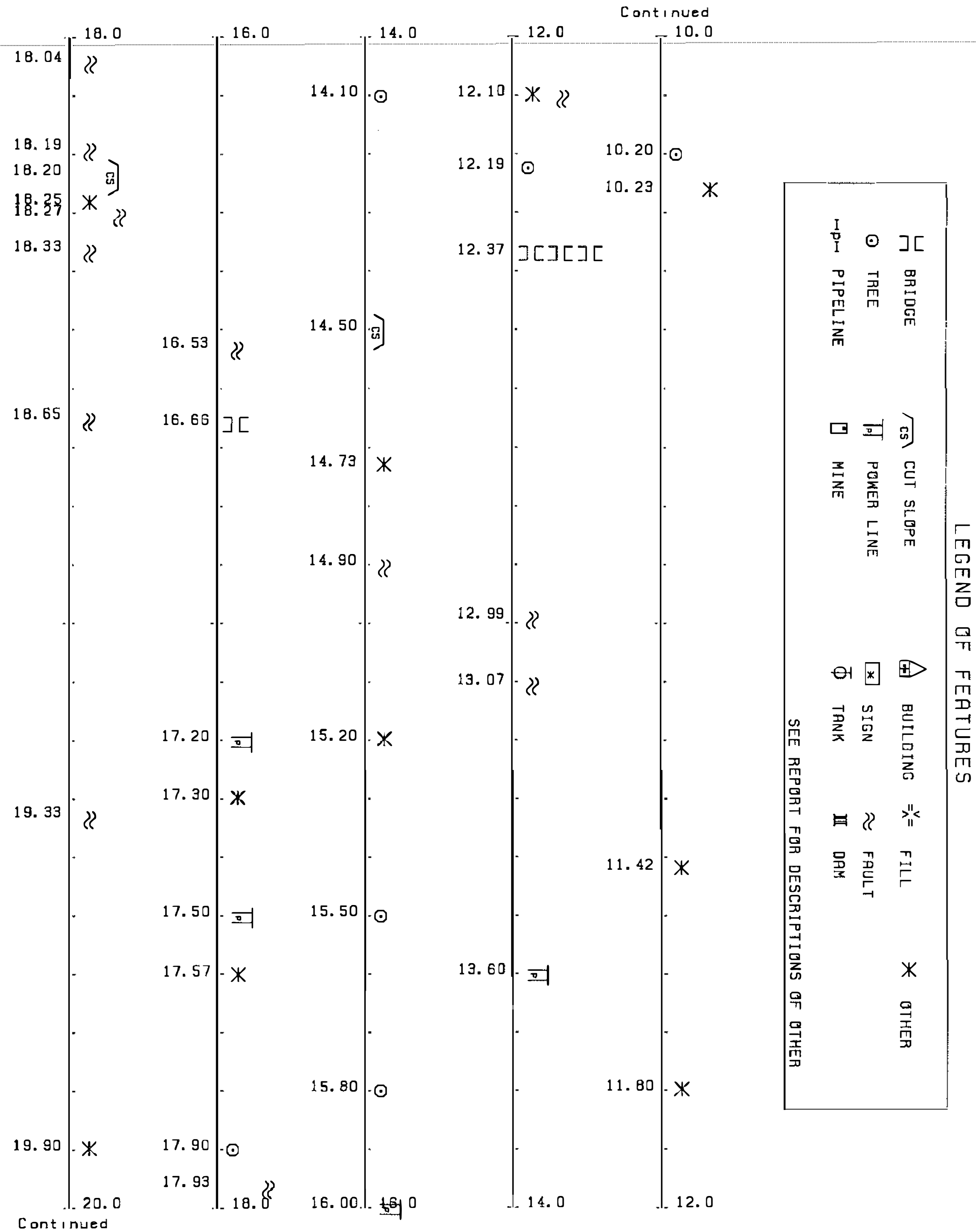
US62U641 LIVINGSTON



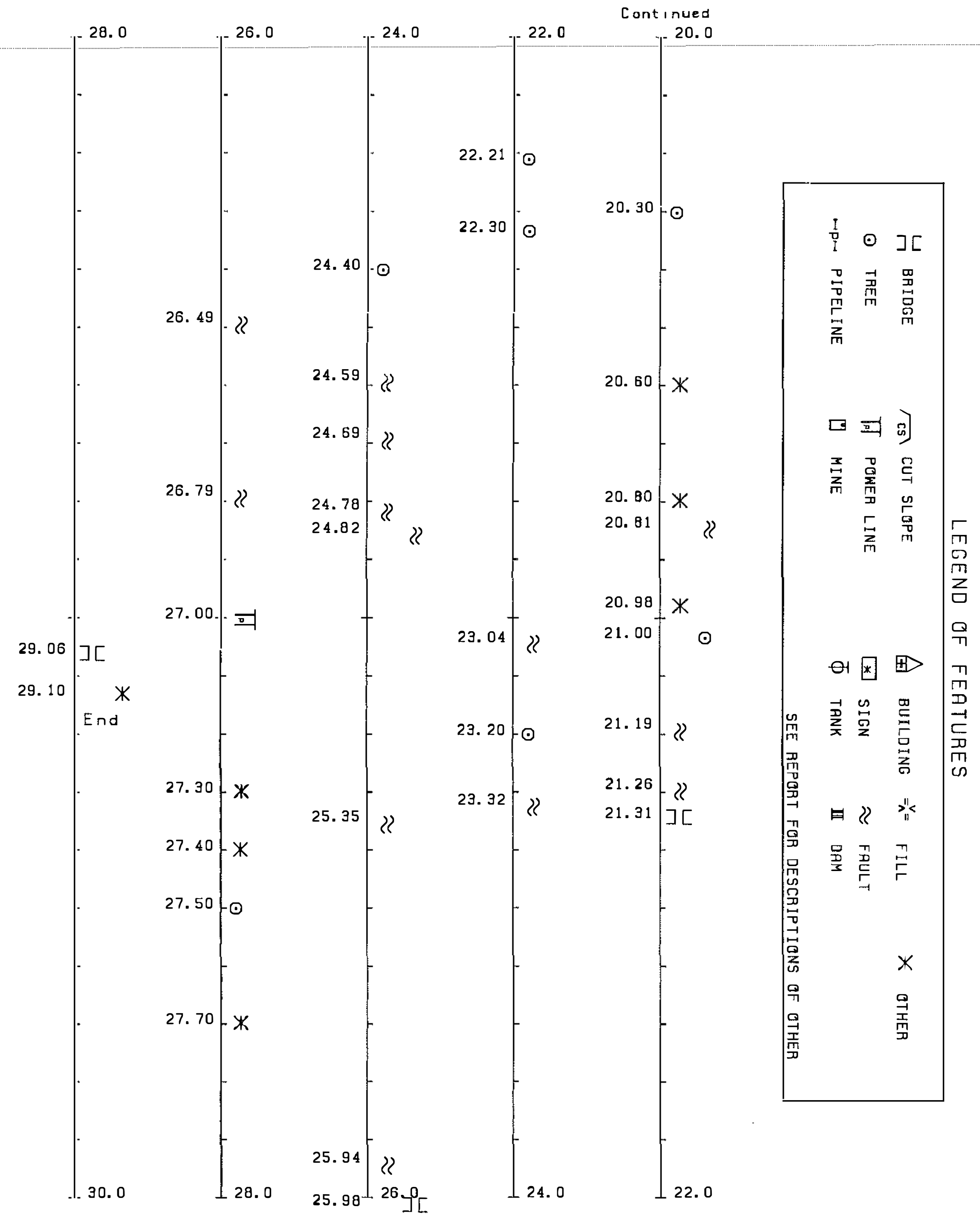
US60 LIVINGSTON



US60 LIVINGSTON



US60 LIVINGSTON



APPENDIX B

SEISMICALLY SIGNIFICANT FEATURES

Milepoint	Feature	Data
0.00	Other	Livingston Co - Marshall Co Boundary Road Surface Type - Flexible
0.31	Bridge	Number of Spans 3 Steel Girder I-Beam Bridge Type - Unknown End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 320 feet Width 28 feet Pier Type - Solid SPC Rating - C Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
0.64	Bridge	Number of Spans 5 Overpass Concrete T-Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed Pier 3 Fixed Pier 4 Fixed End 2 Fixed Deck Type - Concrete Length 390 feet Width 25 feet Pier Type - Open SPC Rating - C Surface Type - Flexible Expansion Type - Other End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown
0.97	Bridge	Number of Spans 3 Over Stream Concrete I-Beam End 1 Rocker Pier 1 Rocker Pier 2 Rocker END 2 Rocker Deck Type - Concrete Length 238 feet Width 45 feet Pier Type - Open SPC Rating - C Surface Type - Flexible Expansion Type - Poured Compression End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown
1.05	Power Line	Electrical Power Line 6 Lines Height 20 feet Steel Support Structure Unknown Volts Road Surface Type - Flexible

Milepoint	Feature	Data
1.10	Other	Junction KY 453 Heading South Road Surface Type - Flexible
1.20	Other	Two Identical Bridges - North and Southbound Road Surface Type - Flexible
1.20	Bridge	Number of Spans 3 Steel Girder I-Beam Bridge Type - Unkown End 1 Rocker Pier 1 Rocker Pier 2 Rocker END 2 Rocker Deck Type - Concrete Length 150 feet Width 25 feet Pier Type - Open SPC Rating - C Surface Type - Flexible Expansion Type - Poured Compression End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown
1.25	Other	Junction KY 453 Road Surface Type - Flexible
1.70	Other	Junction KY 952 Heading Southeast Road Surface Type - Flexible
1.90	Other	Rock Quarry (Rock Pile-Stock Pile) Road Surface Type - Flexible
2.60	Other	Junction KY 917 Heading North Road Surface Type - Flexible
2.75	Fill	Material Type - Soil Height 10 feet Side slope 2:1 Length 1,000 feet Crest 200 feet Type Fill - Other Road Surface Type - Flexible

US 62 / US 641

Milepoint	Feature	Data
2.78	Bridge	Number of Spans 1 Type Unknown Steel Truss Truss Type - Through Through Type - K-truss End 1 Fixed End 2 Fixed Deck Type - Concrete Length 1467 feet Width 25 feet Pier Type - Unknown SPC Rating - C Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
2.80	Other	Livingston Co - Lyon Co Boundary Road Surface Type - Flexible

Milepoint	Feature	Data
0.00	Other	Livingston Co - McCracken Co Boundary Road Surface Type - Flexible
1.85	Trees	Number of Trees 20 Height 70 feet Diameter 24 in. Ending Milepoint 2.00 Distance From Road 20 feet Road Surface Type - Flexible
2.38	Trees	Number of Trees 30 Height 30 feet Diameter 36 in. Ending Milepoint 2.40 Distance From Road 10 feet Road Surface Type - Flexible
3.40	Trees	Number of Trees 10 Height 70 feet Diameter 24 in. Ending Milepoint 3.50 Distance From Road 20 feet Road Surface Type - Flexible
3.90	Power Line	Electrical Power Line 3 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
5.00	Power Line	Electrical Power Line 3 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
5.08	Fault	Fault Road Surface Type - Flexible
5.65	Fault	Fault Road Surface Type - Flexible
5.95	Other	Junction CO 2238 Heading West Road Surface Type - Flexible
6.20	Power Line	Electrical Power Line 3 Lines Height 25 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible

Milepoint	Feature	Data
6.25	Fault	Fault Road Surface Type - Flexible
6.75	Tank	Water Tank Number of Tanks 1 Capacity Unknown Distance From Road 60 feet Road Surface Type - Flexible
6.90	Power Line	Electrical Power Line 3 Lines Height 25 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
7.09	Trees	Number of Trees 10 Height 45 feet Diameter 18 in. Ending Milepoint 7.10 Distance From Road 15 feet Road Surface Type - Flexible
7.39	Fault	Fault Road Surface Type - Flexible
7.40	Other	Junction CO 2238 Heading East Road Surface Type - Flexible
7.48	Fault	Fault Road Surface Type - Flexible
7.84	Other	Junction KY 937 Heading South Road Surface Type - Flexible
8.80	Power Line	Electrical Power Line 3 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
9.30	Trees	Number of Trees 50 Height 30 feet Diameter 24 in. Ending Milepoint 9.50 Distance From Road 10 feet Road Surface Type - Flexible

Milepoint	Feature	Data
9.30	Fault	Fault Road Surface Type - Flexible
9.47	Fault	Fault Road Surface Type - Flexible
9.55	Fault	Fault Road Surface Type - Flexible
9.89	Fault	Fault Road Surface Type - Flexible
10.20	Trees	Number of Trees 20 Height 60 feet Diameter 30 in. Ending Milepoint 10.30 Distance From Road 10 feet Road Surface Type - Flexible
10.23	Other	Fault Under Road (10.23 - 10.04) Milepoint Road Surface Type - Flexible
11.42	Other	Inactive Quarry Road Surface Type - Flexible
11.80	Other	Junction KY 453 Heading Southeast Road Surface Type - Flexible
12.10	Other	Junction KY 70 Heading East Road Surface Type - Flexible
12.10	Fault	Fault Road Surface Type - Flexible
12.19	Trees	Number of Trees 40 Height 45 feet Diameter 18 in. Ending Milepoint 12.20 Distance From Road 20 feet Road Surface Type - Flexible

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Milepoint	Feature	Data
12.37	Bridge	Number of Spans 8 Steel Girder I-Beam Bridge Type - Overpass End 1 Rocker Pier 1 Rocker Pier 2 Rocker Pier 3 Rocker Pier 4 Rocker Pier 5 Rocker Pier 6 Rocker Pier 7 Rocker End 2 Rocker Deck Type - Concrete Length 600 feet Width 25 feet Pier Type - Open SPC Rating - C Surface Type - Flexible Expansion Type - Finger Dam End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown
12.37	Bridge	Number of Spans 1 Overpass Steel Truss Truss Type - Through Through Type - Camel Back End 1 Rocker End 2 Rocker Deck Type - Concrete Length 500 feet Width 25 feet Pier Type - Unknown SPC Rating - C Surface Type - Flexible Expansion Type - Finger Dam End 1 Substructure - Open Abutment End 2 Substructure - Open Abutment Foundation Type - Unknown
12.37	Bridge	Number of Spans 4 Steel Girder I-Beam Bridge Type - Overpass End 1 Rocker Pier 1 Rocker Pier 2 Rocker Pier 3 Rocker End 2 Rocker Deck Type - Concrete Length 300 feet Width 25 feet Pier Type - Open SPC Rating - C Surface Type - Flexible Expansion Type - Finger Dam End 1 Substructure - Open Abutment End 2 Substructure - Stub Foundation Type - Unknown
12.99	Fault	Latrobe Fault Road Surface Type - Flexible

Milepoint	Feature	Data
13.07	Fault	Latrobe Fault Road Surface Type - Flexible
13.60	Power Line	Electrical Power Line 3 Lines Height 25 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
14.10	Trees	Number of Trees 400 Height 40 feet Diameter 36 in. Ending Milepoint 14.50 Distance From Road 10 feet Road Surface Type - Flexible
14.50	Cut Slope	Cut Slope Type - Rock Height 25 feet Length 500 feet Backslope 1:1 Road Surface Type - Flexible
14.73	Other	Inactive Quarry Road Surface Type - Flexible
14.90	Fault	Dyer Hill Fault System (14.9 - 21.3) milepoint Road Surface Type - Flexible
15.20	Other	Junction KY 137 Heading Northwest Road Surface Type - Flexible
15.50	Trees	Number of Trees 5 Height 60 feet Diameter 25 in. Ending Milepoint 15.50 Distance From Road 10 feet Road Surface Type - Flexible
15.80	Trees	Number of Trees 10 Height 45 feet Diameter 36 in. Ending Milepoint 15.80 Distance From Road 10 feet Road Surface Type - Flexible
16.00	Power Line	Electrical Power Line 3 Lines Height 25 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible

Milepoint	Feature	Data
16.53	Fault	Fault Road Surface Type - Flexible
16.66	Bridge	Number of Spans 1 Type Unknown Concrete T-Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 44 feet Width 20 feet Pier Type - Unknown SPC Rating - C Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
17.20	Power Line	Electrical Power Line 3 Lines Height 25 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
17.30	Other	Inactive Quarry Road Surface Type - Flexible
17.50	Power Line	Electrical Power Line 3 Lines Height 25 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
17.57	Other	Fault Under Road (17.51 - 17.81) milepoint Road Surface Type - Flexible
17.90	Trees	Number of Trees 200 Height 50 feet Diameter 24 in. Ending Milepoint 19.00 Distance From Road 15 feet Road Surface Type - Flexible
17.93	Fault	Fault Road Surface Type - Flexible
18.04	Fault	Fault Road Surface Type - Flexible

Milepoint	Feature	Data
18.19	Fault	Fault Road Surface Type - Flexible
18.20	Cut Slope	Cut Slope Type - Rock Height 30 feet Length 100 feet Backslope 1:1 Road Surface Type - Flexible
18.25	Other	Slope Failure Road Surface Type - Flexible
18.27	Fault	Fault Road Surface Type - Flexible
18.33	Fault	Fault Road Surface Type - Flexible
18.65	Fault	Fault Road Surface Type - Flexible
19.33	Fault	Fault Road Surface Type - Flexible
19.90	Other	Junction KY 763 Heading West Road Surface Type - Flexible
20.30	Trees	Number of Trees 7 Height 70 feet Diameter 18 in. Ending Milepoint 20.35 Distance From Road 20 feet Road Surface Type - Flexible
20.60	Other	Junction KY 135 Heading North Road Surface Type - Flexible
20.80	Other	Junction KY 1433 Heading East Road Surface Type - Flexible
20.81	Fault	Fault Road Surface Type - Flexible

Milepoint	Feature	Data
20.98	Other	City of Burma Road Surface Type - Flexible
21.00	Trees	Number of Trees 100 Height 40 feet Diameter 24 in. Ending Milepoint 21.20 Distance From Road 10 feet Road Surface Type - Flexible
21.19	Fault	Fault Road Surface Type - Flexible
21.26	Fault	Fault Road Surface Type - Flexible
21.31	Bridge	Number of Spans 1 Type Unknown Concrete T-Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 23 feet Width 22 feet Pier Type - Unknown SPC Rating - C Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
22.21	Trees	Number of Trees 5 Height 75 feet Diameter 18 in. Ending Milepoint 22.25 Distance From Road 20 feet Road Surface Type - Flexible
22.30	Trees	Number of Trees 8 Height 55 feet Diameter 18 in. Ending Milepoint 22.40 Distance From Road 10 feet Road Surface Type - Flexible
23.04	Fault	Pittsburg Fault System (23.0 - 25.3) milepoint Road Surface Type - Flexible

Milepoint	Feature	Data
23.20	Trees	Number of Trees 50 Height 60 feet Diameter 18 in. Ending Milepoint 23.40 Distance From Road 20 feet Road Surface Type - Flexible
23.32	Fault	Pittsburg Fault System Road Surface Type - Flexible
24.40	Trees	Number of Trees 50 Height 30 feet Diameter 24 in. Ending Milepoint 24.90 Distance From Road 10 feet Road Surface Type - Flexible
24.59	Fault	Pittsburg Fault System Road Surface Type - Flexible
24.69	Fault	Pittsburg Fault System Road Surface Type - Flexible
24.78	Fault	Pittsburg Fault System Road Surface Type - Flexible
24.82	Fault	Pittsburg Fault System Road Surface Type - Flexible
25.35	Fault	Sandy Creek Fault Road Surface Type - Flexible
25.94	Fault	Sandy Creek Fault Road Surface Type - Flexible
25.98	Bridge	Number of Spans 1 Type Unknown Concrete T-Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 43 feet Width 20 feet Pier Type - Unknown SPC Rating - B Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown

Milepoint	Feature	Data
26.49	Fault	Sandy Creek Fault Road Surface Type - Flexible
26.79	Fault	Babb Fault Road Surface Type - Flexible
27.00	Power Line	Electrical Power Line 3 Lines Height 25 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
27.30	Other	Junction KY 133 Heading Northwest Road Surface Type - Flexible
27.40	Other	Junction KY 723 Heading North-South Road Surface Type - Flexible
27.50	Trees	Number of Trees 40 Height 40 feet Diameter 24 in. Ending Milepoint 27.70 Distance From Road 10 feet Road Surface Type - Flexible
27.70	Other	Junction KY 133 Heading Southeast Road Surface Type - Flexible
29.06	Bridge	Number of Spans 1 Type Unknown Concrete T-Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 22 feet Width 19 feet Pier Type - Unknown SPC Rating - B Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
29.10	Other	Livingston Co - Crittenden Co Boundary Road Surface Type - Flexible