Research Report
KTC-89-14

EARTHQUAKE HAZARD MITIGATION OF TRANSPORTATION FACILITIES FOR CHRISTIAN 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. Christian 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 Christian County that should be maintained in a passable condition. The recommended routes, US 68/KY 80, US 41, US 41A and KY 91 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.

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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 Christian 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 CHRISTIAN COUNTY

Christian County is located approximately 97 miles east of the center of the New Madrid Seismic Zone. Figure 1 indicates that Christian County is located in IX band of the MMI scale. This indicates considerable damage could occur in Christian County in the event of a major earthquake.

US 68/KY 80, US 41, US 41A, and KY 91 have been designated as the priority routes for Christian County. US 68/KY 80 starts at the Christian County-Trigg County line and continues east for 21.10 miles, ending at the Christian County-Todd County line. US 41 starts in the City of Hopkinsville and continues north for 16.80 miles, ending at the Christian County-Hopkins County line. US 41A starts in the City of Hopkinsville and continues south for 13.45 miles, ending at the Kentucky-Tennessee Border. KY 91 starts in the City of Hopkinsville and continues northwest for 15.15 miles, ending at the Christian County-Caldwell County line.

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, underground mines, 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 five bridges on US 68/KY 80, three bridge on US 41, seven bridges on US 41A, and four bridges on KY 91 in Christian County. The bridges are located over:

US 68/KY 80

1. Little Sinking Fork Creek,
2. Muddy Fork Creek,
3. Little River,
4. Pennyrile Parkway, and
5. South Fork of Little River.

US 41

1. North Fork of Little River,
2. Campbells Creek, and
3. L & N Rail Road.

US 41A

1. Two I-24 bridges cross over US 41A,
2. Tennessee Central Rail Road bridge crosses over US 41A,
3. North and South bound bridges cross Rock Ridge Branch, and
4. Two Pennyrile Parkway bridges cross US 41A.

KY 91

1. Unnamed Stream,
2. Little Sinking Creek,
3. Muddy Fork, and
4. Sugar 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 Christian County are located as follows:

US 68/KY 80

1. Approach fills for the bridge over Little Sinking Fork Creek,
2. Approach fills for the bridge over Muddy Fork Creek,
3. Approach fills for the Little River bridge,

4. Approach fills for the bridge over the Pennyrile Parkway,

5. Fill 0.20 mile east of the Pennyrile Parkway, and

6. Approach fills for the bridge over the South Fork of Little River.

US 41

1. Approach fills for the bridge over the North Fork of Little River,

2. 2.70 miles south of junction KY 800 (heading West),

3. 0.20 mile south of junction KY 1296 (heading west), and

4. Approach fills for the bridge over Campbells Creek,

US 41A

1. 3.30 and 3.90 miles north of the Kentucky-Tennessee border,

2. 0.53 and 1.44 miles south of the Rail Road bridge,

3. 0.06 mile north of the Rail Road bridge,

4. 0.30 mile north of junction KY 1027,

5. 0.42 mile south of the Rock Ridge Branch bridge,

6. Approach fills for the bridges over Rock Ridge Branch, and

7. 0.54 and 0.84 mile north of junction KY 1613.

KY 91

1. Approach fills for the bridge over the stream 2.16 miles north of Hopkinsville,

2. Approach fills for the Little Sinking Creek bridge,

3. Approach fills for the Muddy Fork bridge, and

4. Approach fills for the Sugar Creek bridge.

CUT SLOPES

Most cut slopes cataloged during surveys of priority routes in Christian County were in rock and were less than 15 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.

The most critical cut slope appears to be one located on KY 91, 0.75 mile west of the Christian County-Caldwell County line.

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 68/KY 80

1. 2.30 and 2.70 miles east of the bridge over the Pennyrile Parkway.

US 41

1. 3.07 miles north of the bridge over the North Fork of Little River, and

2. 0.39 mile north of the Cambell Creek bridge.

US 41A

1. 0.50 mile north of the Kentucky-Tennessee border.

KY 91

1. 0.10 mile east of junction KY 624 (heading southwest), and

2. 0.24 mile east of the Muddy Fork bridge.

MINES

There are several types of mining-related activities in Christian 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 68/KY 80

1. 2.39 miles west of the bridge over the South Fork of Little River, and

2. 0.48 mile east of junction KY 1027 (heading south).

KY 91

1. 0.58 mile east of the Little Sinking Creek bridge, and

2. 0.79 mile east of the Sugar 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 KY 91 in Christian County, and are listed below:

KY 91

1. 0.18 mile north of the bridge over the unnamed stream, and

2. 0.38, 0.68, 1.50 and 2.16 miles north of the junction of KY 1026 (heading southwest) and KY 91.

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 Christian 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 68/KY 80

1. 0.23 mile east of the bridge over Little Sinking Fork Creek,
2. 1.72 miles east of the Muddy Fork Creek bridge, and
3. 0.78, 2.28 and 2.98 miles west of the bridge over the South Fork of Little River.

US 41

1. 1.48, 2.45, and 5.98 miles north of the bridge over the North Fork of Little River,
2. 1.24 and 2.66 miles south of the junction of KY 800 (west) and US 41, and
3. 0.21 mile north of junction of KY 1296 (west) and US 41.

US 41A

1. 1.08 and 1.68 miles north of the junction of KY 1911 and US 41A,
2. 0.22 mile south of the junction of KY 756 and US 41A, and
3. 0.10, 0.70, and 1.25 miles north of the junction of KY 1027 and US 41A.

KY 91

1. 1.00, 1.40, and 1.90 miles north of the junction of KY 1682,
2. 2.03, 1.13 and 0.03 miles south of the Little Sinking Creek bridge,
3. 0.40 mile north of the junction of KY 1349 (heading southwest) and KY 91,
4. 0.10 mile north of the junction of KY 1026 (heading southwest) and KY 91,
5. 0.90 mile south of the junction of KY 624 (heading southwest) and KY 91,
6. 0.86 and 0.26 mile south of the Muddy Fork Creek bridge,
7. 0.13 and 0.53 mile north of the Sugar Creek bridge, and
8. 0.35 mile south of the Christian County-Caldwell County line.

SINKHOLES

Christian County is located in a karst topographic region. In this region, there are numerous sinkholes, caverns, and underground streams. A major earthquake could cause additional and/or rapid subsidence along the priority routes. Sinkholes are located as follows:

1. 0.57 mile east of the Christian County-Trigg County line, and
2. 2.08 miles west of the Christian County-Todd County line.

US 41A

1. 0.43 mile north of the junction of KY 756 and US 41A.

WATER IMPOUNDMENTS

Large ponds which have large earthen dams that lie above the road surface could possibly 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 slope could cause failures in the fill during an earthquake due to the high moisture content. A large pond is located on US 41A, 0.42 mile south of the Rock Ridge Branch bridge.

ALLUVIUM

Soil maps for Christian County indicate that there are small 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 Christian 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.

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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.

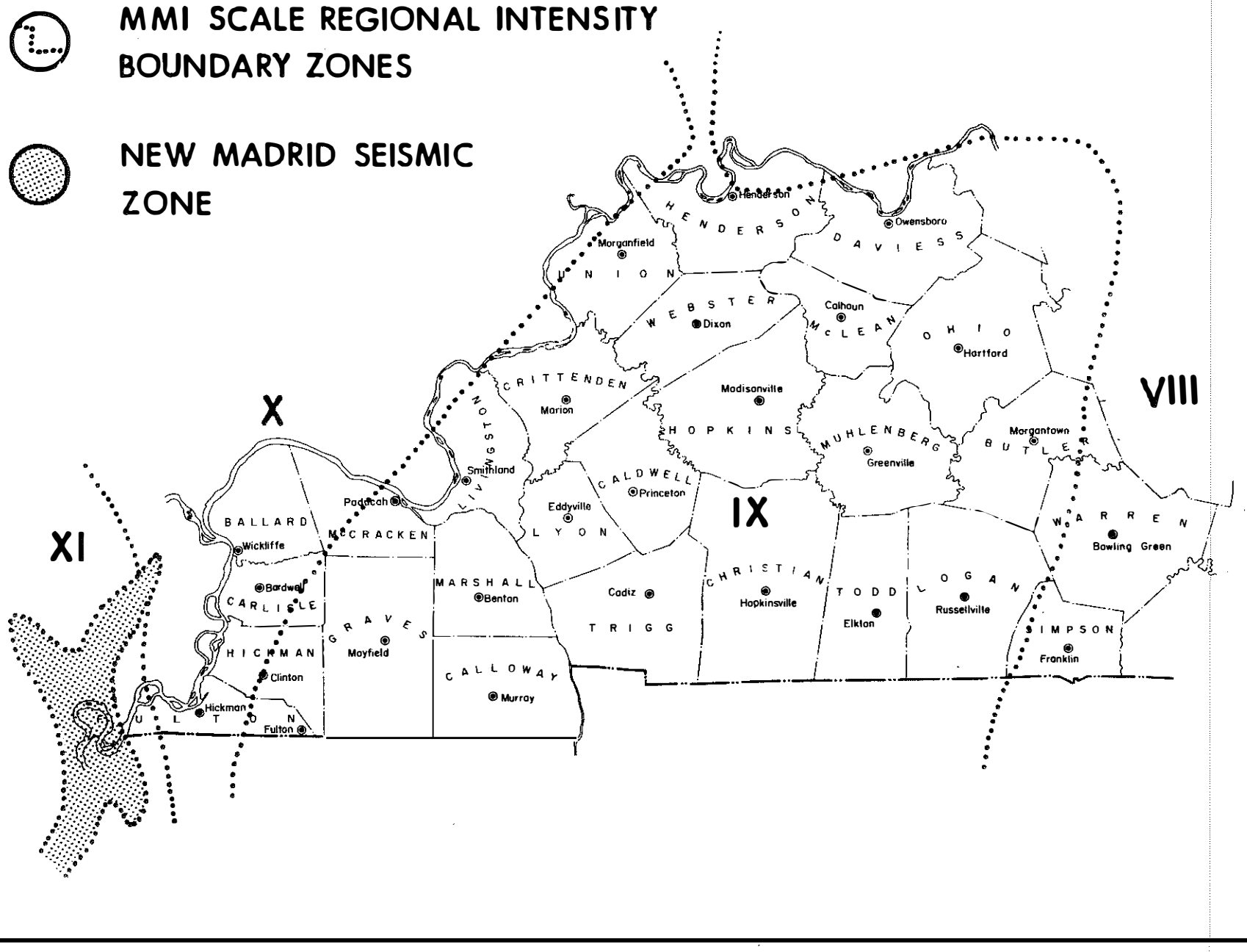


Figure 1: The twenty-six counties included in this study area.

Table 1: MODIFIED MERCALLI INTENSITY SCALE

Modified Mercalli Intensity Scale, 1956 Version

The following comments by Dr. Richter pre ede 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 effe ts 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.

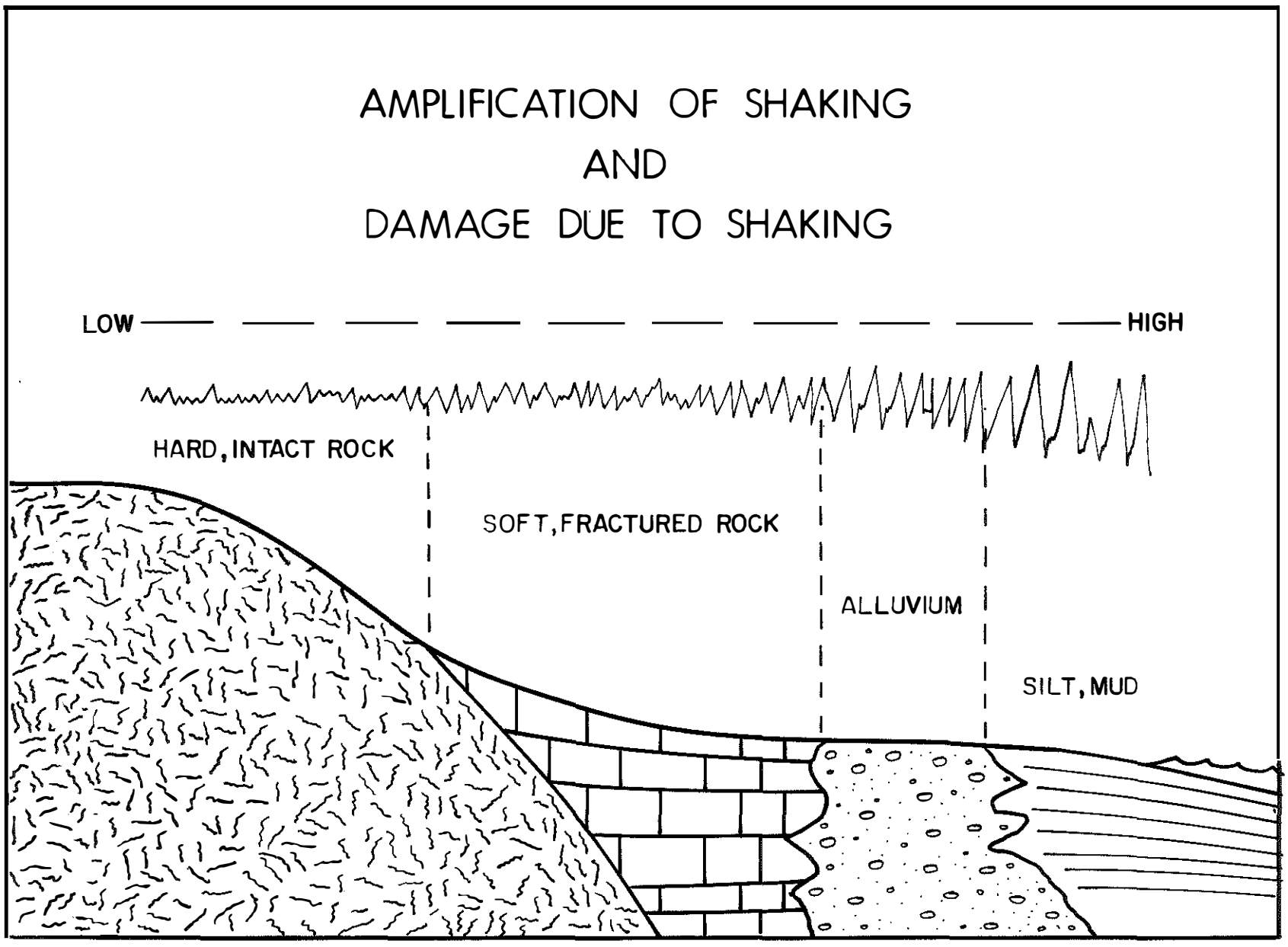


Figure 2 : Amplification of shaking in softer rock & soil during an earthquake.

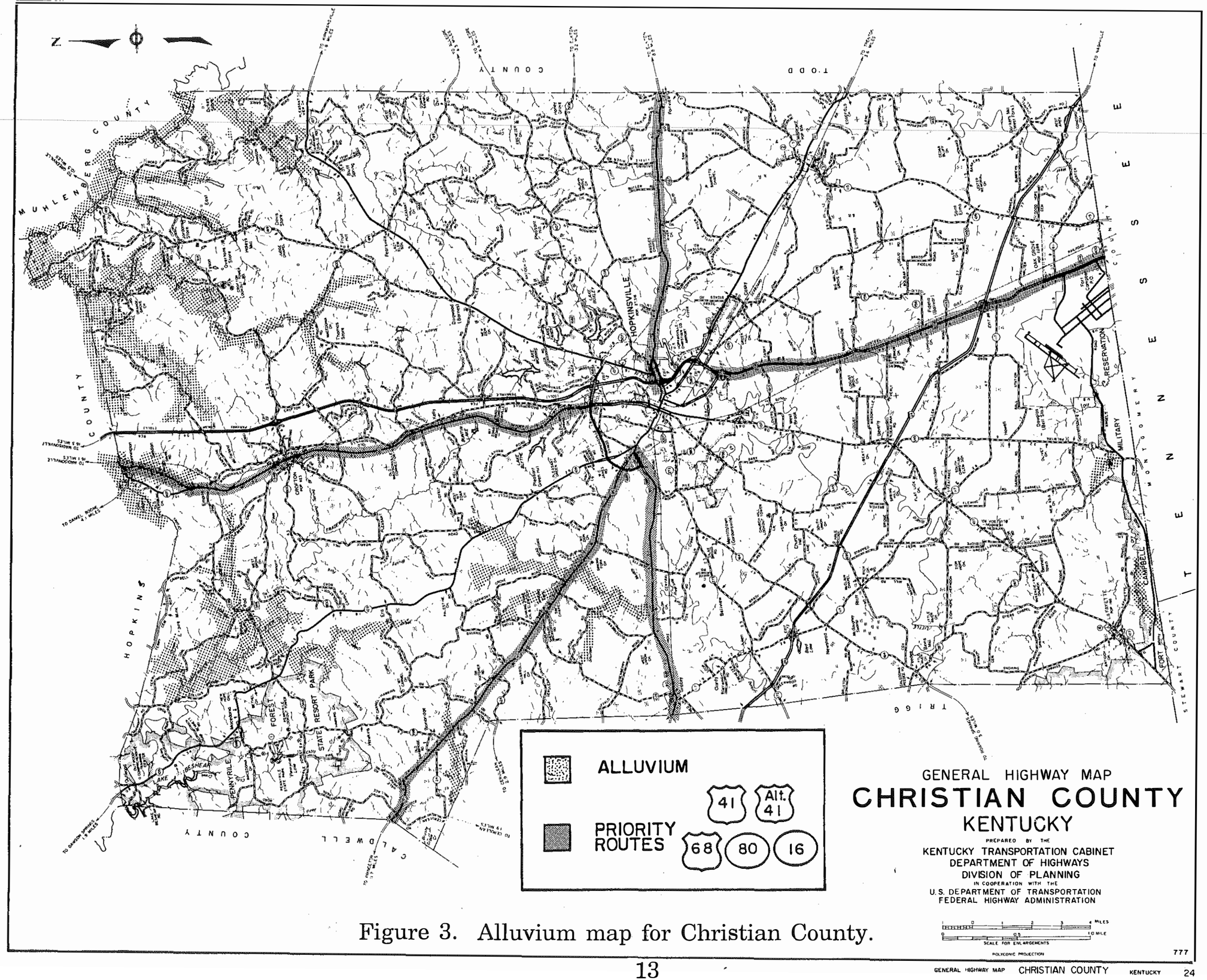


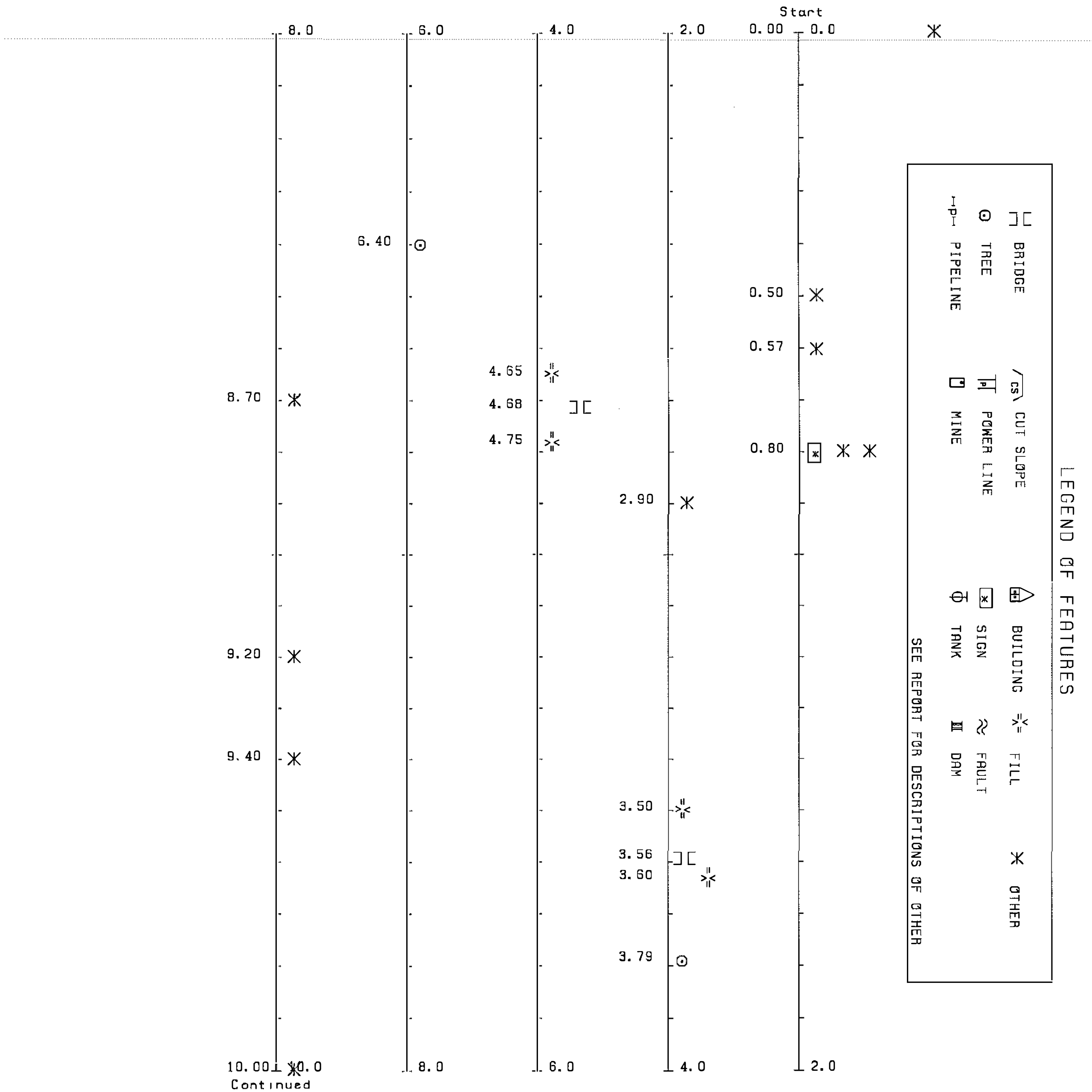
Figure 3. Alluvium map for Christian County.

APPENDIX A

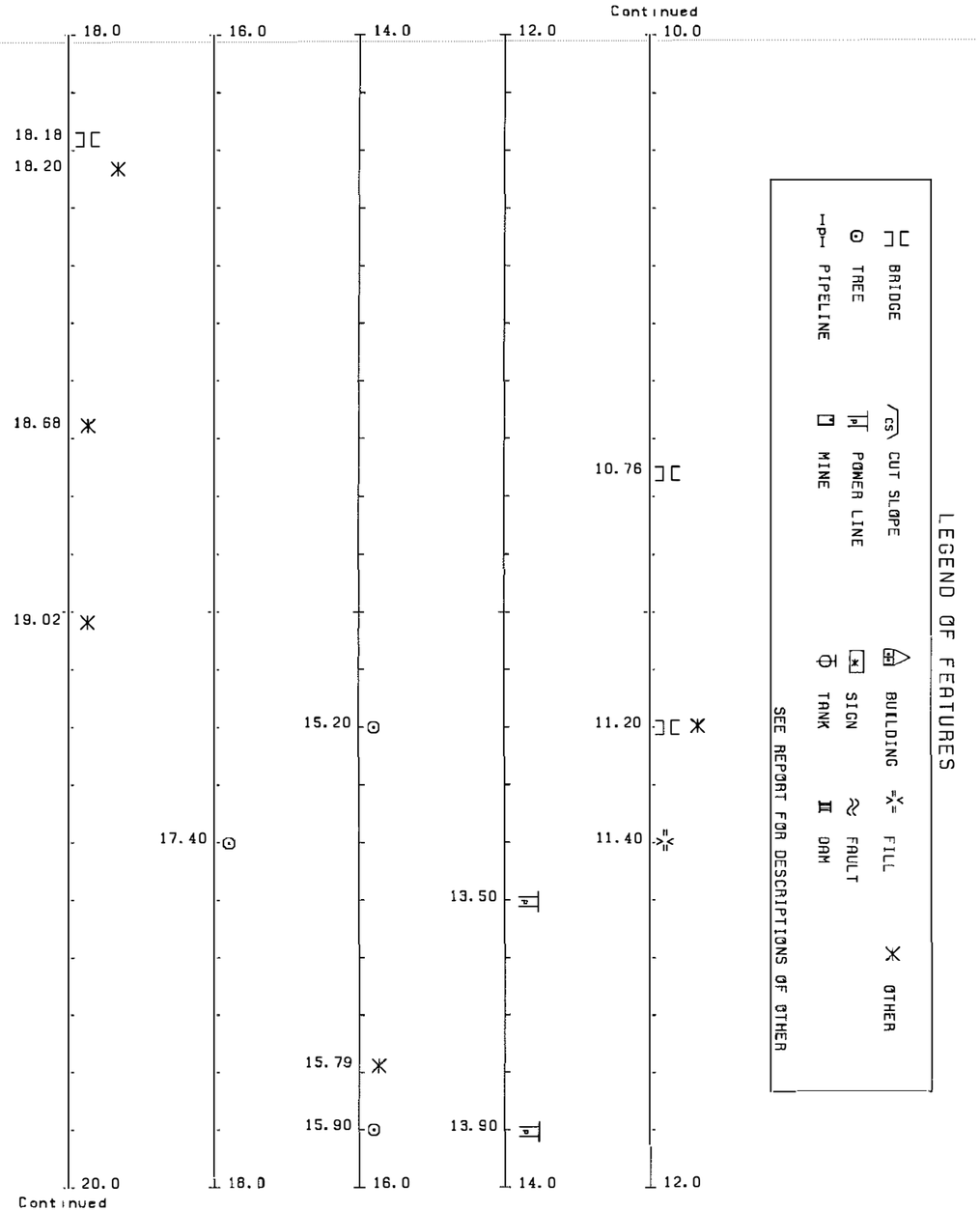
STRIP MAPS FOR CHRISTIAN COUNTY

US 68/KY 80, US 41, US 41A, AND KY 91

US68KY80 CHRISTIAN



US68KY80 CHRISTIAN

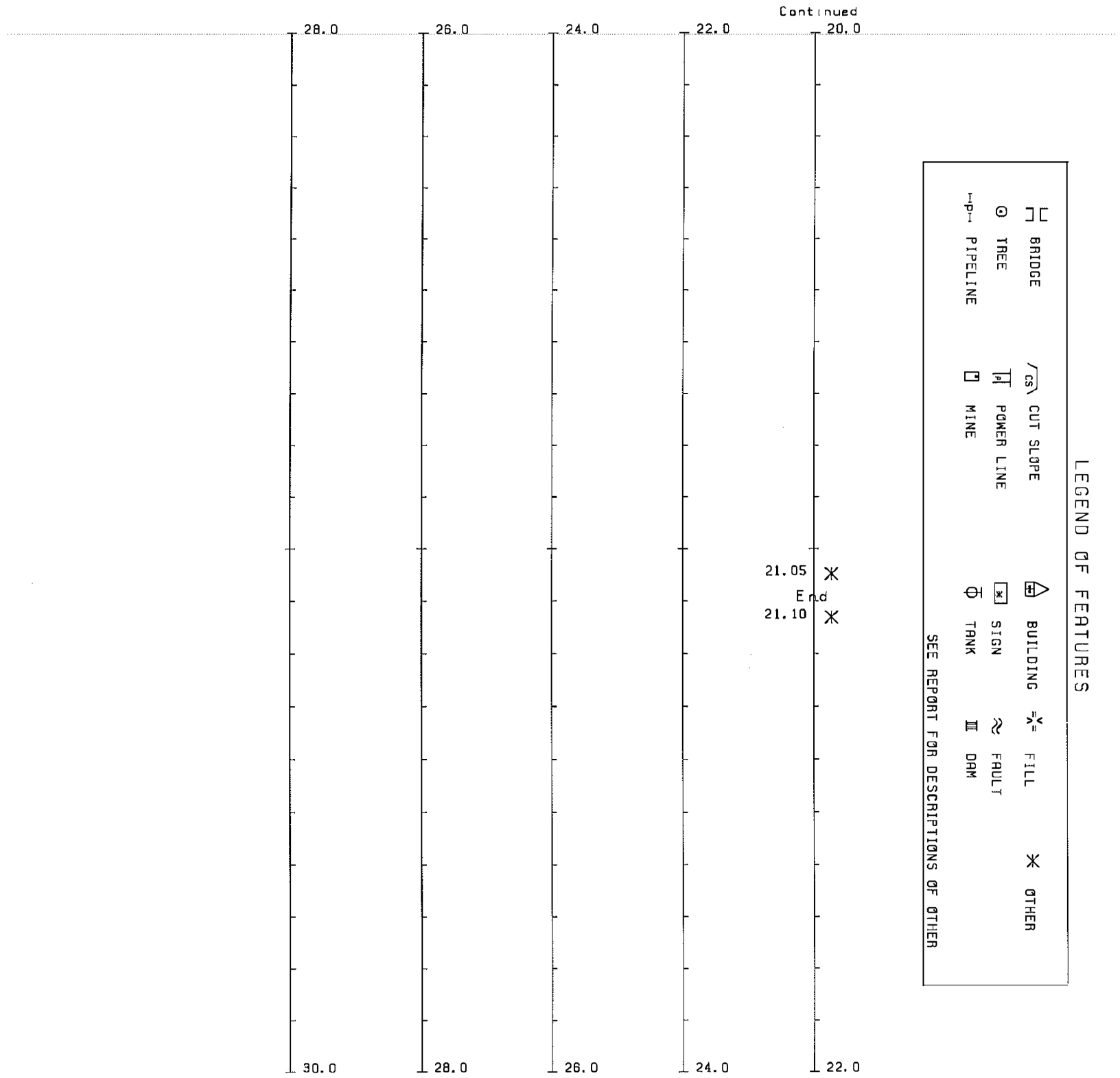


LEGEND OF FEATURES

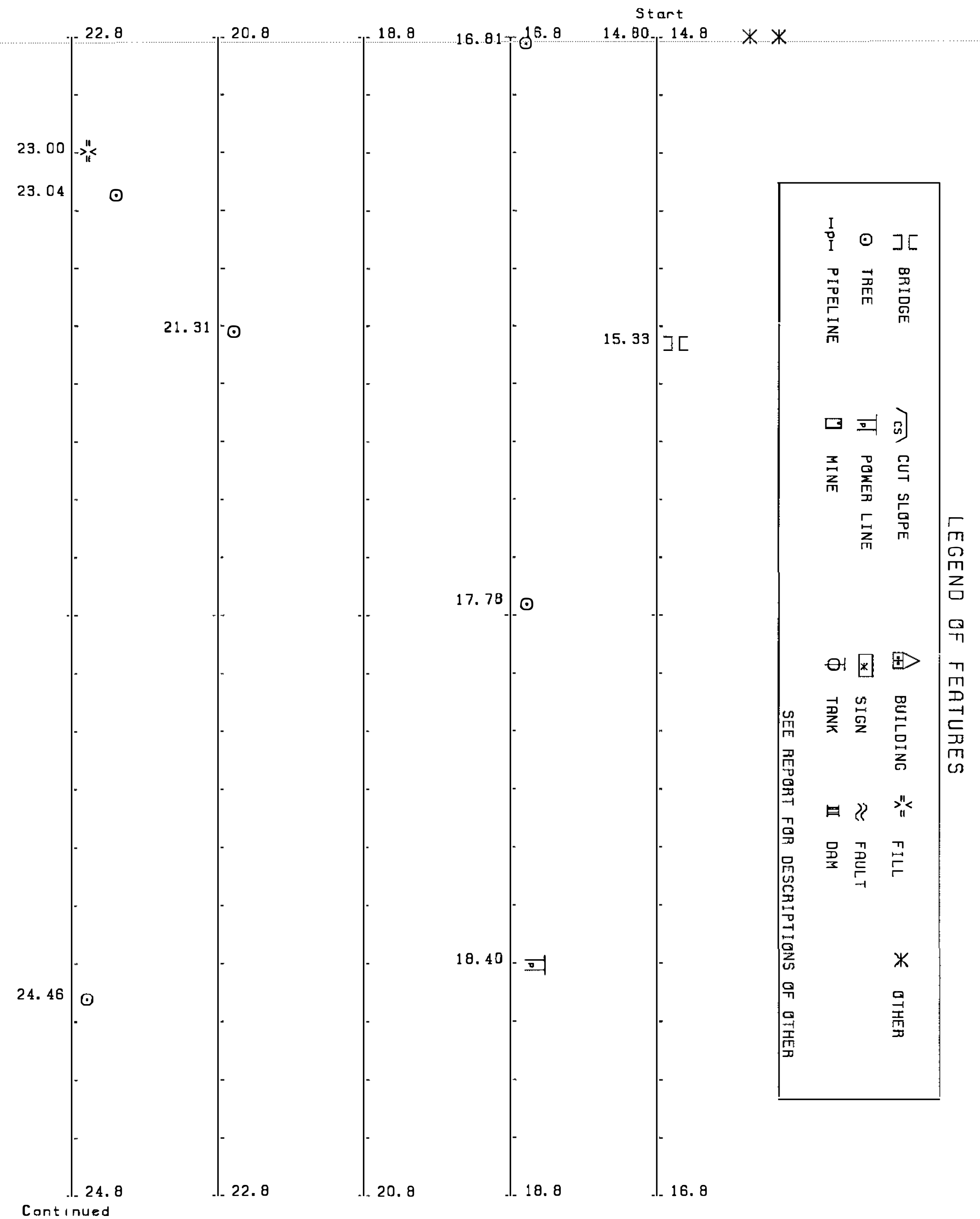
BRIDGE	CS CUT SLOPE	BUILDING	OTHER
TREE	POWER LINE	FILL	
PIPELINE	MINE	SIGN	
		FAULT	
		TANK	
		DAM	

SEE REPORT FOR DESCRIPTIONS OF OTHER

US68KY80 CHRISTIAN



US41 CHRISTIAN



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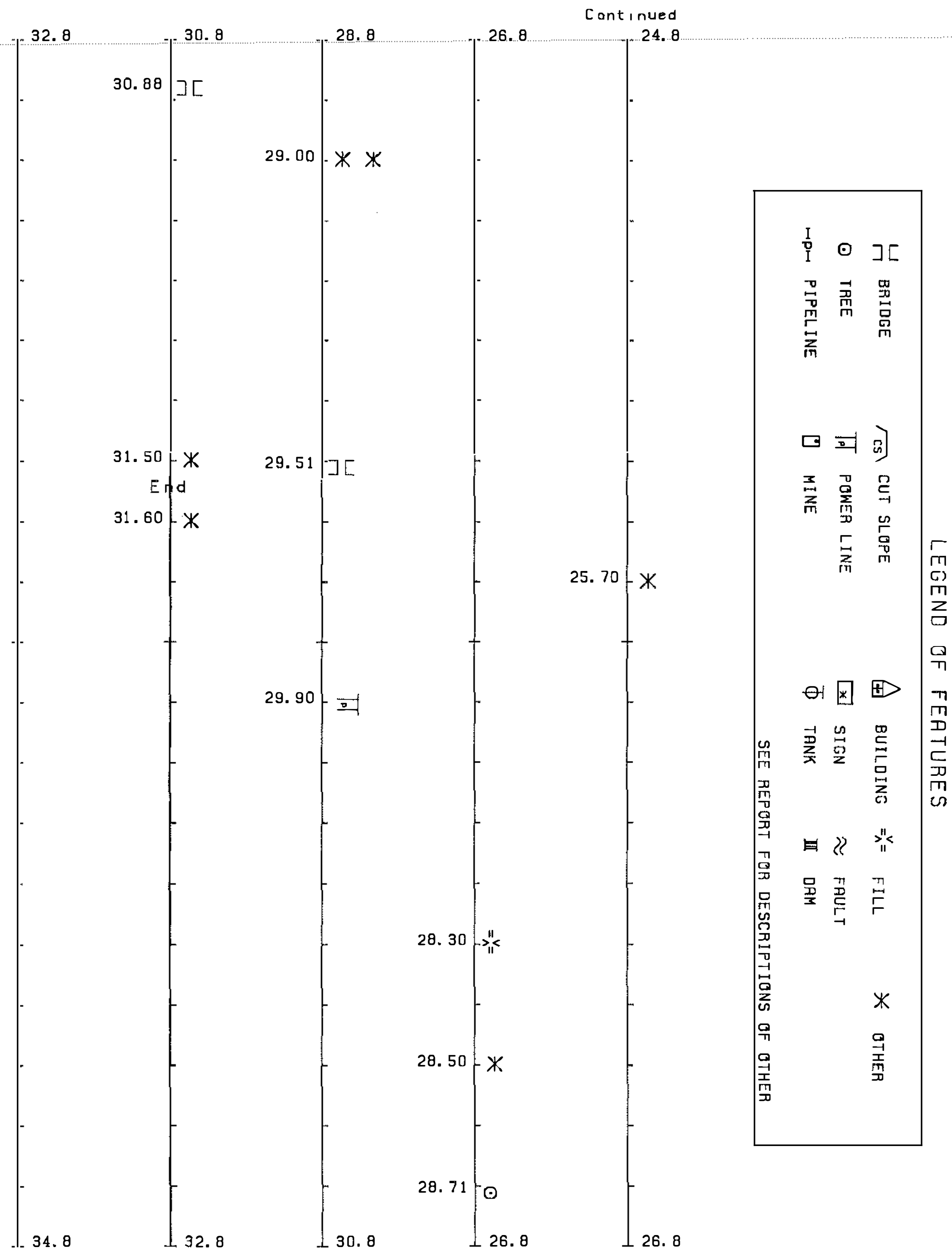
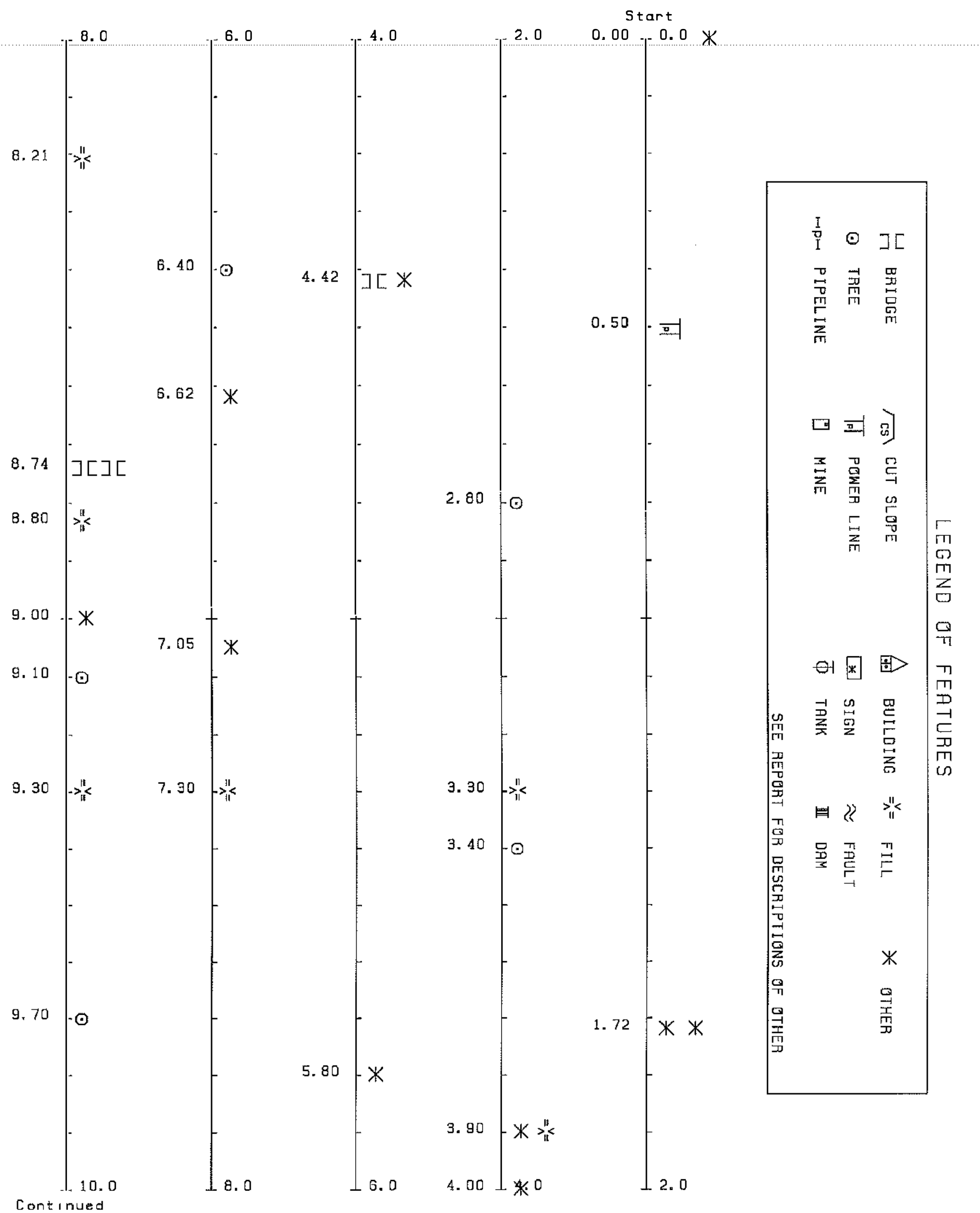


US41A CHRISTIAN



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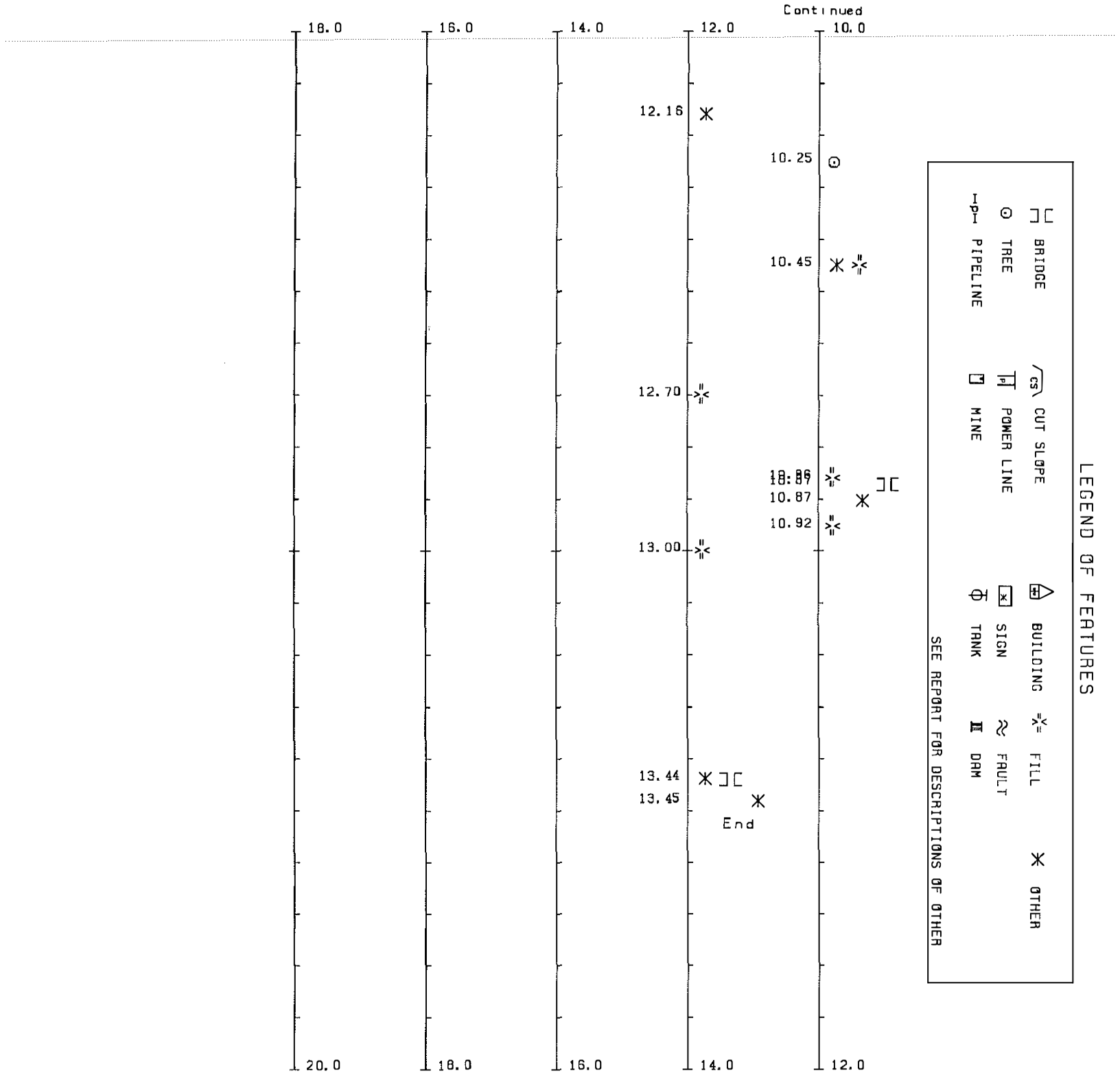
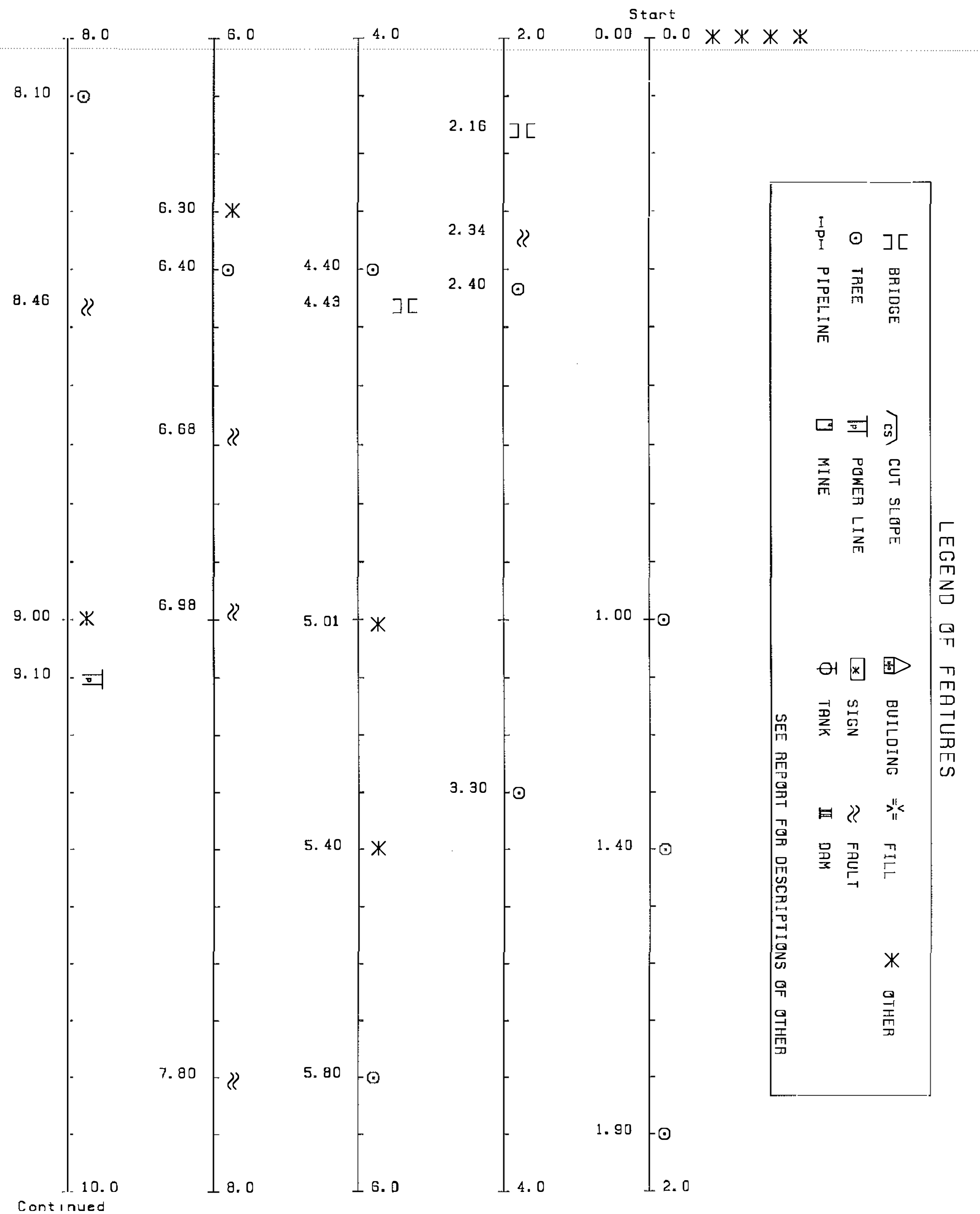


KY91 CHRISTIAN



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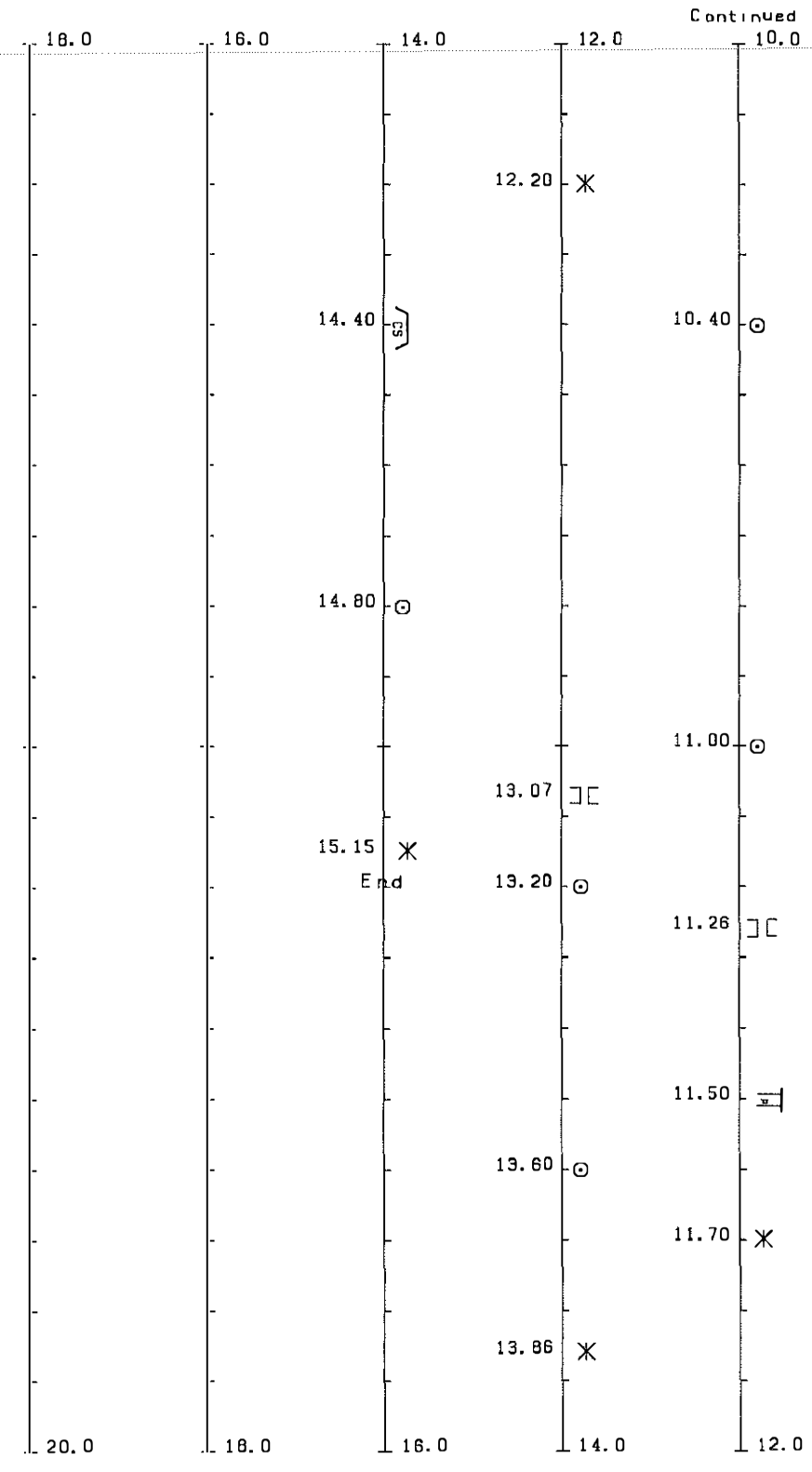

LEGEND OF FEATURES

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

SEE REPORT FOR DESCRIPTIONS OF OTHER

APPENDIX B

SEISMICALLY SIGNIFICANT FEATURES

Report by Road and Milepoint
for Christian County - Kentucky
US 68 / KY 80

Milepoint	Feature	Data
0.00	Other	Christian Co - Trigg Co Boundary Road Surface Type - Flexible
0.50	Other	Junction KY 117 Heading North Road Surface Type - Flexible
0.57	Other	Sinkhole Road Surface Type - Flexible
0.80	Sign	Roadside Sign Height 15 feet Area 5 square feet Road Surface Type - Flexible Steel Support Structure
0.80	Other	Junction KY 1026 Heading North Road Surface Type - Flexible
0.80	Other	Railroad Crossing Road Surface Type - Flexible
2.90	Other	Junction KY 1349 Heading Northeast Road Surface Type - Flexible
3.50	Fill	Material Type - Soil Height 10 feet Side slope 2:1 Length 250 feet Crest 35 feet Type Fill - Other Road Surface Type - Flexible
3.56	Bridge	Number of Spans 3 Over Stream Concrete Box Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 143 feet Width 36 feet Pier Type - Solid SPC Rating - A Surface Type - Flexible Expansion Type - Poured Compression End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Pile

Report by Road and Milepoint
for Christian County - Kentucky
US 68 / KY 80

Milepoint	Feature	Data
3.60	Fill	Material Type - Soil Height 13 feet Side slope 5:2 Length 100 feet Crest 35 feet Type Fill - Other Road Surface Type - Flexible
3.79	Trees	Number of Trees 7 Height 50 feet Diameter 24 in. Ending Milepoint 3.80 Distance From Road 20 feet Road Surface Type - Flexible
4.65	Fill	Material Type - Soil Height 8 feet Side slope 2:1 Length 200 feet Crest 35 feet Type Fill - Other Road Surface Type - Flexible
4.68	Bridge	Number of Spans 3 Over Stream Concrete Box Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 78 feet Width 36 feet Pier Type - Solid SPC Rating - A Surface Type - Flexible Expansion Type - Poured Compression End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Pile
4.75	Fill	Material Type - Soil Height 8 feet Side slope 2:1 Length 150 feet Crest 35 feet Type Fill - Other Road Surface Type - Flexible
6.40	Trees	Number of Trees 2 Height 40 feet Diameter 18 in. Ending Milepoint 6.40 Distance From Road 15 feet Road Surface Type - Flexible
8.70	Other	Junction KY 1682 Heading North Road Surface Type - Flexible

Report by Road and Milepoint
for Christian County - Kentucky
US 68 / KY 80

Milepoint	Feature	Data
9.20	Other	Junction KY 91 Heading Northwest Road Surface Type - Flexible
9.40	Other	Junction KY 109 Heading Northwest Road Surface Type - Flexible
10.00	Other	City of Hopkinsville Road Surface Type - Flexible
10.76	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 84 feet Width 37 feet Pier Type - Solid SPC Rating - A Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Rock
11.20	Bridge	Number of Spans 2 Overpass Concrete T-Beam End 1 Fixed Pier 1 Fixed End 2 Fixed Deck Type - Concrete Length 100 feet Width 75 feet Pier Type - Open SPC Rating - A Surface Type - Rigid Expansion Type - Sliding Plate End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Rock
11.20	Other	Bridge Over Pennyrile Parkway Road Surface Type - Flexible
11.40	Fill	Material Type - Soil Height 25 feet Side slope 3:2 Length 600 feet Crest 60 feet Type Fill - Other Road Surface Type - Flexible

Report by Road and Milepoint
for Christian County - Kentucky
US 68 / KY 80

Milepoint	Feature	Data
13.50	Power Line	Electrical Power Line 3 Lines Height 30 feet Steel Support Structure Unknown Volts Road Surface Type - Flexible
13.90	Power Line	Electrical Power Line 3 Lines Height 35 feet Steel Support Structure Unknown Volts Road Surface Type - Flexible
15.20	Trees	Number of Trees 3 Height 40 feet Diameter 18 in. Ending Milepoint 15.20 Distance From Road 20 feet Road Surface Type - Flexible
15.79	Other	Abandoned Quarry Road Surface Type - Flexible
15.90	Trees	Number of Trees 1 Height 50 feet Diameter 18 in. Ending Milepoint 15.90 Distance From Road 20 feet Road Surface Type - Flexible
17.40	Trees	Number of Trees 20 Height 40 feet Diameter 20 in. Ending Milepoint 17.70 Distance From Road 15 feet Road Surface Type - Flexible
18.18	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 25 feet Pier Type - Solid SPC Rating - B Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown

Report by Road and Milepoint
for Christian County - Kentucky
US 68 / KY 80

Milepoint	Feature	Data
18.20	Other	Junction KY 1027 Heading South Road Surface Type - Flexible
18.68	Other	Abandoned Quarry Road Surface Type - Flexible
19.02	Other	Sinkhole Road Surface Type - Flexible
21.05	Other	Junction KY 115 Heading South Road Surface Type - Flexible
21.10	Other	Christian Co - Todd Co Boundary Road Surface Type - Flexible

Report by Road and Milepoint
for Christian County - Kentucky
US 41

Milepoint	Feature	Data
14.80	Other	City of Hopkinsville Road Surface Type - Flexible
14.80	Other	Junction KY 1682 (Hopkinsville Bypass) Road Surface Type - Flexible
15.33	Bridge	Number of Spans 3 Over Stream Concrete Box Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 74 feet Width 28 feet Pier Type - Solid SPC Rating - A Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
16.81	Trees	Number of Trees 200 Height 35 feet Diameter 24 in. Ending Milepoint 17.10 Distance From Road 10 feet Road Surface Type - Flexible
17.78	Trees	Number of Trees 10 Height 30 feet Diameter 24 in. Ending Milepoint 17.80 Distance From Road 10 feet Road Surface Type - Flexible
18.40	Power Line	Electrical Power Line 4 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
21.31	Trees	Number of Trees 200 Height 30 feet Diameter 24 in. Ending Milepoint 21.50 Distance From Road 10 feet Road Surface Type - Flexible
23.00	Fill	Material Type - Soil Height 20 feet Side slope 2:1 Length 1111 feet Crest 30 feet Type Fill - Other Road Surface Type - Flexible

Report by Road and Milepoint
for Christian County - Kentucky
US 41

Milepoint	Feature	Data
23.04	Trees	Number of Trees 100 Height 30 feet Diameter 28 in. Ending Milepoint 23.10 Distance From Road 10 feet Road Surface Type - Flexible
24.46	Trees	Number of Trees 10 Height 50 feet Diameter 38 in. Ending Milepoint 24.50 Distance From Road 10 feet Road Surface Type - Flexible
25.70	Other	Junction KY 800 Heading West Road Surface Type - Flexible
28.30	Fill	Material Type - Soil Height 20 feet Side slope 2:1 Length 1,000 feet Crest 50 feet Type Fill - Other Road Surface Type - Flexible
28.50	Other	Junction KY 1296 Heading West Road Surface Type - Flexible
28.71	Trees	Number of Trees 300 Height 30 feet Diameter 30 in. Ending Milepoint 30.60 Distance From Road 20 feet Road Surface Type - Flexible
29.00	Other	Junction KY 407 Heading Southwest Road Surface Type - Flexible
29.00	Other	Detour Route Ends Road Surface Type - Flexible
29.51	Bridge	Number of Spans 2 Over Stream Concrete T-Beam End 1 Fixed Pier 1 Fixed End 2 Fixed Deck Type - Concrete Length 66 feet Width 24 feet Pier Type - Unknown SPC Rating - B Surface Type - Flexible Expansion Type - Other End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown

Report by Road and Milepoint
for Christian County - Kentucky
US 41

Milepoint	Feature	Data
29.90	Power Line	Electrical Power Line 3 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
30.88	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 200 feet Width 24 feet Pier Type - Open SPC Rating - B Surface Type - Flexible Expansion Type - Other End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown
31.50	Other	Junction KY 407 Heading South Road Surface Type - Flexible
31.60	Other	Christian Co - Hopkins Co Boundary Road Surface Type - Flexible

Report by Road and Milepoint
for Christian County - Kentucky
US 41A

Milepoint	Feature	Data
0.00	Other	Tennessee - Kentucky Border Road Surface Type - Flexible
0.50	Power Line	Electrical Power Line 3 Lines Height 25 feet Steel Support Structure Unknown Volts Road Surface Type - Flexible
1.72	Other	Fort Campbell Miltary Reservation Road Surface Type - Flexible
1.72	Other	Junction KY 1911 Road Surface Type - Flexible
2.80	Trees	Number of Trees 20 Height 50 feet Diameter 12 in. Ending Milepoint 2.80 Distance From Road 25 feet Road Surface Type - Flexible
3.30	Fill	Material Type - Soil Height 5 feet Side slope 3:1 Length 80 feet Crest 80 feet Type Fill - Other Road Surface Type - Flexible
3.40	Trees	Number of Trees 100 Height 60 feet Diameter 12 in. Ending Milepoint 3.50 Distance From Road 25 feet Road Surface Type - Flexible
3.90	Other	Junction KY 117 Road Surface Type - Flexible
3.90	Fill	Material Type - Soil Height 20 feet Side slope 2:1 Length 1,000 feet Crest 80 feet Type Fill - Other Road Surface Type - Flexible
4.00	Other	City of Oak Grove Road Surface Type - Flexible

Report by Road and Milepoint
for Christian County - Kentucky
US 41A

Milepoint	Feature	Data
4.43	Other	Two Interstate 24 Bridges at I-24 Junction Same Specifications for both Bridges Road Surface Type - Flexible
4.43	Bridge	Number of Spans 2 Steel Girder I-Beam Bridge Type - Overpass End 1 Fixed Pier 1 Fixed End 2 Fixed Deck Type - Concrete Length 180 feet Width 40 feet Pier Type - Unknown SPC Rating - A Surface Type - Flexible Expansion Type - Sliding Plate End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
5.80	Other	Junction KY 1453 Road Surface Type - Flexible
6.40	Trees	Number of Trees 50 Height 50 feet Diameter 12 in. Ending Milepoint 6.41 Distance From Road 25 feet Road Surface Type - Flexible
6.62	Other	Junction KY 756 Road Surface Type - Flexible
7.05	Other	Sinkhole 15 feet from Road Road Surface Type - Flexible
7.30	Fill	Material Type - Soil Height 20 feet Side slope 2:1 Length 300 feet Crest 80 feet Type Fill - Other Road Surface Type - Flexible
8.21	Fill	Material Type - Soil Height 6 feet Side slope 2:1 Length 100 feet Crest 80 feet Type Fill - Other Road Surface Type - Flexible

Report by Road and Milepoint
for Christian County - Kentucky
US 41A

Milepoint	Feature	Data
8.74	Bridge	Number of Spans 2 Steel Girder I-Beam Bridge Type - Overpass End 1 Fixed Pier 1 Fixed End 2 Fixed Deck Type - Steel Length 178 feet Width 25 feet Pier Type - Unknown SPC Rating - A Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
8.74	Bridge	Number of Spans 3 Steel Girder I-Beam Bridge Type - Overpass End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Steel Length 178 feet Width 25 feet Pier Type - Open SPC Rating - A Surface Type - Flexible Expansion Type - Other End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown
8.80	Fill	Material Type - Soil Height 5 feet Side slope 2:1 Length 50 feet Crest 80 feet Type Fill - Other Road Surface Type - Flexible
9.00	Other	Junction KY 1027 Road Surface Type - Flexible
9.10	Trees	Number of Trees 1 Height 60 feet Diameter 24 in. Ending Milepoint 0.00 Distance From Road 10 feet Road Surface Type - Flexible
9.30	Fill	Material Type - Soil Height 60 feet Side slope 2:1 Length 75 feet Crest 80 feet Type Fill - Other Road Surface Type - Flexible

Report by Road and Milepoint
for Christian County - Kentucky
US 41A

Milepoint	Feature	Data
9.70	Trees	Number of Trees 1 Height 60 feet Diameter 24 in. Ending Milepoint 0.00 Distance From Road 20 feet Road Surface Type - Flexible
10.25	Trees	Number of Trees 1 Height 60 feet Diameter 24 in. Ending Milepoint 0.00 Distance From Road 30 feet Road Surface Type - Flexible
10.45	Other	Pond (300 X 175) feet, 15 feet from Road Road Surface Type - Flexible
10.45	Fill	Material Type - Soil Height 10 feet Side slope 2:1 Length 100 feet Crest 80 feet Type Fill - Other Road Surface Type - Flexible
10.86	Fill	Material Type - Soil Height 20 feet Side slope 2:1 Length 100 feet Crest 80 feet Type Fill - Other Road Surface Type - Flexible
10.87	Other	Two Identical Bridges - North and Southbound Road Surface Type - Flexible
10.87	Bridge	Number of Spans 2 Type Unknown Concrete T-Beam End 1 Fixed Pier 1 Fixed End 2 Fixed Deck Type - Concrete Length 86 feet Width 30 feet Pier Type - Unknown SPC Rating - B Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
10.92	Fill	Material Type - Soil Height 25 feet Side slope 2:1 Length 100 feet Crest 80 feet Type Fill - Other Road Surface Type - Flexible

Report by Road and Milepoint
for Christian County - Kentucky
US 41A

Milepoint	Feature	Data
12.16	Other	Junction KY 1613 Road Surface Type - Flexible
12.70	Fill	Material Type - Soil Height 15 feet Side slope 2:1 Length 100 feet Crest 80 feet Type Fill - Other Road Surface Type - Flexible
13.00	Fill	Material Type - Soil Height 5 feet Side slope 3:1 Length 70 feet Crest 80 feet Type Fill - Other Road Surface Type - Flexible
13.44	Other	Two Identical Bridges - North and Southbound Pennryrile Parkway Junction Road Surface Type - Flexible
13.44	Bridge	Number of Spans 2 Steel Girder I-Beam Bridge Type - Overpass End 1 Rocker Pier 1 Rocker End 2 Rocker Deck Type - Concrete Length 200 feet Width 48 feet Pier Type - Unknown SPC Rating - A Surface Type - Flexible Expansion Type - Sliding Plate End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
13.45	Other	Hopkinsville City Limits Road Surface Type - Flexible

Report by Road and Milepoint
for Christian County - Kentucky
KY 91

Milepoint	Feature	Data
0.00	Other	Junction US 68/KY 80 Heading East-West Road Surface Type - Flexible
0.00	Other	City of Hopkinsville Road Surface Type - Flexible
0.00	Other	Junction KY 1682 Road Surface Type - Flexible
0.00	Other	Begin KY 91 Quake Study Road Surface Type - Flexible
1.00	Trees	Number of Trees 20 Height 40 feet Diameter 28 in. Ending Milepoint 1.10 Distance From Road 15 feet Road Surface Type - Flexible
1.40	Trees	Number of Trees 100 Height 35 feet Diameter 28 in. Ending Milepoint 1.50 Distance From Road 20 feet Road Surface Type - Flexible
1.90	Trees	Number of Trees 40 Height 45 feet Diameter 28 in. Ending Milepoint 2.10 Distance From Road 10 feet Road Surface Type - Flexible
2.16	Bridge	Number of Spans 1 Type Unknown Concrete T-Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 33 feet Width 23 feet Pier Type - Unknown SPC Rating - A Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown

Report by Road and Milepoint
for Christian County - Kentucky

KY 91

Milepoint	Feature	Data
2.34	Fault	Fault Road Surface Type - Flexible
2.40	Trees	Number of Trees 500 Height 30 feet Diameter 18 in. Ending Milepoint 4.30 Distance From Road 10 feet Road Surface Type - Flexible
3.30	Trees	Number of Trees 40 Height 45 feet Diameter 28 in. Ending Milepoint 3.50 Distance From Road 10 feet Road Surface Type - Flexible
4.40	Trees	Number of Trees 20 Height 50 feet Diameter 30 in. Ending Milepoint 4.50 Distance From Road 10 feet Road Surface Type - Flexible
4.43	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 117 feet Width 23 feet Pier Type - Solid SPC Rating - B Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
5.01	Other	Abandoned Quarry Road Surface Type - Flexible
5.40	Other	Junction KY 1349 Heading Southwest Road Surface Type - Flexible
5.80	Trees	Number of Trees 200 Height 50 feet Diameter 24 in. Ending Milepoint 6.00 Distance From Road 20 feet Road Surface Type - Flexible

Report by Road and Milepoint
for Christian County - Kentucky
KY 91

Milepoint	Feature	Data
6.30	Other	Junction KY 1026 Heading Southwest Road Surface Type - Flexible
6.40	Trees	Number of Trees 200 Height 50 feet Diameter 36 in. Ending Milepoint 6.70 Distance From Road 15 feet Road Surface Type - Flexible
6.68	Fault	Fault Road Surface Type - Flexible
6.98	Fault	Fault Road Surface Type - Flexible
7.80	Fault	Fault Road Surface Type - Flexible
8.10	Trees	Number of Trees 20 Height 55 feet Diameter 36 in. Ending Milepoint 8.12 Distance From Road 10 feet Road Surface Type - Flexible
8.46	Fault	Fault Road Surface Type - Flexible
9.00	Other	Junction KY 624 Heading Southwest Road Surface Type - Flexible
9.10	Power Line	Electrical Power Line 3 Lines Height 35 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
10.40	Trees	Number of Trees 5 Height 60 feet Diameter 36 in. Ending Milepoint 10.60 Distance From Road 20 feet Road Surface Type - Flexible

Report by Road and Milepoint
for Christian County - Kentucky
KY 91

Milepoint	Feature	Data
11.00	Trees	Number of Trees 100 Height 30 feet Diameter 24 in. Ending Milepoint 11.50 Distance From Road 15 feet Road Surface Type - Flexible
11.26	Bridge	Number of Spans 2 Over Stream Concrete T-Beam End 1 Fixed Pier 1 Fixed End 2 Fixed Deck Type - Concrete Length 86 feet Width 23 feet Pier Type - Unknown SPC Rating - B Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
11.50	Power Line	Electrical Power Line 6 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
11.70	Other	Junction KY 398 Heading North Road Surface Type - Flexible
12.20	Other	Junction KY 124 Heading West Road Surface Type - Flexible
13.07	Bridge	Number of Spans 2 Over Stream Concrete T-Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 57 feet Width 23 feet Pier Type - Unknown SPC Rating - A Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
13.20	Trees	Number of Trees 2 Height 50 feet Diameter 28 in. Ending Milepoint 13.20 Distance From Road 20 feet Road Surface Type - Flexible

Report by Road and Milepoint
for Christian County - Kentucky
KY 91

Milepoint	Feature	Data
13.60	Trees	Number of Trees 100 Height 30 feet Diameter 24 in. Ending Milepoint 13.70 Distance From Road 20 feet Road Surface Type - Flexible
13.86	Other	Abandoned Limestone Mine or Quarry Road Surface Type - Flexible
14.40	Cut Slope	Cut Slope Type - Rock Height 10 feet Length 50 feet Backslope 1:1 Road Surface Type - Flexible
14.80	Trees	Number of Trees 9 Height 40 feet Diameter 24 in. Ending Milepoint 14.82 Distance From Road 15 feet Road Surface Type - Flexible
15.15	Other	Christian Co - Caldwell Co Boundary Road Surface Type - Flexible