Earthquake Hazard Mitigation of Transportation Facilities for Hopkins County

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EARTHQUAKE HAZARD MITIGATION OF TRANSPORTATION FACILITIES FOR HOPKINS COUNTY

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in cooperation with
Transportation Cabinet
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and

Federal Highway Administration
U.S. Department of Transportation

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**Abstract**

Concern has grown in recent years over the seismic activity of the New Madrid seismic zone in Western Kentucky. Hopkins 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 Hopkins County that should be maintained in a passable condition. The recommended routes, US 41, US 41A, US 62, KY 109, and KY 1751 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.
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 Hopkins 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 westernmost 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
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 ROUTES IN HOPKINS COUNTY**

Hopkins County is located approximately 100 miles northeast of the center of the New Madrid Seismic Zone. Figure 1 indicates that Hopkins County is in the IX band of the MMI scale. This indicates considerable damage could occur in Hopkins County in the event of a major earthquake.

US 41, US 41A, US 62, KY 109, and KY 1751 have been designated as the priority routes in Hopkins County. There are two basic routes in the county with KY 109 and US 62 comprising the western route and US 41, US 41A, and KY 1751 comprising the eastern route.

The western route begins with US 62 at the Caldwell County - Hopkins County line and travels east 1.65 miles to the KY 109 junction. The route then continues north with KY 109 18.30 miles to the Webster County line.

The eastern route begins with US 41 at the Christian County - Hopkins County line and continues 1.67 miles to the US 41A junction. The route follows US 41A 16.10 miles to a junction with KY 1751 in Madisonville. KY 1751 continues 1.70 miles to a junction where US 41 resumes as the priority route and continues 8.40 miles to the Webster County line.

A number of features along these priority routes could potentially hamper rescue and relief efforts. These features included bridges, soil fills, cut slopes, gas pipelines, power lines, power lines, water towers, geologic faults, large trees, mines, water impoundments, 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 two bridges on US 62, six on KY 109, ten on US 41A, one on KY 1751 and one on US 41. The bridges are located at:

**US 62**
1. Drainage ditch, and
2. Cane Creek.

**KY 109**
1. Western Kentucky Parkway,  
2. Illinois Central Gulf Railroad,  
3. Illinois Central Gulf Railroad,  
4. Lick Creek,  
5. Clear Creek, and
6. Weirs Creek.

**US 41A**
1. Louisville and Nashville Railroad,  
2. Crab Orchard Creek,  
3. Pleasant Run Creek,  
4. Western Kentucky Parkway,  
5. Louisville and Nashville Railroad,  
6. Louisville and Nashville Railroad,  
7. Hunting Branch,  
8. Illinois Central Gulf Railroad,  
9. Louisville and Nashville Railroad, and  
10. Louisville and Nashville Railroad.

**KY 1751**
1. Louisville and Nashville Railroad.

**US 41**
1. Otter Creek.

Current research is 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 the priority routes Hopkins County are located as follows:

**US 62**
1. Approach fills for the drainage ditch bridge, and
2. Approach fills for the Cany Creek bridge.

**KY 109**
1. Approach fills for the Western Kentucky Parkway bridge,
2. Approach fills for the Illinois Central Gulf Railroad bridge,
3. Approach fills for the Illinois Central Gulf bridge,
4. Approach fills for the Lick Creek bridge,
5. Approach fills for the Clear Creek bridge, and
6. Approach fills for the Weirs Creek bridge.

**US 41A**
1. Approach fills for the Louisville and Nashville Railroad.
2. Approach fills for the Crab Orchard Creek bridge,
3. Approach fills for the Pleasant Run Creek bridge,
4. Approach fills for the Western Kentucky Parkway bridges,
5. Approach fills for the Louisville and Nashville Railroad bridge,
6. Approach fills for the Louisville and Nashville bridge,
7. 0.30 mile north of KY 112 junction,
8. Approach fills for the Hunting Branch bridge,
9. Approach fills for the Illinois Central Gulf Railroad bridge,
10. Approach fills for the Louisville and Nashville Railroad bridge, and
11. Approach fills for the Louisville and Nashville Railroad bridge.

**KY 1751**
1. Approach fills for the Louisville and Nashville Railroad bridge.

**US 41**
1. Approach fills for the Otter Creek bridge.

**CUT SLOPE**

Two cut slopes were cataloged during surveys of the priority routes in Hopkins County. Should a cut slope fail, both lanes of the roadway could be closed. Cut slopes that have a history of failure and those that have
steep slopes should be considered as problem areas. The cut slopes are located at:

**KY 109**
1. 0.19 mile south of the Weirs Creek bridge on KY 109.

**US 41**
1. 2.20 miles south of the Hopkins County - Webster County line.

### GAS PIPELINES
Gas pipelines under or near a priority route could fail in the event of an earthquake. 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 Hopkins County were constructed with little or no seismic considerations. Gas pipelines near priority routes are located at:

**KY 109**
1. 0.50 mile south of the Hopkins County - Webster County line.

**US 41**
1. 2.20 miles south of the Hopkins County - Webster County line.

### POWER LINES
High voltage power lines also were cataloged during the route surveys. The height 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.

In addition to the potential problem of live power lines, power line support towers could fall across and block a priority route. Power lines cross the priority routes at the following locations:

**KY 109**
1. 1.09 mile north of the Western Kentucky Parkway bridge,
2. 0.66 mile south of the Lick Creek bridge, and
3. 0.70 mile south of the Hopkins County - Webster County line.

**US 41A**
1. 0.58 mile north of the Pleasant Run bridge, and
2. 1.35 mile south of the Hunting Branch bridge.

**US 41**
1. 1.67 mile north of the Otter Creek bridge, and
2. 0.45 mile north of the KY 3233 junction.

### 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 which cross under priority routes in Hopkins County are listed below:

**KY 109**
1. In the city of Dawson Springs,
2. 0.17 mile north of the US 62 (east) junction,
3. 0.28 mile south and 0.23, 0.40, and 0.85 mile north of the Illinois Central Gulf Railroad bridge,
4. 0.59, 0.38, and 0.34 mile south and 0.23 mile north of the KY 70 junction,
5. 0.64 and 0.23 mile south of the Clear Creek bridge, and
6. 0.53 and 0.15 mile south of the Weirs Creek bridge.

**US 41A**
1. 0.08 and 2.22 miles north of the Crab Orchard Creek bridge, and
2. 0.07, 0.20, 0.27, 0.37, 0.47, and 1.00 mile north of Pleasant Run Creek.

**KY 1751**
1. At the US 41A junction, and
2. 0.42 mile south and 0.22 mile north of the Louisville and Nashville Railroad bridge.

**US 41**
1. 0.33 mile south of the Otter Creek bridge, and
2. 2.37, 1.69, and 1.65 miles south of the Hopkins County - Webster County line.

**WATER IMPOUNDMENTS**
Small impoundments such as large farm ponds could 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. Impoundments are located at:

**KY 109**
1. 1.12 miles north of the Lick Creek bridge.

**US 41A**
1. 0.20 mile south of the KY 813 junction.

**SWAMPS**
KY 109 is constructed over swamps south of the Clear Creek bridge and south of the Weirs Creek bridge. 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.
OIL WELL

An oil well is located 0.75 mile south of the Western Kentucky Parkway bridge on US 41A. This facility could suffer damage during an earthquake which would result in an oil spillage and/or fire. The priority route could be closed.

MINES

There are several types of mining operations, both current and abandoned, along the priority routes in Hopkins County. These operations include strip mines, deep mines, and quarries.

A large earthquake could collapse portions of quarry walls, breach strip mine water impoundments, or collapse underground shafts. Any of these actions could temporarily block or destroy a section of a priority route. Further inspection should be conducted to determine if these mines constitute a probable threat to the priority routes. Mines are located at:

KY 109
1. 1.49 miles south and 0.12, 0.80, and 1.31 miles north of the Lick Creek bridge,
2. 0.25, 0.19, and 0.06 mile south and 0.15 and 0.23 mile north of the KY 70 junction,
3. 0.61 and 0.48 mile south of the Clear Creek bridge, and
4. 0.19 mile south of the Hopkins County - Webster County line.

US 41A
1. 0.99 mile north of the Crab Orchard Creek bridge,
2. 0.60 and 1.35 miles north of the Western Kentucky Parkway bridges, and
3. 2.85, 2.04, 1.26, and 0.88 miles south and 0.06 mile north of the Hunting Branch 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 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 109
1. 0.29 mile north of the Western Kentucky Parkway bridge,
2. 1.84 and 0.54 miles south of the Lick Creek bridge,
3. 0.26 and 1.16 miles north of the Lick Creek bridge,
4. 0.20 mile north of the KY 70 junction,
5. 1.50 and 2.70 miles north of the city of Beulah,
6. 0.50 mile north of the KY 1034 junction, and
7. 0.40 mile south of the Hopkins County - Webster County line.

ALLUVIUM

Soil maps for Hopkins County indicate that there are 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 Hopkins 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

LARGE WATER IMPOUNDMENTS

There are two impoundments (Nortonville Lake and Loch Mary Reservoir) on US 41A. Nortonville Lake is 0.38 mile south of the Pleasant Run Creek bridge and Loch Mary Reservoir is 0.04 mile north of the KY 112 junction. If these impoundments were to fail, the priority route would probably be washed out.
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


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 I: 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.
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.
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 pilings 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. Alluviated areas sand and mud ejected, earthquake fountains, sand crater.
X. Most masonry and frame structures destroyed with their foundations. Some will-bolted 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.
AMPLIFICATION OF SHAKING
AND
DAMAGE DUE TO SHAKING

Figure 2: Amplification of shaking in softer rock & soil during an earthquake.
Figure 3. Alluvium map for Hopkins County.
APPENDIX A

STRIP MAP FOR HOPKINS COUNTY

US 62, KY 109, US 41, KY 1751, and US 41A
LEGEND OF FEATURES

- ▲ BRIDGE
- ▼ CUT SLOPE
- △ TOWER
- ■ PIPELINE
- ○ TANK
- □ DAM

SEE REPORT FOR DESCRIPTIONS OF OTHER

KY109 HOPKINS
APPENDIX B

SEISMICALLY SIGNIFICANT FEATURES
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<th>Milepoint</th>
<th>Feature</th>
<th>Data</th>
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| 0.00      | Other   | Junction KY 672 - US 62  
Road Surface Type - Flexible |
| 0.23      | Bridge  | Number of Spans 3  
Type Unknown  
Concrete T-Beam  
End 1 Fixed  
Pier 1 Fixed  
Pier 2 Fixed  
End 2 Fixed  
Deck Type - Concrete  
Length 152 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 |
| 1.65      | Other   | Junction KY 109 Heading North-South  
Road Surface Type - Flexible |
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<td>Road Surface Type - Flexible</td>
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<td>Width 30 feet Pier Type - Open</td>
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<td>SPC Rating - B             Surface Type - Flexible</td>
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<td>Expansion Type - Sliding Plate</td>
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<td>----------</td>
<td>------</td>
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<td>4.50</td>
<td>Bridge</td>
<td>Number of Spans 3 Overpass Concrete T-Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 104 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</td>
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<td>Electrical Power Line 6 Lines Height 35 feet Steel Support Structure Unknown Volts Road Surface Type - Flexible</td>
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<td>Trees</td>
<td>Number of Trees 100 Height 30 feet Diameter 30 in. Ending Milepoint 5.5 Distance From Road 15 feet Road Surface Type - Flexible</td>
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<td>Strip Mines - (5.75 to 7.84) Milepoint Road Surface Type - Flexible</td>
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<td>6.60</td>
<td>Power Line</td>
<td>Electrical Power Line 3 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible</td>
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<td>Number of Trees 50 Height 50 feet Diameter 20 in. Ending Milepoint 6.73 Distance From Road 15 feet Road Surface Type - Flexible</td>
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<td>Bridge</td>
<td>Number of Spans 5 Over Stream Concrete T-Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed Pier 3 Fixed End 2 Fixed Deck Type - Concrete Length 165 feet Width 24 feet Pier Type - Open SPC Rating - C Surface Type - Flexible Expansion Type - Other End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown</td>
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| 8.55      | Other   | Abandoned Inclined Shaft  
|           |         | Road Surface Type - Flexible |
| 8.81      | Fault   | Fault  
|           |         | Road Surface Type - Flexible |
| 9.02      | Fault   | Fault  
|           |         | Road Surface Type - Flexible |
| 9.06      | Fault   | Fault  
|           |         | Road Surface Type - Flexible |
| 9.15      | Other   | Inclined Shaft  
|           |         | Road Surface Type - Flexible |
| 9.21      | Other   | Strip Mine  
|           |         | Road Surface Type - Flexible |
| 9.34      | Other   | Inclined Shaft  
|           |         | Road Surface Type - Flexible |
| 9.40      | Other   | Junction KY 70 Heading East-West  
|           |         | Road Surface Type - Flexible |
| 9.55      | Other   | Abandoned Vertical Shaft  
|           |         | Road Surface Type - Flexible |
| 9.60      | Trees   | Number of Trees 200  
|           |         | Height 35 feet  
|           |         | Diameter 8 in.  
|           |         | Ending Milepoint 10.20  
|           |         | Distance From Road 15 feet |
| 9.63      | Fault   | Fault  
|           |         | Road Surface Type - Flexible |
| 9.63      | Other   | Strip Mine (0.0-10.25) Milepoint  
<p>|           |         | Road Surface Type - Flexible |</p>
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<td>14.26</td>
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<td>14.74</td>
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<td>14.80</td>
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<td>Stony Point Mines Fault  Road Surface Type - Flexible</td>
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<td>Cut Slope</td>
<td>Cut Slope Type - Rock  Height 28 feet  Length 300 feet  Backslope 1:1  Road Surface Type - Flexible</td>
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<td>Shady Grove Fault  Road Surface Type - Flexible</td>
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<td>Fill</td>
<td>Material Type - Soil  Height 8 feet  Side slope 1:1  Length 500 feet  Crest 25 feet  Type Fill - Other  Road Surface Type - Flexible</td>
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### Report by Road and Milepoint for Hopkins County - Kentucky

KY 109

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<td>End 1 Substructure - Stub End 2 Substructure - Stub</td>
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### Report by Road and Milepoint for Hopkins County - Kentucky

**US 41A**

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<tr>
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| 0.00      | Other   | Hopkins Co - Christian Co Boundary  
Road Surface Type - Flexible |
| 0.49      | 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 160 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 |
| 0.82      | 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 106 feet  
Width 20 feet  
Pier Type - Open  
SPC Rating - C  
Surface Type - Flexible  
Expansion Type - Other  
End 1 Substructure - Stub  
End 2 Substructure - Stub  
Foundation Type - Unknown |
| 0.90      | Fault   | Martin Chapel Fault  
Road Surface Type - Flexible |
| 1.81      | Other   | Abandoned Shaft  
Road Surface Type - Flexible |
| 3.04      | Fault   | Fault  
Road Surface Type - Flexible |
| 3.04      | Other   | Nortonville Lake  
Road Surface Type - Flexible |
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<td>3.42</td>
<td>Bridge</td>
<td>Number of Spans 7  Overpass  Concrete T-Beam  End 1 Fixed  Pier 1 Fixed  Pier 2 Fixed  Pier 3 Fixed  Pier 4 Fixed  Pier 5 Fixed  Pier 6 Fixed  End 2 Fixed  Deck Type - Concrete  Length 336 feet  Width 30 feet  Pier Type - Open  SPC Rating - C  Surface Type - Flexible  Expansion Type - Other  End 1 Substructure - Stub  End 2 Substructure - Stub  Foundation Type - Unknown</td>
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<td>Nortonville Fault  Road Surface Type - Flexible</td>
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<td>Nortonville Fault  Road Surface Type - Flexible</td>
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<td>Power Line</td>
<td>Electrical Power Line  3 Lines  Height 30 feet  Wood Support Structure  Unknown Volts  Road Surface Type - Flexible</td>
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<td>Trees</td>
<td>Number of Trees 10  Height 40 feet  Diameter 12 in.  Ending Milepoint 4.30  Distance From Road 10 feet  Road Surface Type - Flexible</td>
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| 4.42      | Fault   | St Charles Fault  
Road Surface Type - Flexible |
| 4.50      | Trees   | Number of Trees 20  
Height 40 feet  
Diameter 28 in.  
Ending Milepoint 4.60  
Distance From Road 10 feet  
Road Surface Type - Flexible |
| 4.55      | Other   | Oil Wells  
Road Surface Type - Flexible |
| 5.30      | Bridge  | Number of Spans 6  
Overpass Concrete T-Beam  
End 1 Rocker  
Pier 1 Rocker  
Pier 2 Rocker  
Pier 3 Rocker  
Pier 4 Rocker  
Pier 5 Rocker  
End 2 Rocker  
Deck Type - Concrete  
Length 448 feet  
Width 30 feet  
Pier Type - Open  
SPC Rating - C  
Surface Type - Flexible  
Expansion Type - Other  
End 1 Substructure - Stub  
End 2 Substructure - Stub  
Foundation Type - Unknown |
| 5.60      | Trees   | Number of Trees 300  
Height 50 feet  
Diameter 36 in.  
Ending Milepoint 6.60  
Distance From Road 20 feet  
Road Surface Type - Flexible |
| 5.90      | Other   | Strip Mine  
Road Surface Type - Flexible |
| 6.59      | Bridge  | Number of Spans 1  
Overpass Concrete T-Beam  
End 1 Fixed  
Pier 1 Fixed  
Pier 2 Fixed  
End 2 Fixed  
Deck Type - Concrete  
Length 132 feet  
Width 29 feet  
Pier Type - Open  
SPC Rating - B  
Surface Type - Flexible  
Expansion Type - Other  
End 1 Substructure - Stub  
End 2 Substructure - Stub  
Foundation Type - Unknown |
### Milepoint 6.59: Bridge
- **Number of Spans**: 1
- **Type**: Steel Girder I-Beam
- **Bridge Type**: Overpass
- **End 1**: Fixed
- **End 2**: Fixed
- **Deck Type**: Steel
- **Length**: 125 feet
- **Width**: 29 feet
- **Pier Type**: Unknown
- **SPC Rating**: B
- **Surface Type**: Flexible
- **Expansion Type**: Other
- **End 1 Substructure**: Open Abutment
- **End 2 Substructure**: Open Abutment
- **Foundation Type**: Unknown

### Milepoint 6.59: Bridge
- **Number of Spans**: 4
- **Bridge Type**: Overpass
- **Deck Type**: Concrete T-Beam
- **Length**: 176 feet
- **Width**: 29 feet
- **Pier Type**: Open
- **SPC Rating**: B
- **Surface Type**: Flexible
- **Expansion Type**: Other
- **End 1 Substructure**: Open Abutment
- **End 2 Substructure**: Open Abutment
- **Foundation Type**: Unknown

### Milepoint 6.65: Other
- **Abandoned Inclined Shaft**
- **Road Surface Type**: Flexible

### Milepoint 6.80: Trees
- **Number of Trees**: 300
- **Height**: 50 feet
- **Diameter**: 36 in.
- **Ending Milepoint**: 7.80
- **Distance From Road**: 20 feet
- **Road Surface Type**: Flexible

### Milepoint 7.00: Other
- **Small Pond (100 x 50) feet**
- **Road Surface Type**: Flexible

### Milepoint 7.20: Other
- **Junction KY 813 Heading West**
- **Road Surface Type**: Flexible
<table>
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<tbody>
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<td>Number of Spans 3 Overpass Concrete T-Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 287 feet Width 30 feet Pier Type - Open SPC Rating - B Surface Type - Flexible Expansion Type - Poured Compression End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown</td>
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<td>Trees</td>
<td>Number of Trees 100 Height 40 feet Diameter 36 in. Ending Milepoint 10.50 Distance From Road 10 feet Road Surface Type - Flexible</td>
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<td>10.61</td>
<td>Other</td>
<td>Possible Underground Mine Road Surface Type - Flexible</td>
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<td>Junction KY 112 Heading Southwest Road Surface Type - Flexible</td>
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<td>Loch Mary Reservoir (Earlington) Road Surface Type - Flexible</td>
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<tr>
<td>11.10</td>
<td>Fill</td>
<td>Material Type - Soil Height 45 feet Side slope 2:1 Length 700 feet Crest 125 feet Type Fill - Other Road Surface Type - Rigid</td>
</tr>
<tr>
<td>Milepoint</td>
<td>Feature</td>
<td>Data</td>
</tr>
<tr>
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</tr>
</tbody>
</table>
| 11.30     | Power Line | Electrical Power Line  
12 Lines Height 30 feet  
Steel Support Structure Unknown Volts  
Road Surface Type - Rigid |
| 11.39     | Other    | Strip Mines  
Road Surface Type - Flexible |
| 11.77     | Other    | Underground Mines  
Road Surface Type - Flexible |
| 12.65     | Bridge   | Number of Spans 1  
Type Unknown Concrete T-Beam  
End 1 Fixed  
End 2 Fixed  
Deck Type - Concrete  
Length 32 feet  
Width 72 feet  
Pier Type - Unknown  
SPC Rating - C  
Surface Type - Flexible  
Expansion Type - Other  
End 1 Substructure - Full  
End 2 Substructure - Full  
Foundation Type - Unknown |
| 12.71     | Other    | Victoria Mine Air Shaft  
Road Surface Type - Flexible |
| 13.11     | Bridge   | Number of Spans 2  
Steel Girder I-Beam  
Bridge Type - Underpass  
End 1 Fixed  
Pier 1 Fixed  
End 2 Fixed  
Deck Type - Concrete  
Length 116 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 |
| 14.00     | Other    | Junction KY 70 Heading West  
Road Surface Type - Flexible |
| 14.70     | Other    | Junction KY 70/85 Heading East  
Road Surface Type - Flexible |
### Milepoint Feature Data

<table>
<thead>
<tr>
<th>Milepoint</th>
<th>Feature</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.33</td>
<td>Bridge</td>
<td>Number of Spans 3, Overpass, Concrete T-Beam&lt;br&gt;End 1 Fixed, Pier 1 Fixed, Pier 2 Fixed, Pier 3 Fixed, Pier 4 Fixed, Pier 5 Rocker, End 2 Rocker&lt;br&gt;Deck Type - Concrete, Length 386 feet, Width 29 feet, Pier Type - Open&lt;br&gt;SPC Rating - B, Surface Type - Flexible, Expansion Type - Other&lt;br&gt;End 1 Substructure - Full, End 2 Substructure - Full&lt;br&gt;Foundation Type - Unknown</td>
</tr>
<tr>
<td>15.73</td>
<td>Bridge</td>
<td>Number of Spans 1, Steel Girder I-Beam&lt;br&gt;Bridge Type - Underpass, End 1 Fixed, End 2 Fixed&lt;br&gt;Deck Type - Steel, Length 50 feet, Width 20 feet, Pier Type - Unknown&lt;br&gt;SPC Rating - B, Surface Type - Flexible, Expansion Type - Other&lt;br&gt;End 1 Substructure - Full, End 2 Substructure - Full&lt;br&gt;Foundation Type - Unknown</td>
</tr>
<tr>
<td>16.10</td>
<td>Other</td>
<td>End US 41A - Continue on Ky 1751&lt;br&gt;Road Surface Type - Flexible</td>
</tr>
<tr>
<td>Milepoint</td>
<td>Feature</td>
<td>Other</td>
</tr>
<tr>
<td>-----------</td>
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</tr>
</tbody>
</table>
| 0.00      | Other   | Junction US 41A South  
Road Surface Type - Flexible |
| 0.00      | Fault   | Fault  
Road Surface Type - Flexible |
| 0.72      | Fault   | South Reinecke Fault  
Road Surface Type - Flexible |
| 1.10      | Other   | Junction KY 1069 Heading Northwest  
Road Surface Type - Flexible |
| 1.14      | Bridge  | Number of Spans 3  
Overpass Concrete T-Beam  
End 1 Fixed Pier 1 Fixed Pier 2 Fixed Pier 2 Fixed  
Deck Type - Concrete  
Length 149 feet  
Width 24 feet Pier Type - Open  
SPC Rating - C  
Surface Type - Flexible  
Expansion Type - Other  
End 1 Substructure - Stub  
End 2 Substructure - Stub  
Foundation Type - Unknown |
| 1.36      | Fault   | North Reinecke Fault  
Road Surface Type - Flexible |
| 1.70      | Other   | US 41 Junction  
Road Surface Type - Flexible |
<table>
<thead>
<tr>
<th>Milepoint</th>
<th>Feature</th>
<th>Data</th>
</tr>
</thead>
</table>
| 3.30      | Other   | Route Branches from KY 1751 to US 41  
Road Surface Type - Flexible |
| 5.10      | Other   | Junction KY 862 Heading East  
Road Surface Type - Flexible |
| 5.80      | Fault   | Fault  
Road Surface Type - Flexible |
| 6.13      | Bridge  | Number of Spans 4  
Over Stream  Concrete T-Beam  
End 1 Fixed  Pier 1 Fixed  Pier 2 Fixed  
Pier 3 Fixed  End 2 Fixed  
Deck Type - Concrete  Length 132 feet  
Width 24 feet  Pier Type - Open  
SPC Rating - C  Surface Type - Flexible  
Expansion Type - Other  
End 1 Substructure - Stub  
End 2 Substructure - Stub  
Foundation Type - Unknown |
| 6.60      | Other   | Junction KY 260 Heading East  
Road Surface Type - Flexible |
Report by Road and Milepoint
for Hopkins County - Kentucky
US 41

<table>
<thead>
<tr>
<th>Milepoint</th>
<th>Feature</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.74</td>
<td>Trees</td>
<td>Number of Trees 25  Height 38 feet  Diameter 28 in.  Ending Milepoint 6.80  Distance From Road 10 feet  Road Surface Type - Flexible</td>
</tr>
<tr>
<td>7.07</td>
<td>Other</td>
<td>Abandoned Mine  Road Surface Type - Flexible</td>
</tr>
<tr>
<td>7.80</td>
<td>Power Line</td>
<td>Electrical Power Line  3 Lines  Height 25 feet  Wood Support Structure - Unknown  Volts  Road Surface Type - Flexible</td>
</tr>
<tr>
<td>9.30</td>
<td>Trees</td>
<td>Number of Trees 1  Height 30 feet  Diameter 28 in.  Ending Milepoint 9.30  Distance From Road 10 feet  Road Surface Type - Flexible</td>
</tr>
<tr>
<td>9.33</td>
<td>Fault</td>
<td>Fault  Road Surface Type - Flexible</td>
</tr>
<tr>
<td>9.50</td>
<td>Pipeline</td>
<td>Pipeline Type - Natural Gas  Road Surface Type - Flexible</td>
</tr>
<tr>
<td>9.50</td>
<td>Cut Slope</td>
<td>Cut Slope Type - Soil  Height 20 feet  Length 300 feet  Backslope 1:1  Road Surface Type - Flexible</td>
</tr>
<tr>
<td>10.01</td>
<td>Fault</td>
<td>North Hanson Fault  Road Surface Type - Flexible</td>
</tr>
<tr>
<td>10.05</td>
<td>Fault</td>
<td>North Hanson Fault  Road Surface Type - Flexible</td>
</tr>
<tr>
<td>10.18</td>
<td>Trees</td>
<td>Number of Trees 10  Height 4 feet  Diameter 30 in.  Ending Milepoint 10.20  Distance From Road 20 feet  Road Surface Type - Flexible</td>
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</tbody>
</table>
### Feature Data

<table>
<thead>
<tr>
<th>Milepoint</th>
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<th>Data</th>
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<tbody>
<tr>
<td>10.49</td>
<td>Trees</td>
<td>Number of Trees 2 \ Height 36 feet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diameter 36 in. \ Ending Milepoint 10.50</td>
</tr>
<tr>
<td></td>
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<td>Distance From Road 20 feet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Road Surface Type - Flexible</td>
</tr>
<tr>
<td>11.70</td>
<td>Other</td>
<td>Hopkins Co - Webster Co Boundary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Road Surface Type - Flexible</td>
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</tbody>
</table>