Earthquake Hazard Mitigation of Transportation Facilities for Ohio County

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EARTHQUAKE HAZARD MITIGATION OF TRANSPORTATION FACILITIES FOR OHIO 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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Concern has grown in recent years over the seismic activity of the New Madrid seismic zone in Western Kentucky. Ohio 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 route that has been investigated and recommended as being the route in Ohio County that should be maintained in passable condition. The recommended routes, KY 136 and US 231, 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 potentially critical features is given in Appendix B.
INTRODUCTION

An awareness of earthquakes and their possible effects upon the nation’s infrastructure are 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 Ohio 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 Armenia 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 there 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 and 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;

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 ROUTES IN OHIO COUNTY**

Ohio County is located approximately 136 miles east-northeast of the center of the New Madrid Seismic Zone. Figure 1 indicates Ohio County is in the IX band of the MMI scale. This indicates considerable damage could occur in Ohio County in the event of a major earthquake.

KY 136 and US 231 have been designated as priority routes for Ohio County. KY 136 starts at the McLean County-Ohio County line and continues east for 9.5 miles, ending at the junction of US 231. US 231 starts at the Ohio County-Butler County line and continues north for 24.3 miles, ending at the Ohio County-Daviess County line.

A number of features along this priority route could potentially hamper rescue and relief efforts. These features included bridges, soil fills, cut slopes, gas pipe lines, power lines, geologic faults, large trees, underground 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 four bridges located on KY 136 and ten bridges on US 231 in Ohio County. The four bridges located on KY 136 are located over:

1. Hanley Creek,
2. Barnett Creek,
3. Little No Creek,
4. Big No Creek.

The ten bridges located on US 231 are located over:

1. Western KY Parkway crosses over US 231,
2. Muddy Creek,
3. Collins Drainage Ditch,
4. The North Fork of Muddy Creek,
5. Rough River,
6. Swamp, 0.17 miles north of the Rough River bridge,
7. Swamp, 0.24 miles south of the Barrass Ditch bridge,
8. Barrass Ditch,
9. Big No Creek,
10. Barnett 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 KY 136 and US 231 in Ohio County are located as follows:
KY 136

1. Approach fills for the bridge over Hanley Creek,
2. 0.09 mile east of the bridge over Hanley Creek,
3. 1.14 miles east of the bridge over Hanley Creek,
4. Approach fills for the bridge over Barnett Creek,
5. Approach fills for the bridge over Little No Creek,
6. 0.08 and 0.28 mile east of the Little No Creek bridge,
7. Approach fills for the bridge over Big No Creek,
8. 1.44 miles east of the Big No Creek bridge,

US 231

1. 0.10, 0.40, and 1.50 miles north of the Ohio County - Butler County line,
2. 0.85 and 1.35 miles south of the Western KY Parkway bridges,
3. 1.0 and 1.85 miles north of the Western KY Parkway bridges,
4. Approach fills for the bridge over Muddy Creek,
5. 0.34 mile north of the Muddy Creek bridge,
6. Approach fills for the bridge over Collins Drainage Ditch,
7. Approach fills for the bridge over the North Fork of Muddy Creek,
8. Approach fills for the bridge over Rough River,
9. Approach fills for the two bridges that are built over the swamps,
10. Approach fills for the bridge over Barrass Ditch,
11. 0.30 mile south of the junction of US 231 and KY 1737,
12. Approach fills for the bridge over Big No Creek,
13. 0.90, 1.05, 1.35, 1.80, 2.60, 2.90, 3.55, and 3.75 miles north of the Big No Creek bridge,
14. Approach fills for the Barnett Creek bridge,
15. 0.95, 1.10, 1.20, 1.35, 1.60, 2.30, 2.50, 3.00, 3.40, and 3.85 miles north of the Barnett Creek bridge.

CUT SLOPES

Most cut slopes cataloged during surveys of KY 136 and US 231 were in soil and were less than 35 feet in height. Should any of these slopes fail, both lanes of the roadway probably would not be closed, thus permitting passage around the slide. Cut slopes that have a history of failure and those that have steep slopes should be considered as problem areas.

The most critical cut slope appears to be one located 1.49 miles east of
the Big No Creek bridge on KY 136, and 0.20 mile south the Barnett Creek bridge on US 231.

GAS PIPE LINES

One gas pipe line crosses under KY 136 and eleven pipelines cross under US 231. It is possible that pipelines could fail under or near a priority route causing a temporary closure. If a pipe line 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 pipe lines in Ohio County were constructed with little or no seismic considerations. Gas pipe lines cross under KY 136 and US 231 at the following locations:

**KY 136**
1. 0.70 mile west of the junction of KY 136 and US 231.

**US 231**
1. 2.40 miles north of the Ohio County - Butler County line,
2. 0.28 and 0.38 mile north of the Barrass Ditch Bridge,
3. 1.00, 1.60, 1.90, 2.90, 3.50, and 3.60 miles north of the Big No Creek bridge,
4. 1.40 and 0.40 miles south of the Daviess County - Ohio 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.

Additionally, power line support towers that could potentially fall across a priority route. Power lines cross at the following locations on KY 136 and KY 231.

**KY 136**
1. 0.09 mile east of the Hanley Creek bridge.
2. 0.30 mile west of the junction of KY 136 and US 231.

**US 231**
1. 1.60 and 0.10 miles south of the junction of Western KY Parkway and US 231.
2. 0.50 and 0.60 mile north of the junction of Western KY Parkway and US 231.

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 KY 136 and US 
231 are listed below:

**KY 136**

1. 0.91 mile west of the Hanley Creek bridge,
2. 0.92 mile west of the Barnett Creek bridge,
3. 1.09 miles west of the Little No Creek bridge.

**US 231**

1. 0.83, 2.49, 3.07, 3.68, 3.74, 3.95, and 4.06, miles north of the Big No Creek bridge,
2. 0.25 and 0.10 mile south of the Barnett Creek bridge.

**TREES**

The behavior of trees during an earthquake depends upon many 
factors including their condition, type, height, and size. Local soil 
conditions, geometry of the ground surface, and the 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, KY 136 and US 231 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 136**

1. 1.01 miles west of the Hanley Creek bridge,
2. 0.44 and .94 miles east of the Hanley Creek bridge,
3. 0.56, 0.81, and 1.46 miles east of the Barnett Creek bridge,
4. 0.04, 1.29, 2.49, and 2.84 miles east of the Big No Creek bridge.

**US 231**

1. 0.10 mile south of the junction of US 231 and KY 505,
2. 0.60, 0.90, 1.20, 1.90, and 3.40 miles north of the US 231 and the KY 505 junction,
3. 0.20 mile south of the junction of US 231 and KY 269,
4. 0.38 mile south of the junction of US 231 and the Western KY Parkway,
5. 0.50 mile north of the City of Hartford,
6. 0.30 mile south of the Barnett Creek bridge.

**WATER IMPOUNDMENTS**

Two large farm ponds are located along KY 136 and two along US 231. 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. The impoundments are located as follows:

**KY 136**

1. 0.49 and 1.69 miles east of the Big No Creek bridge.

**US 231**

1. 0.65 mile south of the US 231 and KY 1414 junction,

2. 2.29 miles north of the Barnett Creek bridge.

**SWAMPS**

US 231 is constructed over a swamp approximately 0.17 and 0.56 mile north of the Rough River 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.

**MINES**

There are several types of mining-related activities in Ohio County that could affect priority routes during a major earthquake. A large earthquake could collapse pillars in underground mines and cause rapid subsidence at the surface. Other potential hazards exist from strip mines that might have large spoil banks and possible water impoundments. Abandoned or current operating mines are located at the following.

**KY 136**

1. Abandoned deep mine 0.16 mile west of the Barnett Creek bridge.

**US 231**

1. Strip mine 2.11 miles north of the Western KY Parkway and extending 0.55 mile north along US 231.

2. Abandoned deep mine 1.45 miles north of the Big No Creek bridge.

**ALLUVIUM**

Soil maps for Ohio 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 Ohio 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 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 3 Office of DES which is located in Owensboro. The phone numbers at this office are (502) 564-8603 and (502) 683-6254.

Additional information about the study discussed in this report should be directed to David L. Allen, Project Director, at the Kentucky Transportation Center, (606) 257-4513. Requests to be placed on the mailing list for updated information should be submitted on your company or agency letterhead to the Kentucky Transportation Center at the University of Kentucky, Lexington Kentucky 40506-0043.
Figure 1: The twenty-six counties included in this study area.
Table 1: MODIFIED MERCALLI INTENSITY SCALE

Modified Mercalli Intensity Scale, 1956 Version

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

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

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

Masonry A. Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.
Masonry B. Good workmanship and mortar, reinforced by not designed in detail to resist lateral forces.
Masonry C. Ordinary workmanship and mortar; no extreme weakness like failing to tie corners, but neither reinforced nor designed against horizontal forces.
Masonry D. Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

The following list represents the twelve grades of the scale.

I. Not felt. Marginal and long-period effects of large earthquakes.
II. Felt by persons at rest, on upper floors, or favorable placed.
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 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 the foundations. Some will-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large land slides. Water thrown on banks of canals, rivers, 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.
APPENDIX A

STRIP MAP FOR OHIO COUNTY

KY 136 AND US 231
APPENDIX B

SEISMICALLY SIGNIFICANT FEATURES
### Report by Road and Milepoint for Ohio County - Kentucky

**KY 136**

<table>
<thead>
<tr>
<th>Milepoint</th>
<th>Feature</th>
<th>Data</th>
</tr>
</thead>
</table>
| 0.05      | Trees   | Number of Trees 50  Height 45 feet  
|           |         | Diameter 36 in. Ending Milepoint .30  
|           |         | Distance From Road 20 feet  
|           |         | Road Surface Type - Flexible |
| 0.15      | Fault   | Fault  
|           |         | Road Surface Type - Flexible |
| 1.05      | Fill    | Material Type - Soil  Height 8 feet  
|           |         | Side slope 2:1  Length 100 feet  
|           |         | Crest 25 feet  Type Fill - Other  
|           |         | Road Surface Type - Flexible |
| 1.06      | Bridge  | Number of Spans 4  Over Stream Concrete T-Beam  
|           |         | End 1 Fixed  Pier 1 Fixed  Pier 2 Fixed  
|           |         | End 2 Fixed |
|           |         | Deck Type - Concrete  Length 132 feet  
|           |         | Width 19 feet  Pier Type - Open  
|           |         | SPC Rating - B  Surface Type - Flexible  
|           |         | Expansion Type - Other  
|           |         | End 1 Substructure - Stub  
|           |         | End 2 Substructure - Stub  
|           |         | Foundation Type - Unknown  
| 1.15      | Power Line | Electrical Power Line 6 Lines Height 30 feet  
|           |         | Wood Support Structure Unknown Volts  
|           |         | Road Surface Type - Flexible |
| 1.15      | Fill    | Material Type - Soil  Height 8 feet  
|           |         | Side slope 2:1  Length 100 feet  
|           |         | Crest 25 feet  Type Fill - Other  
|           |         | Road Surface Type - Flexible |
| 1.50      | Trees   | Number of Trees 100  Height 35 feet  
|           |         | Diameter 15 in. Ending Milepoint 1.90  
|           |         | Distance From Road 30 feet  
|           |         | Road Surface Type - Flexible |
Report by County and Milepoint  
for Ohio County - Kentucky  
KY 136

<table>
<thead>
<tr>
<th>Milepoint</th>
<th>Feature</th>
<th>Data</th>
</tr>
</thead>
</table>
| 2.00      | Trees   | Number of Trees 200  Height 35 feet  
Diameter 24 in.  Ending Milepoint 3.50  
Distance From Road 10 feet  
Road Surface Type - Flexible |
| 2.20      | Fill    | Material Type - Soil  Height 8 feet  
Side slope 2:1  Length 150 feet  
Crest 35 feet  Type Fill - Other  
Road Surface Type - Flexible |
| 2.42      | Fault   | Fault  
Road Surface Type - Flexible |
| 2.80      | Other   | Lumber Mill  
Road Surface Type - Flexible |
| 3.18      | Other   | Caved Mine Adit  
Road Surface Type - Flexible |
| 3.20      | Fill    | Material Type - Soil  Height 15 feet  
Side slope 2:1  Length 1,000 feet  
Crest 30 feet  Type Fill - Other  
Road Surface Type - Flexible |
| 3.34      | Bridge  | Number of Spans 5  Over Stream 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 165 feet  
Width 19 feet  Pier Type - Open  
SPC Rating - B  Surface Type - Flexible  
Expansion Type - Other  
End 1 Substructure - Stub  
End 2 Substructure - Stub  
Foundation Type - Unknown |
| 3.90      | Trees   | Number of Trees 20  Height 30 feet  
Diameter 16 in.  Ending Milepoint 4.10  
Distance From Road 10 feet  
Road Surface Type - Flexible |
### Report by County and Milepoint for Ohio County - Kentucky

KY 136

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<tr>
<td>4.15</td>
<td>Trees</td>
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<td>4.58</td>
<td>Fault</td>
<td>Fault Road Surface Type - Flexible</td>
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<tr>
<td>4.80</td>
<td>Trees</td>
<td>Number of Trees 5 Height 45 feet Diameter 30 in. Ending Milepoint 4.81 Distance From Road 15 feet Road Surface Type - Flexible</td>
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<td>5.67</td>
<td>Bridge</td>
<td>Number of Spans 2 Over Stream Concrete T-Beam End 1 Fixed Pier 1 Fixed End 2 Fixed Deck Type - Concrete Length 53 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</td>
</tr>
<tr>
<td>5.75</td>
<td>Fill</td>
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<td>Fill</td>
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<td>6.01</td>
<td>Bridge</td>
<td>Number of Spans 1 Over Stream Concrete T-Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 53 feet Width 19 feet Pier Type - Solid SPC Rating - B Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown</td>
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### Report by County and Milepoint
for Ohio County - Kentucky
KY 136

<table>
<thead>
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<th>Feature</th>
<th>Data</th>
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<tbody>
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<td>Fill</td>
<td>Material Type - Soil Height 10 feet Side slope 3:2 Length 500 feet Crest 25 feet Type Fill - Other Road Surface Type - Flexible</td>
</tr>
<tr>
<td>6.05</td>
<td>Trees</td>
<td>Number of Trees 20 Height 30 feet Diameter 12 in. Ending Milepoint 6.15 Distance From Road 20 feet Road Surface Type - Flexible</td>
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<tr>
<td>6.50</td>
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</tr>
<tr>
<td>7.30</td>
<td>Trees</td>
<td>Number of Trees 50 Height 40 feet Diameter 18 in. Ending Milepoint 7.40 Distance From Road 15 feet Road Surface Type - Flexible</td>
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<td>7.45</td>
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<td>Material Type - Soil Height 30 feet Side slope 1:1 Length 100 feet Crest 25 feet Type Fill - Other Road Surface Type - Flexible</td>
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<td>Cut</td>
<td>Cut Slope Type - Soil Height 15 feet Length 100 feet Backslope 1:1 Road Surface Type - Flexible</td>
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<td>Trees</td>
<td>Number of Trees 8 Height 40 feet Diameter 18 in. Ending Milepoint 8.51 Distance From Road 15 feet Road Surface Type - Flexible</td>
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<td>8.80</td>
<td>Pipeline</td>
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**Report by Road and Milepoint for Ohio County - Kentucky**

**KY 136**

<table>
<thead>
<tr>
<th>Milepoint</th>
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</table>
| 8.85      | Trees     | Number of Trees 20  Height 40 feet  
Diameter 18 in.  Ending Milepoint 8.86  
Distance From Road 15 feet  
Road Surface Type - Flexible |
| 9.20      | Power Line| Electrical Power Line 3 Lines  Height 30 feet  
Wood Support Structure  Unknown Volts  
Road Surface Type - Flexible |
| 9.50      | Other     | Junction US 231 Heading Northwest-Southeast  
Road Surface Type - Flexible |
| 9.50      | Other     | End KY 136 Quake Study  
Road Surface Type - Flexible |
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| 0.00      | Other   | Ohio Co - Butler Co Boundary  
Road Surface Type - Flexible |
| 0.10      | Fill    | Material Type - Soil  
Height 15 feet  
Side slope 2:1  
Length 100 feet  
Crest 20 feet  
Type Fill - Other  
Road Surface Type - Flexible |
| 0.40      | Fill    | Material Type - Soil  
Height 15 feet  
Side slope 2:1  
Length 100 feet  
Crest 20 feet  
Type Fill - Other  
Road Surface Type - Flexible |
| 1.50      | Fill    | Material Type - Soil  
Height 1 feet  
Side slope 2:1  
Length 100 feet  
Crest 20 feet  
Type Fill - Other  
Road Surface Type - Flexible |
| 1.60      | Trees   | Number of Trees 1  
Height 40 feet  
Diameter 36 in.  
Ending Milepoint 1.60  
Distance From Road 15 feet  
Road Surface Type - Flexible |
| 1.70      | Other   | Junction KY 505 Heading Northwest  
Road Surface Type - Flexible |
| 2.30      | Trees   | Number of Trees 1  
Height 45 feet  
Diameter 30 in.  
Ending Milepoint 2.30  
Distance From Road 15 feet  
Road Surface Type - Flexible |
| 2.40      | Pipeline | Pipeline Type - Natural Gas  
Road Surface Type - Flexible |
| 2.60      | Trees   | Number of Trees 2  
Height 45 feet  
Diameter 28 in.  
Ending Milepoint 2.61  
Distance From Road 15 feet  
Road Surface Type - Flexible |
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<td>2.90</td>
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<td>Number of Trees 5 Height 35 feet</td>
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<td>3.60</td>
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<td>Number of Trees 10 Height 30 feet</td>
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<td>Diameter 16 in. Ending Milepoint 5.35</td>
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<td>Wood Support Structure Unknown Volts</td>
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<td>Crest 24 feet Type Fill - Other</td>
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<td>Road Surface Type - Flexible</td>
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Report by County and Milepoint
for Ohio County - Kentucky
US 231

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<td>Trees</td>
<td>Number of Trees 15 Height 35 feet Diameter 16 in. Ending Milepoint 6.40 Distance From Road 12 feet Road Surface Type - Flexible</td>
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<td>Power Line</td>
<td>Electrical Power Line 3 Lines Height 40 feet Steel Support Structure Unknown Volts Road Surface Type - Flexible</td>
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<tr>
<td>6.70</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 75 feet Width 25 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>6.70</td>
<td>Other</td>
<td>Two Bridges - Same Data For Both Road Surface Type - Flexible</td>
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<td>Junction Western KY Parkway Heading East-West Road Surface Type - Flexible</td>
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<td>7.20</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>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>Fill</td>
<td>Material Type - Soil Height 20 feet Side slope 3:1 Length 300 feet Crest 40 feet Type Fill - Other Road Surface Type - Flexible</td>
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Report by County and Milepoint  
for Ohio County - Kentucky  
US 231

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</table>
| 8.55      | Fill          | Material Type - Soil  Height 30 feet  
                         Side slope 2:1  Length 30 feet  
                         Crest 40 feet  Type Fill - Other  
                         Road Surface Type - Flexible  |
| 8.81      | Other         | Strip Mine - Runs to 9.36 Milepoint  
                         Road Surface Type - Flexible  |
| 8.85      | Sign          | Overhead Sign  Height 25 feet  
                         Area 45 square feet  
                         Road Surface Type - Flexible  
                         Aluminum Support Structure  |
| 9.30      | Other         | Junction KY 369 Heading South  
                         Road Surface Type - Flexible  |
| 9.50      | Other         | City of Hartford  
                         Road Surface Type - Flexible  |
| 10.00     | Trees         | Number of Trees 2  Height 40 feet  
                         Diameter 36 in.  Ending Milepoint 10.00  
                         Distance From Road 5 feet  
                         Road Surface Type - Flexible  |
| 10.00     | Other         | Mileposts Inaccurate Inside City Limits  
                         Road Surface Type - Flexible  |
| 10.00     | Other         | City of Beaver Dam  
                         Road Surface Type - Flexible  |
| 10.70     | Other         | Junction US 62 Heading West  
                         Road Surface Type - Flexible  |
| 11.46     | 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 - Solid  
                         SPC Rating - B  Surface Type - Flexible  
                         Expansion Type - Other  
                         End 1 Substructure - Stub  
                         End 2 Substructure - Stub  
                         Foundation Type - Unknown  |
### Milepoint Feature Data

**Milepoint**: 11.80  
**Feature**: Fill  
**Data**: Material Type - Soil  
Height: 15 feet  
Side slope: 2:1  
Length: 500 feet  
Crest: 30 feet  
Type: Fill - Other  
Road Surface Type: Flexible

**Milepoint**: 11.95  
**Feature**: Bridge  
**Data**: Number of Span: 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: B  
Surface Type: Flexible  
Expansion Type: Other  
End 1 Substructure: Stub  
End 2 Substructure: Stub  
Foundation Type: Unknown

**Milepoint**: 11.95  
**Feature**: Fill  
**Data**: Material Type - Soil  
Height: 15 feet  
Side slope: 2:1  
Length: 250 feet  
Crest: 40 feet  
Type: Fill - Other  
Road Surface Type: Flexible

**Milepoint**: 12.10  
**Feature**: Other  
**Data**: Junction KY 69 Heading Northeast  
Road Surface Type: Flexible

**Milepoint**: 12.25  
**Feature**: Fill  
**Data**: Material Type - Soil  
Height: 10 feet  
Side slope: 2:1  
Length: 30 feet  
Crest: 35 feet  
Type: Fill - Other  
Road Surface Type: Flexible

**Milepoint**: 12.30  
**Feature**: Bridge  
**Data**: Number of Span: 1  
Overpass: Concrete T-Beam  
End 1 Fixed  
End 2 Fixed  
Deck Type: Concrete  
Length: 32 feet  
Width: 32 feet  
Pier Type: Unknown  
SPC Rating: B  
Surface Type: Flexible  
Expansion Type: Other  
End 1 Substructure: Full  
End 2 Substructure: Full  
Foundation Type: Unknown
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for Ohio County - Kentucky
US 231

<table>
<thead>
<tr>
<th>Milepoint</th>
<th>Feature</th>
<th>Data</th>
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</thead>
</table>
| 12.35     | Fill    | Material Type - Soil  Height 10 feet  
          |         | Side slope 2:1  Length 30 feet  
          |         | Crest 35 feet  Type Fill - Other  
          |         | Road Surface Type - Flexible |
| 13.20     | Other   | Junction KY 1543 Heading Southeast  
          |         | Road Surface Type - Flexible |
| 13.20     | Other   | Junction KY 69 Heading Southeast  
          |         | Road Surface Type - Flexible |
| 13.32     | Bridge  | Number of Spans 3  Steel Girder I-Beam  
          |         | Bridge Type - Over Stream  
          |         | End 1 Rocker  Pier 1 Rocker  Pier 2 Rocker  
          |         | END 2 Rocker  
          |         | Deck Type - Concrete  Length 219 feet  
          |         | Width 24 feet  Pier Type - Solid  
          |         | SPC Rating - B  Surface Type - Flexible  
          |         | Expansion Type - Other  
          |         | End 1 Substructure - Stub  
          |         | End 2 Substructure - Stub  
          |         | Foundation Type - Unknown |
| 13.40     | Fill    | Material Type - Soil  Height 10 feet  
          |         | Side slope 2:1  Length 150 feet  
          |         | Crest 30 feet  Type Fill - Other  
          |         | Road Surface Type - Flexible |
| 13.49     | Bridge  | Number of Spans 6  Concrete T-Beam  
          |         | Bridge Type Unknown  
          |         | End 1 Fixed  Pier 1 Fixed  Pier 2 Fixed  
          |         | Pier 3 Fixed  Pier 4 Fixed  Pier 5 Fixed  
          |         | End 2 Fixed  
          |         | Deck Type - Concrete  Length 198 feet  
          |         | Width 24 feet  Pier Type - Solid  
          |         | SPC Rating - B  Surface Type - Flexible  
          |         | Expansion Type - Other  
          |         | End 1 Substructure - Full  
          |         | End 2 Substructure - Full  
<pre><code>      |         | Foundation Type - Unknown |
</code></pre>
<table>
<thead>
<tr>
<th>Milepoint</th>
<th>Feature</th>
<th>Data</th>
</tr>
</thead>
</table>
| 13.50     | Fill    | Material Type: Soil  Height: 12 feet  
|           |         | Side slope: 2:1  Length: 1,500 feet  
|           |         | Crest: 35 feet  Type: Fill - Other  
|           |         | Road Surface Type: Flexible |
| 13.85     | Other   | Bridge  Use: 13.45 milepoint  
|           |         | Data  Road Surface Type: Flexible |
| 13.88     | Bridge  | Number of Spans: 6  
|           |         | Overpass: Concrete  
|           |         | T-Beam  
|           |         | End 1 Fixed  Pier 1 Fixed  Pier 2 Fixed  
|           |         | Pier 3 Fixed  Pier 4 Fixed  Pier 5 Fixed  
|           |         | End 2 Fixed  
|           |         | Deck Type: Concrete  Length: 198 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 |
| 13.90     | Fill    | Material Type: Soil  Height: 15 feet  
|           |         | Side slope: 2:1  Length: 1,200 feet  
|           |         | Crest: 35 feet  Type: Fill - Other  
|           |         | Road Surface Type: Flexible |
| 14.12     | Bridge  | Number of Spans: 3  
|           |         | Over Stream: Concrete  
|           |         | I-Beam  
|           |         | End 1 Fixed  Pier 1 Neoprene  Pier 2 Neoprene  
|           |         | End 2 Fixed  
|           |         | Deck Type: Concrete  Length: 212 feet  
|           |         | Width: 30 feet  
|           |         | Pier Type: Solid  
|           |         | SPC Rating: B  
|           |         | Surface Type: Flexible  
|           |         | Expansion Type: Poured Compression  
|           |         | End 1 Substructure: Stub  
|           |         | End 2 Substructure: Stub  
|           |         | Foundation Type: Unknown |
| 14.15     | Fill    | Material Type: Soil  Height: 15 feet  
|           |         | Side slope: 3:1  Length: 800 feet  
|           |         | Crest: 35 feet  Type: Fill - Other  
|           |         | Road Surface Type: Flexible |
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for **Ohio County - Kentucky**
US 231

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<thead>
<tr>
<th>Milepoint</th>
<th>Feature</th>
<th>Data</th>
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</table>
| 14.40     | Pipeline| Pipeline Type - Gas  
Road Surface Type - Flexible |
| 14.50     | Pipeline| Pipeline Type - Gas  
Road Surface Type - Flexible |
| 14.80     | Other   | Junction KY 136 Heading Northwest  
Road Surface Type - Flexible |
| 15.30     | Fill    | Material Type - Soil  
Height 15 feet  
Side slope 3:2  
Length 150 feet  
Crest 30 feet  
Type Fill - Other  
Road Surface Type - Flexible |
| 15.60     | Other   | Junction KY 1737 Heading North  
Road Surface Type - Flexible |
| 15.70     | Fill    | Material Type - Soil  
Height 10 feet  
Side slope 5:2  
Length 500 feet  
Crest 30 feet  
Type Fill - Other  
Road Surface Type - Flexible |
| 15.80     | 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 69 feet  
Width 26 feet  
Pier Type - Open  
SPC Rating - B  
Surface Type - Flexible  
Expansion Type - Other  
End 1 Substructure - Stub  
End 2 Substructure - Stub  
Foundation Type - Unknown |
| 15.85     | Fill    | Material Type - Soil  
Height 10 feet  
Side slope 5:2  
Length 200 feet  
Crest 30 feet  
Type Fill - Other  
Road Surface Type - Flexible |
Report by County and Milepoint for Ohio County - Kentucky
US 231

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### Report by County and Milepoint
**for Ohio County - Kentucky**

#### US 231

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<td>Pond - (60 x 60) feet, 30 feet from Road</td>
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<td>Road Surface Type - Flexible</td>
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## Report by County and Milepoint for Ohio County - Kentucky
*US 231*

<table>
<thead>
<tr>
<th>Milepoint</th>
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<tr>
<td>19.55</td>
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<td>Material Type - Soil Height 20 feet Side slope 2:1 Length 200 feet Crest 30 feet Type Fill - Other Road Surface Type - Flexible</td>
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<td>20.00</td>
<td>Trees</td>
<td>Number of Trees 50 Height 35 feet Diameter 16 in. Ending Milepoint 20.10 Distance From Road 12 feet Road Surface Type - Flexible</td>
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<td>Cut</td>
<td>Cut Slope Type - Rock Height 25 feet Length 200 feet Backslope 1:1 Road Surface Type - Flexible</td>
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<td>20.20</td>
<td>Other</td>
<td>Junction KY 1414 Heading East Road Surface Type - Flexible</td>
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<td>20.25</td>
<td>Fill</td>
<td>Material Type - Soil Height 10 feet Side slope 2:1 Length 200 feet Crest 30 feet Type Fill - Other Road Surface Type - Flexible</td>
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<tr>
<td>20.30</td>
<td>Bridge</td>
<td>Number of Spans 4 Over Stream Concrete T-Beam&lt;br&gt;End 1 Fixed Pier 1 Fixed Pier 2 Fixed&lt;br&gt;Pier 3 Fixed End 2 Fixed&lt;br&gt;Deck Type - Concrete Length 132 feet&lt;br&gt;Width 26 feet Pier Type - Open&lt;br&gt;SPC Rating - B Surface Type - Flexible&lt;br&gt;Expansion Type - Other&lt;br&gt;End 1 Substructure - Stub&lt;br&gt;End 2 Substructure - Stub&lt;br&gt;Foundation Type - Unknown</td>
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