FINAL REPORT

I-69, I-66/I-65 Spurs, and US 60 Connection Strategic Planning Corridor Study

Overview of Existing Conditions

William H. Natcher Parkway, Audubon Parkway, and US 60 Wendell Ford Expressway

May 2014

KENTUCKY TRANSPORTATION CABINET

Palmer ENGINEERING


West Ky Pkwy 6
Morgantown 21
Bowling Green 40

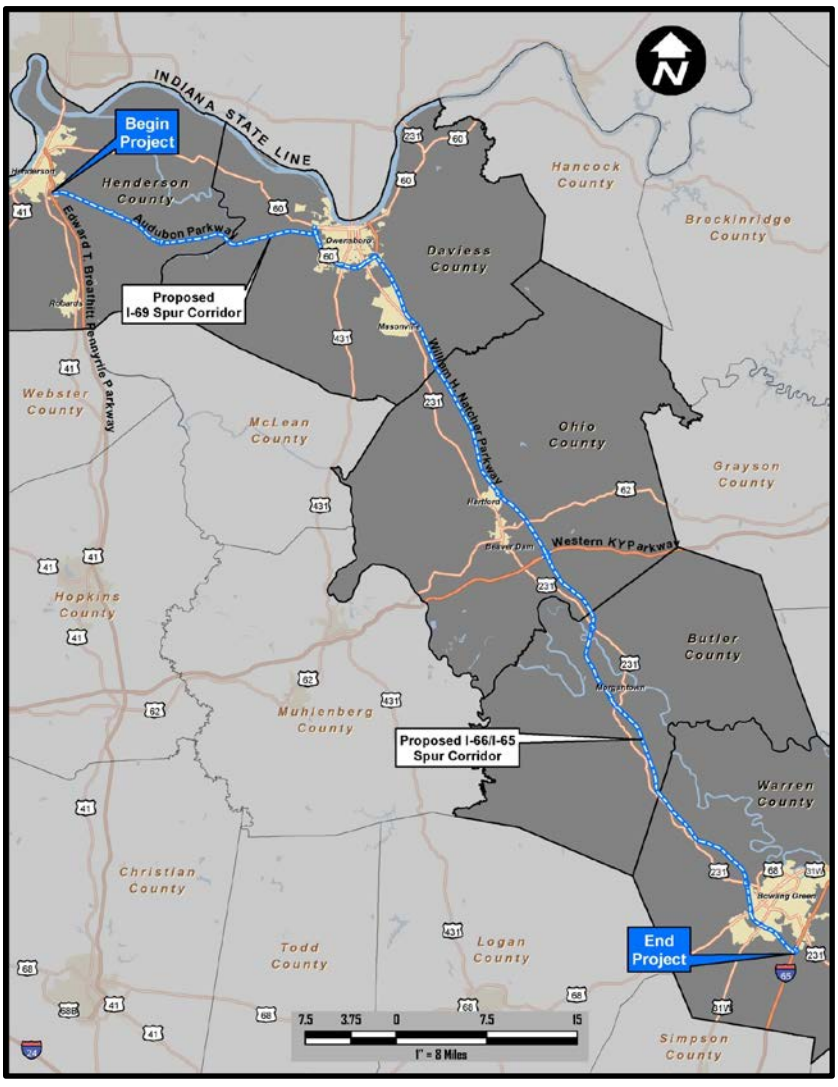
I-69 SPUR, I-66/I-65 SPUR, AND US 60 CONNECTION: HENDERSON TO BOWLING GREEN STRATEGIC CORRIDOR PLANNING STUDY

E X E C U T I V E S U M M A R Y

Kentucky Transportation Cabinet – Division of Planning

MAY 2014

The Kentucky Transportation Cabinet (KYTC) has undertaken a strategic corridor planning study for the proposed interstate routes, Interstate 69 (I-69) Spur and Interstate 66/65 (I-66/I-65) Spur. The project corridor includes the Audubon Parkway from the Edward T. Breathitt (Pennyrile) Parkway in Henderson to Owensboro, Kentucky, US 60 in Owensboro, and the William H. Natcher Parkway from Owensboro to I-65 in Bowling Green, Kentucky. The corridor passes through Henderson, Daviess, Ohio, Butler, and Warren Counties.



STUDY PURPOSE

The primary purpose of this strategic corridor study is to review the existing conditions along the Audubon Parkway, Natcher Parkway, and US 60 to identify locations that do not meet current Association of State Highway Transportation Officials (AASHTO) and Federal Highway Administration (FHWA) highway design guidelines and related criteria. Evaluations include the degree to which these criteria are not met, their impact on safety and capacity, and identify options for making improvements to address identified deficiencies.

PROJECT BACKGROUND

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) Technical Corrections Act of 2008 designates the Audubon Parkway as a future I-69 Spur and the Natcher Parkway as a future I-66 Spur given these routes meet interstate standards and connect to an existing interstate.

STUDY ACTIVITIES

The study activities for the I-69 Spur, I-66/I-65 Spur, and US 60 Connection Strategic Corridor Planning Study included the following:

- Identify criteria and standards per AASHTO and the FHWA for designation as an interstate route;
- Collect data from the KYTC's Highway Information System, As-built plans, crash data, field observation and measurement, and other information provided by local Highway District office;
- Compare and analyze data collected with criteria and identify conditions and locations on the Audubon Parkway, Natcher Parkway, and US 60 that do not meet interstate criteria and standards;
- Develop improvement strategies and costs associated with improving these areas with identified deficiencies to meet criteria and standards for designation as an interstate highway.

KEY FINDINGS

The project routes consist of two travel lanes in each direction, a design speed of 70 miles-per-hour or greater for rural conditions and 50 miles-per-hour for urban conditions, and are fully controlled access facilities. However, some physical features of the project routes do not meet the criteria for an interstate facility. Attached to the end of this summary are figures identifying these physical features, which do not meet interstate criteria.

The following findings are based on available data and limited field reviews:

Operational Considerations and Safety

- Crash Analysis: For the crash analysis, a high crash segment was defined as having a critical crash rate factor greater than or equal to one. Crash segments with a critical crash rate factor between 0.9 and 0.99 are also identified in the report.
- Crash Analysis – Audubon Parkway: Compared to other Kentucky parkways, one segment in Henderson/Daviess County (MP 10.141 – 18.049) has a critical crash rate between 0.9 and 0.99.
- Crash Analysis – Audubon Parkway as an Interstate: Compared to Kentucky interstates, rather than state parkways, one high crash segment was identified along the Audubon Parkway located in Henderson/Daviess County (MP 10.141 – MP 18.049). The segment has a critical crash rate factor of 1.13.
- Additional Findings Related to Crash Analysis: Four crashes coded as *median cross-over* or *head-on* collisions occurred on the Natcher Parkway during the study period (2006-2010). No *median cross-over* or *head-on collisions* were recorded on the Audubon Parkway or US 60 during the study period. Two fatal crashes on the Audubon Parkway, one fatal crash on US 60, and eight fatal crashes on the Natcher Parkway were recorded during the study period (2006-2010).
- Current Traffic (2011): The current traffic (2011) for the Audubon Parkway ranges from 9,450 vehicles per day (vpd) near Henderson to 10,590 vpd near the US 60 interchange in Owensboro. On US 60, the traffic volumes range from 19,200 vpd near the Audubon Parkway interchange to 32,400 vpd between the US 231 and US 431 interchanges. On the Natcher Parkway, the traffic volumes range from 7,940 vpd at the Western Kentucky Parkway interchange to 20,400 vpd near the I-65 interchange in Bowling Green.
- Truck Percentages (2011): The existing truck percentages on the Audubon Parkway range from 19.5% at Owensboro to 21.1% at Henderson, Kentucky. On US 60, the truck percentages range from 10.1% to 12.4%. The existing truck percentages on the Natcher Parkway range from 19.9% in Morgantown to 32.9% north of the Western Kentucky Parkway interchange in Ohio and Daviess Counties.
- Future Traffic (2040) without Interstate Spur Designations: The projected annual growth rates range from 2.1% to 2.3% along the Audubon Parkway, from 1.5% to 2.3% on US 60, and from 0.9% to 3.1% on the Natcher Parkway. The growth rates resulted in a range from 18,400 vpd to 20,500 vpd on the Audubon Parkway, 36,100 vpd to 49,900 vpd on US 60, and 10,800 vpd to 49,500 vpd on the Natcher Parkway.
- Future Traffic (2040) with Interstate Spur Designations: The projected annual growth rates range from 2.3% to 2.6% along the Audubon Parkway, from 1.8% to 2.5% on US 60 and from 1.1% to 3.6% on the Natcher Parkway. The projected growth rates resulted in traffic volumes ranging from

19,500 vpd to 22,300 vpd on the Audubon Parkway, 38,200 vpd to 54,400 vpd on US 60, and 11,500 vpd to 56,900 vpd on the Natcher Parkway.

- Truck Percentages (2040): Future truck volumes were not forecast for this project.
- Level of Service (2011): The Audubon Parkway, Natcher Parkway, and US 60 currently operate at LOS C or better, which is acceptable to the AASHTO guidelines.
- Level of Service (2040): The Audubon Parkway is expected to operate at LOS B or better with or without interstate spur designation. US 60 is expected to operate at LOS D or better with or without interstate spur designation. The rural sections of the Natcher Parkway are expected to operate at LOS B or better with or without interstate spur designation. The urban sections of the Natcher Parkway are expected to operate at LOS D or better without interstate spur designation and LOS E or better with interstate spur designation.

Mainline Geometry/Typical Section

- Design Speed: The Audubon Parkway, US 60, and Natcher Parkway meet or exceed the minimum design speed guidelines for interstate highways in rural and urban areas.
- Lane Width: The lane width on the Audubon Parkway, US 60, and Natcher Parkway meet the minimum AASHTO guidelines for interstate design.
- Outside Shoulder Width: The Audubon Parkway, Natcher Parkway, and US 60 meet the AASHTO minimum outside shoulder width based on the current truck DDHV.
- Inside Shoulder Width: The AASHTO minimum inside shoulder width is met on the Audubon Parkway, Natcher Parkway, and US 60.
- Median Width: The Audubon Parkway, Natcher Parkway, and US 60 meet the rural 36-foot AASHTO minimum median width in rural areas and the 10-foot AASHTO minimum median width in urban areas.
- Clear Zones: Based on the provided information and limited field reviews, it is not possible to evaluate the applicability of the current design standards for clear zone on the Audubon Parkway, Natcher Parkway, and US 60. The fill and cut slopes provided in the typical sections vary from 1V:2H to 1V:4H, the median ditch slope varies from 1V:3H to 1V:12H, and the outside ditch slope is between 1V:3H and 1V:4H.
- Guardrail Placement and Condition: The guardrail leading end treatments on the Audubon Parkway, Natcher Parkway, and US 60 meet the current standards. Dome guardrail trailing end treatments on the Audubon Parkway, Natcher Parkway, and US 60 do not meet current standards. An evaluation of guardrail placement is not possible based on the information provided on the As-built plans.
- Superelevation: From the review of As-built plans, horizontal curves along the Audubon Parkway, Natcher Parkway, and US 60 appear to comply with the AASHTO criteria.
- Horizontal Alignment: The horizontal curvature for the Audubon Parkway, Natcher Parkway, and US 60 is acceptable and in compliance with the current AASHTO design guidelines.
- Vertical Alignment: All of the vertical curves along the Audubon Parkway and US 60 meet the current AASHTO guidelines. One vertical curve on the Natcher Parkway (MP 53.800) does not meet the guideline for the minimum length of vertical curves.
- Stopping Sight Distance: The minimum stopping sight distance guideline is not met for one vertical curve on the Natcher Parkway: MP 53.800.

Bridges and Overpasses

- Lateral Clearance – Audubon Parkway: All of the mainline bridges on the Audubon Parkway meet the minimum lateral clearance. (The bridges at the Pennyrile Parkway and US 60 interchanges are not included.)
- Lateral Clearance – US 60: Four of the mainline bridges on US 60 do not meet the minimum lateral clearance requirement. (The bridges at the Audubon Parkway and Natcher Parkway are not included.)
- Lateral Clearance – Natcher Parkway: Of the 39 mainline bridges on the Natcher Parkway, 32 do not meet the minimum lateral clearance. (The bridges at the US 60 interchanges are not included.)
- Vertical Clearance – Audubon Parkway: All of the overpass bridges meet the minimum 16 foot vertical clearance requirement.

- Vertical Clearance – US 60: One overpass bridge does not meet the minimum 16-foot vertical clearance requirement (MP 11.611). The clearance is not met on the eastbound and westbound lanes on US 60.
- Vertical Clearance – Natcher Parkway: Of the 26 overpass bridges on the Natcher Parkway, 2 do not meet the minimum 16-foot vertical clearance requirement. They are located at MP 62.352 and MP 33.741.
- Functional Adequacy: Seventeen mainline bridges and culverts are identified as functionally obsolete; nine overpass bridges are identified as functionally obsolete.
- Sufficiency Rating: All Audubon Parkway, Natcher Parkway, and US 60 mainline and overpass bridges have a sufficiency rating greater than 60.0. Three culverts have a sufficiency rating less than 60.0.

Interchanges and Ramps

- Design Speed: Design speed for a majority of the interchange ramps was not provided on the as-built plans.
- Lane Width: Lane widths for the interchange ramps range from 15 feet to 16 feet, which is compliant with AASHTO guidelines.
- Shoulder Width: All of the interchange ramps on the Audubon Parkway, Natcher Parkway, and US 60 have 4-foot paved inside shoulders and 6-foot paved outside shoulders, which meet current practice.
- Horizontal Alignment: The minimum horizontal radius is met on all interchange ramps that were provided on the As-built plans.
- Vertical Alignment - Vertical Grade: The minimum vertical grade is met on all interchange ramps that were provided on the As-built plans.
- Vertical Alignment - Vertical Length of Curve: Eight ramp vertical curves do not meet the requirement for minimum length of curve that was calculated based on the minimum ramp design speed. On the Audubon Parkway, these ramps are located at the Pennyrile Parkway interchange (Exit 1) and US 60 interchange (Exit 24). On the Natcher Parkway, these ramps are located at the US 31 W interchange (Exit 6), the US 231 interchange (Exit 28) and the Western Kentucky Parkway interchange (Exit 43). On US 60, the Natcher Parkway and US 60 interchange also has vertical curves that do not meet the calculated minimum length of curve.
- Vertical Alignment - Stopping Sight Distance: Eight vertical curve ramps do not meet the minimum stopping sight distance requirement that was calculated based on the minimum ramp design speed. The vertical curves that do not meet the minimum stopping sight distance are located at the interchanges previously mentioned for vertical length of curve.
- Superelevation: Based on review of As-built plans, existing ramps appear to satisfy the AASHTO criteria for superelevation.
- Speed-Change Lanes: Many of the existing ramps on the Audubon Parkway, Natcher Parkway, and US 60 do not meet the minimum criteria for acceleration and deceleration lengths.
- Weaving Characteristics: The weaving situation within the Natcher Parkway and Western Kentucky Parkway will operate at LOS A in the northbound and southbound directions with future interstate spur traffic projections. The interchanges at Exits 9, 36, and 50 on the Natcher Parkway and Exit 10 on the Audubon Parkway are cloverleaf interchanges with weaving within the interchange.
- Interchange Spacing: On US 60, two locations do not meet the minimum interchange spacing. The interchange spacing between the Audubon Parkway interchange (Exit 10) and the KY 81 interchange (Exit 11) is less than one mile. The interchange spacing between the KY 81 interchange (Exit 11) and the Carter Road interchange (Exit 12) is also less than one mile. On the Natcher Parkway, one location does not meet the minimum interchange spacing requirements. The two interchanges (Exits 28 and 29) in Butler County are within three miles of each other.
- Interchange Control of Access: Two interchanges (Exit 5 and Exit 18) on the Audubon Parkway do not meet the minimum interchange control of access requirement. The minimum interchange control of access requirement is also not met at Exit 12 on US 60, and Exits 28 and 36 on the Natcher Parkway.
- Interchange Configuration: Currently, the Audubon Parkway and Natcher Parkway have four service interchanges that do not meet the recommended interstate interchange configuration. On the Audubon Parkway, the interchange is located at Exit 10. The remaining three interchanges are on

the Natcher Parkway located at Exit 9, Exit 36, and Exit 50. These four interchanges were locations for toll plazas before tolls were removed from the route.

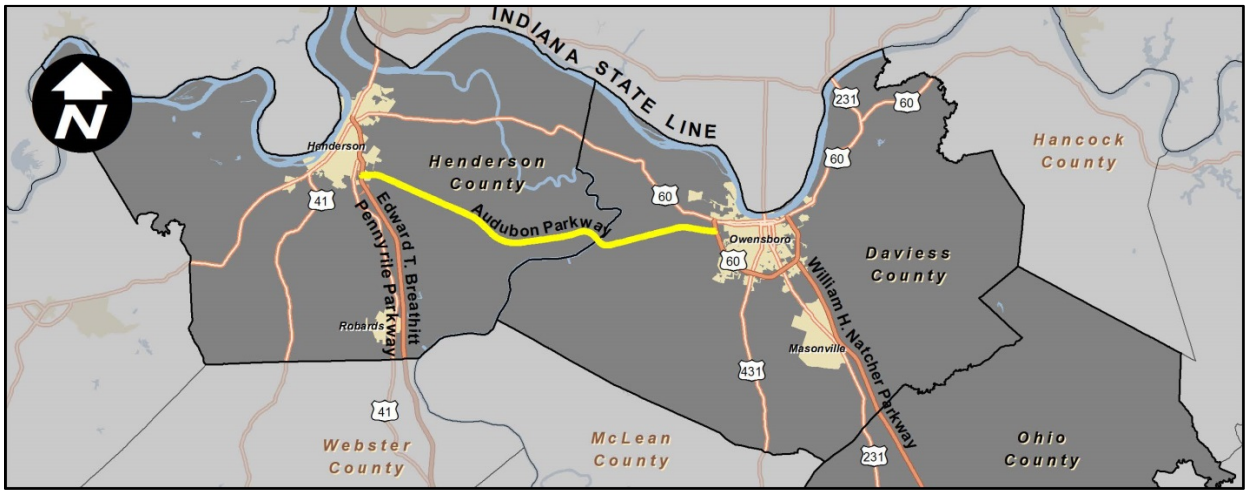
IMPROVEMENT STRATEGIES AND COSTS

The range of improvement strategies under consideration are No Build, Necessary Upgrades and Spot Safety Improvements, and Fully Compliant Reconstruction. These strategies represent incremental levels of infrastructure investment needed to implement I-69 Spur and I-66/I-65 Spur in Central and Western Kentucky.

- **No Build** – The Audubon Parkway, Natcher Parkway, and US 60 would continue to provide connectivity for the future interstate spur traffic but would not meet interstate criteria. The Audubon Parkway, Natcher Parkway, and US 60 would remain as they currently exist without the interstate spur designation. This alternative would not require any additional funding for the construction related to upgrading the facilities to current interstate standards.
- **Necessary Upgrades and Spot Safety Improvements** - Key safety and operational concerns would be addressed. Under this improvement strategy the Audubon Parkway, Natcher Parkway, and US 60 would be upgraded to meet some, but not all current interstate standards. Design exceptions and variances would be required for those design features that do not meet current criteria or standards. Design exceptions and design variances would require further study to determine if a design exception is deemed appropriate by the KYTC and the FHWA. New infrastructure and improvements along the parkways and US 60 would be proposed to upgrade necessary features and improve safety for those locations that are not addressed by design exceptions and variances.
- **Fully Compliant Reconstruction** – This improvement strategy would involve improvements within existing right of way or with minimum right of way acquisition necessary for making the existing parkways and US 60 fully compliant with minimum AASHTO criteria for interstate routes.

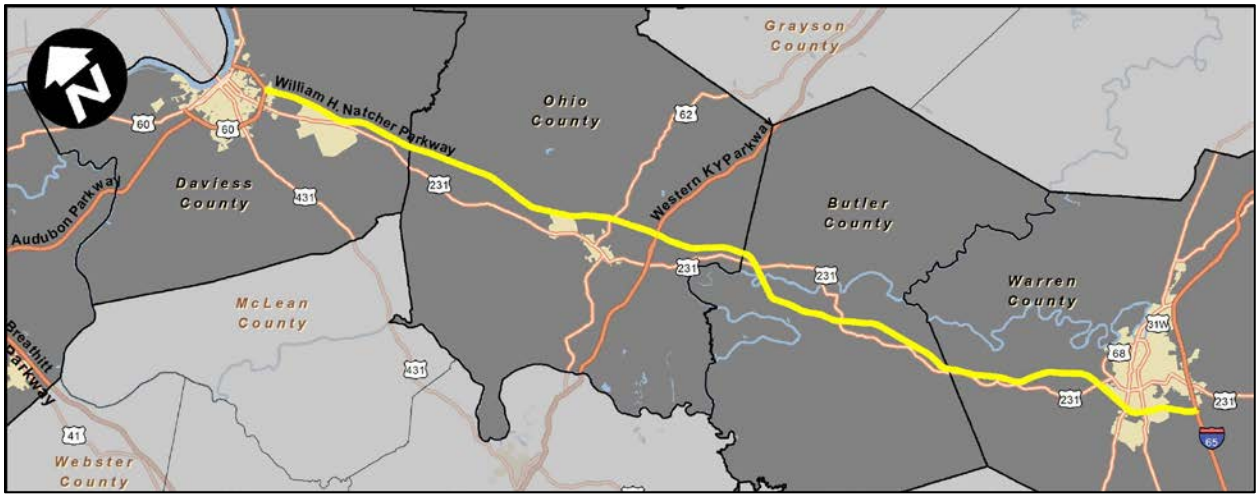
Based on the study, there are four possible interstate route designation options for the Audubon Parkway, Natcher Parkway, and US 60. Options for I-66 Spurs specifically are not included because at this time no active KYTC I-66 projects are within the study area. These possible interstate route designation options are presented below.

- **<u>Option 1 - I-69 Spur</u>**



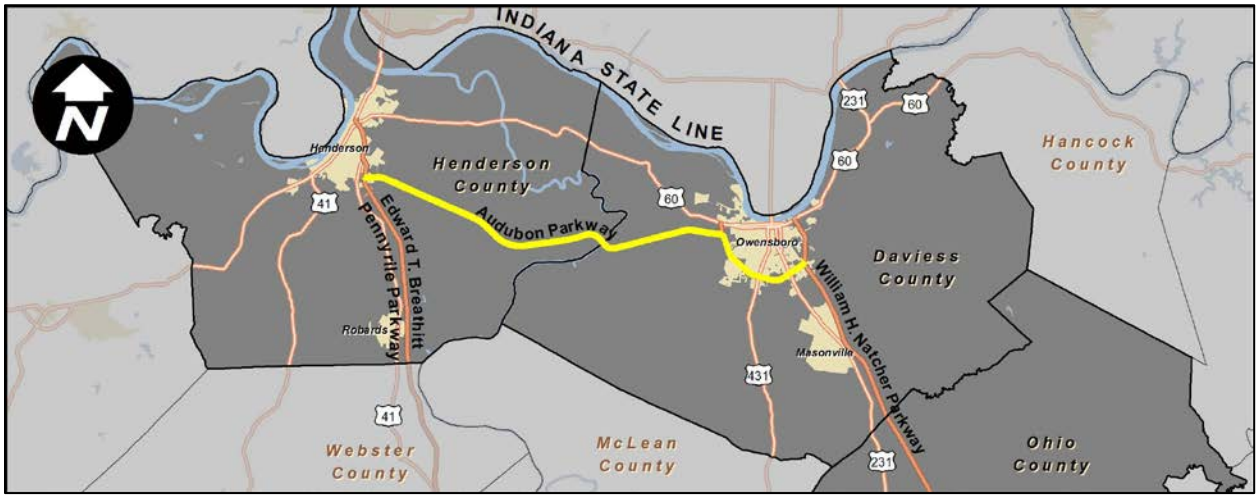
This option designates the I-69 Spur to follow along the Audubon Parkway from Henderson to the US 60 interchange in Owensboro. The interstate spur would begin at I-69 south of Henderson and would terminate at the US 60 interchange in Owensboro. At the time of this report, the I-69 alignment through Henderson is under evaluation, and the intersecting location with the Audubon Parkway is undetermined. The Audubon Parkway cannot be designated as an interstate spur until it connects with a route that has been designated as I-69.

- **Option 2 - I-66/I-65 Spur**



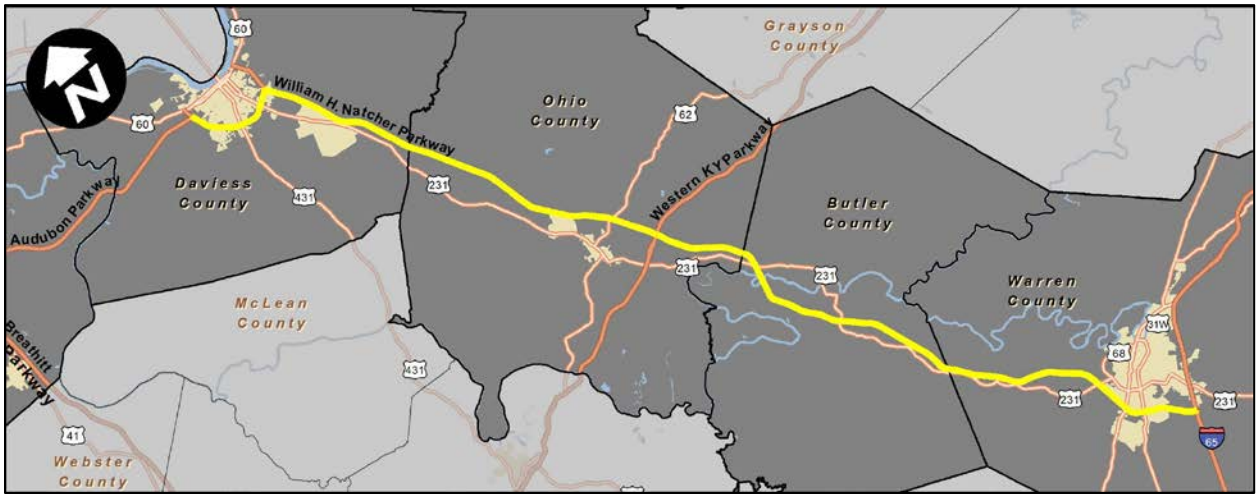
This option designates the I-66/I-65 Spur along the Natcher Parkway from I-65 in Bowling Green to the US 60 interchange in Owensboro. The I-66/I-65 Spur would begin at the existing I-65 and Natcher Parkway interchange and terminate at the existing Natcher Parkway and US 60 interchange at the east side of Owensboro.

- **Option 3 - I-69 Spur including US 60**



The third option designates the Audubon Parkway and US 60 as I-69 Spur. Similar to Option 1, the I-69 Spur would follow along the Audubon Parkway from south of Henderson to the US 60 interchange in Owensboro. The spur would continue along US 60 and terminate at the US 60 and Natcher Parkway interchange on the east side of Owensboro. At the time of this report, the I-69 alignment through Henderson is under evaluation, and the intersecting location with the Audubon Parkway is undetermined. The Audubon Parkway and US 60 cannot be designated as an interstate spur until the Audubon Parkway connects with a route that has been designated as I-69.

- **Option 4 - I-66/I-65 Spur including US 60**



This option designates the Natcher Parkway and US 60 as I-66/I-65 Spur. Similar to Option 2, the I-66/I-65 spur would follow along the Natcher Parkway from I-65 in Bowling Green to the US 60 interchange in Owensboro. The spur would continue on US 60 and terminate at the US 60 and Audubon Parkway interchange on the west side of Owensboro.

The following table provides a range of preliminary cost estimates for the interstate route designations. As noted, the Necessary Upgrades and Spot Safety Improvement Strategy would require design exceptions and variances for those design features that do not meet interstate standards. The Fully Compliant Reconstruction Strategy improves all geometric deficiencies and does not require any design exceptions or variances. The cost range provided illustrates the cost variation between the improvement strategies. The lower cost estimate represents the Necessary Upgrades and Spot Safety Improvement Strategy, and the upper cost estimate represents the Fully Compliant Reconstruction Strategy. After further analysis of the identified deficiencies, KYTC will need to recommend strategies to the Federal Highway Administration to bring the deficiencies into compliance with interstate criteria. Available options include addressing the required improvements through construction, requesting design exceptions/variances, committing to future improvements as part of the on-going maintenance and operation of the facility. It is anticipated that some combination of these approaches will be used. Thus, as projects for implementation of improvement strategies are initiated, additional engineering analyses and studies will be needed to further refine the specifics for improvements and to document the recommendations

Interstate Designation Option	Interstate Miles	Cost [1] (million)			Cost per Mile (million)		
1. I-69 Spur - Audubon Parkway	**23.4**	$13.99	-	$14.73	$0.60	-	$0.63
2. I-66/I-65 Spur - Natcher Parkway	**70.2**	$66.21	-	$75.87	$0.94	-	$1.08
3. I-69 Spur - Audubon Parkway & US 60	**30.1**	$65.17	-	$87.15	$2.17	-	$2.90
4. I-66/I-65 Spur - Natcher Parkway & US 60	**76.9**	$117.39	-	$148.29	$1.53	-	$1.93

Necessary Upgrades and Spot Safety Improvement Strategy

Fully Compliant Reconstruction Strategy

[1] Cost for routine maintenance is not depicted in estimate

Table ES-1 - Cost Comparison of Potential Alternatives

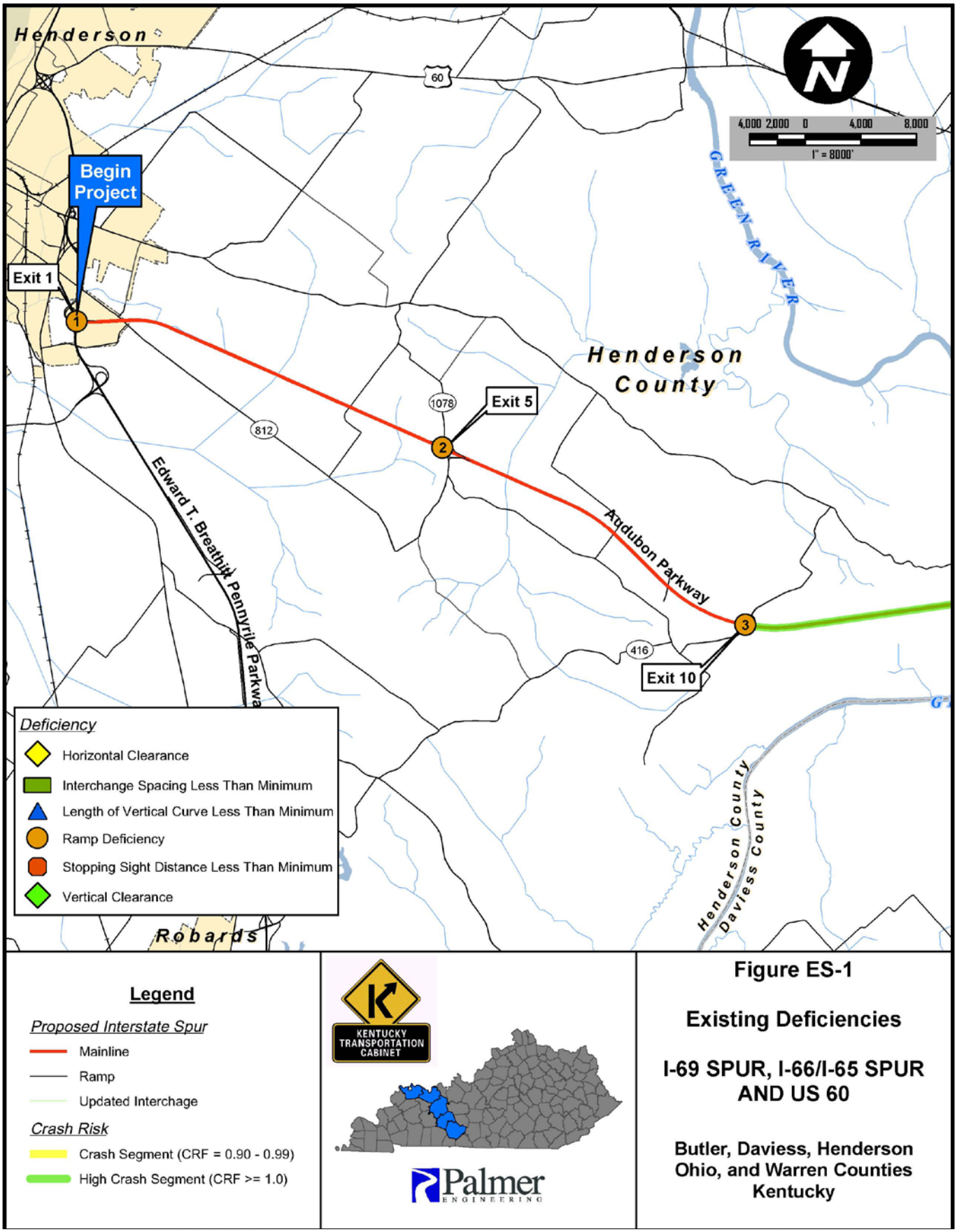
SUMMARY

Information presented herein is a ***first look planning-level study*** to identify deficiencies and impediments for interstate spur designation and to identify a range of improvement strategies needed to upgrade the Audubon Parkway, Natcher Parkway, and US 60 to satisfy applicable interstate criteria. After further analysis of the identified deficiencies, KYTC will need to recommend strategies to the

Federal Highway Administration to bring the deficiencies into compliance with interstate criteria. Available options include addressing the required improvements through construction, requesting design exceptions/variances, committing to future improvements as part of the on-going maintenance and operation of the facility. It is anticipated that some combination of these approaches will be used. Thus, as projects for implementation of improvement strategies are initiated, additional engineering analyses and studies will be needed to further refine the specifics for improvements and to document the recommendations.

For example, the following may be areas for further analysis:

- Operational Considerations – Roadway conditions not shown in crash data may be contributing to crash history. Additional analyses during preliminary engineering may provide additional insight that could refine the scope of needed improvements at a given location.
- Mainline Geometry and Typical Section – Analyses for mainline geometry and typical section were evaluated using As-built plans supplemented with limited field reviews of existing conditions. Actual design features may require further verification with detailed field surveys of the roadway cross-section during preliminary engineering for implementing improvement strategies.
- Interchanges and Ramps – Most of the interchange ramps are deficient, and some design features were illegible on the As-built plans. Therefore, as interchanges are identified for improvement, geometric features (i.e. superelevation rate, horizontal and vertical alignments, design speed, etc.) should be further analyzed.


Henderson
60
Begin Project
Exit 1
1
1078
Exit 5
812
2
Henderson County
GREEN RIVER
4,000 2,000 0 4,000 8,000
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Edward T. Breathitt Pennyrile Parkway
Audubon Parkway
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Interchange Spacing Less Than Minimum
Length of Vertical Curve Less Than Minimum
Ramp Deficiency
Stopping Sight Distance Less Than Minimum
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Legend
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
Crash Risk
Crash Segment (CRF = 0.90 - 0.99)
High Crash Segment (CRF >= 1.0)
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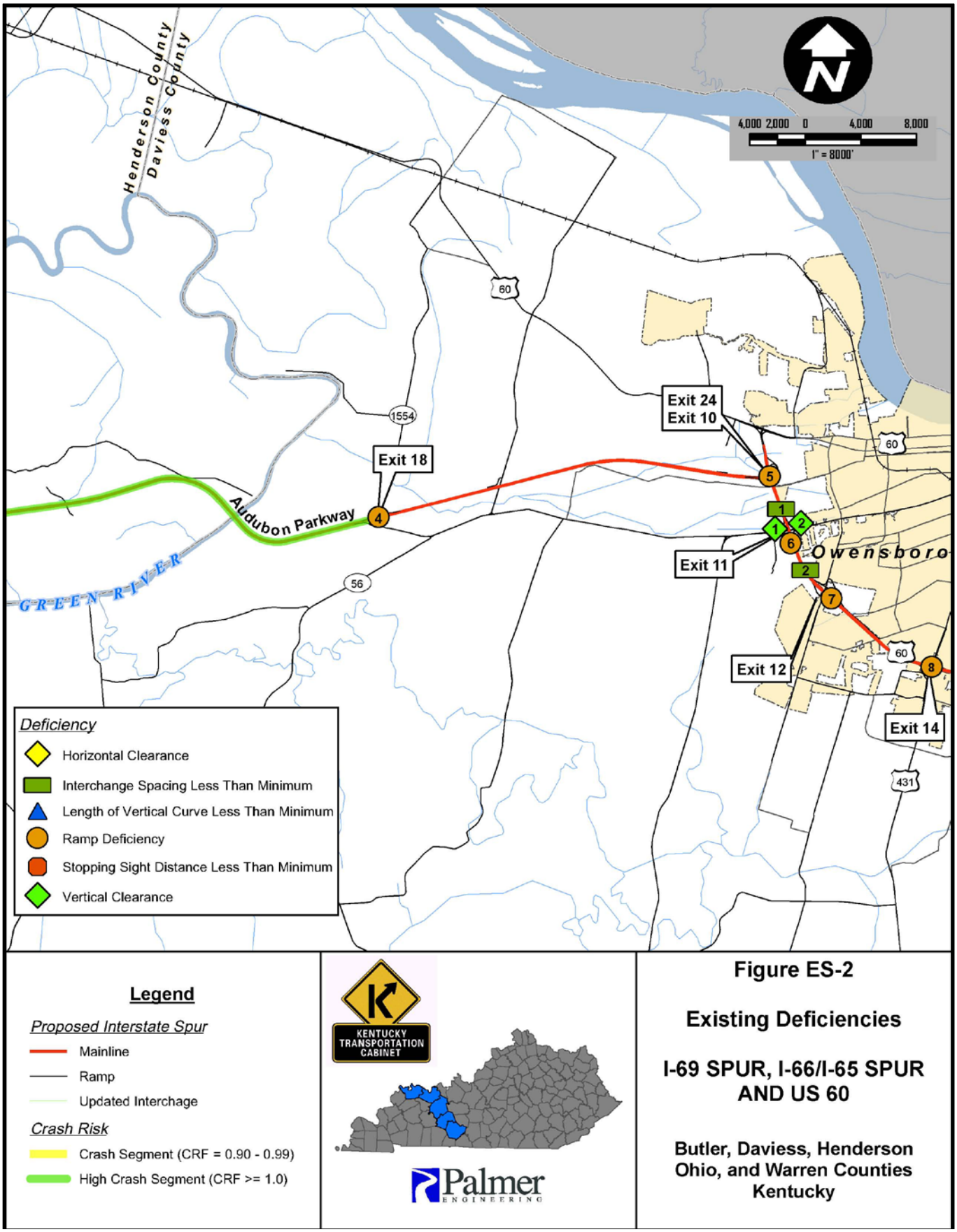
Figure ES-1
Existing Deficiencies
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky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Exit 18
Audubon Parkway
GREEN RIVER
56
Exit 11
Owensboro
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Exit 14
431
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Horizontal Clearance
Interchange Spacing Less Than Minimum
Length of Vertical Curve Less Than Minimum
Ramp Deficiency
Stopping Sight Distance Less Than Minimum
Vertical Clearance
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Proposed Interstate Spur
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Crash Risk
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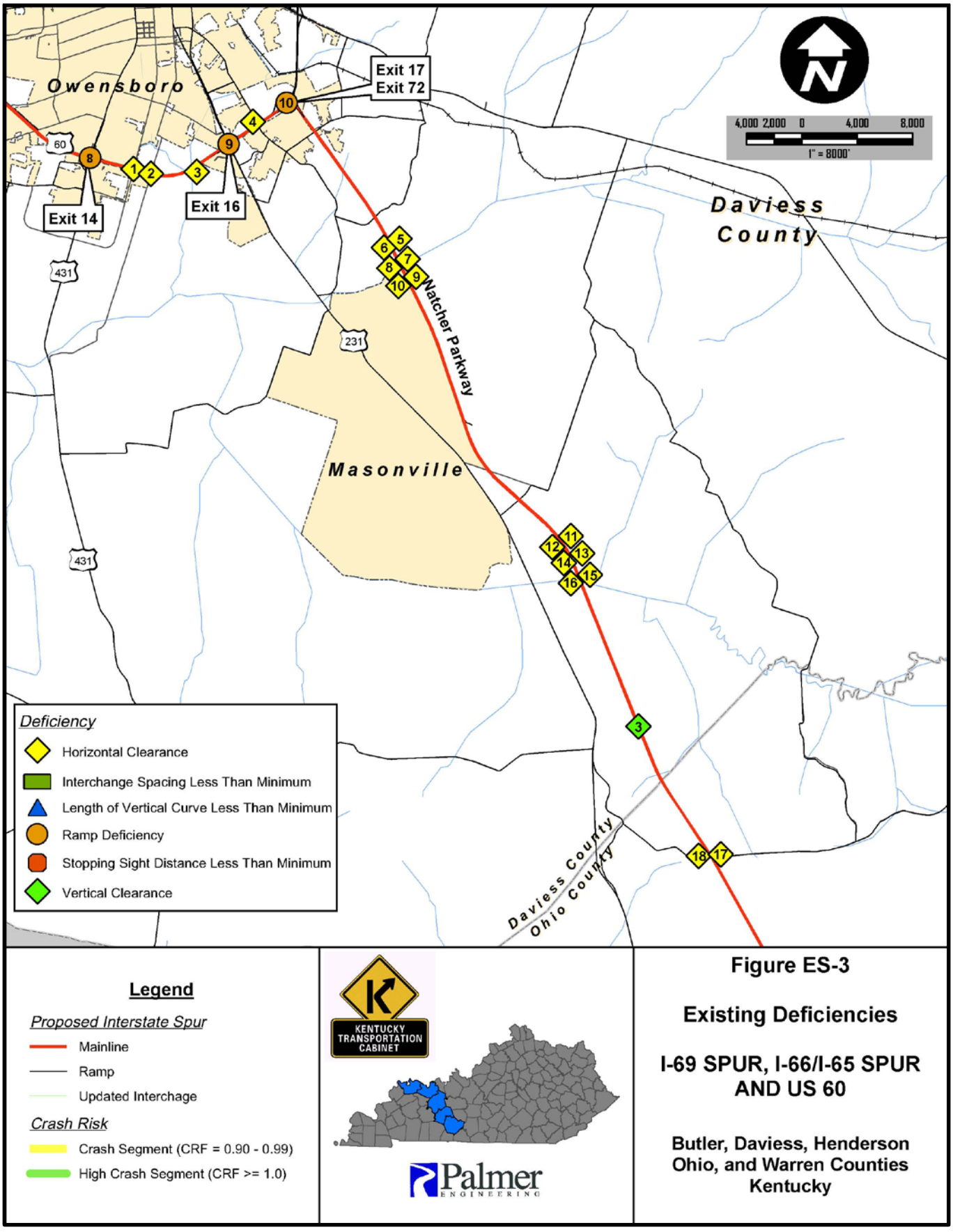
Figure ES-2
Existing Deficiencies
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Owensboro
Exit 17
Exit 72
Exit 14
Exit 16
Daviess
County
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Ohio County
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Deficiency
Horizontal Clearance
Interchange Spacing Less Than Minimum
Length of Vertical Curve Less Than Minimum
Ramp Deficiency
Stopping Sight Distance Less Than Minimum
Vertical Clearance
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High Crash Segment (CRF >= 1.0)
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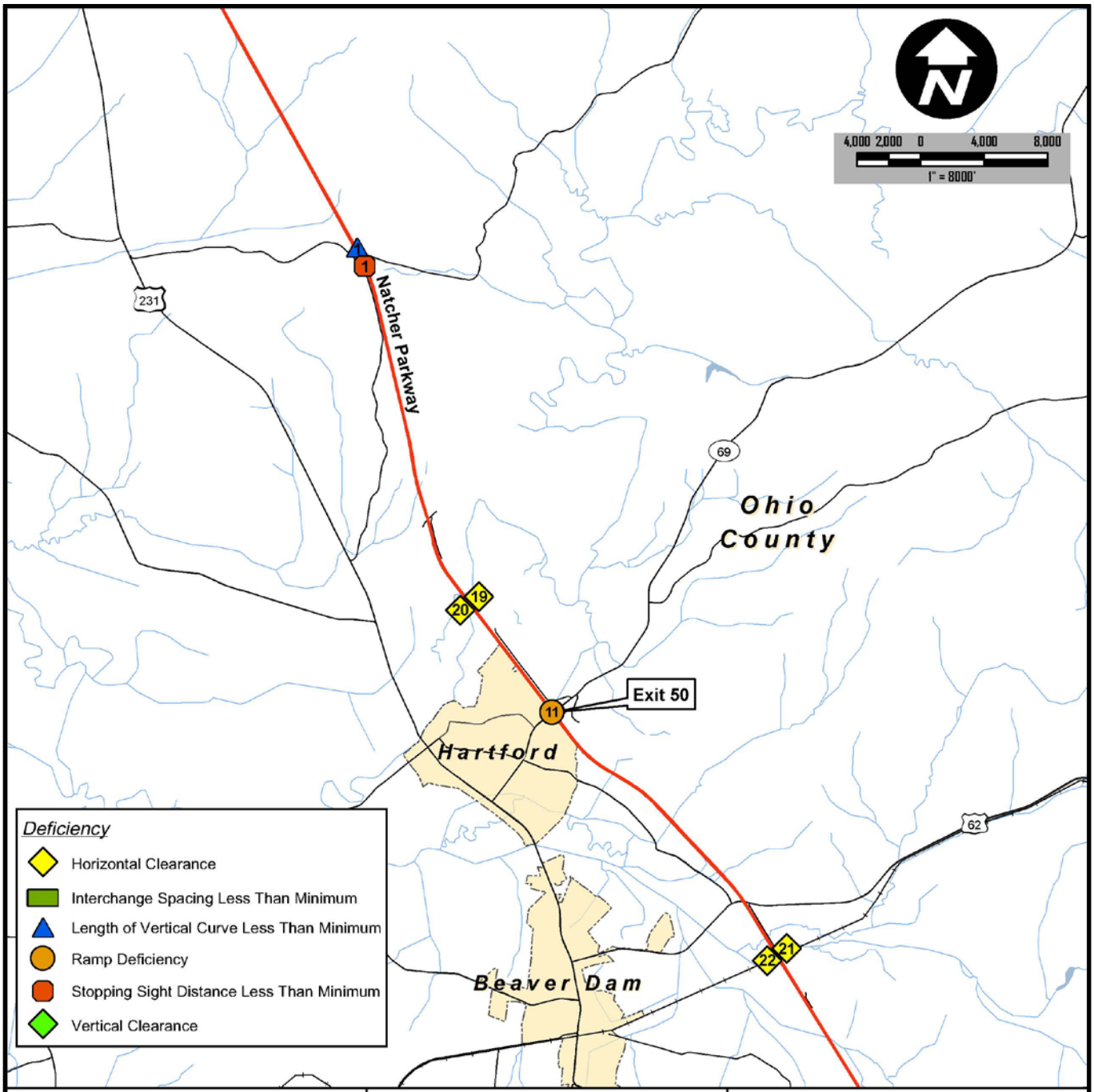
Figure ES-3
Existing Deficiencies
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur
- Mainline
- Ramp
- Updated Interchage

Crash Risk
- Crash Segment (CRF = 0.90 - 0.99)
- High Crash Segment (CRF >= 1.0)

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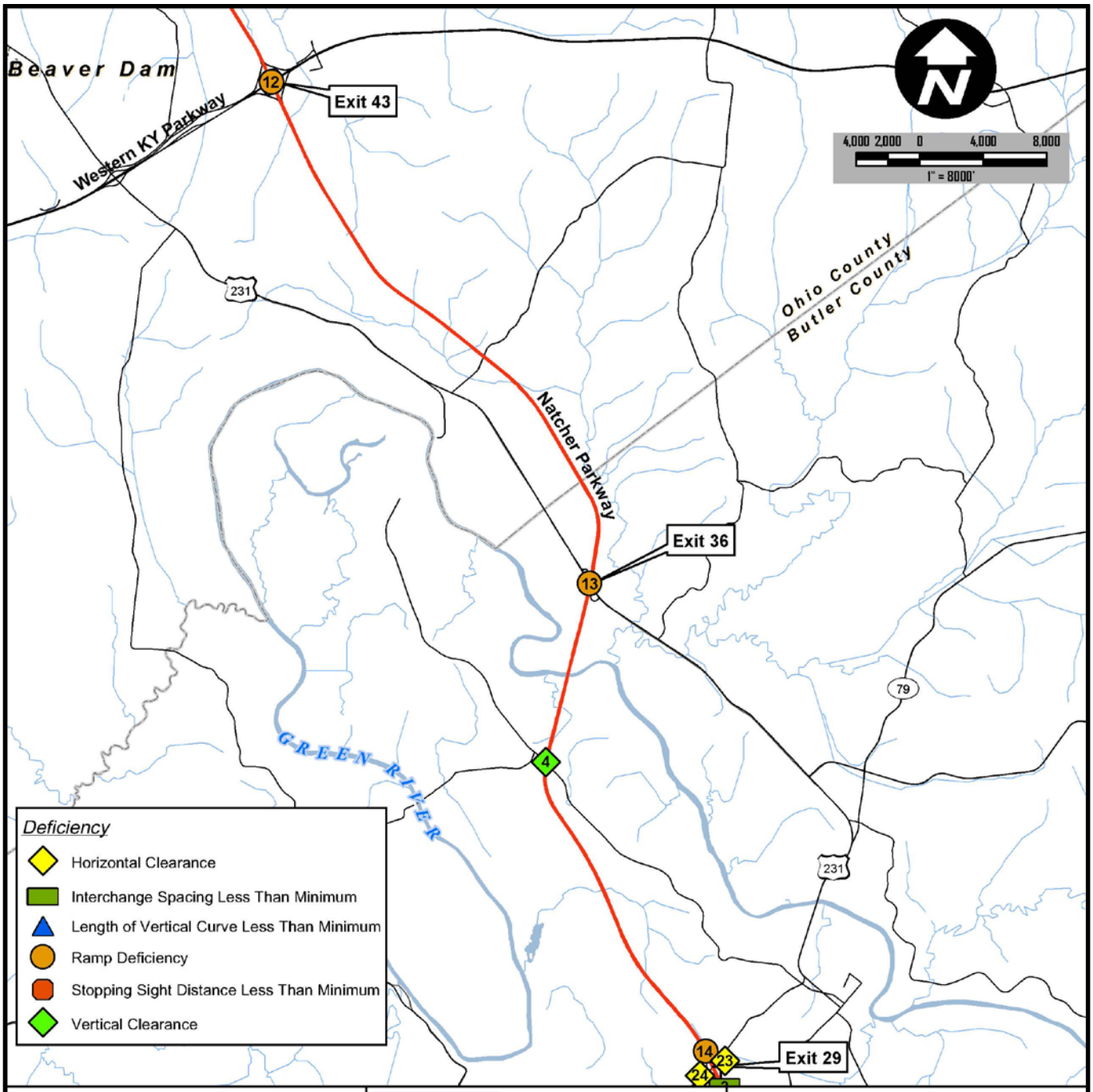
Figure ES-4

Existing Deficiencies

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur
- Mainline
- Ramp
- Updated Interchage

Crash Risk
- Crash Segment (CRF = 0.90 - 0.99)
- High Crash Segment (CRF >= 1.0)

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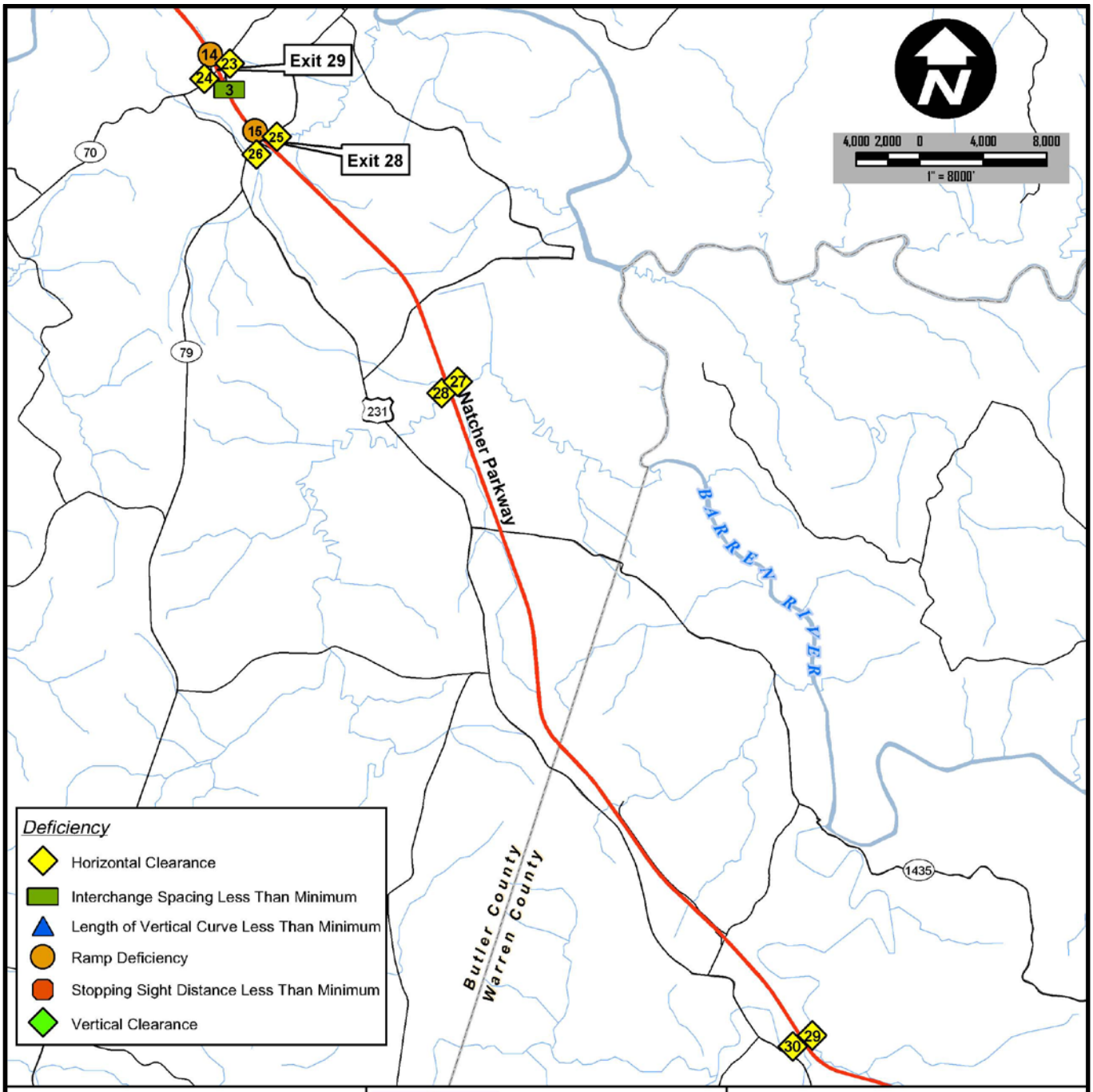
Figure ES-5

Existing Deficiencies

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur

- Mainline
- Ramp
- Updated Interchage

Crash Risk

- Crash Segment (CRF = 0.90 - 0.99)
- High Crash Segment (CRF >= 1.0)

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Figure ES-6

Existing Deficiencies

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky

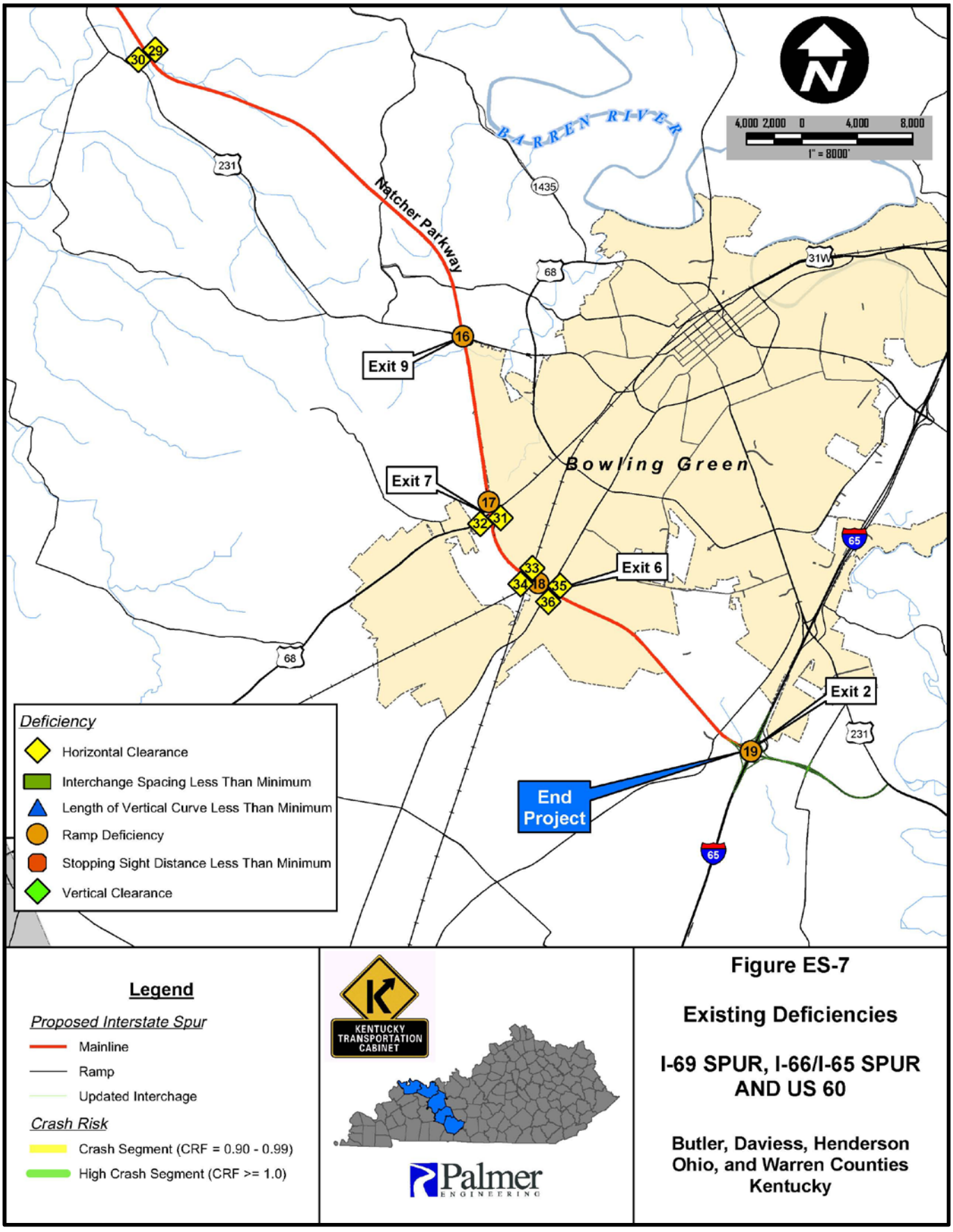
Natcher Parkway
BARREN RIVER
Bowling Green
Exit 9
Exit 7
Exit 6
Exit 2
End Project
231
1435
68
31W
65
4,000 2,000 0 4,000 8,000
1" = 8000'
Deficiency
Horizontal Clearance
Interchange Spacing Less Than Minimum
Length of Vertical Curve Less Than Minimum
Ramp Deficiency
Stopping Sight Distance Less Than Minimum
Vertical Clearance
Legend
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
Crash Risk
Crash Segment (CRF = 0.90 - 0.99)
High Crash Segment (CRF >= 1.0)
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure ES-7
Existing Deficiencies
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky

Table ES-2 Deficiencies Summary

Deficiency Type	Milepoint	Deficiency Description
Audubon Parkway - Henderson / Daviess Counties		
1	Exit 1	Taper Length < Min
2	Exit 5	Taper Length < Min; Ramp Entrance Deficient
		Interchange control of access less than 300' minimum
Barrier Wall Deficiency	6.223	Barrier wall does not meet current standard
	6.223	
	10.141 - 18.049	High Crash Segment - CRF= 1.13 (CRF >=1.0)
3	Exit 10	Taper Length < Min; Ramp Entrance Deficient; Previous Toll Plaza
Barrier Wall Deficiency	15.839	Barrier wall does not meet current standard
4	Exit 18	Taper Length < Min; Divergence Angle > Max;
		Interchange control of access less than 300' minimum
Barrier Wall Deficiency	22.701	Barrier wall does not meet current standard
	22.701	
5	Exit 24 / Exit 10 (US 60)	Divergence Angle > Max; Taper Length < Min
US 60 - Daviess County		
1	11.230	Interchange spacing less than 1 mile minimum
6	Exit 11	Taper Length < Min
1	11.611	Vertical clearance = 15.61' (16' minimum)
2	11.611	Vertical clearance = 15.31' (16' minimum)
2	12	Interchange spacing less than 1 mile minimum
Barrier Wall Deficiency	12.011	Barrier wall does not meet current standard
	12.011	
7	Exit 12	Taper Length < Min
		Interchange control of access less than 100' minimum
Barrier Wall Deficiency	13.564	Barrier wall does not meet current standard
	13.564	
8	Exit 14	Taper Length < Min
Barrier Wall Deficiency	14.416	Barrier wall does not meet current standard
	14.416	
1	15.026	Horizontal Clearance = 30' (Note bridge is less than 200' long)
		Barrier wall does not meet current standard

(**Table ES-2** continued on following page)

Table ES-2 (Continued) Deficiencies Summary

Deficiency Type	Milepoint	Deficiency Description
US 60 - Daviess County		
	15.272	Horizontal Clearance = 30' (Note bridge is less than 200' long)
		Barrier wall does not meet current standards
Barrier Wall Deficiency	15.272	Barrier wall does not meet current standards
	15.842	Horizontal Clearance = 34' (Note bridge is less than 200' long)
	Exit 16	Taper Length < Min
	16.943	Horizontal Clearance = 33.8' (Note bridge is less than 200' long)
	Exit 17 / Exit 72 (Natcher)	Divergence Angle > Max; Taper Length < Min
Natcher Parkway - Daviess / Ohio / Butler / Warren Counties		
	69.846	Horizontal Clearance = 30.5' (Note bridge is less than 200' long)
	69.846	Horizontal Clearance = 30.5' (Note bridge is less than 200' long)
	69.522	Horizontal Clearance = 30.5' (Note bridge is less than 200' long)
	69.522	Horizontal Clearance = 30.5' (Note bridge is less than 200' long)
	69.327	Horizontal Clearance = 30.5' (Note bridge is less than 200' long)
	69.327	Horizontal Clearance = 30.5' (Note bridge is less than 200' long)
	65.028	Horizontal Clearance = 30' (Note bridge is less than 200' long)
		Barrier wall does not meet current standards
	65.028	Horizontal Clearance = 30' (Note bridge is less than 200' long)
		Barrier wall does not meet current standards
	64.835	Horizontal Clearance = 30' (Note bridge is less than 200' long)
		Barrier wall does not meet current standards

(**Table ES-2** continued on following page)

Table ES-2 (Continued) Deficiencies Summary

Deficiency Type	Milepoint	Deficiency Description
Natcher Parkway - Daviess / Ohio / Butler / Warren Counties		
	64.835	Horizontal Clearance = 30' (Note bridge is less than 200' long)
		Barrier wall does not meet current standards
	64.485	Horizontal Clearance = 30' (Note bridge is less than 200' long)
		Barrier wall does not meet current standards
	64.485	Horizontal Clearance = 30' (Note bridge is less than 200' long)
		Barrier wall does not meet current standards
	62.352	Vertical clearance = 15.96' (16' minimum)
	60.328	Horizontal Clearance = 30' (Note bridge is less than 200' long)
		Barrier wall does not meet current standards
	60.328	Horizontal Clearance = 30' (Note bridge is less than 200' long)
		Barrier wall does not meet current standards
	51.491	Horizontal Clearance = 30' (Note bridge is less than 200' long)
		Barrier wall does not meet current standards
	51.491	Horizontal Clearance = 30' (Note bridge is less than 200' long)
		Barrier wall does not meet current standards
	53.800	Length of Vertical Curve = 800' (829' calcuated minimum)
	53.800	Stopping Sight Distance = 710' (730' minimum)
	Exit 50	Taper Length < Min; Entrance Ramp Deficient; Previous Toll Plaza
Barrier Wall Deficiency	46.645	Barrier wall does not meet current standards
	46.645	
Barrier Wall Deficiency	46.146	Barrier wall does not meet current standards
	46.146	
	45.88	Horizontal Clearance = 30' (Note bridge is over 200' long)
		Barrier wall does not meet current standards

(**Table ES-2** continued on following page)

Table ES-2 (Continued) Deficiencies Summary

Deficiency Type	Milepoint	Deficiency Description
Natcher Parkway - Daviess / Ohio / Butler / Warren Counties		
22	45.88	Horizontal Clearance = 30' (Note bridge is over 200' long)
		Barrier Wall does not meet current standard
12	Exit 43	Taper Length < Min
13	Exit 36	Taper Length < Min; Entrance Ramp Deficient; Interchange control of access less than 300' minimum; Previous Toll Plaza
Barrier Wall Deficiency	34.816 (NB & SB)	Barrier Wall does not meet current standard
4	33.741	Vertical clearance = 15.76' (16' minimum)
23	29.533	Horizontal Clearance = 30' (Note bridge is less than 200' long)
24	29.533	Horizontal Clearance = 30' (Note bridge is less than 200' long)
14	Exit 29	Taper Length < Min
		Interchange control of access less than 300' minimum
3	29.000	Interchange spacing less than 3 mile minimum
15	Exit 28	Taper Length < Min
25	28.523	Horizontal Clearance = 30' (Note bridge is less than 200' long)
26	28.523	Horizontal Clearance = 30' (Note bridge is less than 200' long)
27	24.723	Horizontal Clearance = 30' (Note bridge is over 200' long)
		Barrier Wall does not meet current standard
28	24.723	Horizontal Clearance = 30' (Note bridge is over 200' long)
		Barrier Wall does not meet current standard
29	15.627	Horizontal Clearance = 30' (Note bridge is over 200' long)
		Barrier Wall does not meet current standard

(**Table ES-2** continued on following page)

Table ES-2 (Continued) Deficiencies Summary

Deficiency Type	Milepoint	Deficiency Description
Natcher Parkway - Daviess / Ohio / Butler / Warren Counties		
30	15.627	Horizontal Clearance = 30' (Note bridge is over 200' long)
		Barrier Wall does not meet current standard
16	Exit 9	Taper Length < Min; Entrance Ramp Deficient; Previous Toll Plaza
17	Exit 7	Taper Length < Min
31	7.083	Horizontal Clearance = 30' (Note bridge is over 200' long)
		Barrier Wall does not meet current standard
32	7.083	Horizontal Clearance = 30' (Note bridge is over 200' long)
		Barrier Wall does not meet current standard
33	6.003	Horizontal Clearance = 30' (Note bridge is less 200' long)
		Barrier Wall does not meet current standard
34	6.003	Horizontal Clearance = 35.1' (Note bridge is less 200' long)
		Barrier Wall does not meet current standard
18	Exit 6	Taper Length < Min
35	5.686	Horizontal Clearance = 30' (Note bridge is over 200' long)
		Barrier Wall does not meet current standard
36	5.686	Horizontal Clearance = 30' (Note bridge is over 200' long)
		Barrier Wall does not meet current standard
19	Exit 2	Taper Length < Min
Aucubon Parkway / US 60 / Natcher Parkway		
Guardrail Trailing End Treatments	Appendix D	Guardrail Trailing End Treatments do not meet current standard. Reference Appendix D for locations

PREFACE

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) Technical Corrections Act of 2008 designates the Audubon Parkway as a future I-69 Spur and the Natcher Parkway as a future I-66 Spur given these routes meet interstate standards and connects to an existing interstate. The Kentucky Transportation Cabinet (KYTC) has undertaken a strategic corridor planning study for the proposed interstate routes, Interstate 69 (I-69) Spur and Interstate 66/65 (I-66/I-65) Spur.

Information presented herein is a ***first look planning-level study*** to identify deficiencies and impediments for interstate spur designation and to identify a range of improvement strategies needed to upgrade the Audubon Parkway, Natcher Parkway, and US 60 to satisfy applicable interstate criteria. After further analysis of the identified deficiencies, KYTC will need to recommend strategies to the Federal Highway Administration to bring the deficiencies into compliance with interstate criteria. Available options include addressing the required improvements through construction, requesting design exceptions/variances, committing to future improvements as part of the on-going maintenance and operation of the facility. It is anticipated that some combination of these approaches will be used. Thus, as projects for implementation of improvement strategies are initiated, additional engineering analyses and studies will be needed to further refine the specifics for improvements and to document the recommendations.

The primary purpose of this strategic corridor study is to review the existing conditions along the Audubon Parkway, Natcher Parkway, and US 60 to identify locations that do not meet current Association of State Highway Transportation Officials (AASHTO) and Federal Highway Administration (FHWA) highway design guidelines and related criteria. Evaluations include the degree to which these criteria are not met, their impact on safety and capacity, and identify options for making improvements to address identified deficiencies.

OVERVIEW OF EXISTING CONDITIONS
PROPOSED I-69 SPUR, I-66/I-65 SPUR, AND US 60 CONNECTION
HENDERSON TO BOWLING GREEN
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Appendix A – Metropolitan Organization Meeting Material
Appendix B – Traffic Counts and Directional Design Hourly Volumes (DDHV)
Appendix C – Traffic Projection Background Data and Analysis
Appendix D – Highway Information System Summary of Roadway Data
Appendix E – Project Meeting Minutes

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I. PROJECT INTRODUCTION

The Kentucky Transportation Cabinet (KYTC) has undertaken a strategic corridor planning study to evaluate the Audubon Parkway from the Edward T. Breathitt (Pennyrile) Parkway, south of Henderson to US 60 in Owensboro (I-69 Spur) and the William H. Natcher Parkway from Interstate 65 (I-65) in Bowling Green, KY to Owensboro (I-66/I-65 Spur). Options also are included for US 60 between the Audubon Parkway and Natcher Parkway as an interstate spur. As shown in **Figure 1-1**, the project corridor includes the Audubon Parkway from the Pennyrile Parkway to US 60, US 60 from the Audubon Parkway to the Natcher Parkway, and the Natcher Parkway between US 60 in Owensboro and I-65 in Bowling Green. The corridor passes through Henderson, Daviess, Ohio, Butler, and Warren Counties.

Project Purpose and Need

The primary purpose of this strategic corridor study is to review the existing conditions along the Audubon Parkway, Natcher Parkway, and US 60 to identify locations that do not meet current Association of State Highway Transportation Officials (AASHTO) and Federal Highway Administration (FHWA) highway design guidelines and related criteria. Evaluations include the degree to which these criteria are not met, their impact on safety and capacity, and identify options for making improvements to address identified deficiencies.

This ***first look planning-level study*** utilized As-built construction plans provided by KYTC, the KYTC Highway Information System (HIS) database, and field reviews to collect roadway geometry and highway operations. Other studies undertaken for the Federal Highway Administration (FHWA) were also reviewed for information on a national level. This study addresses the need and justification of upgrades to the Audubon and Natcher Parkways and US 60 to comply with interstate highway design guidelines.

A. Background of I-69 and I-66 Corridors

The federal Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 identified the I-69 (Corridor 18) and I-66 as Priority Corridors. The results from a 1995 Federal Highway Administration *Corridor 18 Feasibility Study* concluded that the future construction of I-69 from Canada to Mexico was economically feasible. The I-69 corridor begins at Port Huron, Michigan, and the Canadian border; passes through Michigan, Indiana, Kentucky, Tennessee, Mississippi, Arkansas, Louisiana, and Texas; and terminates at the Lower Rio Grande Valley and Mexican border. The I-66 corridor begins on the Atlantic Coast near Washington, D.C.; passes through Virginia, West Virginia, Kentucky, Illinois, Missouri; and continues westward across southern Kansas to Wichita.

The *Corridor 18 Special Issues Study* completed in 1997 identified a Representative Corridor that best serves the purposes of Corridor 18 and yields the most benefits relative to facility costs. This study also identified Segments of Independent Utility (SIU) that would allow completion of the I-69 corridor in segments that could function independently. In Kentucky, the Representative SIU segments were defined as follows:

- SIU 4
  - I-64/I-164 north of Evansville, Indiana to the Edward T. Breathitt (Pennyrile) Parkway at Henderson, Kentucky;
- SIU 5
  - The Edward T. Breathitt (Pennyrile) Parkway from Henderson, Kentucky to the interchange with Wendell H. Ford (Western Kentucky) Parkway;
  - The Ford Parkway to the interchange with I-24;

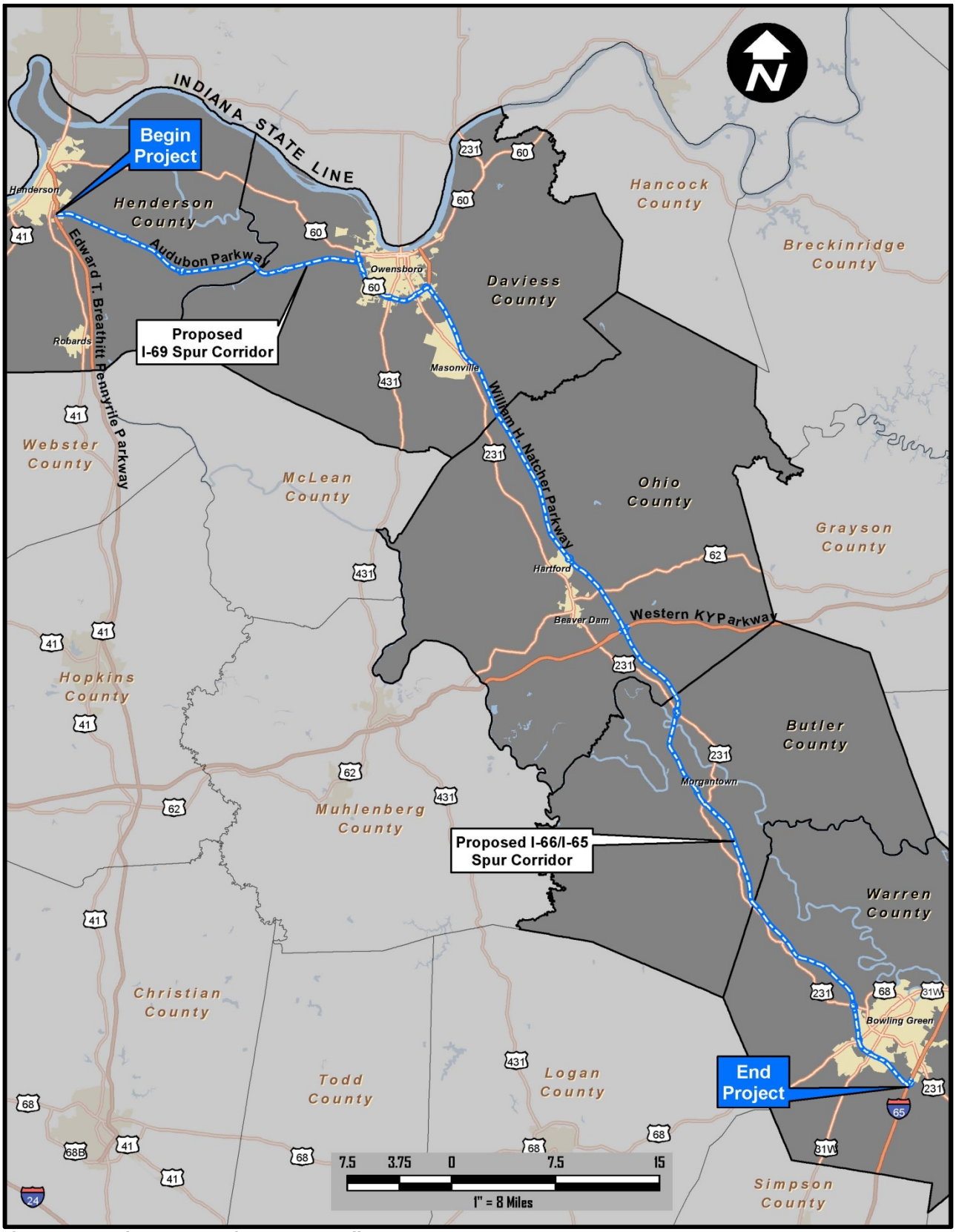


Figure 1-1 Study Area, Henderson to Bowling Green, KY

- SIU 6
  - I-24 at Ford Parkway to the interchange with the Julian M. Carroll (Purchase) Parkway;
  - The Purchase Parkway to the Tennessee state line.

Strategic corridor planning studies have been completed for SIU 5 and SIU 6, and KYTC is currently developing strategies for implementation.

The ISTEA of 1991 identifies the portion of I-66 through Kentucky as "centered on the cities of Pikeville, Jenkins, Hazard, London, Somerset; then, generally following the Louie B. Nunn Parkway corridor from Somerset to Columbia, to I-65; then, to Bowling Green, Hopkinsville, Benton, and Paducah." A national East-West Transamerica Corridor Feasibility Study completed in 1994 concluded that the entire coast-to-coast corridor was not economically feasible, but individual segments of the corridor should be further analyzed for feasibility. In 1997, the Kentucky Transportation Center completed the *Southern Kentucky Corridor (I-66) Economic and Justification and Financial Feasibility Final Report.* That report determined I-66 was economically justified and economically feasible in Kentucky. Since that study, KYTC has further studied four segments of the Southern Kentucky Corridor (I-66):

- Appalachian Corridor Segment – A route of I-66 connecting US 23 in Pike County, Kentucky to King Coal Highway in Mingo County, West Virginia.
- Somerset to London – A route of I-66 extending the Louie B. Nunn (Cumberland) Parkway, west of Somerset, to the Hal Rogers Parkway east of London, Kentucky.
- Barren, Edmonson, and Hart Counties – A route of I-66 between the Natcher Parkway and the Cumberland Parkway.
- Western Kentucky to Missouri - A route from I-24 near Paducah, Kentucky into Missouri and/or Illinois.

At the time of this report, no active KYTC I-66 projects are within the study area of this project. If designating the Natcher Parkway as an interstate is pursued in the future, KYTC and FHWA may consider designating the Natcher Parkway as I-65 Spur due to the current lack of I-66 designation within the vicinity of the Natcher Parkway.

The initial national goals for this project included enhancing the movement of goods, creating greater employment opportunities, and improving system linkage. In Kentucky, these national goals are consistent with the regional and local goals of providing improved mobility and serving local connectivity needs. Utilizing the existing Parkway system for an I-69 Spur and an I-66/I-65 Spur meets the national and local goals.

B. I-69 and I-66/I-65 Spurs and US 60

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) Technical Corrections Act of 2008 designates the Audubon Parkway as a future I-69 Spur and the Natcher Parkway as a future I-66 Spur given these routes meet interstate standards and connect to an existing interstate. A more descriptive summary of the I-69, I-66/I-65 Spurs, and US 60 follows:

The I-69 Spur follows the entire length of the Audubon Parkway. It begins at the Pennyrile Parkway (Future I-69) interchange south of Henderson (MP 0.0) and runs east to the US 60 interchange in Owensboro (MP 23.44).

The I-66/I-65 Spur follows the entire length of the Natcher Parkway. It begins at the interchange with I-65 in Bowling Green (MP 2.08) and runs north through the cities of Morgantown and Hartford before intersecting with US 60 in Owensboro (MP 72.26).

The segment of US 60 studied begins at the Audubon Parkway interchange on the west side of Owensboro (MP 10.85) and runs east along the south side of Owensboro to the Natcher Parkway

(MP 17.50). Although US 60 has not been designated as an interstate corridor, in this study it was evaluated to interstate standards.

The following chart summary illustrates the I-69 Spur and I-66/I-65 Spur and US 60 by county.

ROUTE	COUNTY	BEGIN MP	END MP	TOTAL MILEAGE
AUDUBON PARKWAY	Henderson	0.00	15.88	15.88
	Daviess	15.88	23.43	7.55
			Total	23.43
US 60	Daviess	10.85	17.50	6.65
			Total	6.65
NATCHER PARKWAY	Warren	2.08	20.25	18.17
	Butler	20.25	37.14	16.90
	Ohio	37.14	61.55	24.41
	Daviess	61.55	72.26	10.70
			Total	70.18
TOTAL PROJECT				100.26

Table 1-1 I-69 Spur, I-66/I-65 Spur, and US 60 Mileages

C. Analysis Considerations

The Audubon Parkway, Natcher Parkway, and US 60 were evaluated based on the current KYTC and FHWA design standards and guidelines. Applicable references are listed below:

- "A Policy on Geometric Design of Highways and Streets, 6^{th} Edition" (American Association of State Highway Officials)
- "AASHTO Roadside Design Guide" (American Association of State Highway Officials, Current Edition)
- "Highway Capacity Manual" (Transportation Research Board, Current Edition)
- "Manual of Uniform Traffic Control Devices, Millennium Edition" (Institute of Transportation Engineers, Current Edition)
- "A Policy on Design Standards Interstate System" (American Association of State Highway Officials, Current Edition).
- Kentucky Transportation Cabinet Highway Design Manual (KYTC, Current Edition)

The existing conditions of the Audubon Parkway, Natcher Parkway, and US 60 were established by utilizing As-built plans provided by KYTC, the HIS database, and CRASH database. This information was analyzed based on the reference list above to determine the extent to which it meets the current design guidelines. The analyses include determining whether the Audubon Parkway, Natcher Parkway, and US 60 currently satisfy the safety and operational concerns that might be expected from converting these routes into an interstate highway. The following table illustrates the urban and rural sections of the Audubon Parkway, Natcher Parkway, and US 60. The sections listed below were compared to respective urban or rural interstate criteria.

ROUTE	URBAN / RURAL	BEGIN MP	END MP
AUDUBON PARKWAY	Urban	0.00	0.60
	Rural	0.60	19.71
	Urban	19.71	23.43
US 60	Urban	10.85	17.50
NATCHER PARKWAY	Urban	2.08	10.22
	Rural	10.22	70.28
	Urban	70.28	72.26

Table 1-2 I-69 Spur, I-66/I-65 Spur, and US 60 Rural/Urban Sections

The following report is structured based on key factors in determining applicable design guideline compliance of the Audubon Parkway, Natcher Parkway, and US 60. A summary of these key factors is described below:

- **MPO Coordination (Chapter II) -** An overview of the study was presented to the Bowling Green and Owensboro Metropolitan Organizations. This presentation is provided in **Appendix A.**
- **Operational Considerations (Chapter III)** - An analysis of operational factors including crash history, traffic volumes, and operational levels of service for existing and future traffic conditions.
- **Mainline Geometry and Typical Section (Chapter IV)** – A discussion and evaluation of the existing corridor on the following topics: Mainline geometric issues, design speed, median widths, clear zones, horizontal and vertical alignments, superelevation rates, and sight distances.
- **Bridges and Overpasses (Chapter V)** - An evaluation of the existing bridges and overpasses based on lateral and vertical clearance.
- **Interchanges and Ramps (Chapter VI)** – A summary of interchange and ramp conditions and a comparison of those conditions with AASHTO guidelines for design speed, typical sections, alignment geometry, speed-change lanes, and weaving situations.
- **Key Findings of Existing Conditions Overview (Chapter VII)** – An overview of the identified deficiencies in the project corridor.
- **Improvement Strategies and Development Costs (Chapter VIII)** – An overview of a range of improvement strategies and interstate route designation options.
- **Summary (Chapter IX) –** A summary of findings from the Strategic Corridor Planning Study and description of future analyses necessary to provide direction for decisions.

D. Design Exceptions and Variances

The FHWA has identified thirteen design features that are important to the operational and safety performance of a highway. These controlling design features compiled are commonly known as the *13 controlling criteria*. A formal written design exception is required when any of the 13 criteria are not met on the National Highway System (NHS). The Interstate System is part of the NHS. The *13 controlling criteria* are listed below:

1. Design speed
2. Lane width
3. Shoulder width
4. Bridge width
5. Horizontal alignment
6. Superelevation
7. Vertical alignment
8. Grade
9. Stopping sight distance
10. Cross slope
11. Vertical clearance
12. Lateral offset to obstruction
13. Structural capacity

These design features are evaluated in this report and are evaluated for compliance. Design features that deviate from common practice but are not included in the *13 controlling criteria* will be termed design variance. There are two categories for design variances. A design variance is a design feature that (1) varies from the current AASHTO criteria but not part of the *13 controlling criteria* or (2) varies from common practice but not part of the *13 controlling criteria*.

Design exceptions and variances require a formal detailed analysis for safety and operational consideration. FHWA requires an application for any design exceptions and design variances as documentation for the design exception process and decision.

FHWA provides the following fundamental activities for the design exception process:

- Determine the Costs and Impacts of Meeting Design Criteria
- Develop and Evaluate Multiple Alternatives
- Evaluate Risk
- Evaluate Mitigation Measures
- Document, Review, and Approve
- Monitor and Evaluate In-Service Performance

II. MPO COORDINATION

As part of this study, a meeting was conducted with the Bowling Green and Owensboro Metropolitan Organizations (MPO) in an effort to provide the public with information about this study and the potential I-69 and I-66/I-65 Spur corridors. The Owensboro MPO meeting was held on November 27, 2012, in Owensboro, and the Bowling Green MPO meeting took place at Barren River Area Development District on December 10, 2012.

At these meetings, preliminary information -- including the purpose and need for the project-- was collected and compiled. Other information collected, compiled, analyzed, and presented in display format included the current traffic operations, existing conditions, and a crash history of the Audubon Parkway, Natcher Parkway, and US 60. In efforts to educate the organizations on the existing conditions, a Powerpoint presentation was presented on previous studies along with the scope of work. In the presentation, key geometric features were identified as needing improvements in order to meet interstate standards.

The Powerpoint presentation of these meetings is provided in **Appendix A** of this report.

III. OPERATIONAL CONSIDERATIONS

The current and future operations of the Audubon Parkway, Natcher Parkway, and US 60, functioning as both a parkway/four-lane divided highway (non-interstate) and an interstate, should be evaluated for the proposed designations as I-69 Spur and I-66/I-65 Spur. The evaluation of the operational considerations includes a crash history and traffic analysis of the Audubon Parkway, Natcher Parkway, and US 60.

A. Crash History and Analysis

The objective of the crash history analysis was to identify locations of high crash rates and crash patterns on the Audubon Parkway, Natcher Parkway, and US 60. Further investigation of these high crash rate locations was conducted to establish causation or whether they occurred randomly.

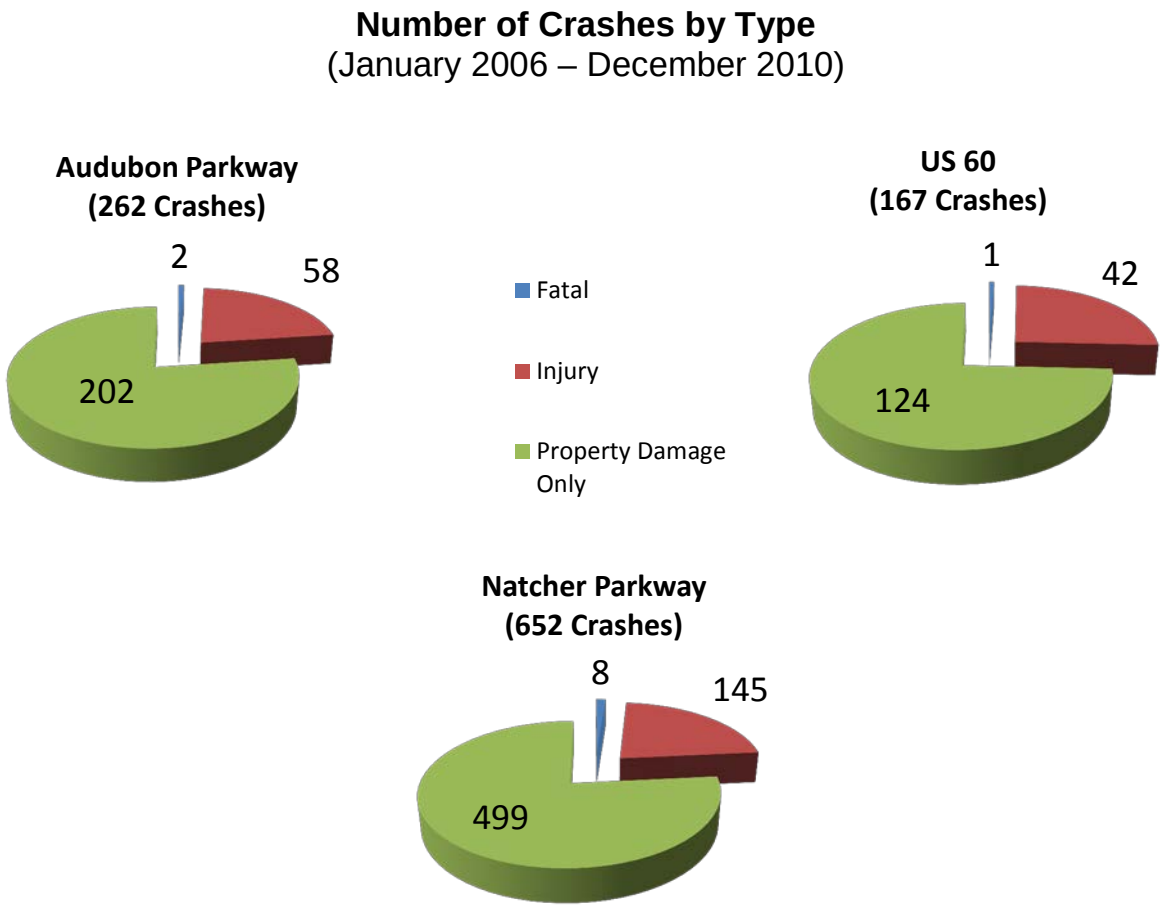
1. Crash Analysis Methodology and Data Source

The Kentucky Transportation Center's *Analysis of Traffic Crash Data in Kentucky (2006-2010)* was referenced for methodology, formulas, and factors to calculate crash rates for the Audubon Parkway, Natcher Parkway, and US 60. Segments of the project for the analyses were established based on changes in Annual Daily Traffic (ADT), roadway features and roadway classification. The crash rate was calculated within each segment based on length, ADT, type of roadway (parkway/four-lane divided non-interstate or parkway/interstate), functional classification (rural/urban), and crashes that occurred in the segment during the crash history period. Crash data for the analyses was collected from the Collision Report Analysis for Safer Highways (CRASH) database from January 1, 2006 to December 31, 2010, within the project limits of the Audubon Parkway, Natcher Parkway, and US 60.

2. Types and Locations of Crashes

In order to calculate the crash rate, utilizing the referenced documentation, the project routes were divided into segments based on roadway geometry, roadway classification, and traffic volumes. The required inputs are functional classification (rural/urban), median type (divided/undivided), and changes in ADT volume.

The graph on the following page shows the total number and type of crashes during the analysis time frame for the Audubon Parkway, Natcher Parkway, and US 60. For this analysis, crashes were classified as fatal, injury, or property-damage-only type. Of the total crashes on the Audubon Parkway, 2 were fatal (1%), 58 involved injury (22%), and 202 were property-damage-only (77%) crashes. Of the total crashes on the Natcher Parkway, 8 were fatal (1%), 145 injury (22%), and 499 were property-damage-only (77%) crashes. Of the total crashes on US 60, 1 was fatal (1%), 42 involved injury (25%), and 124 were property-damage-only (74%) crashes.



Source: Collision Report Analysis for Safer Highways (CRASH) database

3. Analysis as Existing Facility

The crash history data from both the Audubon Parkway and Natcher Parkway was analyzed as a parkway facility and as an interstate facility. The US 60 crash history data was analyzed as a four-lane divided highway (non-interstate or parkway) and an interstate facility. The following discussion relates to the analysis of the Audubon Parkway and Natcher Parkway as a parkway facility and US 60 as a four-lane undivided (non-interstate or parkway) facility. The analysis of the Audubon Parkway, Natcher Parkway, and US 60 functioning as an interstate is discussed in the following section.

For the analysis of segments, a high crash segment was defined as having a critical crash rate factor greater than or equal to 1.0. A fatality crash rate factor was calculated for the segments to identify segments with a history of fatal crashes.

The statewide average crash rate for all parkways is 61 crashes per 100 million vehicle miles (acc/hmvm) for rural areas and 102 acc/hmvm in urban areas. The statewide average crash rate for all four-lane divided (non-interstate or parkway) highways is 277 acc/hmvm for urban areas. Based on the calculation and data, the crash rates range from 55.93 to 83.5 acc/hmvm on the Audubon Parkway, 33.26 to 67.02 acc/hmvm on US 60, and 30.84 to 86.89 acc/hmvm on the Natcher Parkway.

Reviewing **Table 3-1**, a crash segment on the Audubon Parkway in Henderson County (MP 10.141 – MP 18.049) has a critical crash rate factor between 0.9 and 0.99.

Route	County	Begin MP	End MP	Length (miles)	ADT	Lanes	Divided/ Undivided	Rural/ Urban	Avg Crash Rate	Critical Crash Rate	Avg Fatality Rate	Critical Fatality Rate	Crashes				HMVM	Rates per HMVM				Critical Crash Rate Factor	Critical Fatality Rate Factor
													Fatal	Injury	PDO	Total		Fatal	Injury	PDO	Total		
Audubon Parkway	Henderson	0.000	0.600	0.600	10,040	4	Divided	Urban	102	185.01	0.7	11.75	0	1	5	6	0.11	0.00	9.10	45.48	54.58	0.29	0.00
	Henderson	0.600	5.333	4.733	10,040	4	Divided	Rural	61	83.18	0.7	3.59	0	13	27	40	0.87	0.00	14.99	31.13	46.12	0.55	0.00
	Henderson	5.333	10.141	4.808	9,450	4	Divided	Rural	61	83.70	0.7	3.67	1	8	44	53	0.83	1.21	9.65	53.06	63.92	0.76	0.33
	Henderson / Daviess	10.141	18.049	7.908	9,990	4	Divided	Rural	61	78.10	0.7	2.84	0	25	84	109	1.44	0.00	17.34	58.26	75.60	0.97	0.00
	Daviess	18.049	19.710	1.661	10,590	4	Divided	Rural	61	98.07	0.7	6.06	0	2	9	11	0.32	0.00	6.23	28.04	34.27	0.35	0.00
	Daviess	19.710	23.432	3.722	10,590	4	Divided	Urban	102	133.37	0.7	3.94	1	9	33	43	0.72	1.39	12.51	45.88	59.78	0.45	0.35
US 60	Daviess	10.849	11.611	0.762	19,200	4	Divided	Urban	277	361.84	0.9	7.50	0	6	5	11	0.27	0.00	22.47	18.73	41.20	0.11	0.00
	Daviess	11.611	12.600	0.989	19,100	4	Divided	Urban	277	351.47	0.9	6.51	0	7	13	20	0.34	0.00	20.31	37.71	58.01	0.17	0.00
	Daviess	12.600	14.416	1.816	23,600	4	Divided	Urban	277	326.12	0.9	4.30	0	8	20	28	0.78	0.00	10.23	25.57	35.80	0.11	0.00
	Daviess	14.416	16.460	2.044	28,200	4	Divided	Urban	277	319.28	0.9	3.76	1	14	66	81	1.05	0.95	13.31	62.74	77.00	0.24	0.25
	Daviess	16.460	17.498	1.038	30,900	4	Divided	Urban	277	333.89	0.9	4.95	0	7	20	27	0.59	0.00	11.96	34.17	46.13	0.14	0.00
Natcher Parkkway	Warren	2.080	5.686	3.606	20,380	4	Divided	Urban	102	124.84	0.7	2.93	0	11	30	41	1.34	0.00	8.20	22.37	30.57	0.24	0.00
	Warren	5.686	7.083	1.397	18,540	4	Divided	Urban	102	140.90	0.7	4.89	0	7	20	27	0.47	0.00	14.81	42.31	57.12	0.41	0.00
	Warren	7.083	9.523	2.440	11,920	4	Divided	Urban	102	138.65	0.7	4.60	0	4	28	32	0.53	0.00	7.54	52.75	60.29	0.43	0.00
	Warren	9.523	10.220	0.697	10,200	4	Divided	Urban	102	178.08	0.7	10.54	0	4	6	10	0.13	0.00	30.83	46.24	77.07	0.43	0.00
	Butler / Warren	10.220	28.523	18.303	10,200	4	Divided	Rural	61	72.05	0.7	2.01	2	35	127	164	3.41	0.59	10.27	37.28	48.13	0.67	0.29
	Butler	28.523	29.533	1.010	10,180	4	Divided	Rural	61	110.11	0.7	8.34	1	2	5	8	0.19	5.33	10.66	26.65	42.63	0.39	0.64
	Butler	29.533	35.932	6.399	8,310	4	Divided	Rural	61	81.94	0.7	3.40	1	15	28	44	0.97	1.03	15.46	28.85	45.34	0.55	0.30
	Ohio / Butler	35.932	43.311	7.379	7,940	4	Divided	Rural	61	80.92	0.7	3.25	0	10	48	58	1.07	0.00	9.35	44.89	54.24	0.67	0.00
	Ohio	43.311	49.888	6.577	8,900	4	Divided	Rural	61	80.93	0.7	3.25	1	12	40	53	1.07	0.94	11.23	37.44	49.61	0.61	0.29
	Ohio / Daviess	49.888	70.280	20.392	9,830	4	Divided	Rural	61	71.66	0.7	1.96	2	39	146	187	3.66	0.55	10.66	39.91	51.12	0.71	0.28
	Daviess	70.280	72.264	1.984	9,830	4	Divided	Urban	102	147.01	0.7	5.72	1	6	21	28	0.36	2.81	16.86	59.00	78.67	0.54	0.49

Table 3-1 Crash Analysis as Existing Facility

Source: Collision Report Analysis for Safer Highways (CRASH) database, and the Kentucky Transportation Center's Analysis of Traffic Accident Data in Kentucky (2006-2010)

Using the Kentucky Transportation Center's *Analysis of Traffic Crash Data in Kentucky (2006-2010)* methodology, an additional critical *spot* analysis was conducted on the Audubon Parkway, Natcher Parkway, and US 60. The methodology defines a critical *spot* as a 0.3-mile length of roadway with more than the critical number of crashes defined by roadway type and area type. **Table 3-2** illustrates the critical *spots* along the project corridor. The critical number of crashes is 8 for a rural parkway and 16 for an urban parkway. The critical number of crashes for a rural four-lane divided highway (non-interstate or parkway) is 13 and 51 for an urban highway. The Audubon and Natcher Parkway were analyzed using the parkway critical number of crashes. US 60 was analyzed using the four-lane divided highway (non-interstate or parkway) critical number of crashes.

COUNTY	BEGIN MP	END MP	RURAL/ URBAN	CRITICAL CRASH RATE FACTOR	CRASHES
Audubon Parkway					
Henderson	5.70	6.00	Rural	1.21	8
Henderson	5.80	6.10	Rural	1.36	9
Henderson	5.90	6.20	Rural	1.21	8
Henderson	6.00	6.30	Rural	1.21	8
Henderson	9.90	10.20	Rural	1.36	9
Henderson	10.00	10.30	Rural	1.97	13
Henderson	10.10	10.40	Rural	1.66	11
Henderson	10.20	10.50	Rural	1.72	12
Henderson	14.70	15.00	Rural	1.29	9
US 60					
None					
Natcher Parkway					
Warren	15.38	15.68	Rural	0.97	8
Warren	19.58	19.88	Rural	0.97	8
Butler	26.68	26.98	Rural	0.97	8
Butler	34.48	34.78	Rural	1.15	8
Butler	34.88	35.18	Rural	1.29	9
Butler	34.98	35.28	Rural	1.15	8
Ohio	38.88	39.18	Rural	1.23	8
Ohio	59.98	60.28	Rural	1.42	10
Ohio	60.08	60.38	Rural	1.56	11
Ohio	60.18	60.48	Rural	1.14	8
Ohio/Daviess	61.38	61.68	Rural	1.28	9

Table 3-2 Spot Crash Analysis as Existing Facility

4. Analysis as an Interstate Facility

In Kentucky, the average crash rate for an interstate facility is lower than a parkway facility. The statewide average crash rate for an interstate facility is 98 acc/hmvm for urban areas and 51 acc/hmvm for rural areas. The lower average crash rate for an interstate facility versus a parkway facility indicates that per vehicle-mile of travel, fewer crashes occur on interstates.

Table 3-3 on the following page illustrates one segment is defined as a high crash rate segment. It is located at MP 10.141 – MP 18.049 along the Audubon Parkway in Henderson and Daviess Counties.

A critical *spot* is defined to have had 18 crashes occur within a 0.3 mile segment of roadway on a rural interstate and 57 crashes on an urban interstate. No critical *spots* were identified on the Audubon Parkway, Natcher Parkway or US 60 when compared to rural/urban interstate critical numbers.

Table 3-3 and **Figures 3-1** through **3-7** on the following pages illustrate the Audubon Parkway, Natcher Parkway, and US 60 crash analysis as an interstate facility.

Route	County	Begin MP	End MP	Lenght (miles)	ADT	Lanes	Divided/ Undivided	Rural/ Urban	Avg Crash Rate	Critical Crash Rate	Avg Fatality Rate	Critical Fatality Rate	Crashes				HMVM	Rates per HMVM				Critical Crash Rate Factor	Critical Fatality Rate Factor
													Fatal	Injury	PDO	Total		Fatal	Injury	PDO	Total		
Audubon Parkway	Henderson	0.000	0.600	0.6	10,040	4	Divided	Urban	98	179.46	0.4	9.86	0	1	5	6	0.11	0.00	9.10	45.48	54.58	0.30	0.00
	Henderson	0.600	5.333	4.733	10,040	4	Divided	Rural	51	71.33	0.7	3.59	0	13	27	40	0.87	0.00	14.99	31.13	46.12	0.65	0.00
	Henderson	5.333	10.141	4.808	9,450	4	Divided	Rural	51	71.81	0.7	3.67	1	8	44	53	0.83	1.21	9.65	53.06	63.92	0.89	0.33
	Henderson / Daviess	10.141	18.049	7.908	9,990	4	Divided	Rural	51	66.67	0.7	2.84	0	25	84	109	1.44	0.00	17.34	58.26	75.60	1.13	0.00
	Daviess	18.049	19.710	1.661	10,590	4	Divided	Rural	51	85.03	0.7	6.06	0	2	9	11	0.32	0.00	6.23	28.04	34.27	0.40	0.00
	Daviess	19.710	23.432	3.722	10,590	4	Divided	Urban	98	128.76	0.4	3.02	1	9	33	43	0.72	1.39	12.51	45.88	59.78	0.46	0.46
US 60	Daviess	10.849	11.611	0.762	19,200	4	Divided	Urban	98	149.22	0.4	5.43	0	6	5	11	0.27	0.00	22.47	18.73	41.20	0.28	0.00
	Daviess	11.611	12.600	0.989	19,100	4	Divided	Urban	98	142.88	0.4	4.63	0	7	13	20	0.34	0.00	20.31	37.71	58.01	0.41	0.00
	Daviess	12.600	14.416	1.816	23,600	4	Divided	Urban	98	127.47	0.4	2.88	0	8	20	28	0.78	0.00	10.23	25.57	35.80	0.28	0.00
	Daviess	14.416	16.460	2.044	28,200	4	Divided	Urban	98	123.34	0.4	2.46	1	14	66	81	1.05	0.95	13.31	62.74	77.00	0.62	0.39
	Daviess	16.460	17.498	1.038	30,900	4	Divided	Urban	98	132.19	0.4	3.38	0	7	20	27	0.59	0.00	11.96	34.17	46.13	0.35	0.00
Natcher Parkkway	Warren	2.080	5.686	3.606	20,380	4	Divided	Urban	98	120.39	0.4	2.18	0	11	30	41	1.34	0.00	8.20	22.37	30.57	0.25	0.00
	Warren	5.686	7.083	1.397	18,540	4	Divided	Urban	98	136.15	0.4	3.83	0	7	20	27	0.47	0.00	14.81	42.31	57.12	0.42	0.00
	Warren	7.083	9.523	2.440	11,920	4	Divided	Urban	98	133.94	0.4	3.58	0	4	28	32	0.53	0.00	7.54	52.75	60.29	0.45	0.00
	Warren	9.523	10.220	0.697	10,200	4	Divided	Urban	98	172.65	0.4	8.78	0	4	6	10	0.13	0.00	30.83	46.24	77.07	0.45	0.00
	Butler / Warren	10.220	28.523	18.303	10,200	4	Divided	Rural	51	61.11	0.7	2.01	2	35	127	164	3.41	0.59	10.27	37.28	48.13	0.79	0.29
	Butler	28.523	29.533	1.010	10,180	4	Divided	Rural	51	96.13	0.7	8.34	1	2	5	8	0.19	5.33	10.66	26.65	42.63	0.44	0.64
	Butler	29.533	35.932	6.399	8,310	4	Divided	Rural	51	70.19	0.7	3.40	1	15	28	44	0.97	1.03	15.46	28.85	45.34	0.65	0.30
	Ohio / Butler	35.932	43.311	7.379	7,940	4	Divided	Rural	51	69.26	0.7	3.25	0	10	48	58	1.07	0.00	9.35	44.89	54.24	0.78	0.00
	Ohio	43.311	49.888	6.577	8,900	4	Divided	Rural	51	69.27	0.7	3.25	1	12	40	53	1.07	0.94	11.23	37.44	49.61	0.72	0.29
	Ohio / Daviess	49.888	70.280	20.392	9,830	4	Divided	Rural	51	60.75	0.7	1.96	2	39	146	187	3.66	0.55	10.66	39.91	51.12	0.84	0.28
	Daviess	70.280	72.264	1.984	9,830	4	Divided	Urban	98	142.15	0.4	4.54	1	6	21	28	0.36	2.81	16.86	59.00	78.67	0.55	0.62

Table 3-3 Crash Analysis as an Interstate Facility

Source: Collision Report Analysis for Safer Highways (CRASH) database, and the Kentucky Transportation Center's Analysis of Traffic Accident Data in Kentucky (2006-2010)

Crash Rate Segment (CRF = 0.9-0.99)

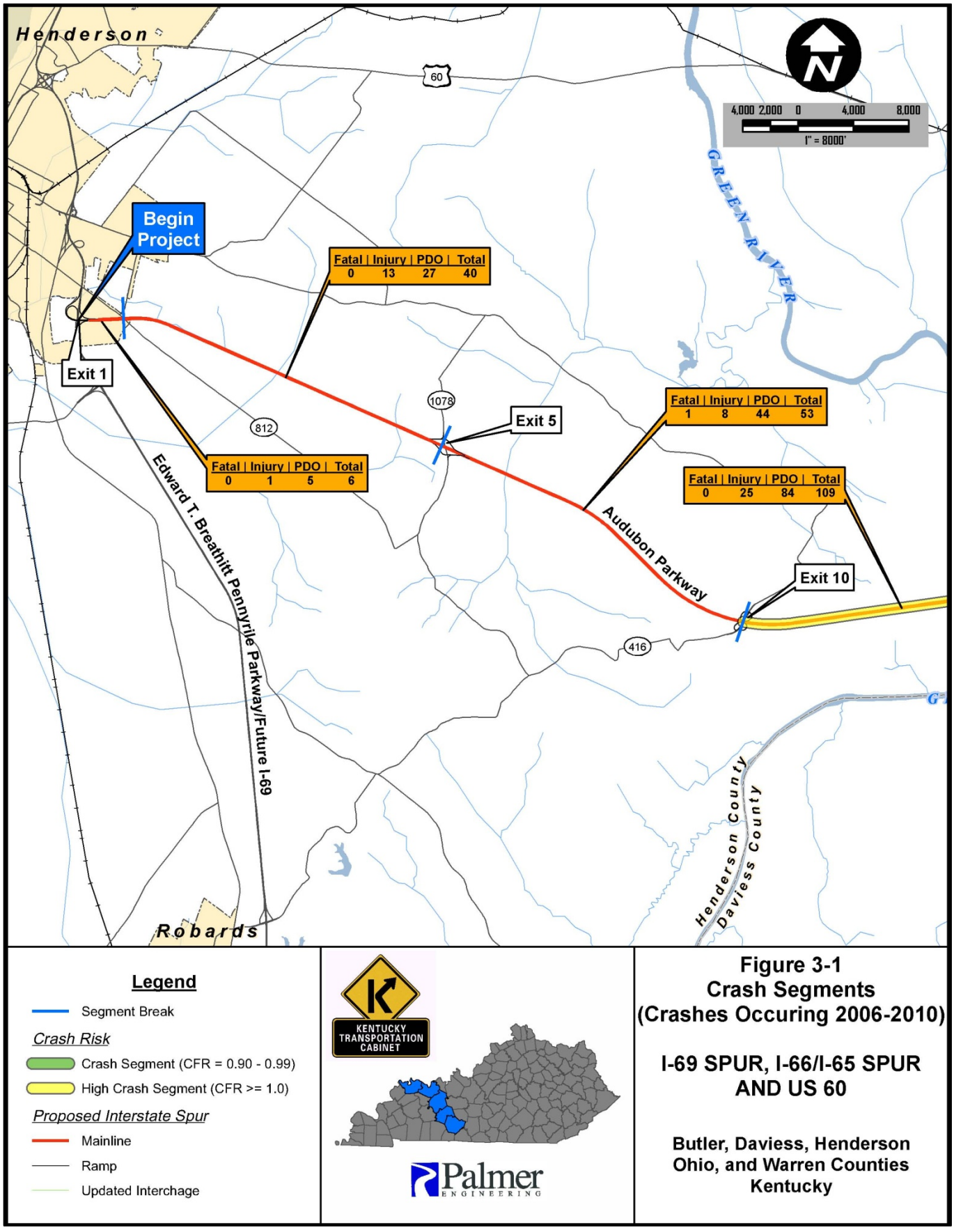
High Crash Rate Segment (CRF => 1.0)

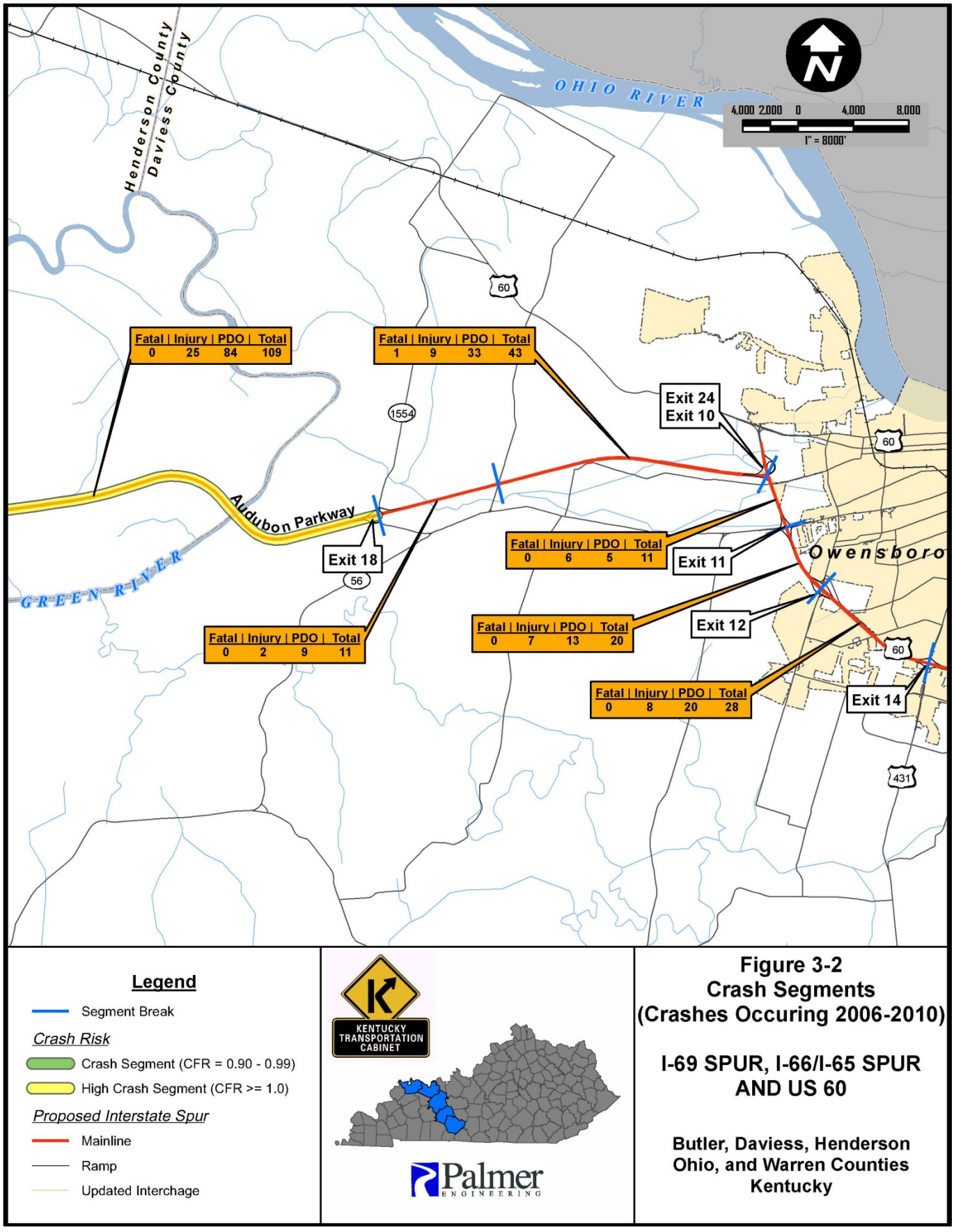
Legend

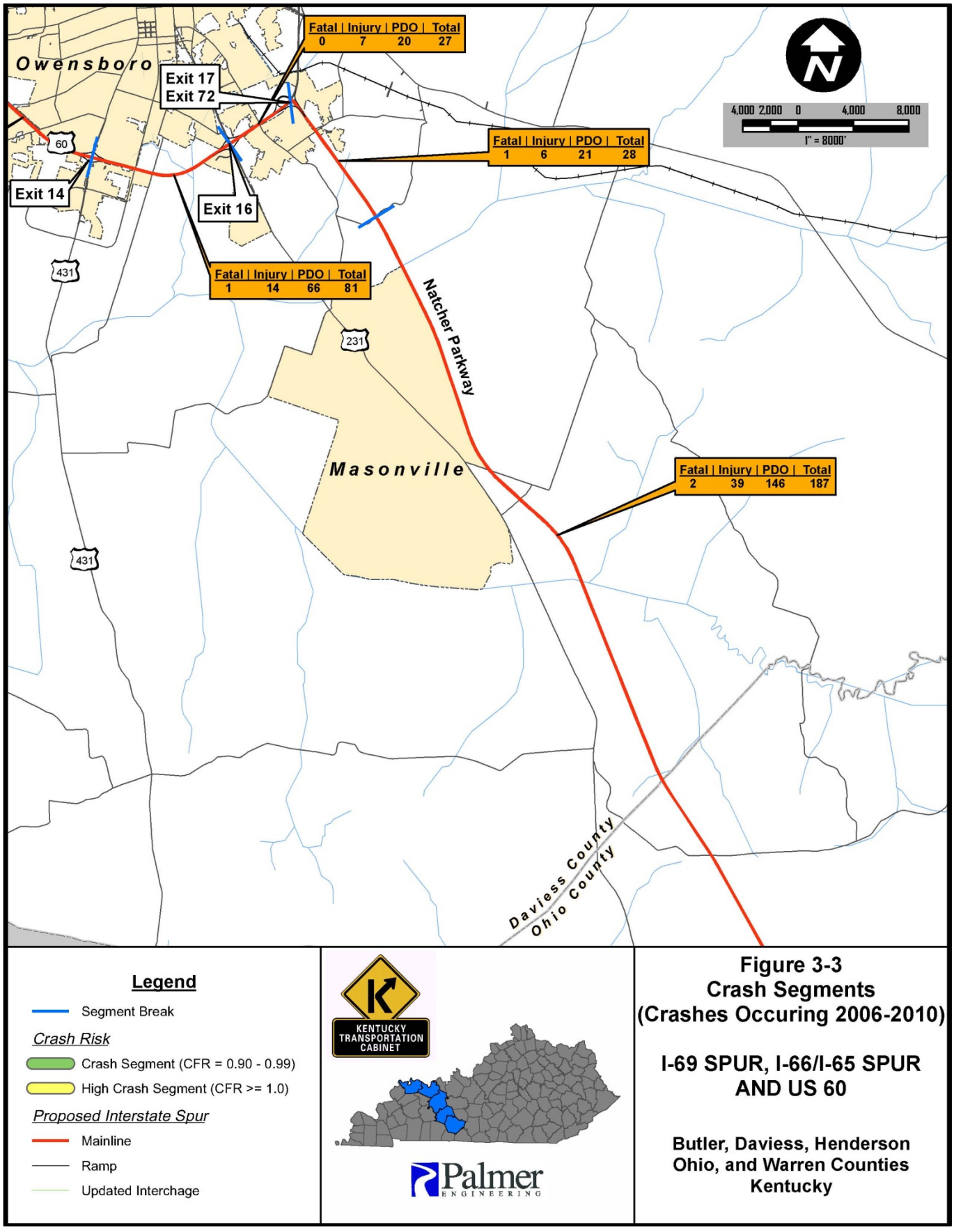
Abbreviations shown are defined as follows: MP – Milepoint; ADT – Average Daily Traffic (vehicles per day); PDO – Property Damage Only; HMVM – Hundred Million Vehicle Miles (vehicle miles per year divided by 100,000,000)

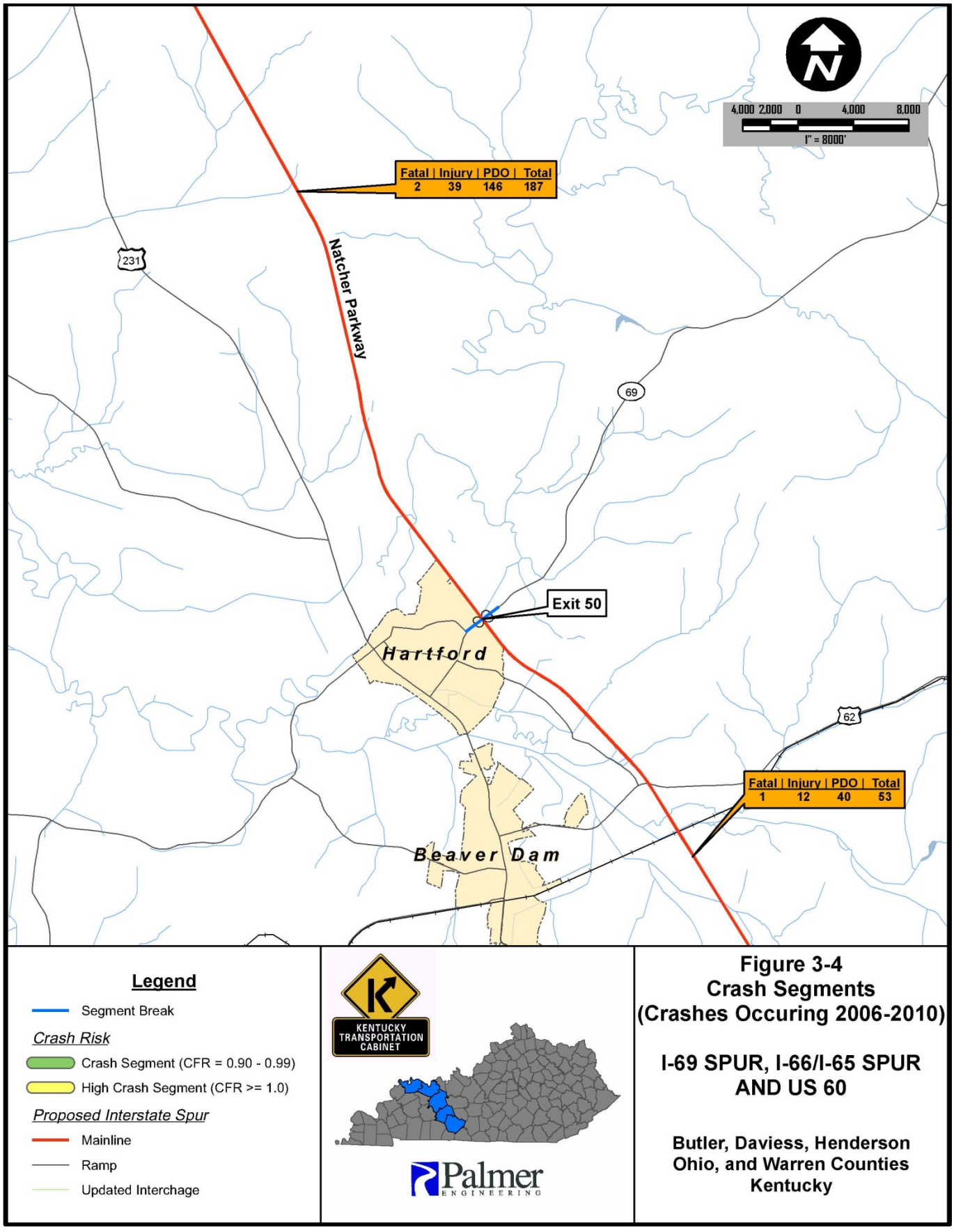
Crash Analysis Methodology

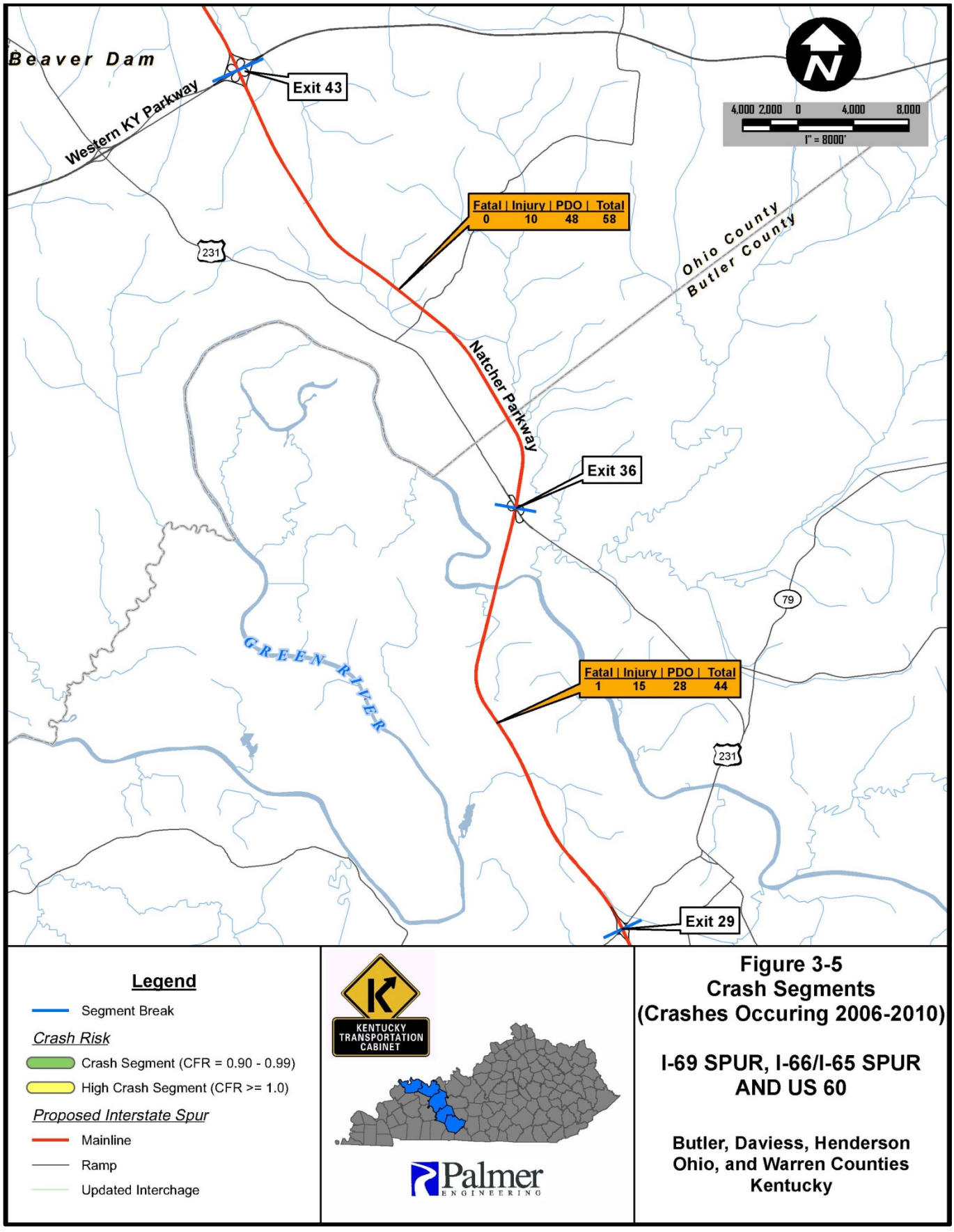
The Kentucky Transportation Center Analysis of Traffic Accident Data in Kentucky (2006-2010) was referenced for crash analysis methodology, formulas, and factors to calculate crash rates.

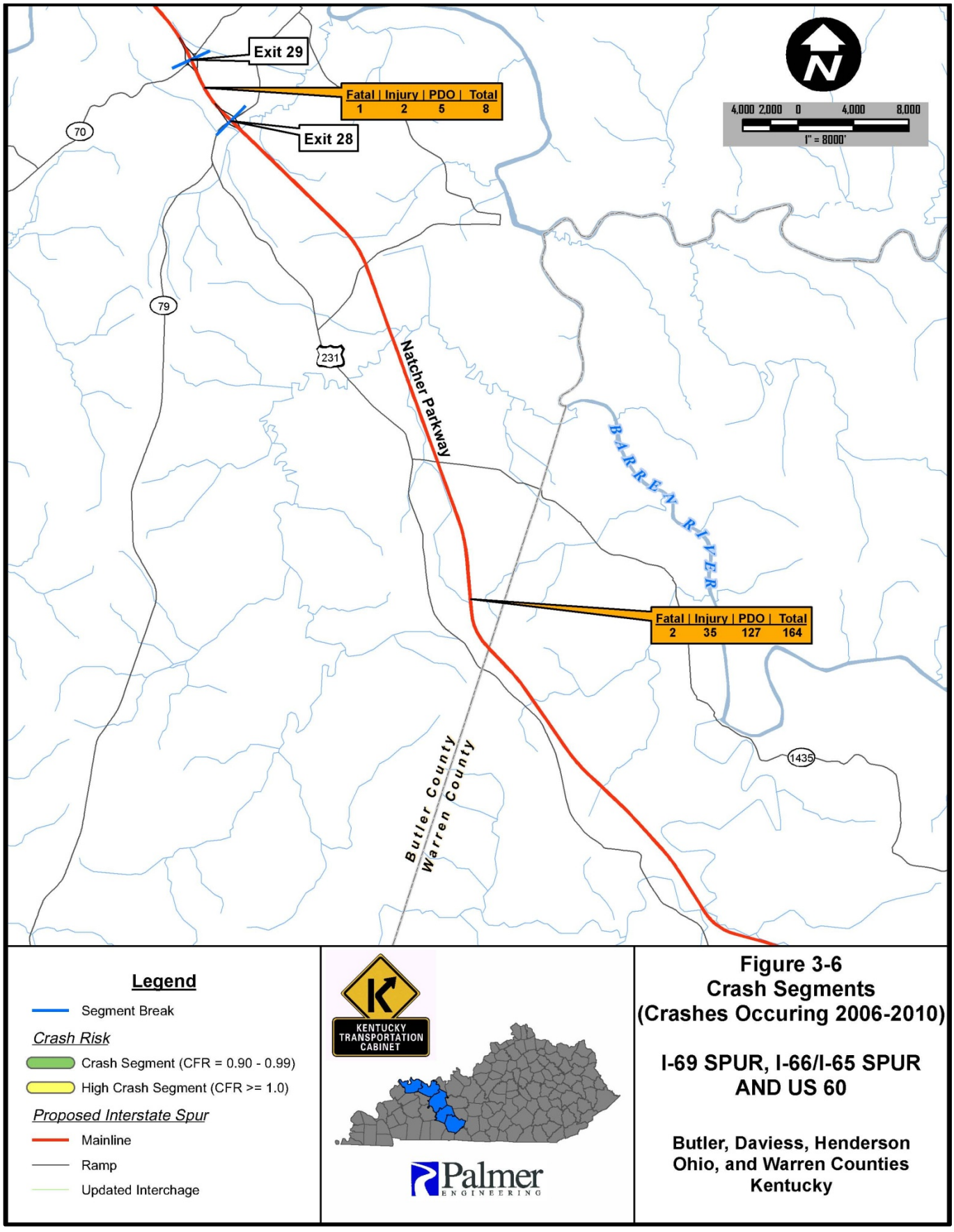

Henderson
60
4,000 2,000 0 4,000 8,000
1" = 8000'
GREEN RIVER
Begin Project
Exit 1
Fatal | Injury | PDO | Total
0 13 27 40
1078
812
Exit 5
Fatal | Injury | PDO | Total
1 8 44 53
Fatal | Injury | PDO | Total
0 1 5 6
Fatal | Injury | PDO | Total
0 25 84 109
Audubon Parkway
Exit 10
Edward T. Breathitt Pennyrile Parkway/Future I-69
416
Henderson County
Daviess County
Robards
Legend
Segment Break
Crash Risk
Crash Segment (CFR = 0.90 - 0.99)
High Crash Segment (CFR >= 1.0)
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 3-1
Crash Segments
(Crashes Occuring 2006-2010)
I-69 SPUR, I-66/I-65 SPUR
AND US 60
Butler, Daviess, Henderson
Ohio, and Warren Counties
Kentucky

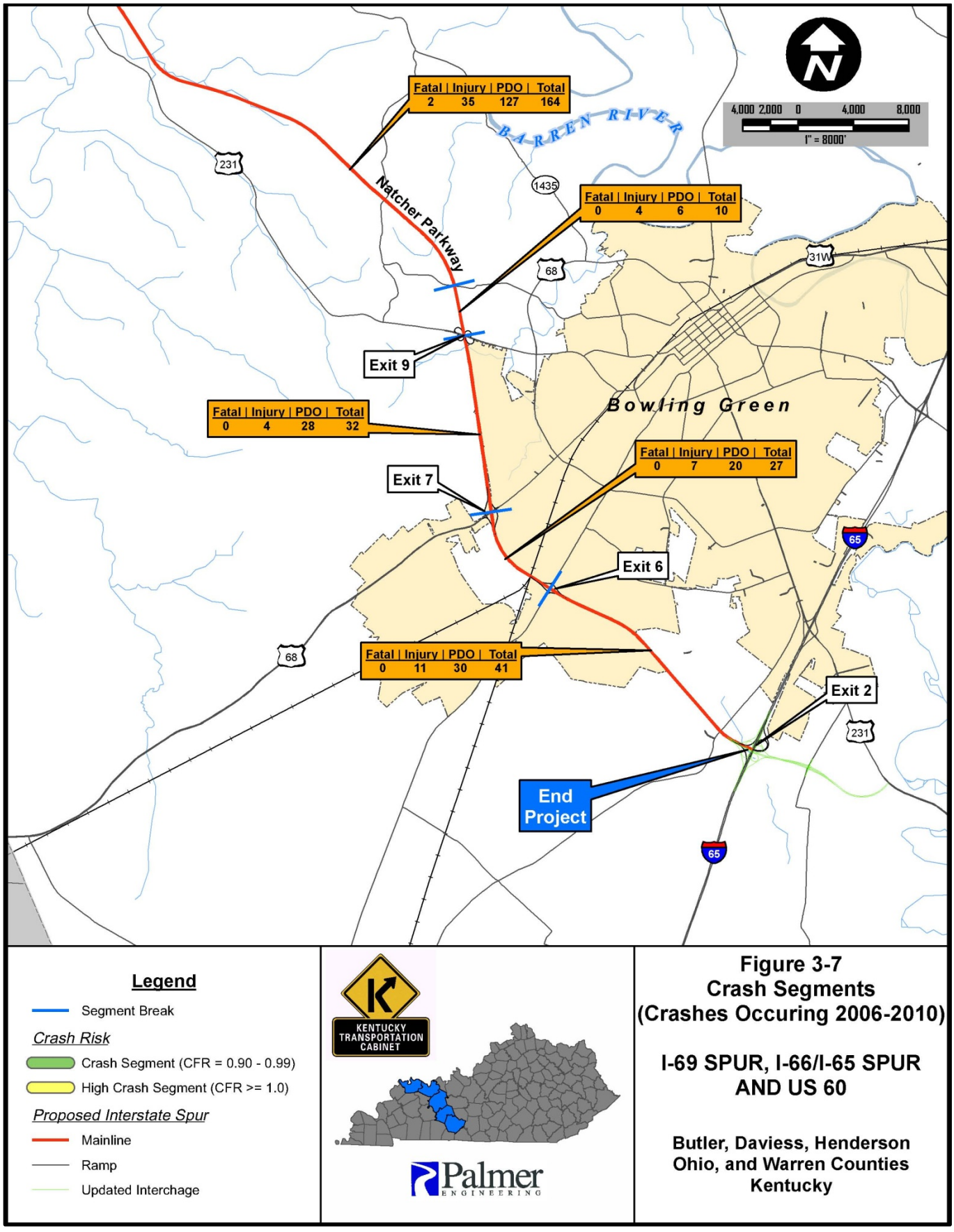

OHIO RIVER
Henderson County
Daviess County
4,000 2,000 0 4,000 8,000
1" = 8000'
60
1554
Fatal | Injury | PDO | Total
0 25 84 109
Fatal | Injury | PDO | Total
1 9 33 43
Exit 24
Exit 10
Audubon Parkway
GREEN RIVER
Exit 18
56
Fatal | Injury | PDO | Total
0 6 5 11
Exit 11
Owensboro
Fatal | Injury | PDO | Total
0 2 9 11
Fatal | Injury | PDO | Total
0 7 13 20
Exit 12
Fatal | Injury | PDO | Total
0 8 20 28
Exit 14
431
Legend
Segment Break
Crash Risk
Crash Segment (CFR = 0.90 - 0.99)
High Crash Segment (CFR >= 1.0)
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 3-2
Crash Segments
(Crashes Occuring 2006-2010)
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Owensboro
Exit 17
Exit 72
Exit 14
Exit 16
60
431
231
Fatal | Injury | PDO | Total
0 7 20 27
Fatal | Injury | PDO | Total
1 6 21 28
Fatal | Injury | PDO | Total
1 14 66 81
Fatal | Injury | PDO | Total
2 39 146 187
Natcher Parkway
Masonville
Daviess County
Ohio County
4,000 2,000 0 4,000 8,000
1" = 8000'
Legend
Segment Break
Crash Risk
Crash Segment (CFR = 0.90 - 0.99)
High Crash Segment (CFR >= 1.0)
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 3-3
Crash Segments
(Crashes Occuring 2006-2010)
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Fatal | Injury | PDO | Total
2 39 146 187
Natcher Parkway
231
69
Exit 50
Hartford
62
Fatal | Injury | PDO | Total
1 12 40 53
Beaver Dam
4,000 2,000 0 4,000 8,000
1" = 8000'
Legend
Segment Break
Crash Risk
Crash Segment (CFR = 0.90 - 0.99)
High Crash Segment (CFR >= 1.0)
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 3-4
Crash Segments
(Crashes Occuring 2006-2010)
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Beaver Dam
Western KY Parkway
Exit 43
4,000 2,000 0 4,000 8,000
1" = 8000'
Fatal | Injury | PDO | Total
0 10 48 58
231
Ohio County
Butler County
Natcher Parkway
Exit 36
79
GREEN RIVER
Fatal | Injury | PDO | Total
1 15 28 44
231
Exit 29
Legend
Segment Break
Crash Risk
Crash Segment (CFR = 0.90 - 0.99)
High Crash Segment (CFR >= 1.0)
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 3-5
Crash Segments
(Crashes Occuring 2006-2010)
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Exit 29
Exit 28
Fatal | Injury | PDO | Total
1 2 5 8
Fatal | Injury | PDO | Total
2 35 127 164
70
79
231
1435
Natcher Parkway
BARREN RIVER
Butler County
Warren County
4,000 2,000 0 4,000 8,000
1" = 8000'
Legend
Segment Break
Crash Risk
Crash Segment (CFR = 0.90 - 0.99)
High Crash Segment (CFR >= 1.0)
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 3-6
Crash Segments
(Crashes Occuring 2006-2010)
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Fatal | Injury | PDO | Total
2 35 127 164
Fatal | Injury | PDO | Total
0 4 6 10
Fatal | Injury | PDO | Total
0 4 28 32
Fatal | Injury | PDO | Total
0 7 20 27
Fatal | Injury | PDO | Total
0 11 30 41
BARREN RIVER
Natcher Parkway
Bowling Green
Exit 9
Exit 7
Exit 6
Exit 2
End Project
231
1435
68
31W
65
4,000 2,000 0 4,000 8,000
1" = 8000'
Legend
Segment Break
Crash Risk
Crash Segment (CFR = 0.90 - 0.99)
High Crash Segment (CFR >= 1.0)
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 3-7
Crash Segments
(Crashes Occuring 2006-2010)
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky

5. Crash Causation Factors

Determining the crash causation factors for the high crash areas will help identify potential problem areas. To identify the cause of the crash for crash rate segments, crashes for each segment were grouped into major crash types, which are summarized below:

High Crash Rate Segments--Critical Crash Rate Factor >=1.0

Along the Audubon Parkway in Henderson/Daviess County, between MP 10.141 and MP 18.049, crash causation factors included the following (shown in Table 3-4):

- 36% (39 crashes) of crashes were coded *Collision with Animal*. This percentage is much higher than the 22% of *Collision with Animal* crashes that occurred along the project corridor. 21 of the 77 crashes occurred with wet/icy/slushy road conditions.
- *Ran Off Road* represented 23% of all crashes (25 of 109 crashes), which is greater than the 19% of all crashes of the same type on the project.

Crash Type	Crashes in Segment	% in Segment	Crashes on Parkways/US 60	% on Parkways/US 60
Collision with Animal	39	36%	243	22%
Ran Off Roadway	25	23%	205	19%
Collision with Fixed Object	14	13%	270	25%
All Other Types	31	28%	363	34%

Table 3-4 Crash Types for Crash Segment MP 10.141 – MP 18.049

6. Other Crash Considerations

In efforts to identify potential problem areas on the Audubon Parkway, Natcher Parkway, and US 60, cross-over or head-on collisions and collisions near interchanges were further evaluated.

Cross-Over and Head-On Crashes

A trend of cross-over or head-on collisions on the parkways and US 60 could indicate potential problems with median width and type, directional separation, or interchange signage. Between 2006 and 2010, four crashes were coded *median cross-over*. These crashes were located on the Natcher Parkway. No *head-on collision* crashes were coded for the Audubon Parkway, Natcher Parkway, or US 60. These crashes are shown in **Table 3-5.** Cross-over crashes account for 0.6% of crashes on the Natcher Parkway.

COUNTY	MP	CRASH TYPE	INTERCHANGE WITHIN 1 MILE
Natcher Parkway			
Warren	2.391	Median cross-over	I-65 (MP 2.079)
Warren	3.551	Median cross-over	No
Warren	14.692	Median cross-over	No
Ohio	50.653	Median cross-over	KY 69 (MP 49.888)

Table 3-5 Cross-Over and Head-on Crashes

Crashes at Interchanges

As part of this analysis, crashes occurring 0.1 mile within either direction of an interchange were summarized by crash type. The interchange crash types are summarized as follows:

Audubon Parkway

- 32 crashes were within 0.1 mile of the interchanges[1] on the Audubon Parkway including mainline and ramp-related crashes.
- 40% (13 of 32) were coded as ramp-related crashes, including rear-end and other multiple-vehicle collisions

- 34% (11 of 32) were collisions with a fixed object, and 22% (7 of 32) were ran-off-road collisions

US 60

- 306 crashes were within 0.1 mile of the interchanges[1] on US 60.
- 92% (280 of 306) were coded as ramp-related crashes, including rear-end and other multiple-vehicle collisions.
- 80% (246 of 306) were rear-end collisions

Natcher Parkway

- 187 crashes were within 0.1 mile of the interchanges[1] on the Natcher Parkway.
- 79% (148 of 187) were coded as ramp-related crashes, including rear-end and other multiple-vehicle collisions.
- 41% (77 of 187) were collisions with a fixed object, and 29% (54 of 187) were rear-end collisions.

[1]**Table 6-2 Interchange Crash Data** on page 6-15 provides a more detailed summary of crash types at interchanges along the Audubon Parkway, US 60 and Natcher Parkway.

B. Traffic Volumes and Operational Level of Service

A traffic analysis was conducted on the Audubon Parkway, Natcher Parkway, and US 60 Connection to identify any traffic congestion problems related to increased traffic on the parkways and US 60 from interstate traffic projections. Current and future traffic projections were conducted based on the parkways and US 60 with and without I-69 Spur and I-66/I-65 Spur designation.

1. Current Traffic Volumes (2011)

The 2011 traffic volumes for this project are based on data from the KYTC HIS database and traffic classification counts conducted by KYTC in 2012. Truck percentage and directional design hourly volumes were calculated based on the classification counts in 2012.

The current traffic (2011) volumes for the Audubon Parkway range from 9,450 vehicles per day (vpd) near Henderson to 10,590 vpd near the US 60 interchange in Owensboro. On US 60, the traffic volumes range from 19,100 vpd near the Audubon Parkway interchange to 32,400 vpd between the US 231 and US 431 interchanges. On the Natcher Parkway, the traffic volumes range from 7,940 vpd at the Western Kentucky Parkway interchange to 20,400 vpd near the I-65 interchange in Bowling Green. The existing truck percentages on the Audubon Parkway range from 19.5% at Owensboro to 21.1% at Henderson, Kentucky. On US 60, the truck percentages range from 10.1% to 12.4%. The existing truck percentages on the Natcher Parkway range from 19.9% in Morgantown to 32.9% north of the Western Kentucky Parkway interchange in Ohio and Daviess Counties. Average Daily Traffic and corresponding truck percentages are provided on the following page in **Table 3-6.**

County	Begin MP	End MP	Length (miles)	Rural/ Urban	% Trucks	2011 ADT	LOS
Audubon Parkway							
Henderson	0.00	0.60	0.60	Urban	21.1%	10,040	A
Henderson	0.60	5.33	4.73	Rural	21.1%	10,040	A
Henderson	5.33	10.14	4.81	Rural	20.0%	9,450	A
Henderson	10.14	15.88	5.74	Rural	20.0%	9,990	A
Daviess	15.88	18.05	2.17	Rural	20.0%	9,990	A
Daviess	18.05	19.71	1.66	Rural	20.0%	10,590	A
Daviess	19.71	23.44	3.73	Urban	19.5%	10,590	A
US 60 Connection							
Daviess	10.85	11.61	0.76	Urban	12.4%	19,200	B
Daviess	11.61	12.60	0.99	Urban	11.0%	19,100	A
Daviess	12.60	14.42	1.82	Urban	10.4%	23,600	B
Daviess	14.42	16.46	2.04	Urban	11.0%	32,400	C
Daviess	16.46	17.50	1.04	Urban	10.1%	28,200	B
Natcher Parkway							
Warren	2.08	5.69	3.61	Urban	24.2%	20,400	B
Warren	5.69	7.08	1.39	Urban	22.0%	18,540	A
Warren	7.08	9.52	2.44	Urban	22.0%	11,920	A
Warren	9.52	10.22	0.70	Urban	19.9%	10,200	A
Warren	10.22	20.25	10.03	Rural	19.9%	10,200	A
Butler	20.25	28.52	8.27	Rural	19.9%	10,200	A
Butler	28.52	29.53	1.01	Rural	25.0%	10,200	A
Butler	29.53	35.93	6.40	Rural	25.0%	8,310	A
Butler	35.93	37.14	1.21	Rural	25.0%	7,940	A
Ohio	37.14	43.31	6.17	Rural	31.6%	7,940	A
Ohio	43.31	49.89	6.58	Rural	32.9%	8,900	A
Ohio	49.89	61.55	11.66	Rural	32.9%	9,830	A
Daviess	61.55	70.28	8.73	Rural	32.9%	9,830	A
Daviess	70.28	72.26	1.98	Urban	32.9%	9,830	A

Table 3-6 Current Traffic Characteristics (2011)

Also included as part of this study is the Directional Design Hourly Volume (DDHV) in the context of minimum outside shoulders discussed in **Chapter IV**. **Table 3-7** summarizes the DDHV data for the Audubon Parkway, Natcher Parkway, and US 60 Connection based on classification counts conducted by KYTC in 2012 (**Appendix B**).

County	Rural/ Urban	DDHV	% Trucks at Peak Hour	Trucks at Peak Hour	DDHV	% Trucks at Peak Hour	Trucks at Peak Hour
Audubon Parkway							
		Eastbound			Westbound		
Henderson (MP 4.0)	Rural	404	11%	45	369	13%	48
Daviess (MP 22.2)	Rural	397	12%	48	347	15%	52
US 60							
		Eastbound			Westbound		
Daviess (MP 11.1)	Urban	938	11%	104	746	8%	60
Daviess (MP 13.1)	Urban	1,181	12%	142	1,078	8%	86
Daviess (MP 16.8)	Urban	1,129	4%	46	1,343	9%	211
Natcher Parkway							
		Northbound			Southbound		
Warren (MP 3.18)	Urban	1,079	22%	238	966	22%	213
Warren (MP 12.52)	Rural	444	16%	71	417	17%	71
Ohio (MP 42.3)	Rural	262	21%	55	254	22%	56
Ohio (MP 44.3)	Rural	277	24%	70	270	34%	92

Table 3-7 Existing (2012) Directional Design Hourly Volumes (DDHV)

2. Future Traffic Volumes (2040) without Interstate Spur Designation

The future traffic volumes (2040) were calculated using growth rates based on available previous studies and historical ADT volumes. **Appendix C** provides a detailed review of previous studies and development of annual growth rates and projected traffic volumes. The future traffic volumes are shown in **Table 3-8**. The annual growth rates range from 2.1% to 2.3% without interstate spur designation on the Audubon Parkway and from 1.5% to 2.3% on US 60. On the Natcher Parkway, the annual growth rates range from 0.9% to 3.1%. The growth rates resulted in a range from 18,400 vpd to 20,500 vpd on the Audubon Parkway, 36,100 vpd to 49,900 vpd on US 60, and 10,800 vpd to 49,500 vpd on the Natcher Parkway.

County	Begin MP	End MP	Length (miles)	Rural/ Urban	Annual Growth Rate	% Trucks	2011 ADT	2040 ADT	LOS
Audubon Parkway									
Henderson	0.00	0.60	0.60	Urban	2.3%	21.1%	10,040	19,500	B
Henderson	0.60	5.33	4.73	Rural	2.3%	21.1%	10,040	19,500	A
Henderson	5.33	10.14	4.81	Rural	2.6%	20.0%	9,450	19,900	A
Henderson	10.14	15.88	5.74	Rural	2.5%	20.0%	9,990	20,500	A
Daviess	15.88	18.05	2.17	Rural	2.5%	20.0%	9,990	20,500	A
Daviess	18.05	19.71	1.66	Rural	2.6%	20.0%	10,590	22,300	B
Daviess	19.71	23.44	3.73	Urban	2.6%	19.5%	10,590	22,300	B
US 60									
Daviess	10.85	11.61	0.76	Urban	2.4%	12.4%	19,200	38,200	C
Daviess	11.61	12.60	0.99	Urban	2.5%	11.0%	19,100	39,100	C
Daviess	12.60	14.42	1.82	Urban	2.5%	10.4%	23,600	48,300	D
Daviess	14.42	16.46	2.04	Urban	1.8%	11.0%	32,400	54,400	D
Daviess	16.46	17.50	1.04	Urban	2.1%	10.1%	28,200	51,600	D
Natcher Parkway									
Warren	2.08	5.69	3.61	Urban	3.6%	24.2%	20,400	56,900	E
Warren	5.69	7.08	1.39	Urban	3.4%	22.0%	18,540	48,900	D
Warren	7.08	9.52	2.44	Urban	3.4%	22.0%	11,920	31,500	C
Warren	9.52	10.22	0.70	Urban	2.6%	19.9%	10,200	21,500	B
Warren	10.22	20.25	10.03	Rural	2.6%	19.9%	10,200	21,500	B
Butler	20.25	28.52	8.27	Rural	2.6%	19.9%	10,200	21,500	B
Butler	28.52	29.53	1.01	Rural	1.3%	25.0%	10,200	14,900	A
Butler	29.53	35.93	6.40	Rural	1.1%	25.0%	8,310	11,500	A
Butler	35.93	37.14	1.21	Rural	1.3%	25.0%	7,940	11,600	A
Ohio	37.14	43.31	6.17	Rural	1.3%	31.6%	7,940	11,600	A
Ohio	43.31	49.89	6.58	Rural	2.6%	32.9%	8,900	17,300	A
Ohio	49.89	61.55	11.66	Rural	2.6%	32.9%	9,830	20,700	B
Daviess	61.55	70.28	8.73	Rural	2.6%	32.9%	9,830	20,700	B
Daviess	70.28	72.26	1.98	Urban	2.6%	32.9%	9,830	20,700	B

Table 3-8 Future Traffic Volumes without Interstate Spur Designation

3. Future Traffic Volumes (2040) with Interstate Spur Designation

The future traffic volumes (2040) with interstate designation are shown in **Table 3-9**. The projected growth rates resulted in traffic volumes ranging from 19,500 vpd to 22,300 vpd on the Audubon Parkway, 38,200 vpd to 54,400 vpd on US 60, and 11,500 vpd to 56,900 vpd on the Natcher Parkway.

County	Begin MP	End MP	Length (miles)	Rural/ Urban	Annual Growth Rate	% Trucks	2011 ADT	2040 ADT	LOS
Audubon Parkway									
Henderson	0.00	0.60	0.60	Urban	2.1%	21.1%	10,040	18,400	A
Henderson	0.60	5.33	4.73	Rural	2.1%	21.1%	10,040	18,400	A
Henderson	5.33	10.14	4.81	Rural	2.4%	20.0%	9,450	18,800	A
Henderson	10.14	15.88	5.74	Rural	2.3%	20.0%	9,990	19,400	A
Daviess	15.88	18.05	2.17	Rural	2.3%	20.0%	9,990	19,400	A
Daviess	18.05	19.71	1.66	Rural	2.3%	20.0%	10,590	20,500	B
Daviess	19.71	23.44	3.73	Urban	2.3%	19.5%	10,590	20,500	B
US 60									
Daviess	10.85	11.61	0.76	Urban	2.2%	12.4%	19,200	36,100	C
Daviess	11.61	12.60	0.99	Urban	2.3%	11.0%	19,100	37,000	C
Daviess	12.60	14.42	1.82	Urban	2.3%	10.4%	23,600	45,700	D
Daviess	14.42	16.46	2.04	Urban	1.5%	11.0%	32,400	49,900	D
Daviess	16.46	17.50	1.04	Urban	1.8%	10.1%	28,200	47,400	D
Natcher Parkway									
Warren	2.08	5.69	3.61	Urban	3.1%	24.2%	20,400	49,500	D
Warren	5.69	7.08	1.39	Urban	2.9%	22.0%	18,540	42,500	C
Warren	7.08	9.52	2.44	Urban	3.1%	22.0%	11,920	28,900	B
Warren	9.52	10.22	0.70	Urban	2.3%	19.9%	10,200	19,800	A
Warren	10.22	20.25	10.03	Rural	2.3%	19.9%	10,200	19,800	A
Butler	20.25	28.52	8.27	Rural	2.3%	19.9%	10,200	19,800	A
Butler	28.52	29.53	1.01	Rural	1.0%	25.0%	10,200	13,700	A
Butler	29.53	35.93	6.40	Rural	0.9%	25.0%	8,310	10,800	A
Butler	35.93	37.14	1.21	Rural	1.3%	25.0%	7,940	11,600	A
Ohio	37.14	43.31	6.17	Rural	1.3%	31.6%	7,940	11,600	A
Ohio	43.31	49.89	6.58	Rural	2.3%	32.9%	8,900	17,300	A
Ohio	49.89	61.55	11.66	Rural	2.6%	32.9%	9,830	20,700	B
Daviess	61.55	70.28	8.73	Rural	2.6%	32.9%	9,830	20,700	B
Daviess	70.28	72.26	1.98	Urban	2.6%	32.9%	9,830	20,700	B

Table 3-9 Future Traffic Volumes with Interstate Spur Designation

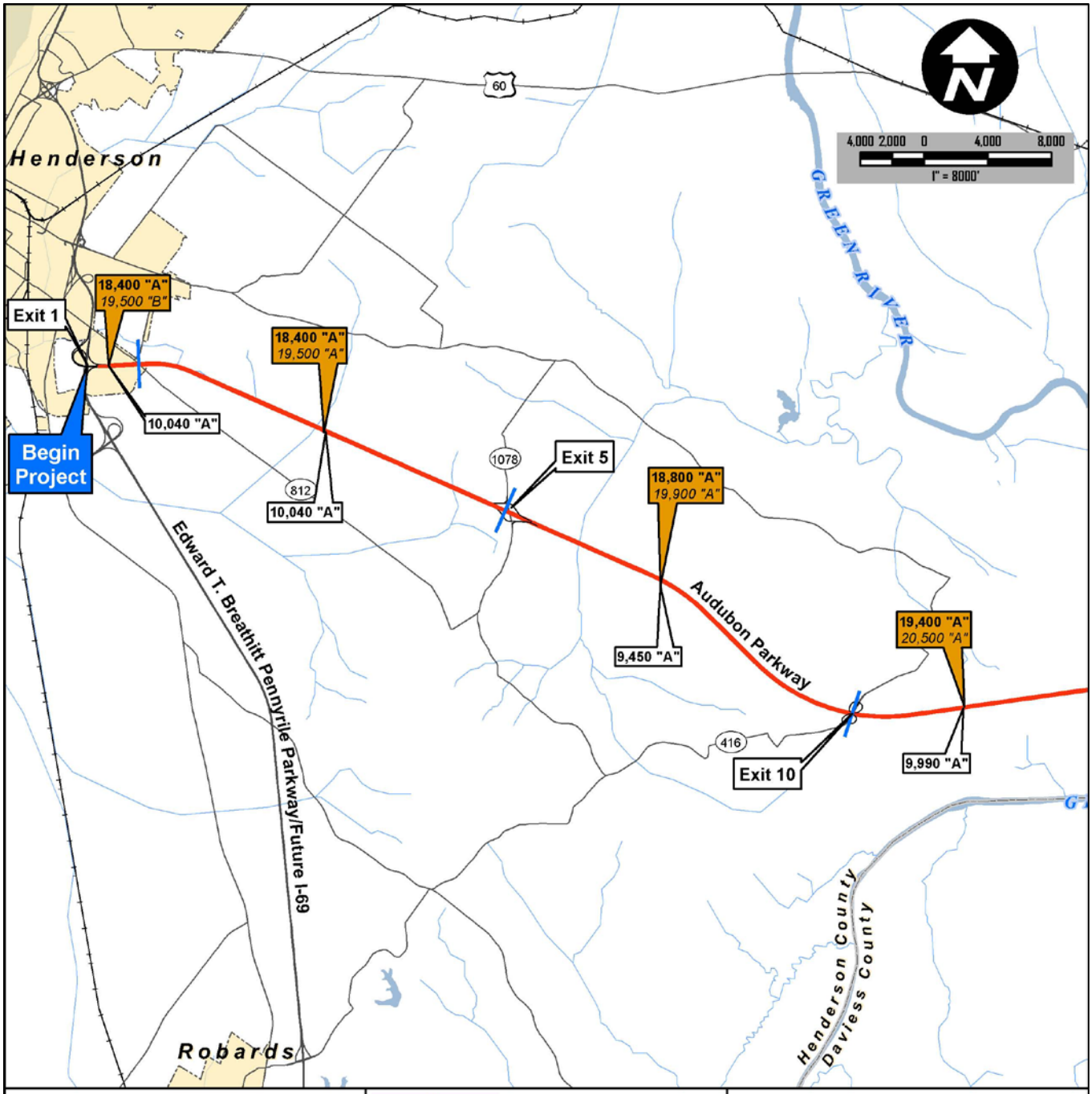
4. Level of Service

Level of service (LOS), as defined by the *Highway Capacity Manual,* is a quality measure describing operational conditions within a traffic stream, based on services measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience. There are six LOS and are designated by the letters A through F. LOS A represents the best operating conditions and service and LOS F represents the worst.

It is preferable to design a rural interstate to a LOS B, but a LOS C is acceptable. For an urban interstate, it is preferable to design to a LOS C, but a LOS D is acceptable. The *Highway Capacity Manual 2010 Edition* and Highway Capacity Software were used to calculate the LOS for the project area. The LOS was calculated based on the mainline geometry and traffic operations for the Audubon Parkway, Natcher Parkway, and US 60. This LOS does not represent the LOS for interchanges in the project corridor.

Referring to **Tables 3-8** and **3-9** on the previous pages, the Audubon Parkway and rural segments of the Natcher Parkway will operate at a LOS B or better with or without the estimated additional interstate spur projected traffic. The US 60 Connection will operate at a LOS D or better with or without the estimated additional interstate spur projected traffic. An increase in LOS ocurrs within the urban limits of Bowling Green (Warren County MP 2.08 – 9.52) due to the increased estimated interstate traffic and reduced speed. The segment of the Natcher Parkway between I-65 and US 31W (MP 2.08 – 5.69) is projected to operate at a LOS E.

Figure 3-8 through **Figure 3-14** illustrates the current and future traffic projections with and without interstate spur designation on the Audubon Parkway, Natcher Parkway, and US 60.



LEGEND

Segment Break

Proposed Interstate Spur

Mainline

Ramp

Updated Interchage

Traffic Forcast

8,900 "B" - 2011 ADT "Level of Service"

18,800 "B" / 18,800 "B" - 2040 ADT without Spurs "Level of Service" / 2040 ADT with Spurs "Level of Service"

KENTUCKY TRANSPORTATION CABINET

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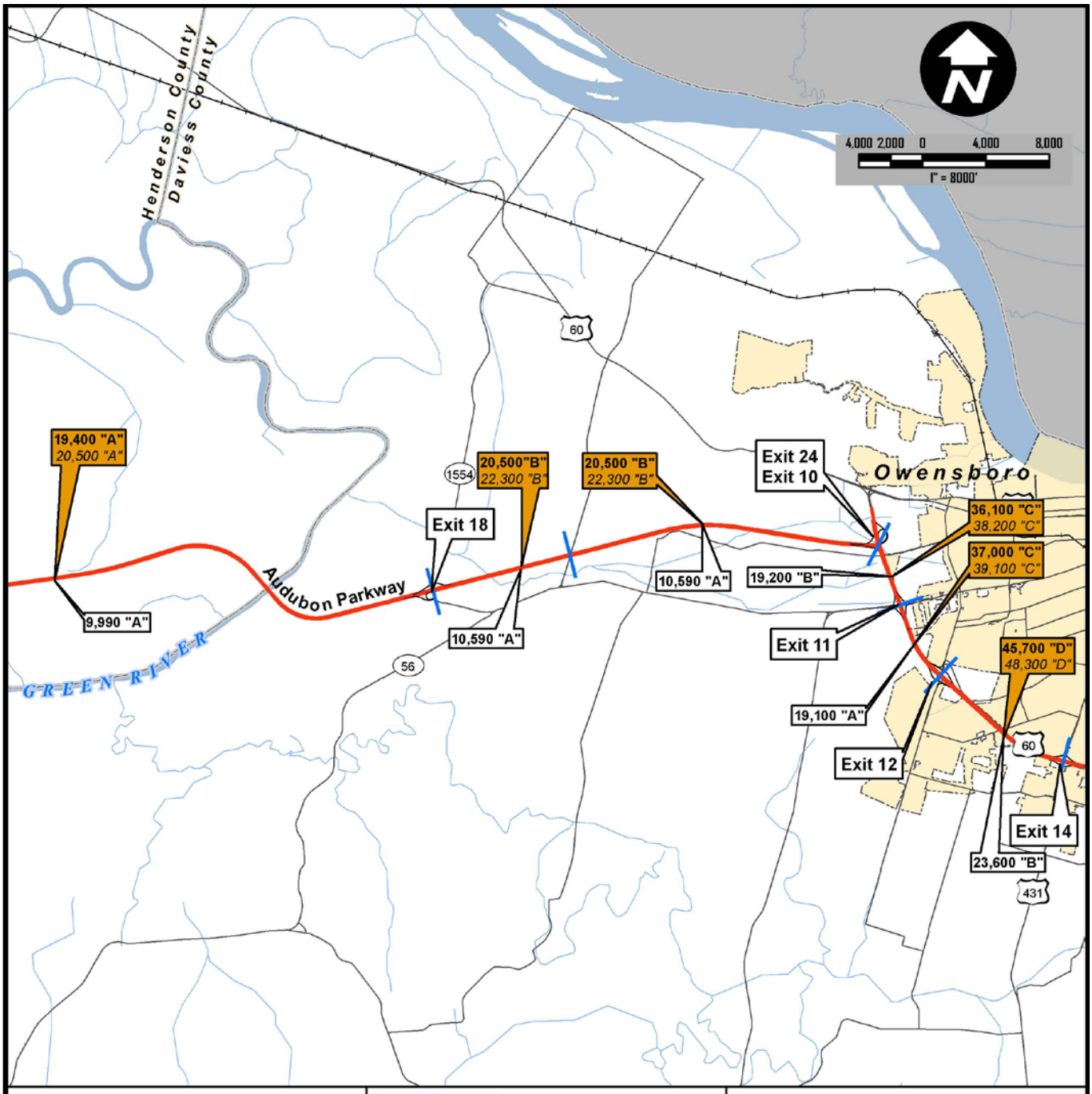
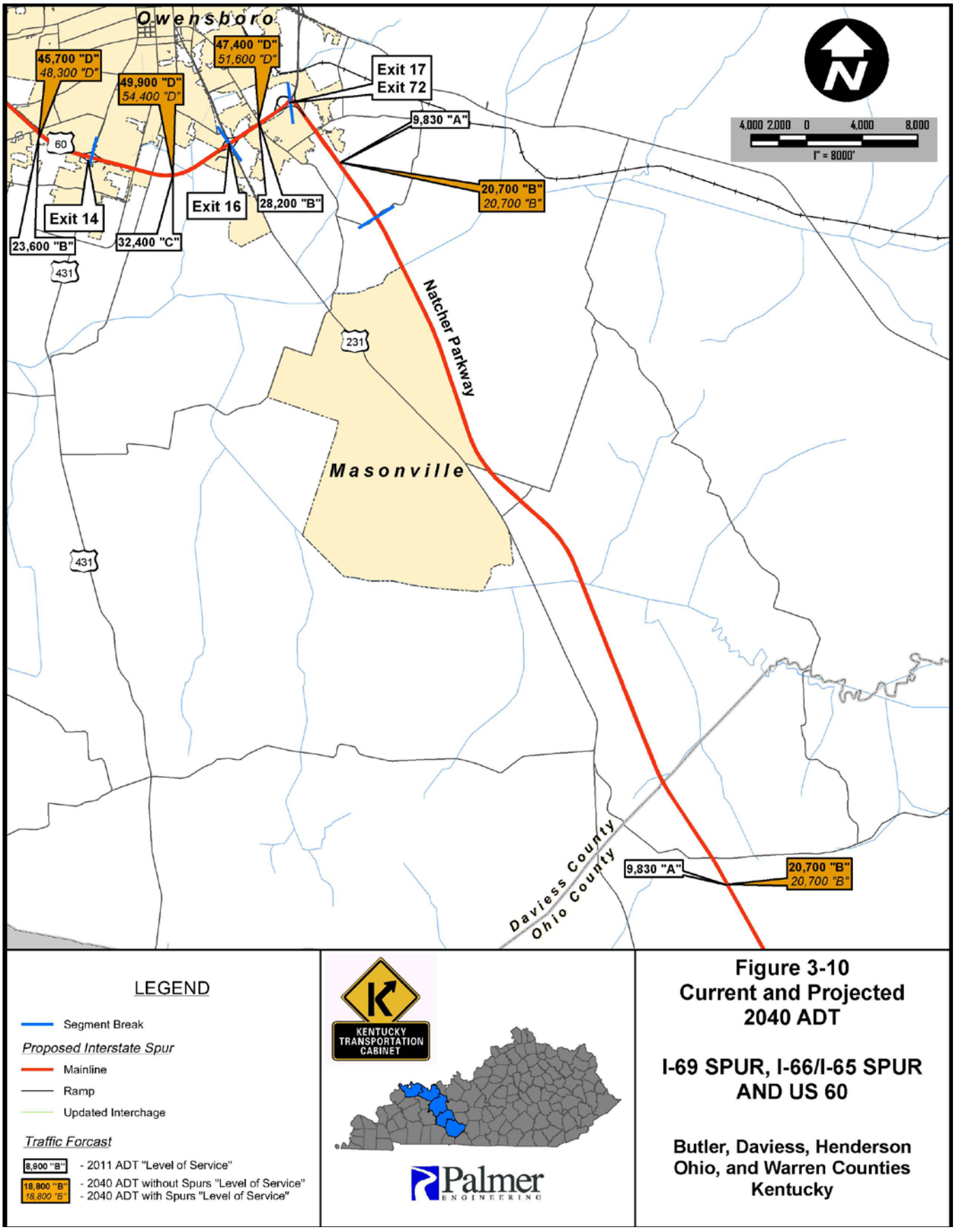
Figure 3-8
Current and Projected 2040 ADT

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Henderson County
Daviess County
N
4,000 2,000 0 4,000 8,000
1" = 8000'
60
19,400 "A"
20,500 "A"
9,990 "A"
1554
20,500"B"
22,300 "B"
Exit 18
10,590 "A"
20,500 "B"
22,300 "B"
10,590 "A"
Audubon Parkway
GREEN RIVER
56
Exit 24
Exit 10
Owensboro
36,100 "C"
38,200 "C"
37,000 "C"
39,100 "C"
19,200 "B"
Exit 11
19,100 "A"
45,700 "D"
48,300 "D"
Exit 12
60
Exit 14
23,600 "B"
431
LEGEND
Segment Break
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
Traffic Forcast
8,900 "B" - 2011 ADT "Level of Service"
18,800 "B" 18,800 "B" - 2040 ADT without Spurs "Level of Service"
- 2040 ADT with Spurs "Level of Service"
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 3-9
Current and Projected 2040 ADT
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Owensboro
45,700 "D"
48,300 "D"
49,900 "D"
54,400 "D"
47,400 "D"
51,600 "D"
Exit 17
Exit 72
9,830 "A"
20,700 "B"
20,700 "B"
28,200 "B"
Exit 16
Exit 14
23,600 "B"
32,400 "C"
60
431
231
Natcher Parkway
Masonville
Daviess County
Ohio County
4,000 2,000 0 4,000 8,000
1" = 8000'
LEGEND
Segment Break
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
Traffic Forcast
8,900 "B" - 2011 ADT "Level of Service"
18,800 "B" 18,800 "B" - 2040 ADT without Spurs "Level of Service" - 2040 ADT with Spurs "Level of Service"
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 3-10
Current and Projected 2040 ADT
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky

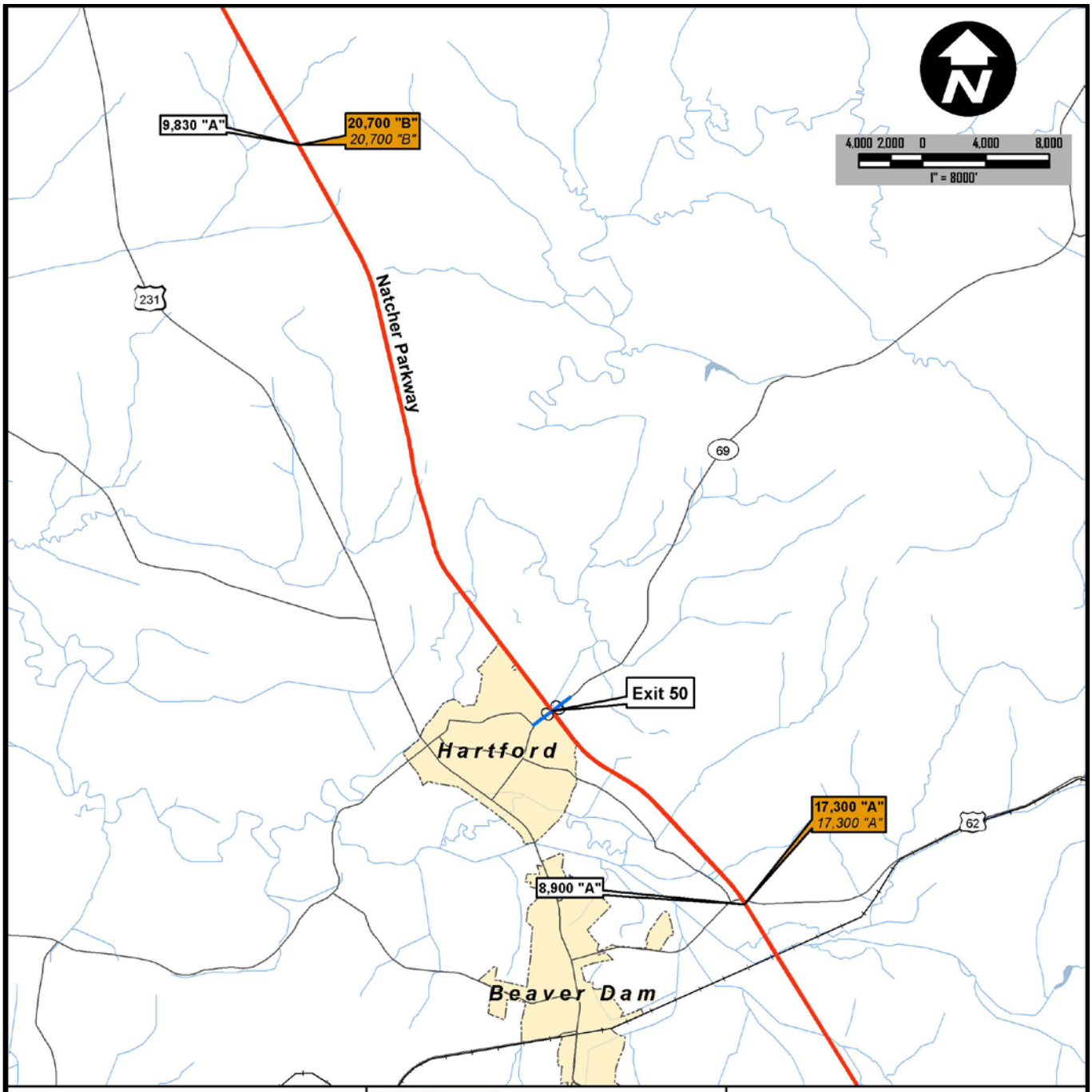

9,830 "A"
20,700 "B"
20,700 "B"
Natcher Parkway
231
69
62
Exit 50
Hartford
17,300 "A"
17,300 "A"
8,900 "A"
Beaver Dam
4,000 2,000 0 4,000 8,000
1" = 8000'
LEGEND
Segment Break
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
Traffic Forcast
8,900 "B" - 2011 ADT "Level of Service"
18,800 "B" 18,800 "B" - 2040 ADT without Spurs "Level of Service"
- 2040 ADT with Spurs "Level of Service"
KENTUCKY TRANSPORTATION CABINET
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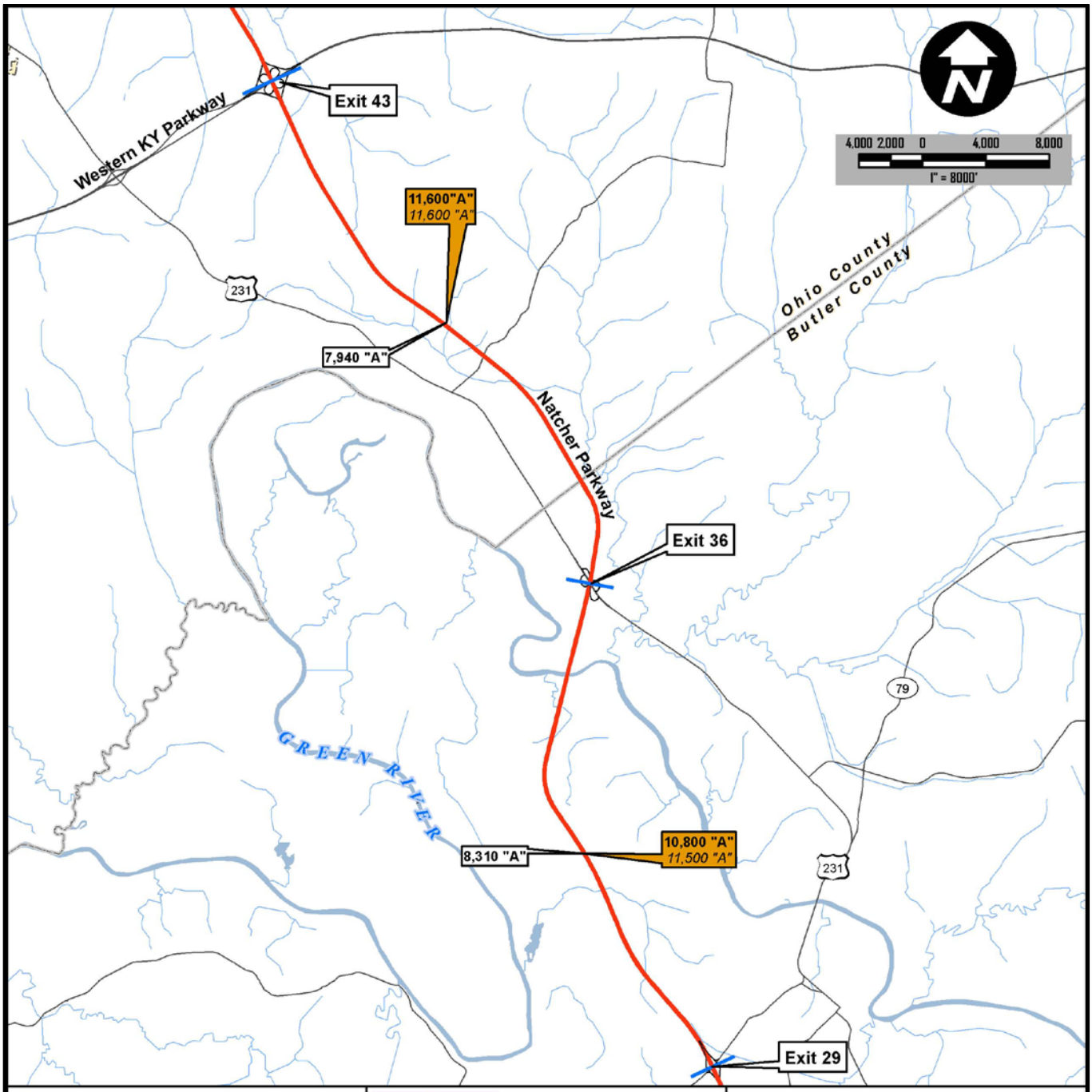
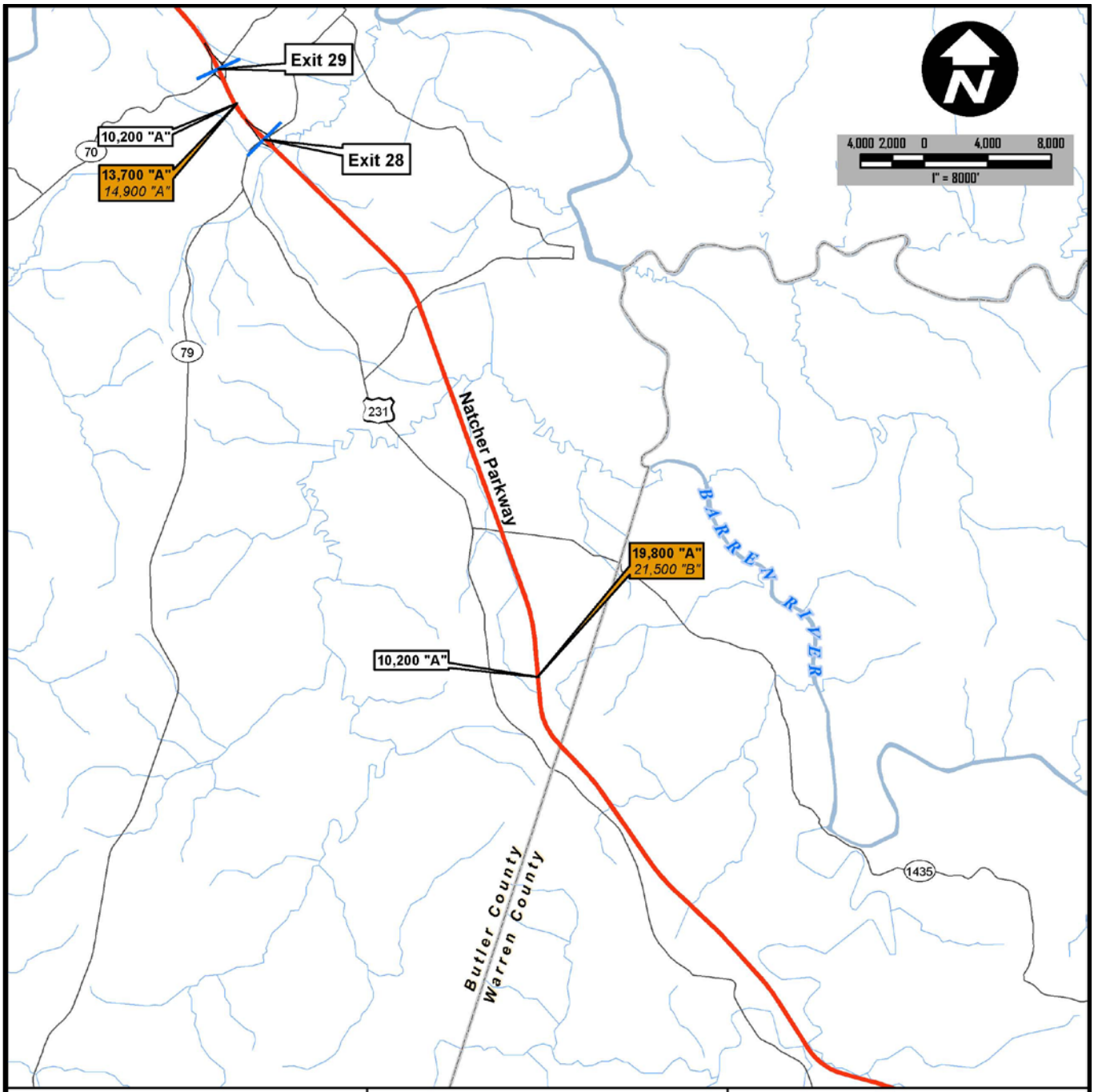
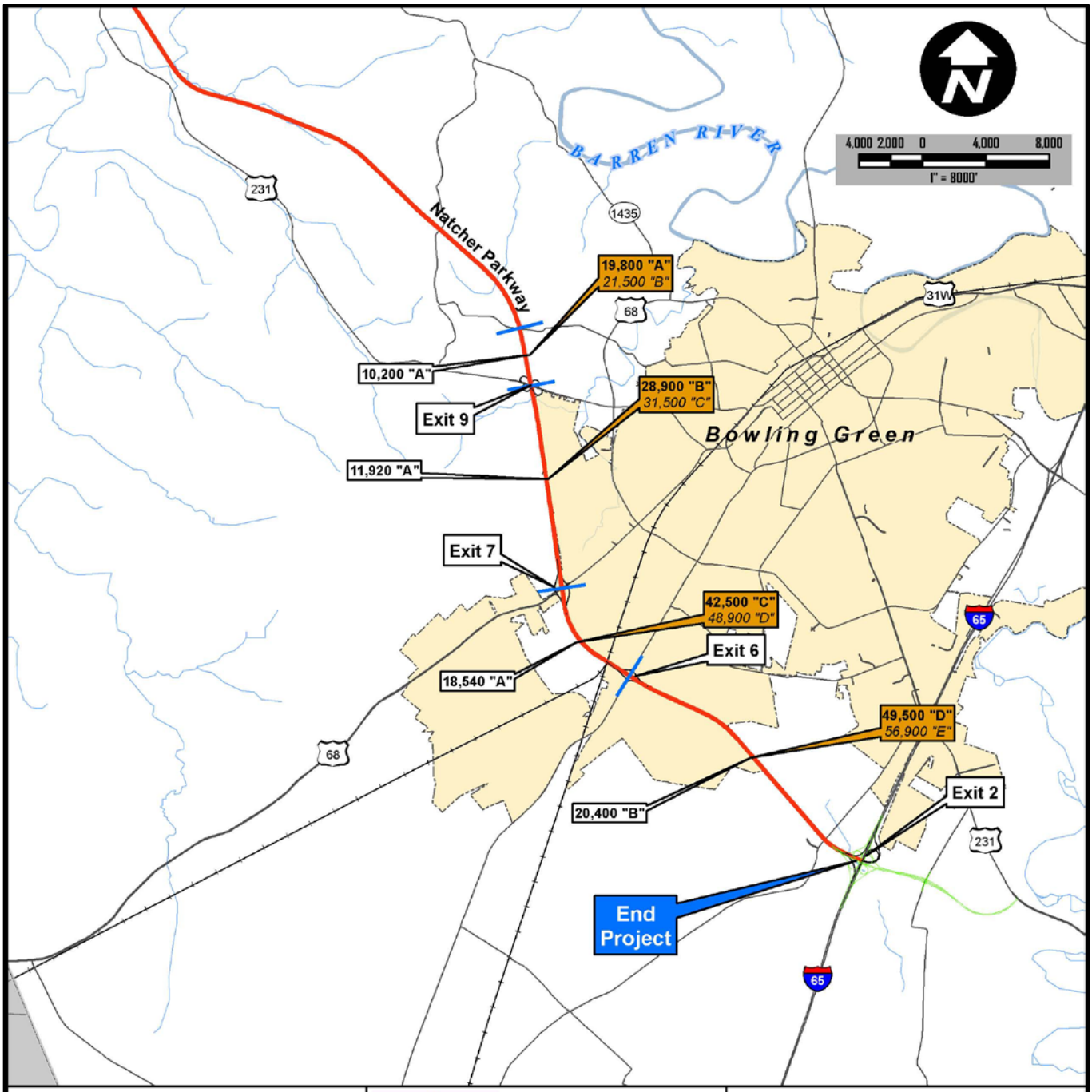
Figure 3-11
Current and Projected 2040 ADT
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Exit 43
Western KY Parkway
11,600 "A"
11,600 "A"
231
7,940 "A"
Ohio County
Butler County
Natcher Parkway
Exit 36
79
G-R-E-E-N R-I-V-E-R
8,310 "A"
10,800 "A"
11,500 "A"
231
Exit 29
4,000 2,000 0 4,000 8,000
1" = 8000'
LEGEND
Segment Break
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
Traffic Forcast
8,900 "B" - 2011 ADT "Level of Service"
18,800 "B" - 2040 ADT without Spurs "Level of Service"
18,800 "B" - 2040 ADT with Spurs "Level of Service"
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 3-12
Current and Projected 2040 ADT
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Exit 29
Exit 28
10,200 "A"
13,700 "A"
14,900 "A"
70
79
231
Natcher Parkway
19,800 "A"
21,500 "B"
10,200 "A"
BARREN RIVER
1435
Butler County
Warren County
4,000 2,000 0 4,000 8,000
1" = 8000'
LEGEND
Segment Break
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
Traffic Forcast
8,900 "B" - 2011 ADT "Level of Service"
18,800 "B" 18,800 "B" - 2040 ADT without Spurs "Level of Service"
- 2040 ADT with Spurs "Level of Service"
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 3-13
Current and Projected 2040 ADT
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



LEGEND

Segment Break

Proposed Interstate Spur

Mainline

Ramp

Updated Interchage

Traffic Forcast

8,900 "B" - 2011 ADT "Level of Service"

18,800 "B" / *18,800 "B"* - 2040 ADT without Spurs "Level of Service" / 2040 ADT with Spurs "Level of Service"

KENTUCKY TRANSPORTATION CABINET

Palmer ENGINEERING

Figure 3-14
Current and Projected 2040 ADT

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky

5. Interchange Ramp Volumes

a. Natcher Parkway and I-65

Traffic volumes were evaluated at the Natcher Parkway and I-65 interchange. At the time of this study, no ramp volumes were available. The future (2040) ADT volumes were estimated using annual growth rates from the KYTC statewide traffic forecasting model. Future traffic volumes (2040) with interstate spur designation were calculated with annual growth rates based on previous studies and historical ADT volumes. **Figure 3-15** provides the projected 2040 traffic volumes for the Natcher Parkway and I-65 interchange with interstate spur designation and without interstate spur designation. Design hourly volumes were estimated at 15% of the ADT. The interchange has been reconstructed as shown in **Figure 3-15** and is currently open to traffic.

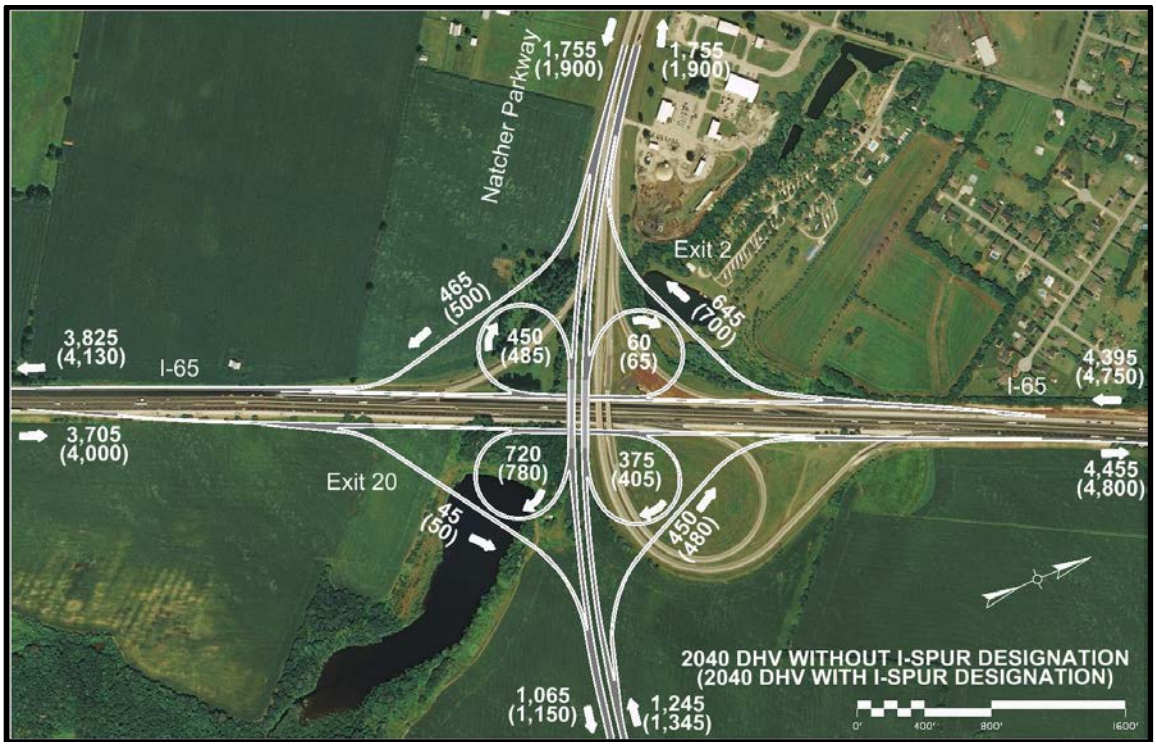


Figure 3-15 Natcher Parkway and I-65 Interchange Ramp Volumes

b. Natcher Parkway and Western Kentucky Parkway

Traffic volumes were collected and evaluated at the Natcher Parkway and Western Kentucky Parkway interchange. Future ramp traffic volumes (2040) with and without interstate spur designation were calculated with annual growth rates based on previous studies and historical ADT volumes, as shown in **Tables 3-8** and **3-9**. Based on the review of previous studies, the route designation has minimal impact to the projected annual growth rate along the Natcher Parkway at the Western Kentucky Parkway interchange. Therefore, the projected 2040 ramp volumes shown below are equal regardless whether or not the Natcher Parkway is designated as an interstate.

Figure 3-16 Natcher Parkway and Western Kentucky Parkway Interchange Ramp Volumes

c. Natcher Parkway and US 60

Traffic volumes were collected and evaluated at the Natcher Parkway and US 60 interchange in Owensboro in 2012. Future ramp traffic volumes (2040) with and without interstate spur designation were calculated with annual growth rates based on previous studies and historical ADT volumes, as shown in **Tables 3-8** and **3-9**. The projected ramp volumes (2040) without interstate spur designation were calculated using a 1.8% annual growth rate. The future ramp volumes with interstate spur designation were calculated using a 2.1% annual growth rate. **Figure 3-17** provides the projected 2040 ramp volumes for the Natcher Parkway and US 60 interchange with interstate spur designation and without interstate spur designation.

Figure 3-17 Natcher Parkway and US 60 Interchange Ramp Volumes

d. Audubon Parkway and US 60

Traffic volumes were collected and evaluated at the Audubon Parkway and US 60 interchange in Owensboro in 2012. Future ramp traffic volumes (2040) with and without interstate spur designation were calculated with annual growth rates based on previous studies and historical ADT volumes, as shown in **Tables 3-8** and **3-9**. The future ramp volumes (2040) without interstate spur designation were calculated using a 2.3% annual growth rate. The future ramp volumes with interstate spur designation were calculated using a 2.6% annual growth rate. **Figure 3-18** provides the projected 2040 ramp volumes for the Audubon Parkway and US 60 interchange with interstate spur designation and without interstate spur designation.

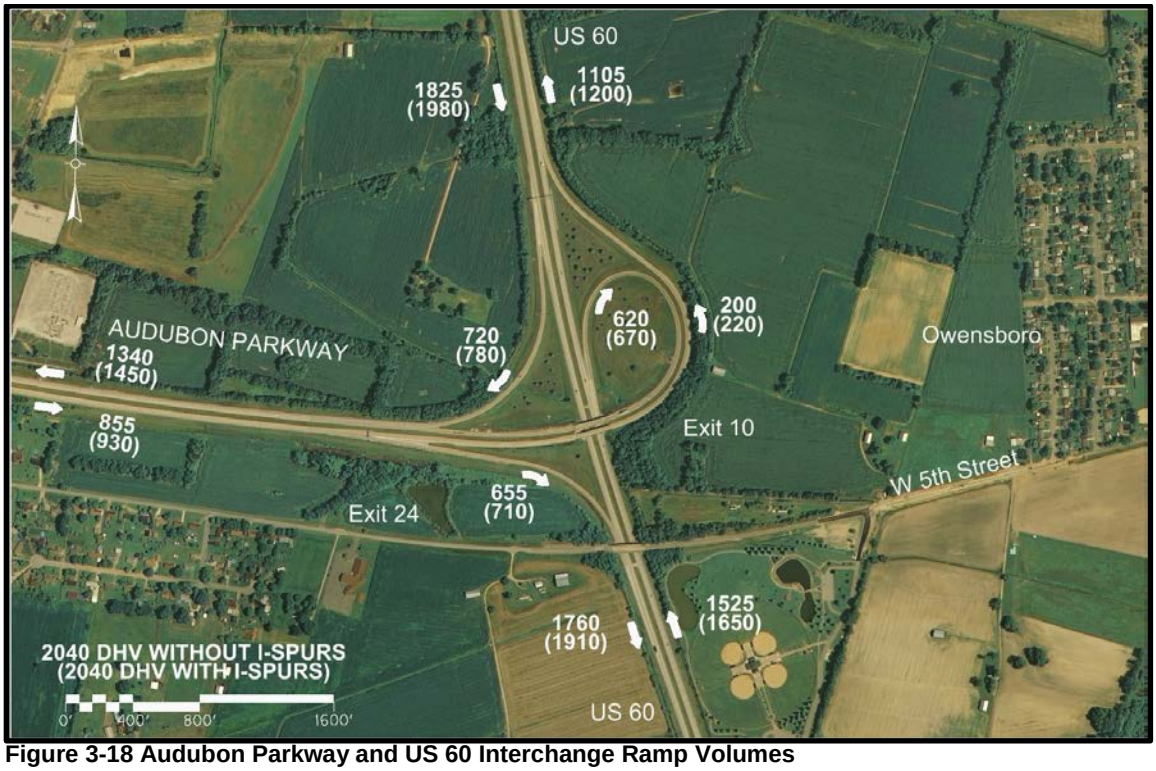


Figure 3-18 Audubon Parkway and US 60 Interchange Ramp Volumes

C. Commercial Vehicle Weight Standards

The Audubon Parkway, Natcher Parkway and US 60 are part the Extended Weight Coal and Coal By-Products Haul Road System. With the designation of the Audubon Parkway, Natcher Parkway, or US 60 as interstates, these project routes would no longer be on the Extended Weight Coal and Coal By-Products Haul Road System and weight restrictions would comply with Federal regulations.

Routes on the Extended Weight Coal and Coal By-Products Haul Road System are limited to the following weight limitations according to Kentucky Revised Statutes (KRS) 177.9771:

- "A single unit truck having one (1) steering axle and two (2) axles in tandem shall be limited to a maximum gross weight of ninety thousand (90,000) pounds with a tolerance of five (5%) percent"
- "A single unit truck having one (1) steering axle and three (3) axles in tridem arrangement shall be limited to a maximum gross weight of one hundred thousand (100,000) pounds with a tolerance of five (5%) percent"
- "Tractor-semitrailer combinations with five (5) or more axles shall be limited to a maximum gross weight of one hundred twenty thousand (120,000) pounds with a tolerance of five (5%) percent"

On the Interstate Highway System, truck length, width and weight limitations are set by Federal Regulation Title 23 and Part 658 (23 CFR 658). Based on the regulation, the commercial vehicle maximum standards on the Interstate Highway System are:

- Single Axle: 20,000 pounds
- Tandem Axle: 34,000 pounds
- Gross Vehicle Weight: 80,000 pounds

In efforts to preserve the bridges on the interstate system, Congress enacted the Bridge Formula in 1975. The formula limits the weight-to-length ratio of a commercial vehicle. The maximum gross weight of a vehicle is calculated with the formula, which could be less than 80,000 pounds depending on axle weights and configuration.

The Audubon Parkway, Natcher Parkway, and the project section of US 60 are classified by KYTC as Class AAA. According to Kentucky Administrative Regulations (KAR) 603 Chapter 5 (603 KAR 5:066) Weight (mass) limits for trucks, the maximum gross weight limits for trucks on a non-interstate Class AAA highway is 80,000 pounds.

IV. MAINLINE GEOMETRY/TYPICAL SECTION

A Policy of Geometric Design of Highways and Streets, 5th Edition, 2004, published by AASHTO provides design guidelines for streets and highways. This manual is commonly referred to as The Green Book. For guidelines related to roadside clearance, obstructions, and barriers, the *Roadside Design Guide, Current Edition,* written by AASHTO was referenced. More specific guidance on interstate standards is provided in AASHTO's *A Policy on Design Standards Interstate System, Current Edition*.

The intent of the ASSHTO Green Book is to provide guidance for the design of highways and streets. The book references a recommended range of values for critical dimensions based on established practices and recent research. The Green Book provides minimum values for critical dimensions of roadway design.

In order for the project routes to be designated as interstate spurs, the existing geometric conditions need to be compared to current interstate guidelines set forth by AASHTO. To identify these deficiencies and necessary design modifications, design information on the parkways and US 60 was collected from the Kentucky Transportation Cabinet's HIS, *As-Built Plans* for the Parkway, and site visits and compared to the current AASHTO guidelines for interstate highway facilities. A summary of this information is provided in **Appendix D.**

This chapter reviews the existing design speed, median width and type, clear zone, horizontal and vertical alignments, superelevation rates, and sight distance and compares them to the AASHTO guidelines. Although this chapter is based on comparing the existing geometric conditions of the parkways and US 60 to the minimum AASHTO guidelines set forth in the Green Book and other references mentioned, the Green Book permits and encourages sufficient design flexibility based on the project needs.

A. Design Speed

The design speed of a facility dictates many of the geometric design parameters. The design speed selected is meant to satisfy a level of public expectation for safety and LOS.

The AASHTO minimum mainline design speed for a rural interstate is 70 mph and 50 mph for an urban interstate. According to the As-Built plans, the Audubon Parkway was designed to a 80 mph design speed, the Natcher Parkway was designed to a 70 mph design speed, and US 60 was designed to a 60 mph design speed. Based on the As-Built plans, the minimum requirement is met for the parkways and US 60. The following sections and chapters that review existing mainline geometric conditions of the parkways and US 60 are based on these design speeds.

B. Typical Roadway Sections

The Audubon Parkway, Natcher Parkway and US 60 have similar typical roadway cross-sections. These typical sections generally represent the existing conditions along the parkways and US 60; however, any improvements made over the life of the routes may have resulted in changes to information that may not be represented in this study. The typical sections of the Audubon Parkway, Natcher Parkway and US 60 are shown in **Figure 4-1** on the following page.

1. Lane Widths

The minimum lane width of a freeway facility is 12 feet. The existing lane widths of the Audubon Parkway, the Natcher Parkway, and the US 60 mainline are 12 feet, therefore, meeting the minimum AASHTO guidelines for interstate design.

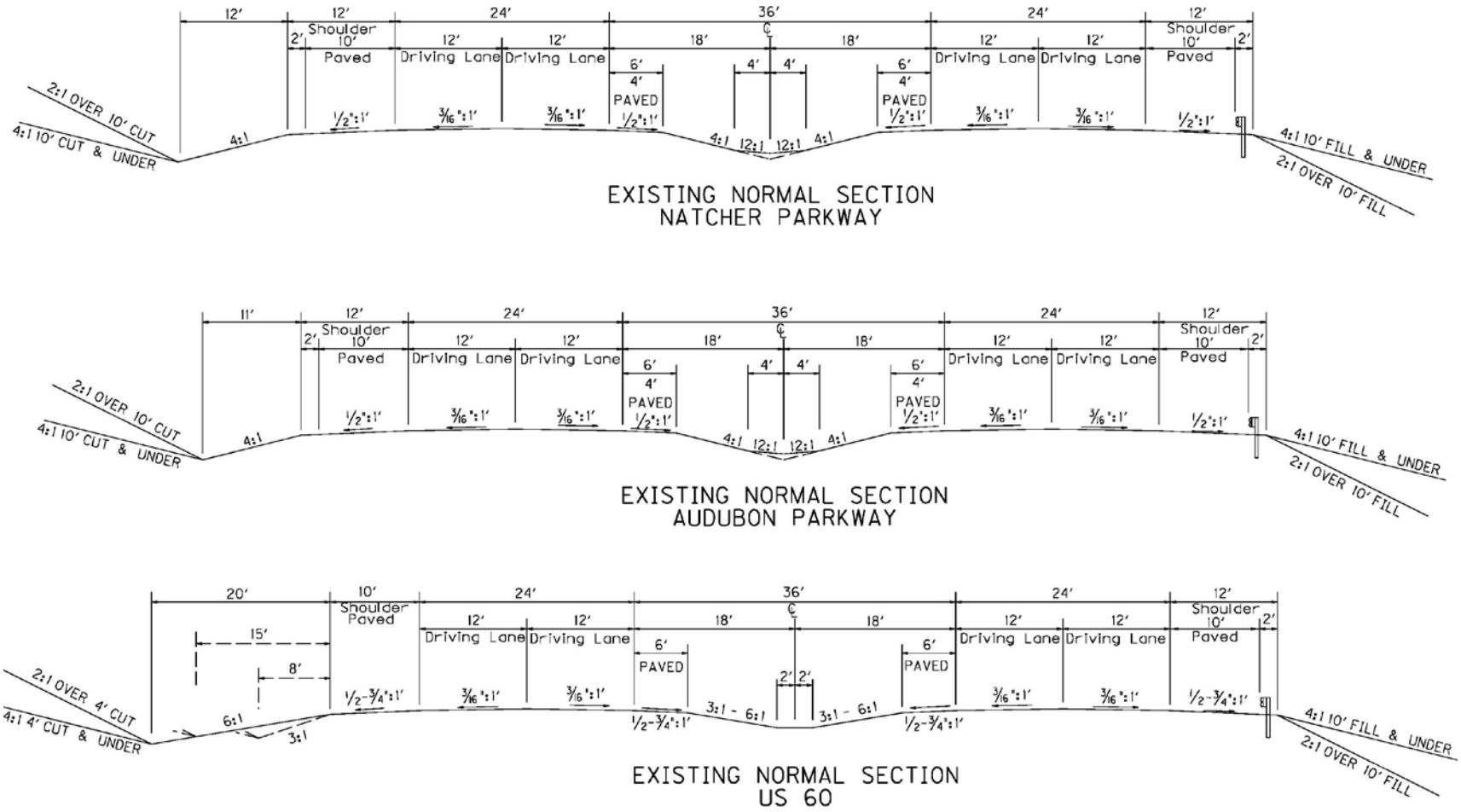


Figure 4-1 Existing Audubon Parkway, Natcher Parkway, and US 60 Typical Sections

Note: Typical Sections are based upon As-Built Plans provided by the Kentucky Transportation Cabinet

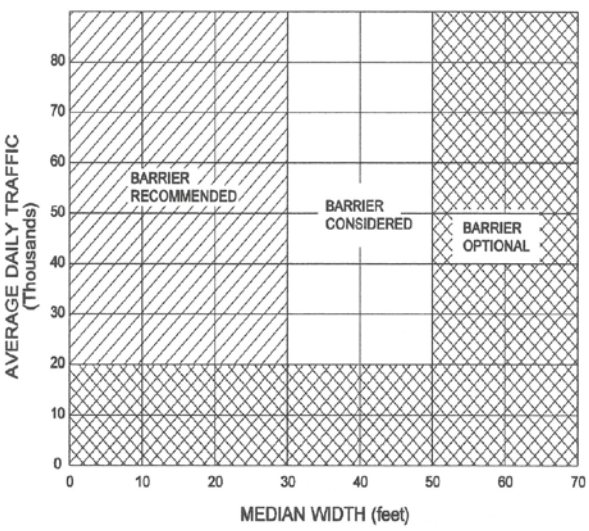
2. Shoulder Widths

The minimum AASHTO guidelines for interstate shoulders are 10 foot paved outside shoulder and 4-foot paved inside shoulder for each direction of travel. According to the As-built plans, the inside shoulder width on the Audubon Parkway and Natcher Parkway is 6 foot wide, of which 4 feet is paved. The As-built plans for US 60 show the inside shoulder to be 6 feet wide and paved; but from field measurements, the paved width of the inside shoulder is 4 feet. Also, according to the As-built plans, the outside shoulders on the Audubon Parkway and Natcher Parkway are 12 feet wide of which 10 feet is paved. The outside shoulder on US 60 is shown on the As-built plans as 10 feet wide and paved. Based on the existing (2012) directional design hourly volumes (**Table 3-7** on page 3-17), the Audubon Parkway, Natcher Parkway, and US 60 outside paved shoulder widths meet the minimum criteria.

3. Median Width and Type

The purpose of a median separation is to provide driver comfort and safety. The width of a median is measured from the inside edge of the travel lane in one direction to the inside edge of the travel lane in the other direction. The median width also includes the shoulder width. The Audubon Parkway, Natcher Parkway, and US 60 have 36-foot depressed medians.

Guidelines contained within the AASHTO Green Book recommend a minimum 50-foot median for a rural interstate. Within the AASHTO *Policy on Design Standards, Interstate System* a minimum 36-foot median for a rural interstate is required. According to the Green Book, the minimum guidelines for an urban interstate are based on the number of lanes and number of large trucks. A 10-foot median is recommended for a 4-lane urban interstate. The 10-foot median allows for 4-foot inside shoulders and a 2-foot concrete median. For urban interstates with more than two lanes in each direction, the minimum median width is 22 feet for truck volumes less than 250 vph and 26 feet for truck volumes greater than 250 vph.



Suggested guidelines for median barriers on high-speed roadways

The AASHTO's *Roadside Design Guide* is referenced to determine the warrants for barrier installation in the median. The guide provides a warrants chart based on average daily traffic, median width, and crash history. The chart to the left (Figure 6.1 in the *Roadside Design Guide*) is the warrant chart for the suggested guidelines for the installation of a median barrier on a high speed facility taken from Chapter 6 of the *Roadside Design Guide,* which has a detailed discussion of the installation of median barrier and curbs. Besides serving drainage purposes, curbs are not recommended on high speed facilities.

The crash history review in **Chapter III** indicates that the Audubon Parkway, Natcher Parkway, or US 60 do not have history of cross-over collisions.

The current traffic (2011) volumes for the Audubon Parkway range from 9,450 vpd to 10,590 vpd, and the future traffic (2040) volumes range from 19,500 to 22,300 with I-69 Spur designation. The current traffic (2011) volumes along US 60 range from 19,100 vpd to 32,400 vpd, and the future traffic (2040) volumes range from 38,200 vpd to 54,400 vpd with interstate spur designation. The current traffic (2011) volumes along the Natcher Parkway range from 7,940 vpd to 20,400 vpd, and the future traffic (2040) volumes range from 11,500 vpd to 56,900 vpd with I-66/I-65 Spur designation.

Based on the references, minimum guidelines and ADT, the parkways and US 60 medians are in compliance.

4. Clear Zones

The clear zone of a roadway is the area outside the edge of the travel lane, including the shoulder that is free of obstructions and used for vehicle recovery. Guidelines for clear zone widths for roadways based on design speed, traffic volumes, fill/cut slopes, ditch slopes, and distance from fixed obstructions such as bridge piers, sign supports, culvert headwalls, trees, rock outcrops, and drainage channels are provided in the *Roadside Design Guide.*

A foreslope of 1V:4H or flatter is considered recoverable, and foreslopes between 1V:3H and 1V:4H are considered traversable, but non-recoverable. As described in the guide, the recommendation for a clear zone range is 30 feet to 46 feet for recoverable fill slopes (1V:4H or flatter) on a roadway with a design speed of 70 mph and Average Daily Traffic (ADT) greater than 6,000 vehicles. The recommended clear zone range is 20 feet to 28 feet for recoverable fill slopes (1V:4H) on a roadway with a design speed of 50 mph and ADT greater than 6,000 vehicles. Foreslopes steeper than 1V:4H, obstructions should not be present in the vicinity of the toes of these slopes.

For a roadway in a cut section and ADT greater than 6,000 vehicles, the clear zone for backslope of 1V:3H or flatter varies from 22 feet to 30 feet for 70 mph design speed and 14 feet to 22 feet for 50 mph design speed.

In the review of the As-built plans, the fill and cut slopes vary from 1V:2H to 1V:4H; see typical provided in **Figure 4-1** on page 4-2. These side slopes depend on the height of fill or depth of cut required. Based on information available in As-built plans, it is not possible to readily summarize the clear zone distances for the Audubon Parkway, Natcher Parkway, and US 60.

5. Guardrail Placement and Condition

Guardrail is a longitudinal barrier to shield motorists from natural or man-made obstacles located on either side of a traveled way. The guardrail protects a vehicle potentially leaving the roadway by absorbing the vehicle's energy, protecting it from roadside hazards. Chapter 5 of the *Roadside Design Guide* addresses the application and situation of guardrail placement. The information available on the As-built plans does not provide sufficient information to determine if the guardrail placement on the parkways and US 60 meets the current standard. A field review of the existing guardrail end treatment was conducted on the parkways and US 60 mainline and interchange ramps. This review showed that the leading guardrail end treatments on the parkways and US 60 meet current KYTC standards. From the review of the trailing end treatments, there were 60 locations on the Natcher Parkway, 56 locations on the Audubon Parkway and 13 locations on US 60 that do not meet current KYTC standards. The locations of the trailing guardrail end treatment deficiencies are compiled in **Appendix D**.

C. Horizontal Alignment

This section includes the review of existing superelevation and horizontal curvature for the parkways and US 60 and compares them to the current minimum standards.

1. Superelevation Rate

Superelevation (road banking) is the physical tilting of the roadway to help counteract the centripetal forces developed as a vehicle goes around a curve. Superelevation and friction keep a vehicle from sliding off the roadway while traveling through a curve. Superelevation is calculated based on design speed and horizontal curvature of the roadway. According to AASHTO's The Green Book, the maximum superelevation rate is controlled by climate conditions, terrain conditions, type of area, and frequency of slow-moving vehicles that may be affected by high superelevation rates. A specific maximum superelevation is not recommended for an Interstate facility by AASHTO. It is left to the user agencies to make specific policy decisions concerning allowable rates of superelevation. The KYTC policy references The Green Book for freeway geometric design. The Green Book provides superelevation rate tables for 4%, 6%, 8%, 10%, and 12% maximum superelevations. From review of As-built plans and field inspection, it appears that the parkways and US 60 were constructed on the basis of a 10%

maximum superelevation. The superelevations for the parkways and US 60 are compiled in **Appendix D**.

2. Degree of Horizontal Curvature

The guidelines for horizontal curvature design were designated by degree of curvature during the design of the parkways and US 60. The existing parkways and US 60 were designed to a maximum 3° 00' curve, which equates to a minimum radius of approximately 1910 feet. The current AASHTO guidance for minimum curvature references curve radius rather than degree of curvature. The current minimum horizontal curvature radius for a design speed of 70 mph for a rural interstate is 1810 feet, which equates to approximately 3°10' of curvature. The minimum radius for an urban interstate with a 50 mph design speed is 758 feet or approximately 7° 33' of curvature.

The smallest radius of curve on the Audubon Parkway is 3,274 feet located at MP 16.439 in a rural section. The smallest radius of curve on the Natcher Parkway is 3,820 feet located at MP 2.482, MP 15.321, MP 18.476, MP 33.478, and MP 36.759. The smallest radius of curve on US 60 is 3,820 feet located at MP 15.613. All of the mainline horizontal curves meet the minimum 1810 feet for 70 mph rural interstate and 758 feet for 50 mph urban interstate criteria. A compilation of horizontal curves is located in **Appendix D**.

D. Vertical Alignment

The vertical alignment of a roadway depends on the existing terrain. The changes in vertical terrain result in the introduction of vertical curves into the roadway design. A vertical curve is classified as sag or crest. A sag vertical curve is used when traversing through a valley, and a crest vertical curve is introduced when traveling over a hill. The design of these curves is critical to stopping sight distance. Stopping sight distance is measured by how far a driver can see while traveling in a typical vehicle and still maintain the ability to stop within that distance. Design speed, length of vehicle light beam distance, and approach and departing grades determine the length of crest and sag vertical curves.

1. Vertical Grade

The Audubon Parkway and Natcher Parkway are considered to have a rolling terrain. AASHTO guidelines designate a maximum 4% vertical grade for a rural section with a rolling terrain and 5% for an urban section. According to the as-built plans, the Audubon Parkway and Natcher Parkway meet this maximum criteria for both urban and rural sections. Thirteen vertical curves on the Natcher Parkway have a 4% vertical grade. The largest vertical grade on the Audubon Parkway is 3% and is present on 7 vertical curves. US 60 is considered to have a level terrain. AASHTO guidelines designate a maximum 3% vertical grade for rural section with a level terrain and a maximum 4% for an urban section. According to the As-built plans, US 60 meets this maximum criteria for an urban section. US 60 has 6 vertical curves with a vertical grade of 3%. The review of the As-built plans for the Audubon Parkway, the Natcher Parkway, and US 60 showed all sections met the maximum vertical grade.

2. Vertical Length of Curve

The minimum length of curve was calculated based on the vertical grades of the approaching alignment, and compared to the recommended rate of vertical curvature for a design speed. One vertical curve does not meet the recommended vertical length of curve based on this calculation. This vertical sag curve is located on the Natcher Parkway in a rural area in Ohio County at:

- MP 53.800 – Actual 800 feet; calculated minimum 829 feet

3. Stopping Sight Distance

Stopping sight distance was reviewed for all vertical curves on the Audubon Parkway, the Natcher Parkway, and US 60 Connection. Stopping sight distance is calculated based on design speed and sight distance. The minimum stopping sight distance for a 70 mph design is

730 feet and 425 feet for a 50 mph design speed. One vertical sag curve has less than the minimum stopping sight distance. It is located in a rural area in Ohio County at:

- MP 53.800 – Calculated Stopping Sight Distance 710 feet

V. BRIDGES AND OVERPASSES

One hundred fourteen bridge structures are located on the Audubon Parkway, Natcher Parkway, and US 60; a detailed table of data for these structures is included in **Appendix D**. A mainline bridge is a structure that carries the through traffic. An overpass bridge is a structure that carries traffic over the mainline roadway. The following table illustrates the breakdown of the mainline and overpass bridges and culverts on the Audubon Parkway, Natcher Parkway, and US 60.

TYPE	NUMBER OF STRUCTURES			
	AUDUBON PARKWAY	NATCHER PARKWAY	US 60	TOTAL
MAINLINE BRIDGES	9	41	14	64
OVERPASSES	9	26	4	39
CULVERTS	3	8	0	11

Table 5-1 Summary of Structure Types

The concerns for mainline bridge structures on the roadway and overpass bridge structures passing above the roadway are the lateral widths and vertical height clearance. In addition to geometric design, functional and structural condition of these bridges is a concern. Given the increased traffic, especially truck traffic, the functional and structural capacity of these structures is a safety concern. The following discussions include lateral and vertical clearance issues, condition, and safety appurtenances to identify structures in the project area that are deficient under current design guidelines.

A. Lateral Clearances of Bridges

Lateral clearance is defined as the width of a mainline bridge, measured from curb to curb. The lateral clearances of the mainline bridges were evaluated to determine if they were too narrow to meet current design guidelines.

According to the latest AASHTO guidelines, *A Policy on Design Standards Interstate System* (American Association of State Highway Officials, 2005), the width of a mainline bridge, less than 200 feet in length, shall equal the full paved width of the approach roadway. The full paved width of the approach roadway includes the two 12-foot travel lanes, 4-foot inside paved shoulder and 10-foot outside paved shoulder for a total of 38 feet. AASHTO guidelines allow bridges over 200 feet in length to be evaluated individually and that the minimum distance between the travel lane and barrier shall be at least 3.5 feet for these bridges. Therefore, a bridge over 200 feet can have a minimum clearance of 31 feet (two 12- foot lanes and 3.5-foot inside and outside shoulders). Further guidance is given on evaluating long bridges, over 200 feet in length.

From page 8-4 the Green Book:

“On bridges longer than 60 m [200 ft], some economy in substructure costs may be gained by building a single structure rather than twin parallel structures. In such cases, the approach shoulder widths are provided and a median barrier is extended across the bridge.”

Further discussion of lateral clearance on long bridges is found on pages 10-18 of the same reference:

“On long bridges, particularly on long-span structures where cost per square meter [square yard] is greater than the cost on short-span structures, widths that are less than ideal may be acceptable; however, economy alone should not be the governing factor in determining structure widths. The analysis of traffic characteristics, potential crash frequency and severity, emergency contingencies, and benefit/cost ratios should be fully considered before the desirable structure width is reduced.”

The following paragraph taken from *A Policy on Design Standard Interstate System*, 2005 addresses existing bridges to remain in place when a route is to be incorporated in the interstate system:

"Mainline bridges on the interstate system and bridges on routes to be incorporated into the system may remain in place if, as a minimum, they meet the following: a) the bridge cross section consists of 3.6 m (12 ft) lanes, 3.0 m (10 ft) shoulder on the right and 1.1 m (3.5 ft) shoulder on the left; b) for long bridges, the offset to the face of parapet or bridge rail on both the left and right is 1.1 m (3.5 ft) measured from the edge of the nearest traveled lane; c) bridge railing shall meet or be upgraded to current standards."

Table 5-2 on the following page summarizes the length and horizontal width of the Audubon Parkway, Natcher Parkway, and US 60 mainline bridges. The horizontal clearance is measured from curb to curb.

Twenty-four of the 40 mainline bridges less than 200 feet in length do not meet the 38 foot minimum horizontal clearance criteria. Twelve mainline bridges greater than 200 feet in length do not meet the 31 foot minimum horizontal clearance criteria.

Natcher Parkway – Mainline Bridge over US 62 in Ohio County

In addition to the lateral clearance, mainline bridge side railings/barriers are a concern for bridges on the interstate system. The Federal Highway Administration (FHWA) requires highway bridges on the National Highway System (NHS) and Interstate Highway System to have crash-tested railing. The National Cooperative Highway Research Program (NCHRP) Report 350, *Recommended Procedures for the Safety Performance of Highway Features* provides guidance on testing highway features such as bridge railing. Since the construction of the bridges on the Audubon Parkway, Natcher Parkway and US 60, side railings/barriers design guidelines have been modified to improve crash-worthiness. A majority of the mainline bridges on the Audubon Parkway, Natcher Parkway, and US 60 are constructed with a vertical barrier railing with aluminum handrail and a 10 inch high curb, or brush block, which do not meet current specifications. Retrofitting options are available to update the bridge railing to meet current crash-worthy criteria.

Four mainline bridges on the Natcher Parkway are located at Exit 28 and Exit 29 interchanges and have been retrofitted from brush block/railing to a sloped-face barrier wall. From field measurements, the bridge brush block/railing has been retrofitted to a 32-inch tall 3.5° sloped-face barrier wall. The sloped-face barrier walls on the US 60 and Natcher Parkway interchange bridges were measured 34 inches tall with a 4.2° sloped face. According to AASHTO *Roadside Design Guide,* a 32-inch vertical and single sloped faced concrete wall meets a test level 4 (TL-4). Although vertical and sloped faced barrier walls meet a TL 4, they are not designed to absorb crash energy like the New Jersey barrier and F-shaped barrier walls. The mainline bridges that have barrier walls that meet the current crash-worthy criteria are included in **Table 5-2**.

COUNTY	BRIDGE NO.	MP	FEATURES INTERSECTED	LENGTH (ft)	EXISTING WIDTH (GUTTER TO GUTTER)(ft)	MINIMUM INTERSTATE STANDARD	BARRIER WALL CURRENT STANDARD
AUDUBON PARKWAY							
Henderson	B00073L	0.005	Pennyrile Parkway	190.9	26	-	NO
Henderson	B00073R	0.005	Pennyrile Parkway	190.9	26	-	NO
Henderson	B00077L	6.223	Lick Creek	69.9	39	38	NO
Henderson	B00077R	6.223	Lick Creek	69.9	39	38	NO
Henderson	B00072N	15.839	Green River	941.9	31 (WB)	31	NO
					31 (EB)	31	NO
Daviess	B00059L	22.701	KY 2120 (Worthington Rd)	140.1	39	38	NO
Daviess	B00059R	22.701	KY 2120 (Worthington Rd)	140.1	39	38	NO
Daviess	B00058L	23.432	US 60	189	26	-	NO
Daviess	B00058R	23.432	US 60	189	26	-	NO
US 60							
Daviess	B00072L	12.011	Bittle Road	143.0	39.25	38	NO
Daviess	B00072R	12.011	Bittle Road	143.0	39.25	38	NO
Daviess	B00074L	13.564	Tamarack Road	150.0	39.25	38	NO
Daviess	B00074R	13.564	Tamarack Road	150.0	39.25	38	NO
Daviess	B00075L	14.416	US 431	172.0	39.25	38	NO
Daviess	B00075R	14.416	US 431	172.0	39.25	38	NO
Daviess	B00077L	15.026	J. R. Miller Blvd	151.9	30	38	NO
Daviess	B00077R	15.026	J. R. Miller Blvd	151.9	39.25	38	NO
Daviess	B00076L	15.272	Sutherland Road	115.5	30	38	NO
Daviess	B00076R	15.272	Sutherland Road	115.5	39.25	38	NO
Daviess	B00078L	15.842	Horse Fork Creek	92.8	34	38	YES
Daviess	B00078R	15.842	Horse Fork Creek	92.8	39.25	38	YES
Daviess	B00068L	16.943	Old Hartford Road	149.9	33.8	38	YES
Daviess	B00068R	16.943	Old Hartford Road	149.9	40	38	YES
NATCHER PARKWAY							
Warren	B00049L	2.079	I-65	412.5	54	-	YES
Warren	B00049R	2.079	I-65	412.5	54	-	YES
Warren	B00051L	5.686	US 31W	202	30	31	NO
Warren	B00051R	5.686	US 31W	202	30	31	NO
Warren	B00052L	6.003	CSX RR	194	30	38	NO
Warren	B00052R	6.003	CSX RR	194	35.1	38	NO
Warren	B00053L	7.083	US 68/80	220	30	31	NO
Warren	B00053R	7.083	US 68/80	220	30	31	NO
Warren	B00054L	15.627	Gasper River	258	30	31	NO
Warren	B00054R	15.627	Gasper River	258	30	31	NO
Butler	B00057L	24.723	Little Muddy Creek	224.5	30	31	NO
Butler	B00057R	24.723	Little Muddy Creek	224.5	30	31	NO
Butler	B00059L	28.523	US 231 (Bowling Green Rd)	176	30	38	YES
Butler	B00059R	28.523	US 231 (Bowling Green Rd)	176	30	38	YES
Butler	B00060L	29.533	KY 70 (Veterans Hwy)	157	30	38	YES
Butler	B00060R	29.533	KY 70 (Veterans Hwy)	157	30	38	YES
Butler	B00061N	34.816	Green River	778	31 (NB)	31	NO
					31 (SB)	31	NO
Ohio	B00075L	45.88	P & L RR	236.9	30	31	NO
Ohio	B00075R	45.88	P & L RR	236.9	30	31	NO
Ohio	B00076L	46.146	Pidgeon Creek	134.8	39	38	NO
Ohio	B00076R	46.146	Pidgeon Creek	134.8	39	38	NO

Bridge horizontal clearance less than interstate standard

One-lane bridge part of existing trumpet interchange

Table 5-2 Summary of Substandard Lateral Clearances

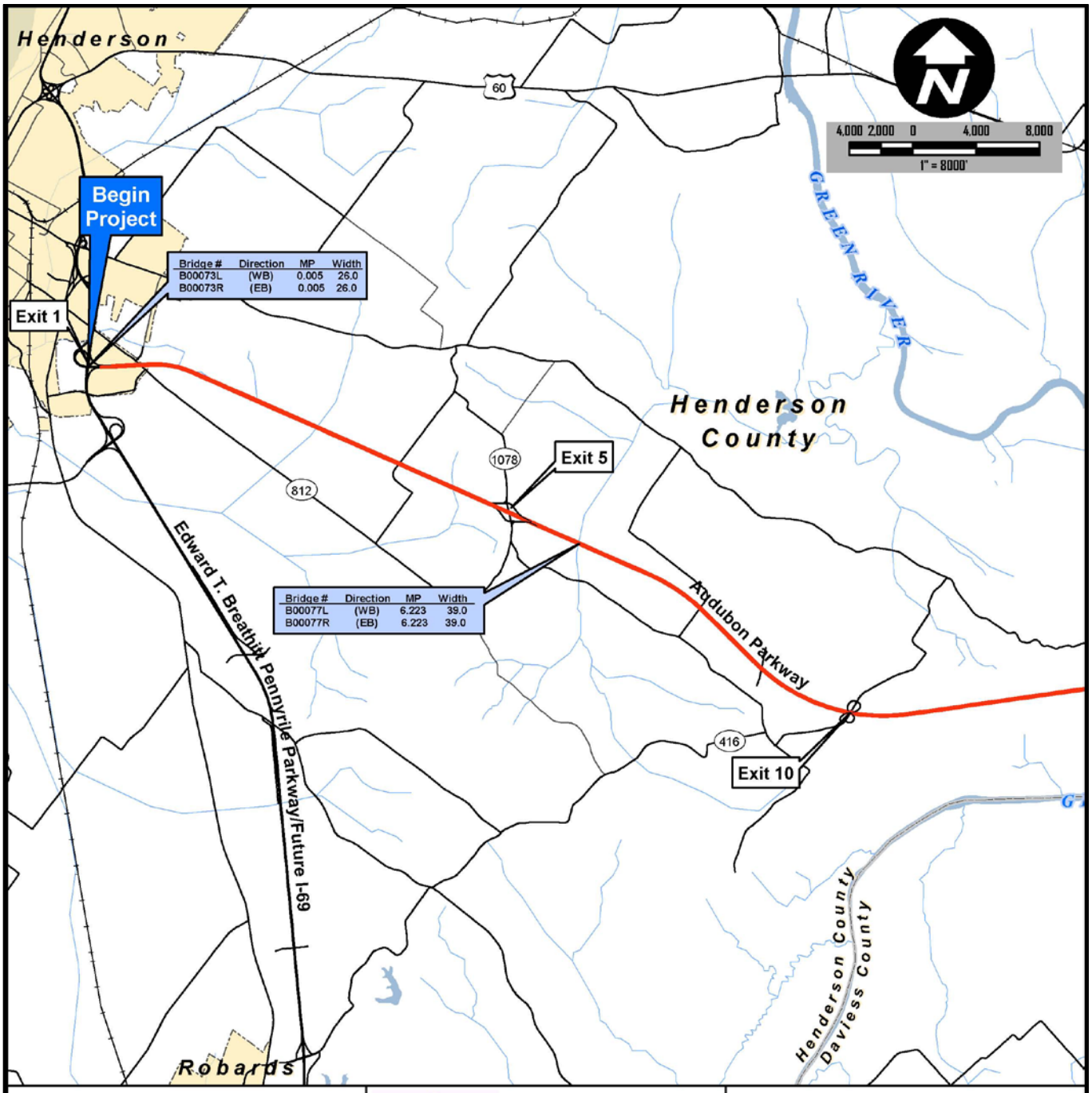
COUNTY	BRIDGE NO.	MP	FEATURES INTERSECTED	LENGTH (ft)	EXISTING WIDTH (GUTTER TO GUTTER)(ft)	MINIMUM INTERSTATE STANDARD	BARRIER WALL CURRENT STANDARD
NATCHER PARKWAY							
Ohio	B00060L	46.645	US 62 (Louisville Rd)	227	31	31	NO
Ohio	B00060R	46.645	US 62 (Louisville Rd)	227	31	31	NO
Ohio	B00063L	51.491	Rough River	245.1	30	31	NO
Ohio	B00063R	51.491	Rough River	245.1	30	31	NO
Ohio	B00067L	60.328	KY 764	168.0	30	38	NO
Ohio	B00067R	60.328	KY 764	168.0	30	38	NO
Daviess	B00088L	64.485	S Fork Panther Creek	169.5	30	38	NO
Daviess	B00088R	64.485	S Fork Panther Creek	169.5	30	38	NO
Daviess	B00089L	64.835	S Fork Panther Creek	155.0	30	38	NO
Daviess	B00089R	64.835	S Fork Panther Creek	155.0	30	38	NO
Daviess	B00090L	65.028	S Fork Panther Creek	155.0	30	38	NO
Daviess	B00090R	65.028	S Fork Panther Creek	155.0	30	38	NO
Daviess	B00094L	69.327	N Fork Panther Creek	154.9	30.5	38	YES
Daviess	B00094R	69.327	N Fork Panther Creek	154.9	30.5	38	YES
Daviess	B00081L	69.522	N Fork Panther Creek	180.0	30.5	38	YES
Daviess	B00081R	69.522	N Fork Panther Creek	180.0	30.5	38	YES
Daviess	B00082L	69.846	N Fork Panther Creek	155.0	30.5	38	YES
Daviess	B00082R	69.846	N Fork Panther Creek	155.0	30.5	38	YES
Daviess	B00085L	72.255	US 60	189	25	-	YES
Daviess	B00085R	72.255	US 60	189	25	-	YES

Bridge horizontal clearance less than interstate standard

One-lane bridge part of existing trumpet interchange

Table 5-2 Summary of Substandard Lateral Clearances (continued)

Figures 5-1 through **5-7** show the locations and the lateral clearance of the bridges on the Parkways and US 60.



Legend

Proposed Interstate Spur

Mainline

Ramp

Updated Interchage

KENTUCKY TRANSPORTATION CABINET

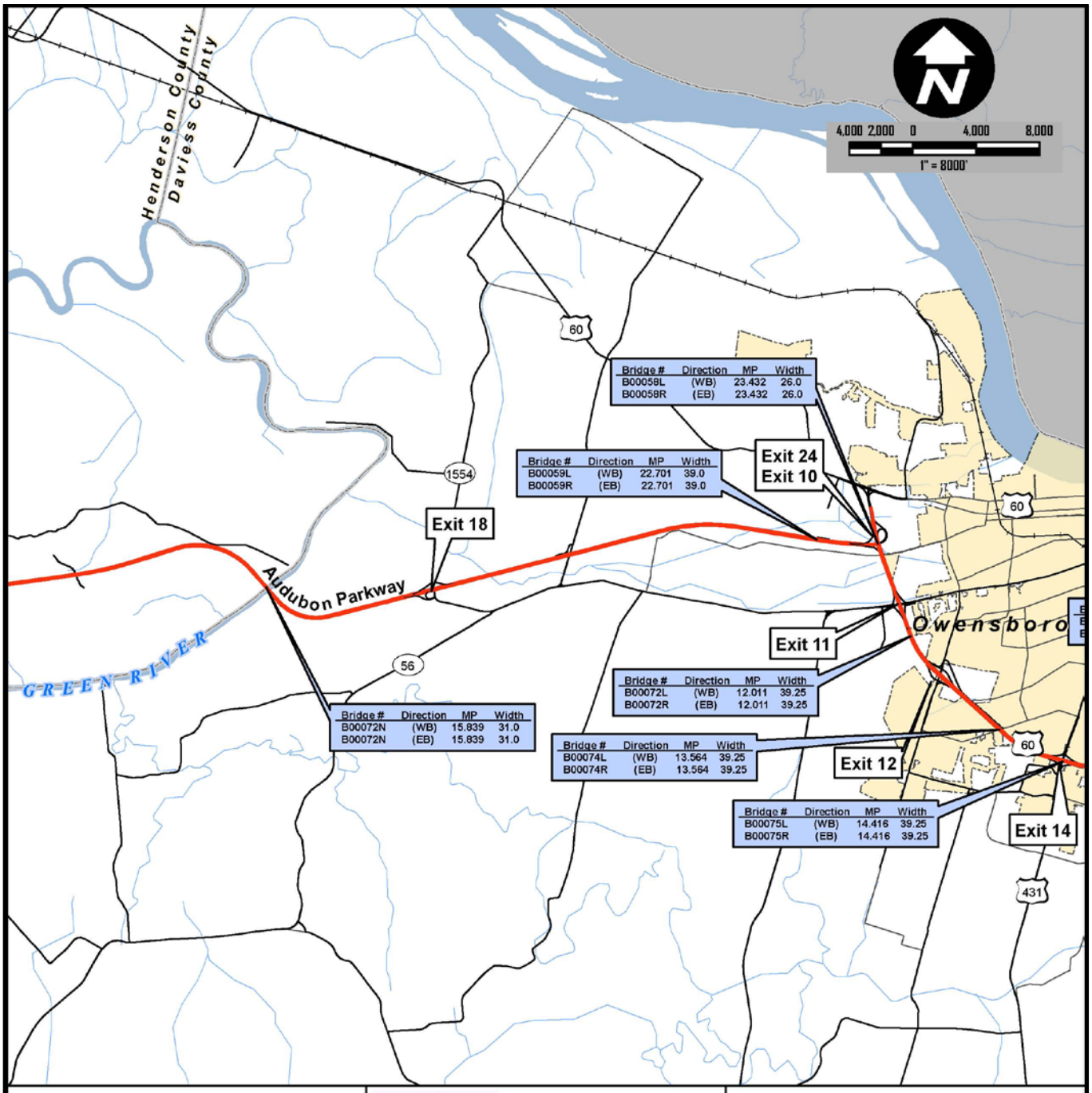
Palmer ENGINEERING

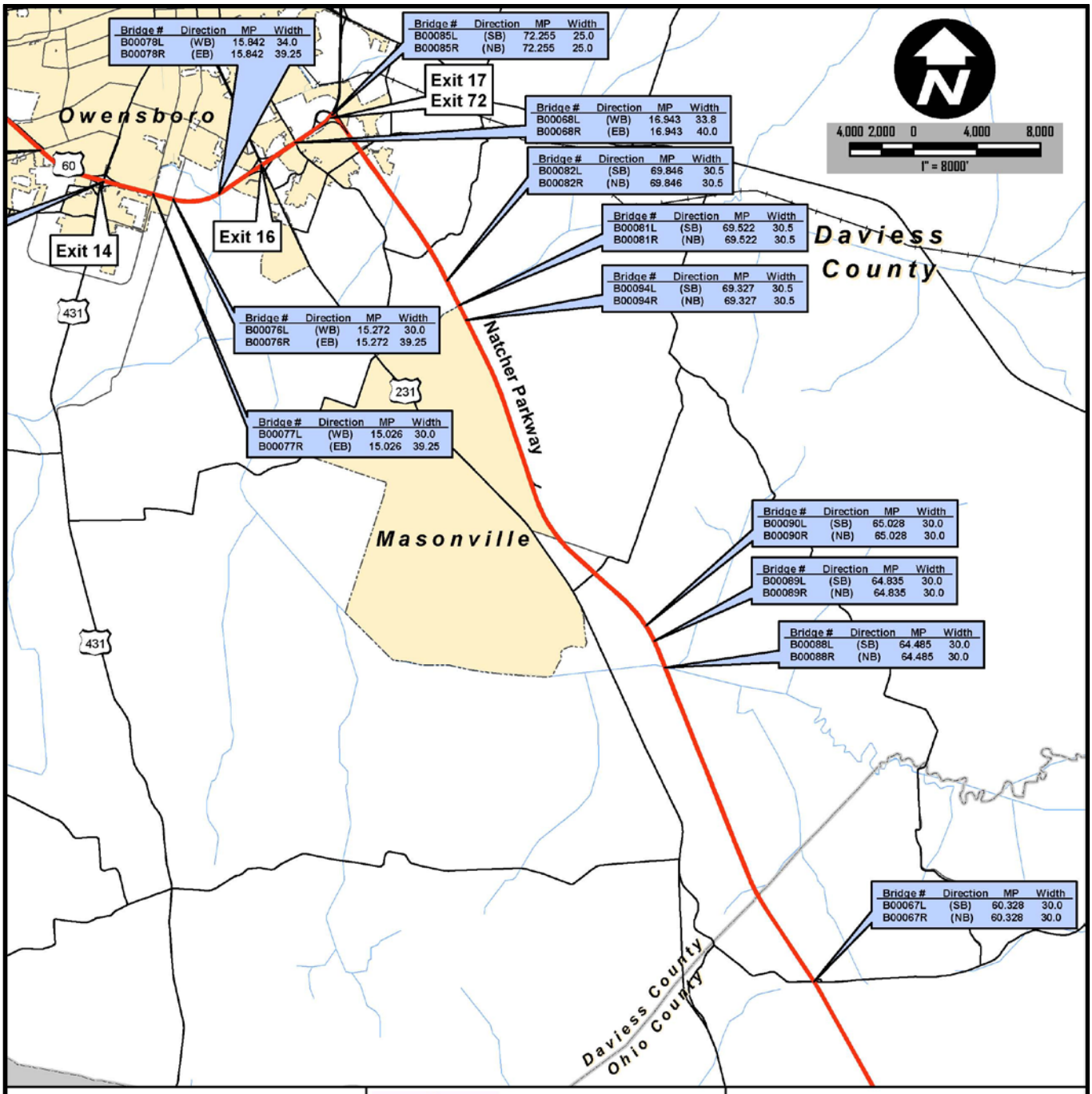
Figure 5-1

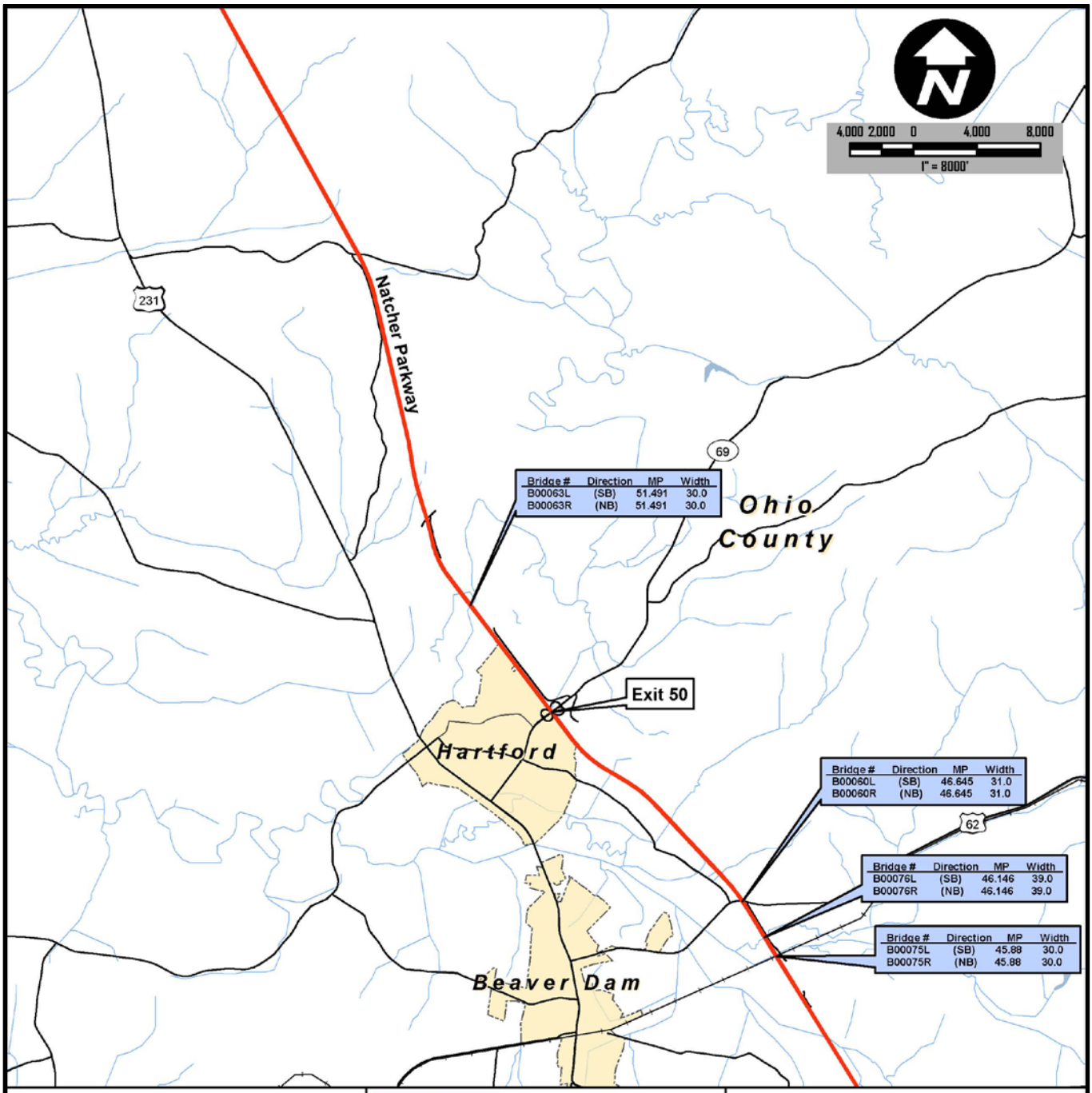
Existing Bridge Condition Horizontal Clearance

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Henderson County
Daviess County
N
4,000 2,000 0 4,000 8,000
1" = 8000'
60
1554
Exit 18
Audubon Parkway
G-R-E-E-N R-I-V-E-R
56
Exit 24
Exit 10
Exit 11
Exit 12
Exit 14
Owensboro
431
Bridge # Direction MP Width
B00058L (WB) 23.432 26.0
B00058R (EB) 23.432 26.0
Bridge # Direction MP Width
B00059L (WB) 22.701 39.0
B00059R (EB) 22.701 39.0
Bridge # Direction MP Width
B00072N (WB) 15.839 31.0
B00072N (EB) 15.839 31.0
Bridge # Direction MP Width
B00072L (WB) 12.011 39.25
B00072R (EB) 12.011 39.25
Bridge # Direction MP Width
B00074L (WB) 13.564 39.25
B00074R (EB) 13.564 39.25
Bridge # Direction MP Width
B00075L (WB) 14.416 39.25
B00075R (EB) 14.416 39.25
Legend
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 5-2
Existing Bridge Condition Horizontal Clearance
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Bridge # Direction MP Width
B00078L (WB) 15.842 34.0
B00078R (EB) 15.842 39.25
Bridge # Direction MP Width
B00085L (SB) 72.255 25.0
B00085R (NB) 72.255 25.0
Exit 17
Exit 72
Bridge # Direction MP Width
B00068L (WB) 16.943 33.8
B00068R (EB) 16.943 40.0
Bridge # Direction MP Width
B00082L (SB) 69.846 30.5
B00082R (NB) 69.846 30.5
Bridge # Direction MP Width
B00081L (SB) 69.522 30.5
B00081R (NB) 69.522 30.5
Bridge # Direction MP Width
B00094L (SB) 69.327 30.5
B00094R (NB) 69.327 30.5
Owensboro
60
Exit 14
Exit 16
431
Bridge # Direction MP Width
B00076L (WB) 15.272 30.0
B00076R (EB) 15.272 39.25
231
Bridge # Direction MP Width
B00077L (WB) 15.026 30.0
B00077R (EB) 15.026 39.25
Natcher Parkway
Masonville
Daviess County
Bridge # Direction MP Width
B00090L (SB) 65.028 30.0
B00090R (NB) 65.028 30.0
Bridge # Direction MP Width
B00089L (SB) 64.835 30.0
B00089R (NB) 64.835 30.0
Bridge # Direction MP Width
B00088L (SB) 64.485 30.0
B00088R (NB) 64.485 30.0
Bridge # Direction MP Width
B00067L (SB) 60.328 30.0
B00067R (NB) 60.328 30.0
Daviess County
Ohio County
4,000 2,000 0 4,000 8,000
1" = 8000'
Legend
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 5-3
Existing Bridge Condition
Horizontal Clearance
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur

Mainline

Ramp

Updated Interchage

KENTUCKY TRANSPORTATION CABINET

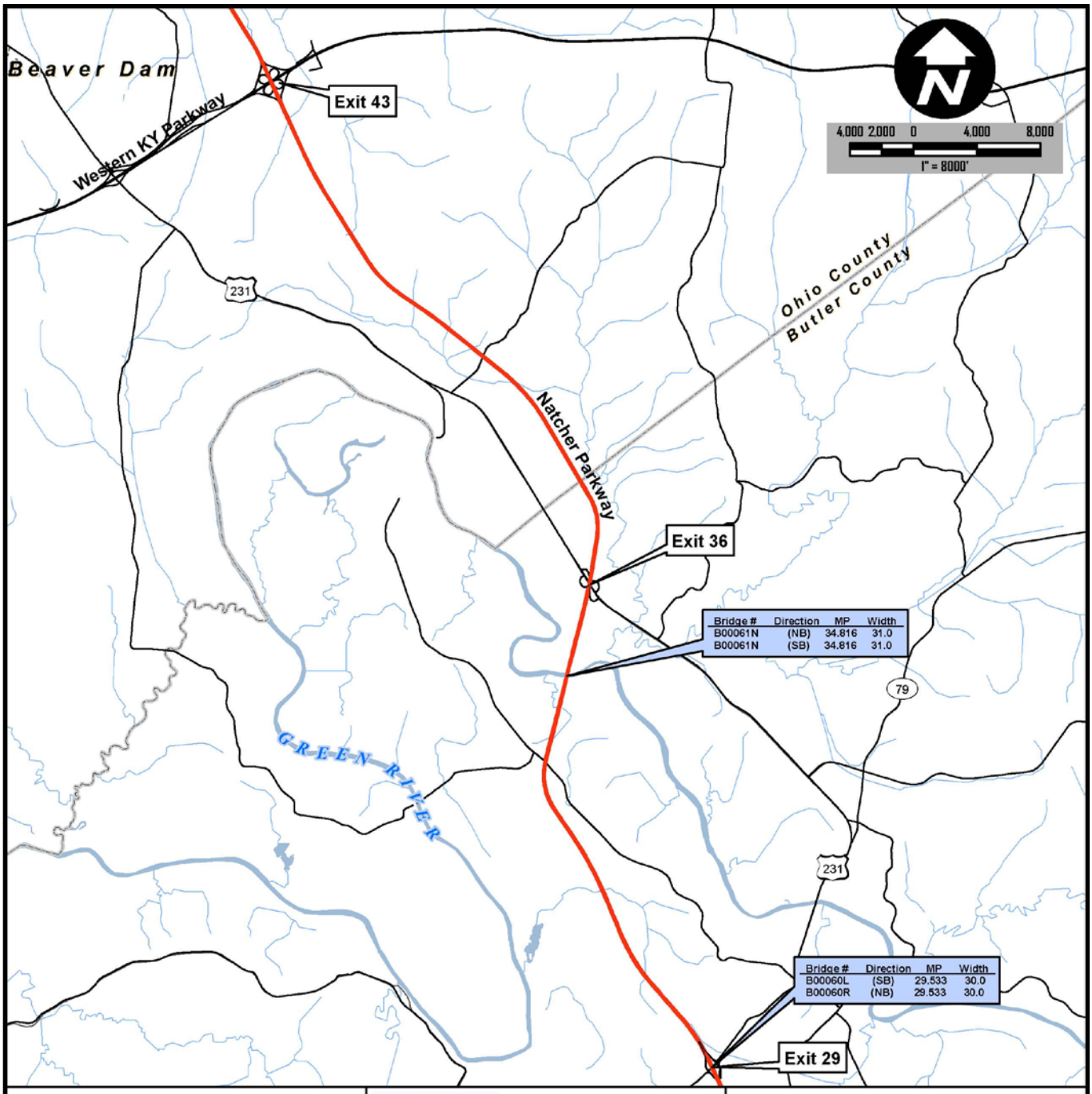
Palmer ENGINEERING

Figure 5-4

Existing Bridge Condition Horizontal Clearance

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur

Mainline

Ramp

Updated Interchage

KENTUCKY TRANSPORTATION CABINET

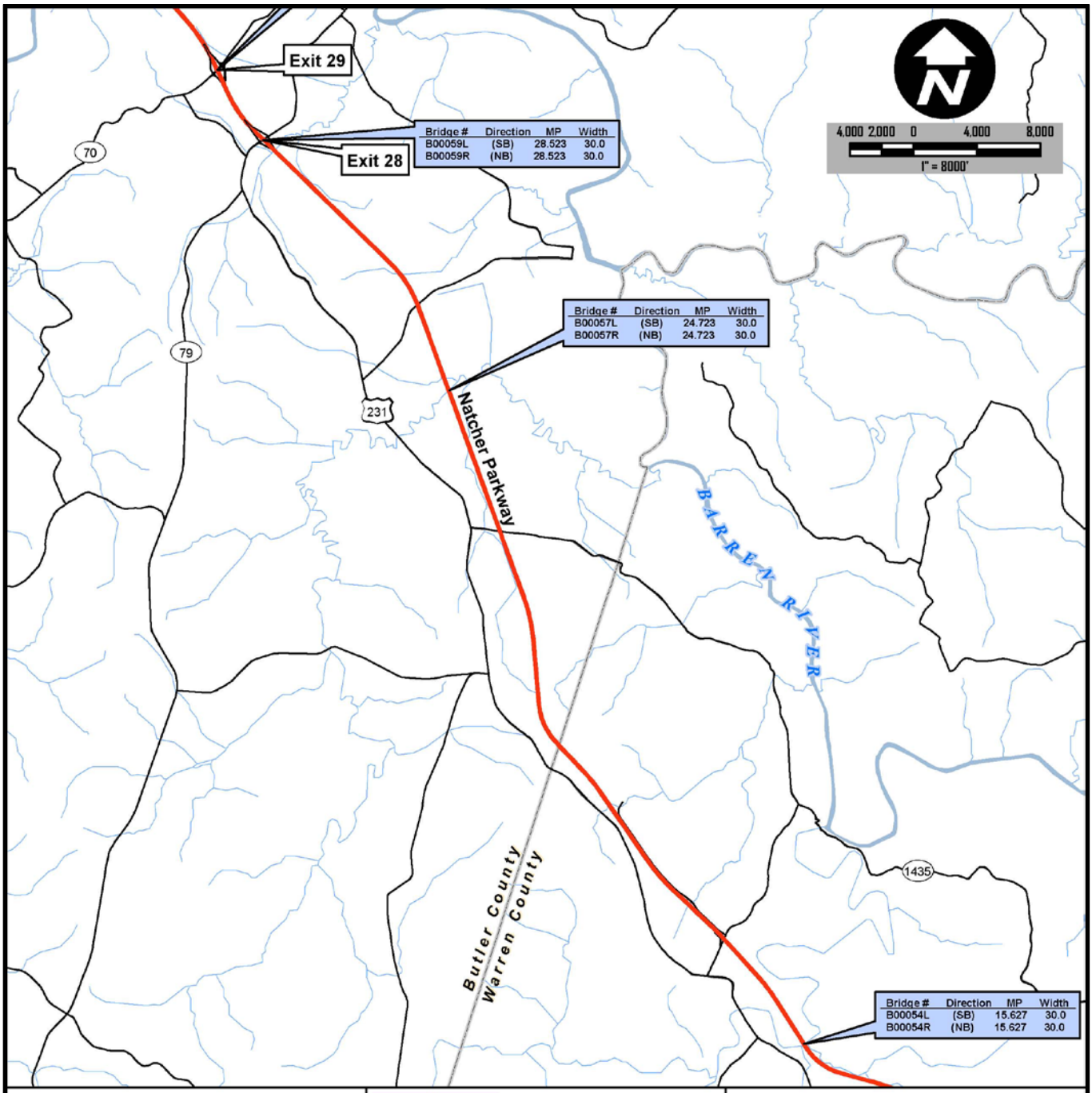
Palmer ENGINEERING

Figure 5-5

Existing Bridge Condition Horizontal Clearance

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur

- Mainline
- Ramp
- Updated Interchage

KENTUCKY TRANSPORTATION CABINET

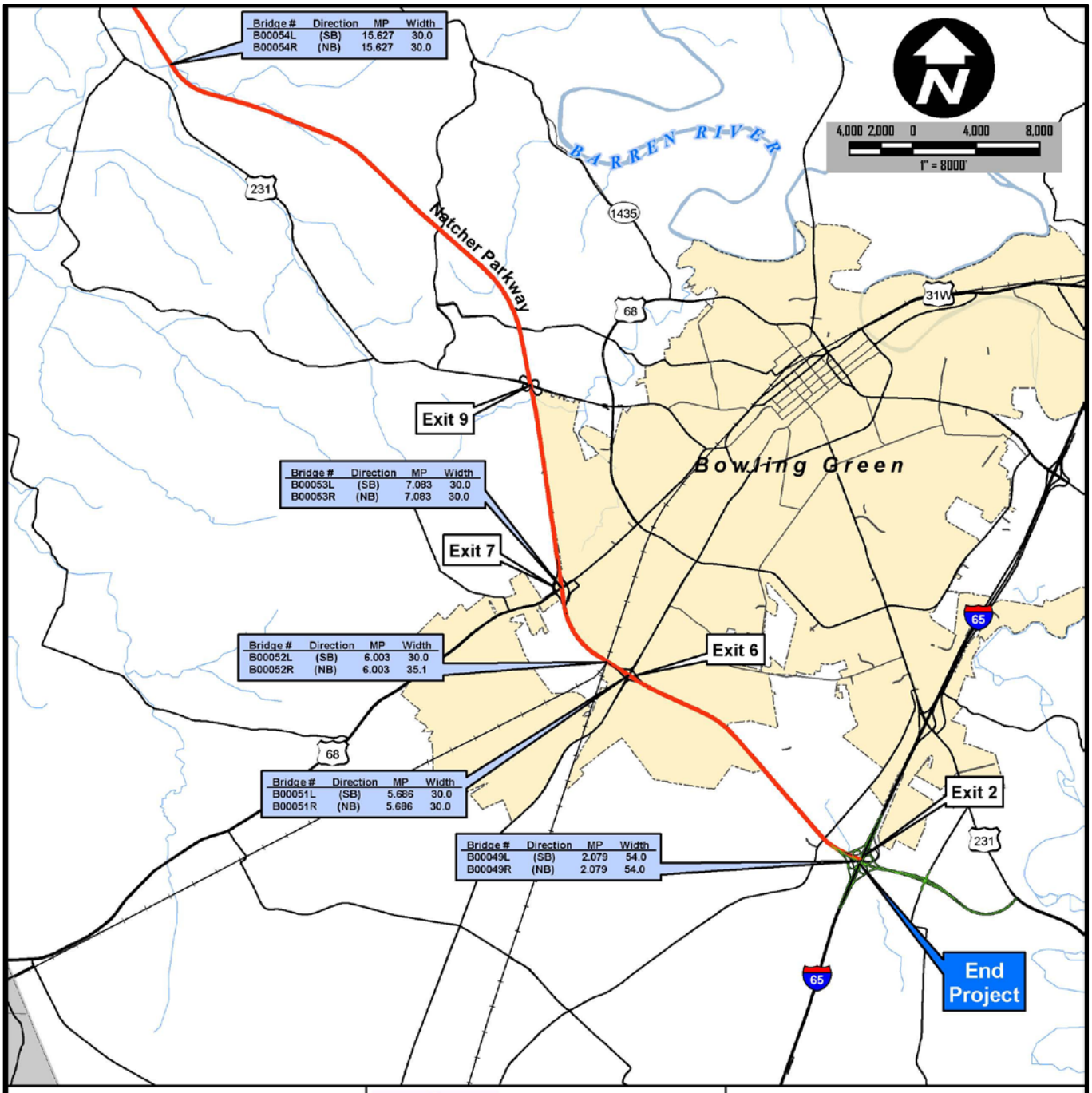
Palmer ENGINEERING

Figure 5-6

Existing Bridge Condition Horizontal Clearance

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur

Mainline

Ramp

Updated Interchage

KENTUCKY TRANSPORTATION CABINET

Palmer ENGINEERING

Figure 5-7

Existing Bridge Condition Horizontal Clearance

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky

B. Vertical Clearance of Overpasses and Sign Trusses

The vertical clearance of an overpass bridge is defined as the minimum height between the pavement and the bottom of the overpass structure and should be at least 16 feet across the entire width of the roadway, including the auxiliary lanes and the width of paved shoulder. The vertical clearance for a sign truss that crosses over the highway is a minimum 17 feet for the entire width of the roadway.

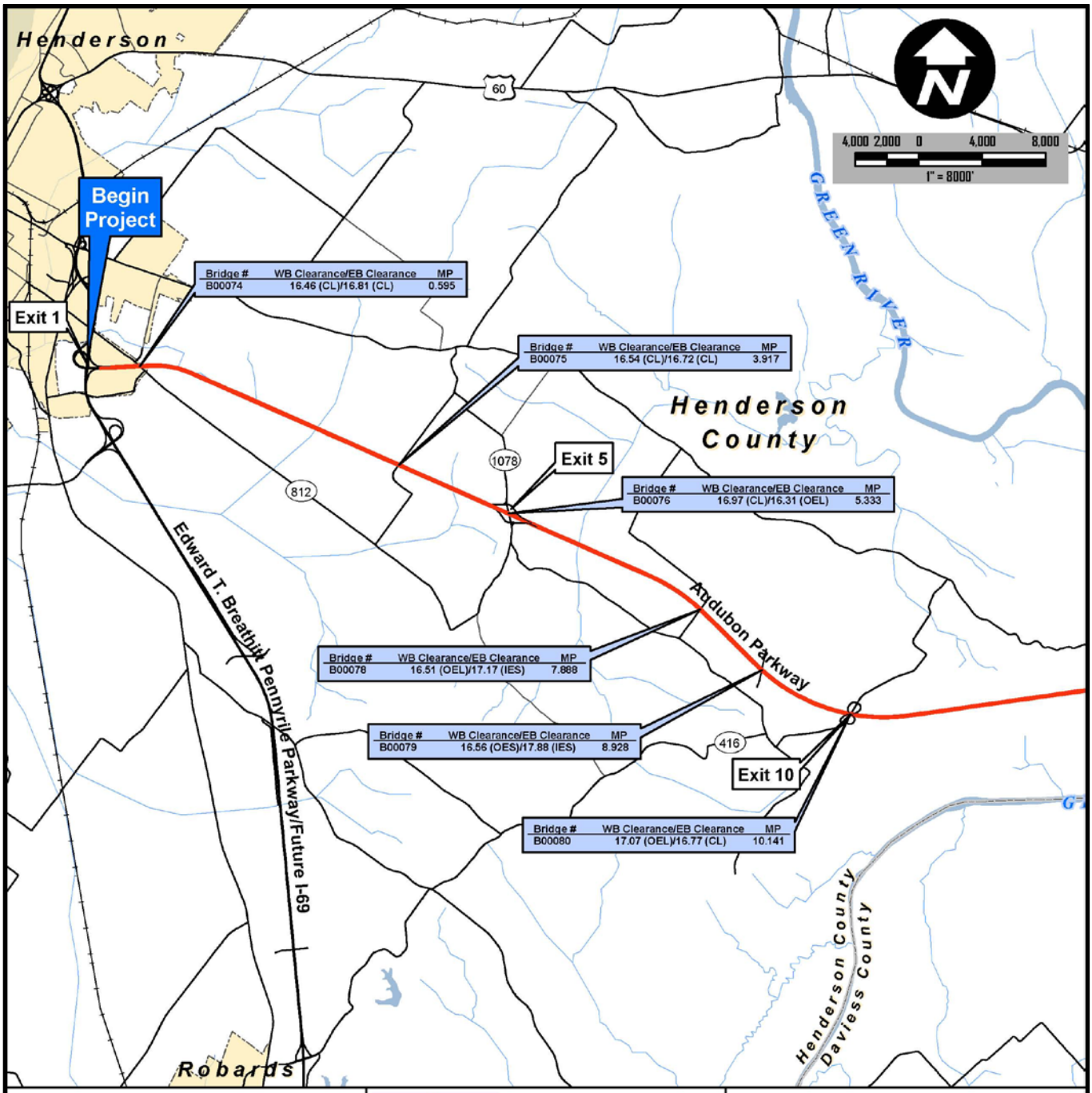
The vertical clearance for the overpass bridges on the parkways and US 60 was measured in the field to obtain the most accurate results for this study. The vertical clearance of sign trusses that cross over the roadways was measured in the field as well. The clearance values depicted in **Table 5-3** on the following page are the minimum clearance measured by location on the roadway. Also noted are bridges that are less than 16.5 feet. The vertical clearance of these bridges will need to be monitored closely with future pavement rehabilitation.

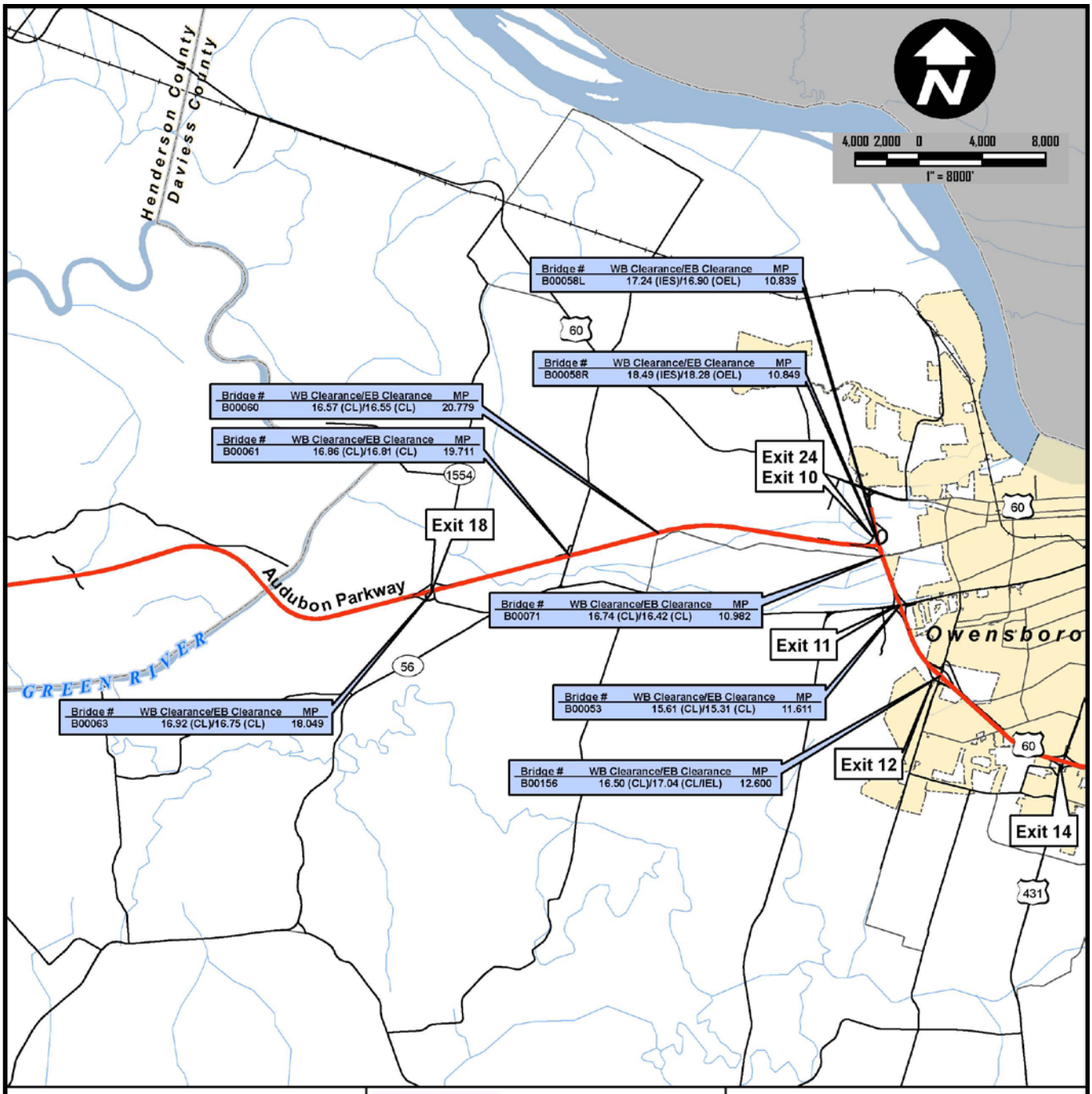
As shown in the table, the Natcher Parkway has 2 bridges that have clearances less than 16 feet. At MP 33.741, the vertical clearance of the KY 403 overpass bridge is 15.76 feet at the outside edge of the southbound shoulder. The vertical clearance of the overpass bridge at MP 62.352 is 15.96 feet, measured at the centerline of the northbound lanes. On US 60, the minimum vertical clearance is not met at the KY 81 interchange. The vertical clearances are 15.61 feet (westbound) and 15.31 feet (eastbound) at the KY 81 interchange bridges. The vertical bridge clearance information is provided in **Figure 5-8** through **Figure 5-14** on the following pages.

Natcher Parkway - KY 403 Overpass

MP	COUNTY	BRIDGE NO.	FEATURES INTERSECTED	MINIMUM VERTICAL CLEARANCE (ft)	
				WB	EB
AUDUBON PARKWAY					
0.595	Henderson	B00074	KY 812 (Airline Road)	16.46 (CL)	16.81 (CL)
3.917	Henderson	B00075	Posey Ball Road	16.54 (CL)	16.72 (CL)
5.333	Henderson	B00076	KY 1078	16.97 (CL)	16.31 (OEL)
7.888	Henderson	B00078	Tom Smith Road	16.51 (OEL)	17.17 (IES)
8.928	Henderson	B00079	Alves Ferry Road	16.56 (OES)	17.88 (IES)
10.141	Henderson	B00080	KY 416	17.07 (OEL)	16.77 (CL)
18.049	Daviess	B00063	KY 1554	16.92 (CL)	16.75 (CL)
19.711	Daviess	B00061	KY 279	16.86 (CL)	16.81 (CL)
20.779	Daviess	B00060	Lyddane Bridge Road	16.57 (CL)	16.55 (CL)
MP	**COUNTY**	**BRIDGE NO.**	**FEATURES INTERSECTED**	**MINIMUM VERTICAL**	
				WB	**EB**
US 60					
10.839	Daviess	B00058L	WB Audubon Parkway	17.24 (IES)	16.90 (OEL)
10.849	Daviess	B00058R	EB Audubon Parkway	18.49 (IES)	18.28 (OEL)
10.982	Daviess	B00071	KY 2701	16.74 (CL)	16.42 (CL)
11.611	Daviess	B00053	KY 81 (W Parrish Ave)	15.61 (CL)	15.31 (CL)
12.600	Daviess	B00156	Carter Road	16.50 (CL)	17.04 (CL/IEL)
16.460	Daviess	B00163	US 231 (New Hartford Road)	17.73 (CL)	17.78 (CL)
17.491	Daviess	B00085L	NB Natcher Parkway	16.81 (IES)	16.64 (OEL)
17.499	Daviess	B00085R	SB Natcher Parkway	18.01 (IES)	17.89 (OEL)
MP	**COUNTY**	**BRIDGE NO.**	**FEATURES INTERSECTED**	**MINIMUM VERTICAL CLEARANCE (ft)**	
				NB	**SB**
NATCHER PARKWAY					
2.591	Warren	B00050	Three Springs Road	17.99 (IES)	16.27 (OES)
3.699	Warren	B00057	Elrod Road	16.78 (OES)	17.05 (OES)
9.523	Warren	B00055	US 231 (Morgantown Road)	16.31 (CL)	16.41 (CL)
10.220	Warren	B00058	KY 2665 (Glen Lily Rd)	18.96 (OES)	16.78 (OES)
11.771	Warren	B00059	KY 2665 (Glen Lily Rd)	>40	>40
12.564	Warren	B00060	Prices Chapel Road	16.27 (OES)	19.14 (IES)
17.201	Warren	B00056	KY 626 (Highland Church Rd)	18.52 (IES)	17.22 (OES)
25.810	Butler	B00062	KY 403 (Woodbury Loop)	16.20 (OES)	17.98 (IES)
26.957	Butler	B00063	Cool Springs Road	17.38 (OES)	16.28 (OES)
33.741	Butler	B00053	KY 403 (Logansport Rd)	17.34 (IES)	15.76 (OES) 16.55 (OEL)
35.932	Butler	B00054	US 231 (Beaver Dam Rd)	19.19 (IEL)	16.88 (OEL)
39.064	Ohio	B00069	KY 505	17.89 (IES)	16.62 (OES)
40.599	Ohio	B00070	Cromwell Road	18.09 (IES)	16.39 (OES)
43.311	Ohio	B00072R	EB Western Kentucky Parkway	17.32 (CL)	18.04 (CL)
43.341	Ohio	B00072L	WB Western Kentucky Parkway	16.57 (CL)	17.35 (CL)
45.323	Ohio	B00074	Davis Road	16.66 (OES)	17.85 (IES)
47.588	Ohio	B00061	CR 1209 (Maples Rd)	18.52 (OES)	16.74 (OES)
49.888	Ohio	B00062	KY 69	16.52 (CL)	16.46 (CL)
52.655	Ohio	B00064	Hoopee Hill Road	16.41 (IES)	16.21 (OES)
55.916	Ohio	B00065	KY 1414	16.05 (OES)	17.84 (IEL)
62.352	Daviess	B00086	Crane Pond Road	15.96 (CL)	16.08 (CL)
65.906	Daviess	B00019	KY 142	17.39 (CL)	16.45 (OEL)
67.199	Daviess	B00092	Masonville Habit Road	16.52 (OEL)	16.24 (CL)
68.806	Daviess	B00039	Sutherlin Lane	16.35 (OEL)	18.04 (IEL)
70.281	Daviess	B00083	KY 1456	16.03 (CL)	16.06 (CL)
71.705	Daviess	B00084	Fairview Drive	16.22 (CL)	16.18 (CL)
	Bridge with Vertical Clearance less than the AASHTO recommended minimum of 16 feet				
	Bridge with Vertical Clearance less than 16.5 feet				
IES- Inside Edge of Shoulder; IEL- Inside Edge of Lane; CL-Center Line; OEL-Outside Edge of Lane; OES-Outside Edge of Shoulder					

Table 5-3 Summary of Substandard Vertical Clearances


Henderson
60
Begin Project
Exit 1
Bridge # WB Clearance/EB Clearance MP
B00074 16.46 (CL)/16.81 (CL) 0.595
Bridge # WB Clearance/EB Clearance MP
B00075 16.54 (CL)/16.72 (CL) 3.917
Henderson County
1078
Exit 5
812
Bridge # WB Clearance/EB Clearance MP
B00076 16.97 (CL)/16.31 (OEL) 5.333
Edward T. Breathitt Pennyrile Parkway/Future I-69
Audubon Parkway
Bridge # WB Clearance/EB Clearance MP
B00078 16.51 (OEL)/17.17 (IES) 7.888
Bridge # WB Clearance/EB Clearance MP
B00079 16.56 (OES)/17.88 (IES) 8.928
416
Exit 10
Bridge # WB Clearance/EB Clearance MP
B00080 17.07 (OEL)/16.77 (CL) 10.141
GREEN RIVER
4,000 2,000 0 4,000 8,000
1" = 8000'
Henderson County
Daviess County
Robards
Legend
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 5-8
Existing Bridge Condition Vertical Clearance
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur

- Mainline
- Ramp
- Updated Interchage

KENTUCKY TRANSPORTATION CABINET

Palmer ENGINEERING

Figure 5-9

Existing Bridge Condition Vertical Clearance

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky

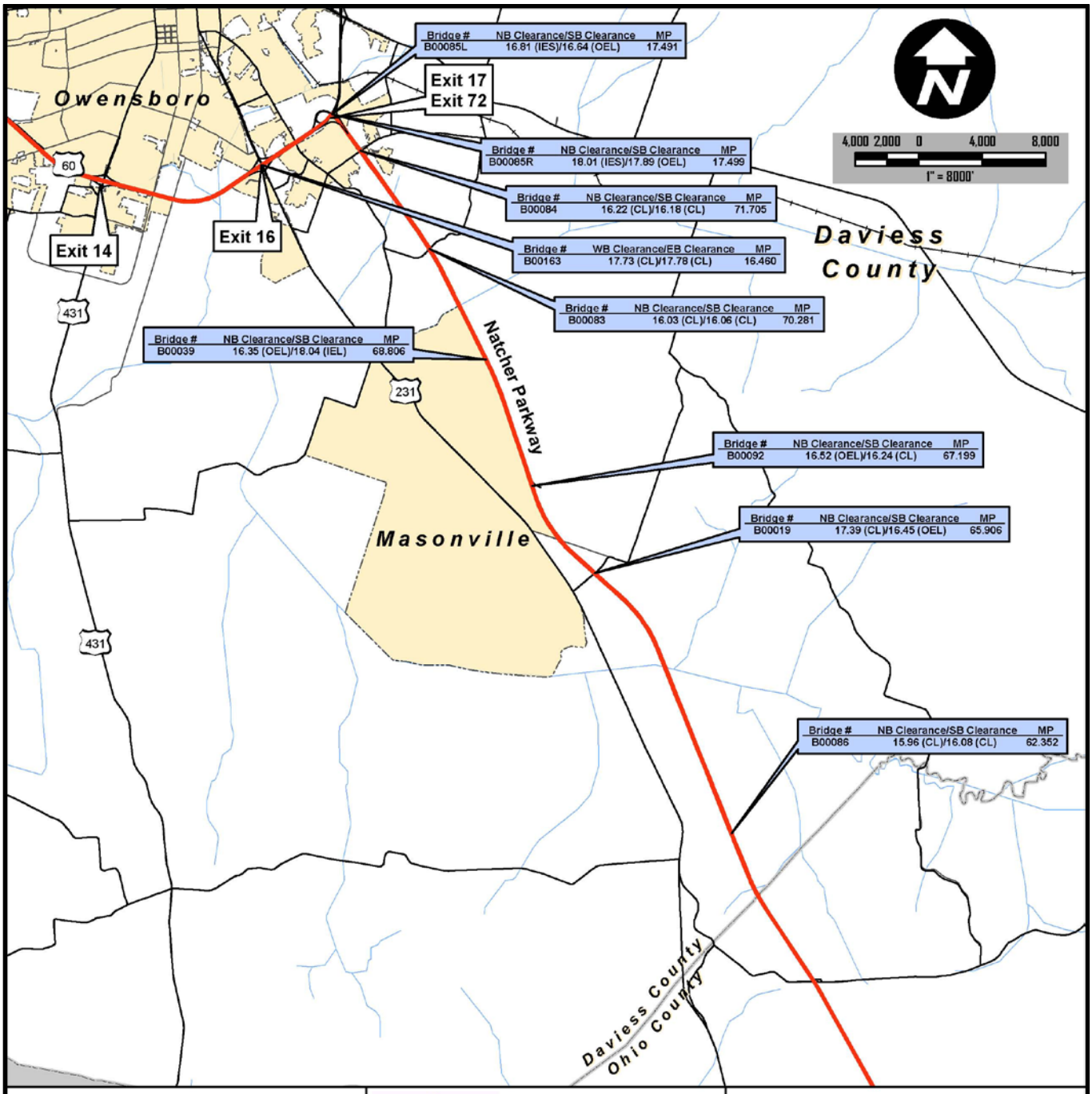
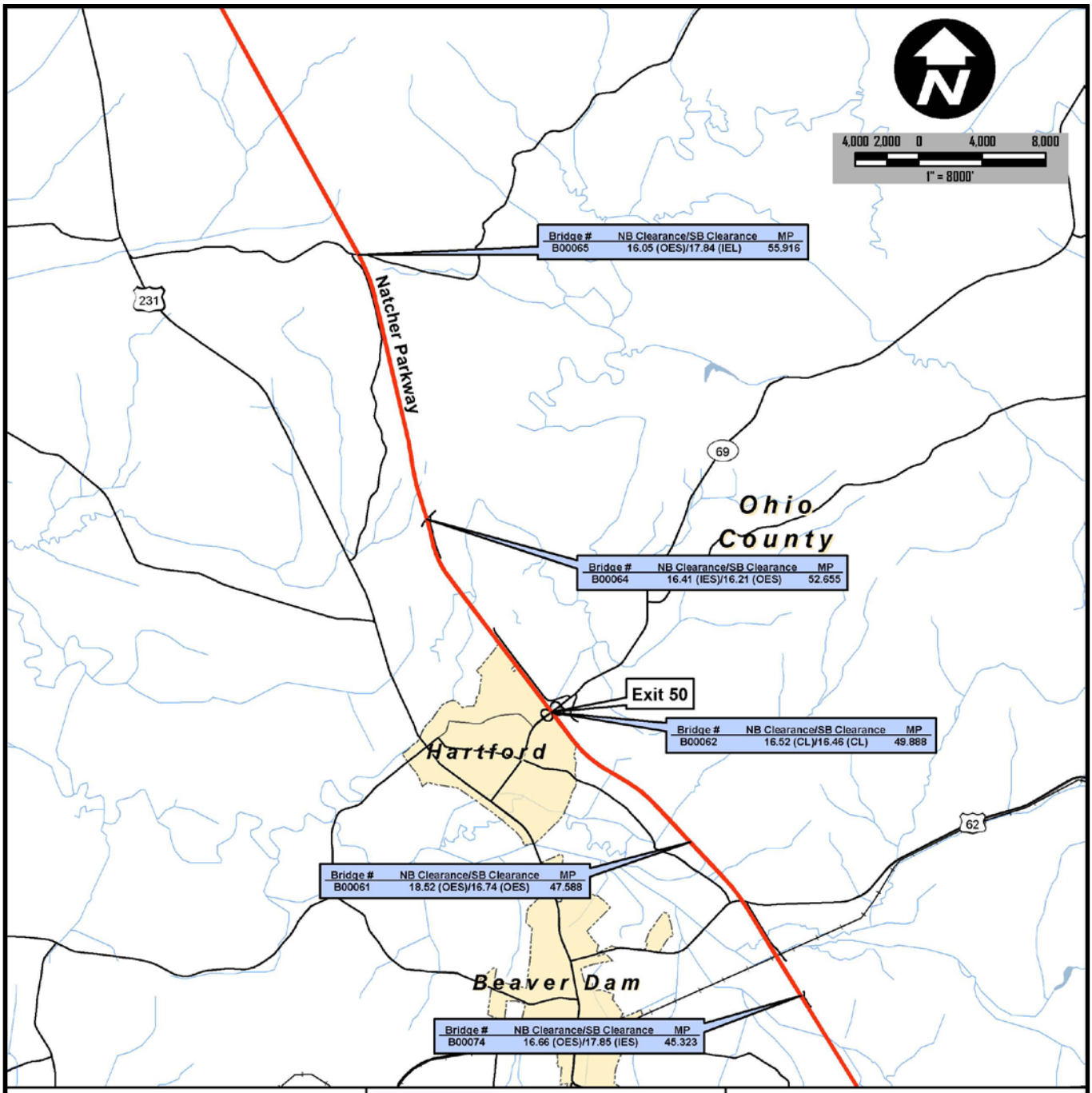


Figure 5-10

Existing Bridge Condition Vertical Clearance

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur

- Mainline
- Ramp
- Updated Interchage

KENTUCKY TRANSPORTATION CABINET

Palmer ENGINEERING

Figure 5-11

Existing Bridge Condition Vertical Clearance

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky

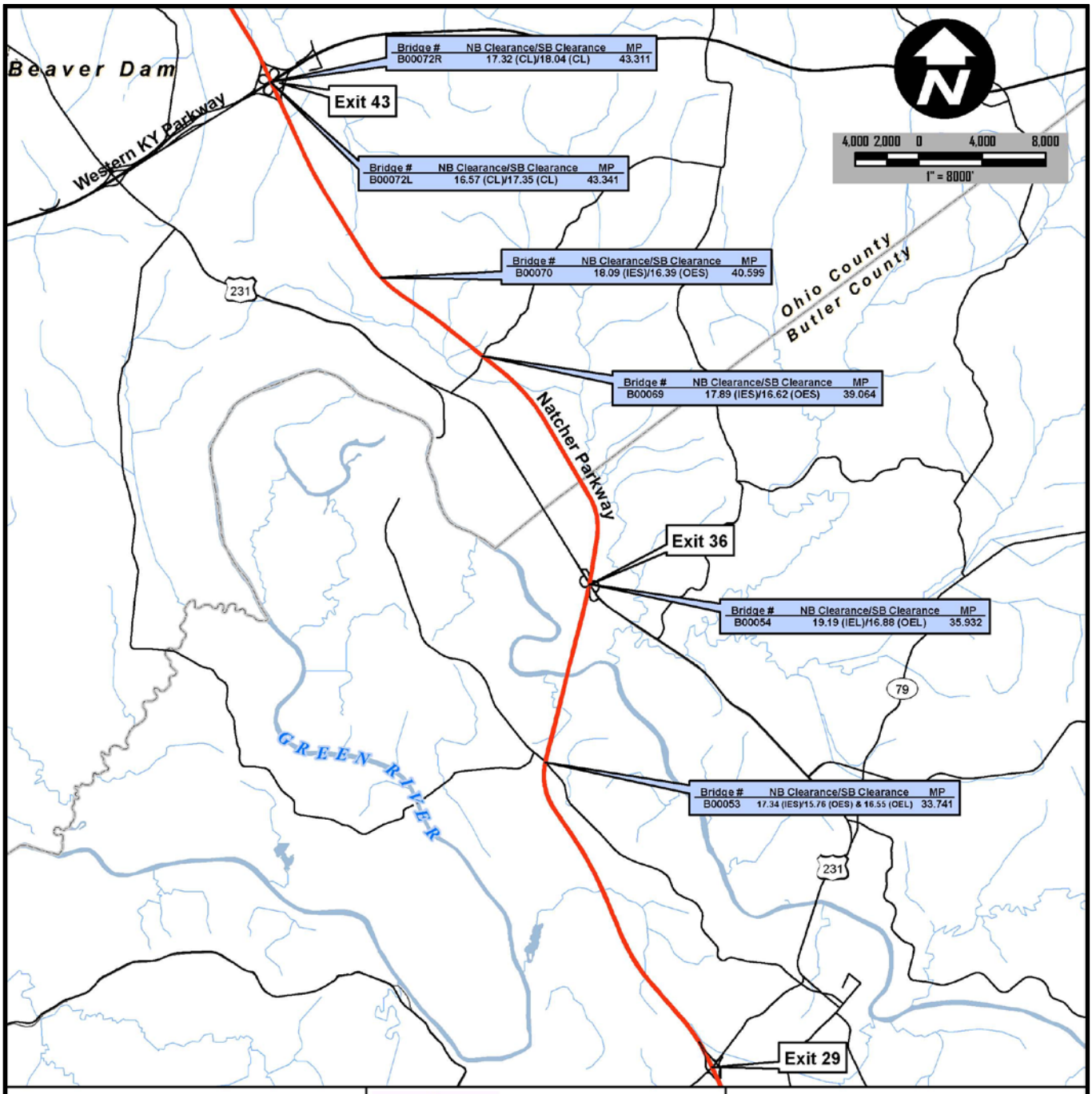
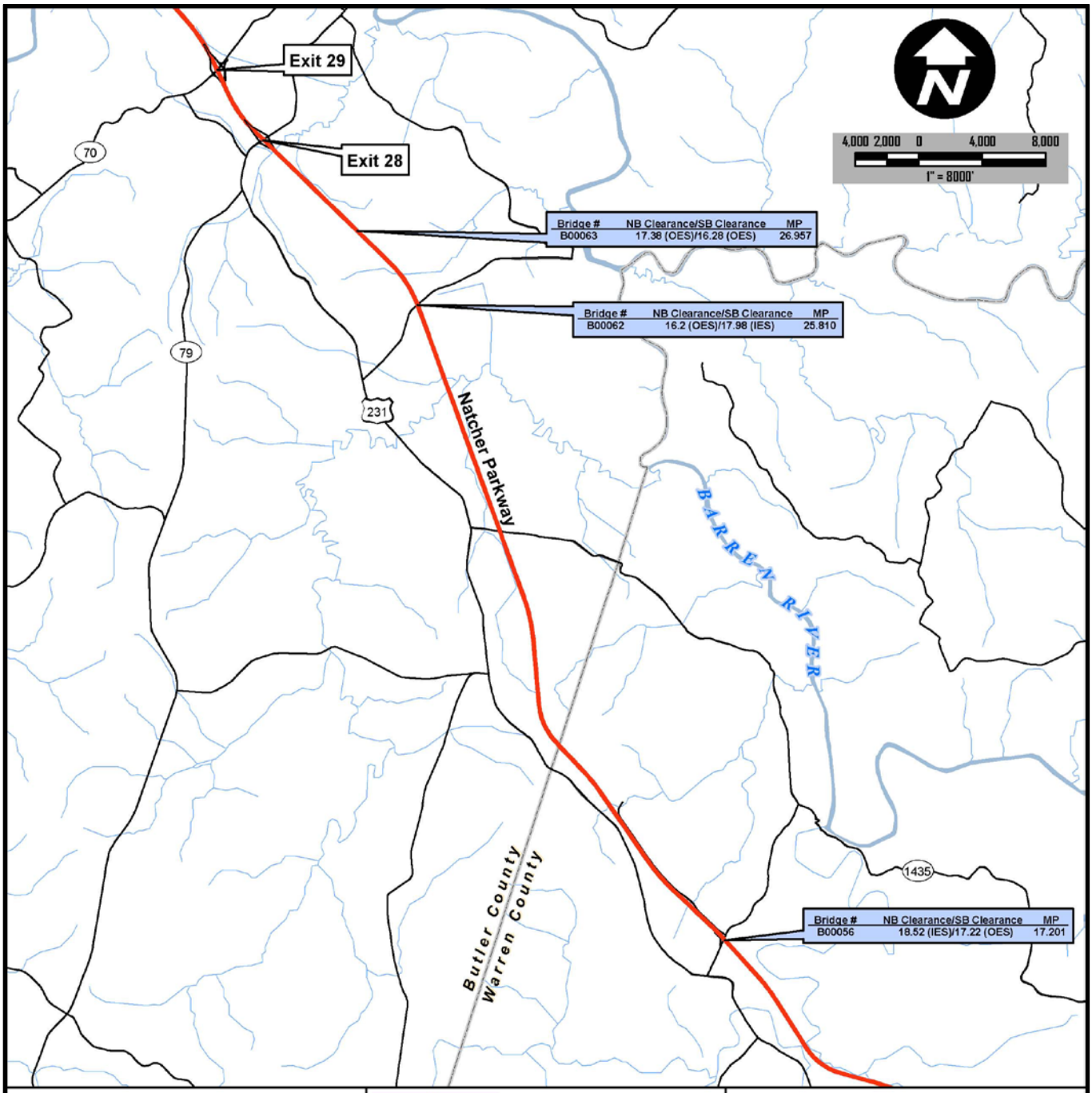


Figure 5-12

Existing Bridge Condition Vertical Clearance

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur

- Mainline
- Ramp
- Updated Interchage

KENTUCKY TRANSPORTATION CABINET

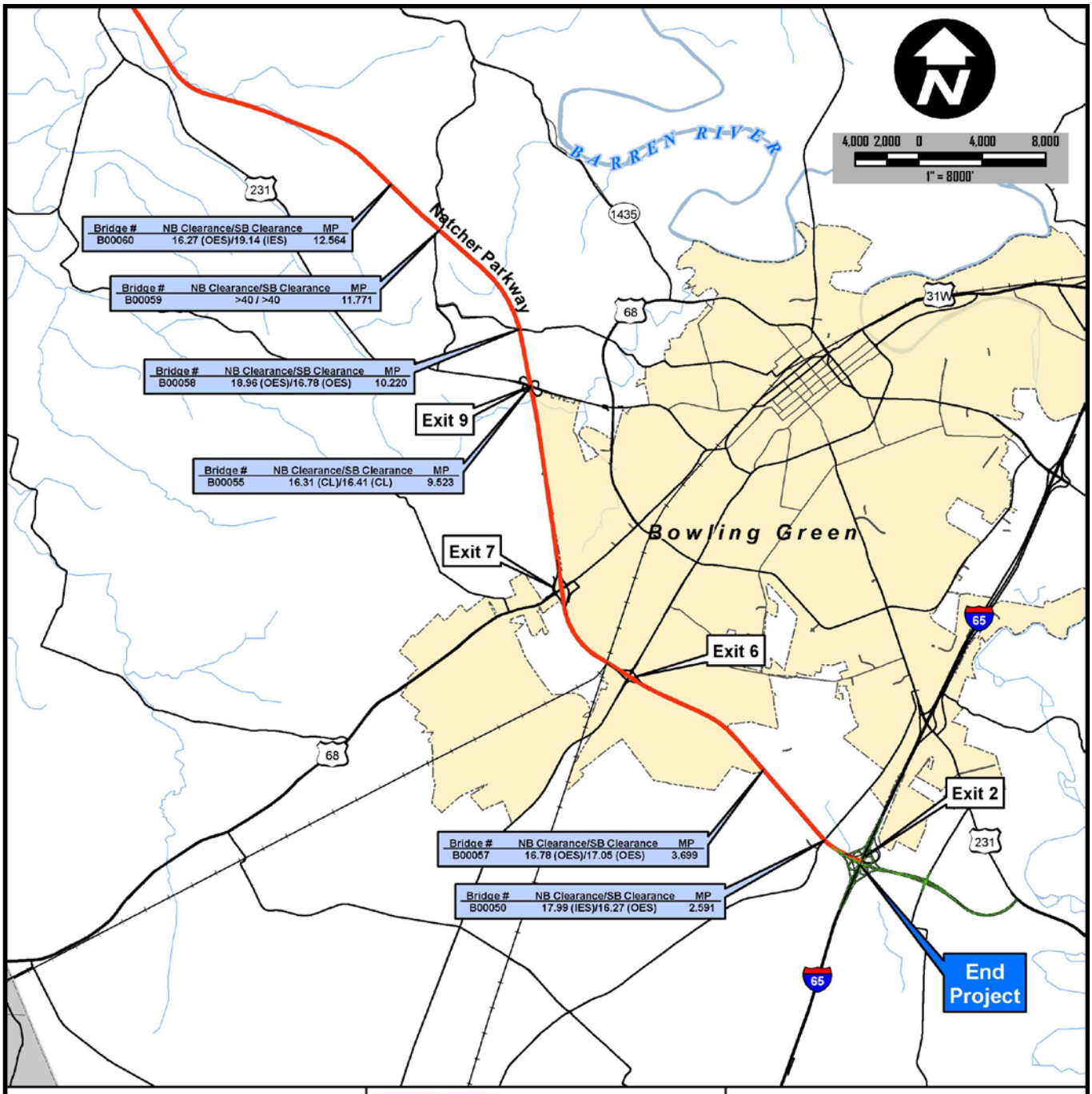
Palmer ENGINEERING

Figure 5-13

Existing Bridge Condition Vertical Clearance

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur

- Mainline
- Ramp
- Updated Interchage

KENTUCKY TRANSPORTATION CABINET

Palmer ENGINEERING

Figure 5-14

Existing Bridge Condition Vertical Clearance

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky

C. Bridge Conditions

For this study the structural and functional capacity of each bridge was evaluated. The structural capacity of a bridge is determined by its sufficiency rating. A bridge that can no longer carry the vehicle weight it was originally designed to carry is classified as structurally deficient. A bridge that does not meet current geometric design guidelines, such as lane width, approach alignment, overhead clearance, etc is defined as functionally obsolete. Sufficiency and inventory ratings for bridges on the Audubon Parkway, Natcher Parkway, and US 60 are provided in **Appendix D**. The following is a summary of the bridge sufficiency ratings on the Audubon Parkway, Natcher Parkway, and US 60.

- Currently, all Audubon Parkway, Natcher Parkway and US 60 mainline and overpass bridges have a sufficiency rating greater than 60.0.
- One overpass bridge at MP 17.201 in Warren County on the Natcher Parkway has a sufficiency rating of 69.0.
- One culvert at MP 13.360 on the Audubon Parkway in Henderson County has a sufficiency rating of 53.7, an inventory rating of HS 11.1, and an operating rating of HS 22.2
- The culverts at MP 11.362 and MP 18.727 on the Audubon Parkway have sufficiency ratings of 63.1 and 68.0, respectively.
- One mainline bridge on the Natcher Parkway has a sufficiency rating of 69.3 and an inventory rating of HS18.9.

According to the KYTC, 26 structures are identified as functionally obsolete in the study area. Of these 26 structures, 5 are culverts, 9 are overpass bridges, and 12 are mainline bridges. The locations of these structures are provided in **Appendix D**. This identification is not in comparison to Interstate standards. Additional bridges can be expected to be identified as functionally obsolete when compared to interstate standards

D. Overhead Signs

The minimum vertical clearance for an overhead sign truss is 17 feet according to current guidelines. For this study, the overhead sign truss, cantilever sign trusses, and signs connected to overpass bridges were measured. The vertical clearances of the overhead sign trusses on the Audubon Parkway, Natcher Parkway and US 60 were measured in the field and none were found to be less than 17 feet. **Table 5-4** on the following page shows the locations and vertical clearance of overhead signs on the Audubon Parkway, Natcher Parkway, and US 60. Two signs on the Natcher Parkway have light apparatuses that hang lower than the signs. These signs are noted in the table.

Overhead Sign Trusses on Natcher Parkway approaching US 60

COUNTY	DIRECTION	MP	TYPE	VERTICAL CLEARANCE (ft)
Audubon Parkway				
Henderson	WB	0.3	Overhead Truss	18.1
Henderson	WB	1.3	Overhead Truss	17.4
Daviess	EB	22.1	Overhead Truss	18.2
Daviess	EB	23.2	Overhead Truss	18.2
Natcher Parkway				
Warren	SB	2.4	Overhead Truss	20.0
Warren	SB	2.6	Bridge	> Bottom of Bridge
Warren	SB	3.2	Overhead Truss	18.2
Ohio	SB	43.2	Bridge	> Bottom of Bridge
Ohio	SB	43.6	Overhead Truss	18.8
Ohio	NB	42.9	Overhead Truss	19.4
Ohio	NB	43.2	Bridge	> Bottom of Bridge
Daviess	NB	71.5	Overhead Truss	17.0 [1]
Daviess	NB	71.8	Overhead Truss	17.3 [2]
Daviess	NB	71.9	Cantilever	17.6
Daviess	NB	72	Overhead Truss	20.0
US 60				
Daviess	EB	10.8	Overhead Truss	18.0
Daviess	EB	11.6	Bridge	> Bottom of Bridge
Daviess	EB	16.5	Bridge	17.3
Daviess	EB	17.5	Bridge	> Bottom of Bridge
Daviess	WB	10.8	Overhead Truss	19.0
Daviess	WB	10.9	Bridge	> Bottom of Bridge
Daviess	WB	11	Bridge	> Bottom of Bridge
Daviess	WB	11.7	Bridge	> Bottom of Bridge
Daviess	WB	12.6	Bridge	> Bottom of Bridge
Daviess	WB	17.5	Bridge	> Bottom of Bridge

[1] Sign has light apparatus - Clearance 16.6 feet

[2] Sign has light apparatus - Clearance 16.2 feet

Table 5-4 Overhead Sign Vertical Clearance

VI. INTERCHANGES AND RAMPS

This chapter summarizes the interchanges and ramp conditions on the Audubon Parkway, Natcher Parkway and US 60. Nineteen interchanges are located along the project study corridor. Similar to the mainline geometry guidelines, AASHTO has criteria for minimum standards for interchanges and ramps. These guidelines are design speed, typical sections, and horizontal and vertical alignment. This chapter addresses each of those factors along with speed-change lanes, weaving characteristics, interchange crash data, interchange spacing, control of access, and interchange configuration. **Figures 6-1 through 6-7** and **Table 6-1** summarize the comparison of the interchange and ramp conditions taken from the as-built plans with the AASHTO guidelines for the key areas for interchange design.

A. Design Speed

The AASHTO minimum design speed for directional entrance ramps and exit ramps is 40 mph. The design speed for semi-directional ramps in rural areas is 35 mph and 25 mph in urban areas. For urban and rural areas, the minimum design speed for loop ramps is 25 mph. The corresponding horizontal minimum radii for 40 mph, 35 mph, and 25 mph design speeds are 444 feet, 314 feet, 134 feet, respectively.

The design speed for most of the ramps was either unavailable or illegible on the As-built plans.

B. Typical Sections

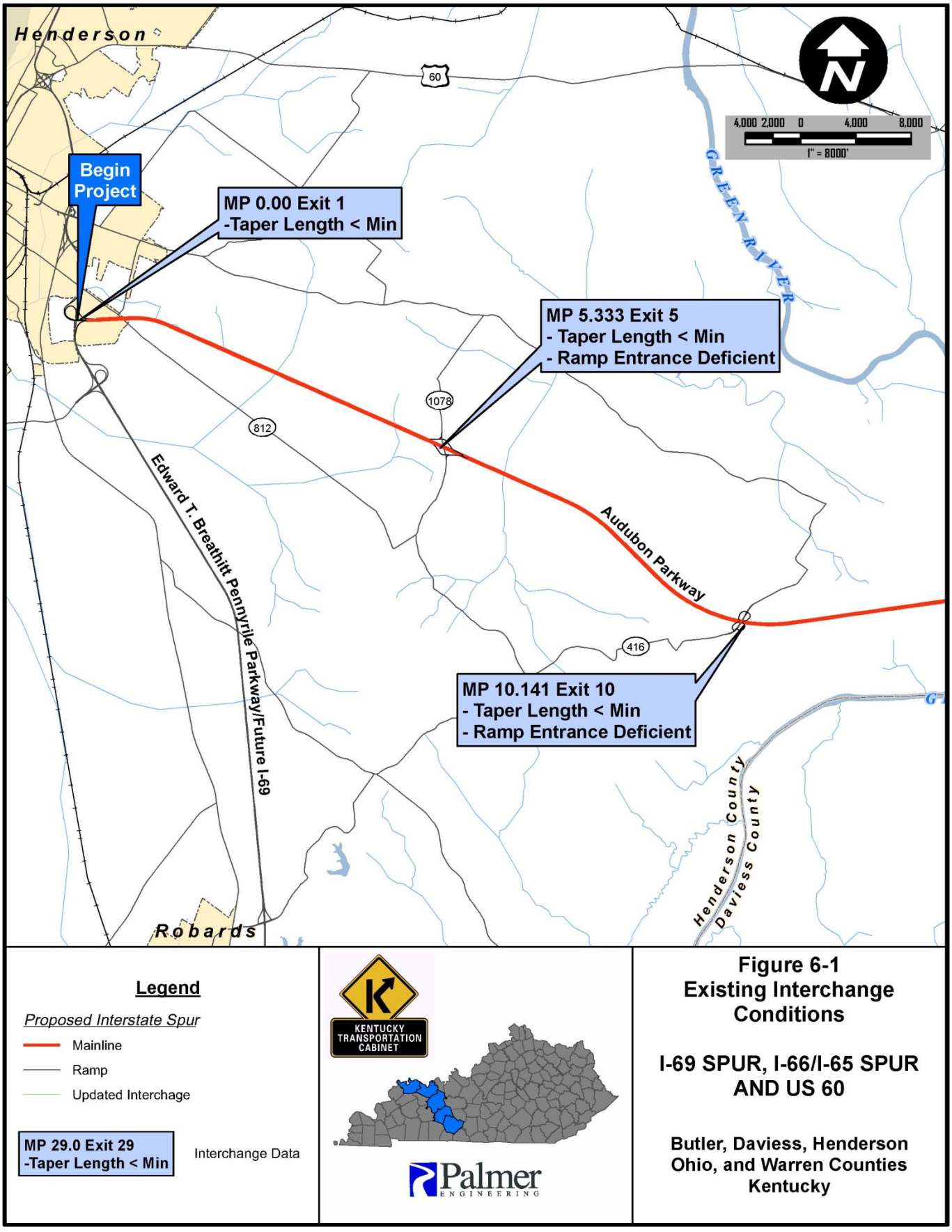
Similar to AASHTO's minimum guidelines of lane widths and shoulder widths of the mainline typical section, guidelines are established for the minimum typical section for ramp lane and shoulder width. The following discussion is a comparison of the existing typical section for lane and shoulder widths to the current AASHTO guidelines and a discussion of existing rolled curbs on interchange ramps.

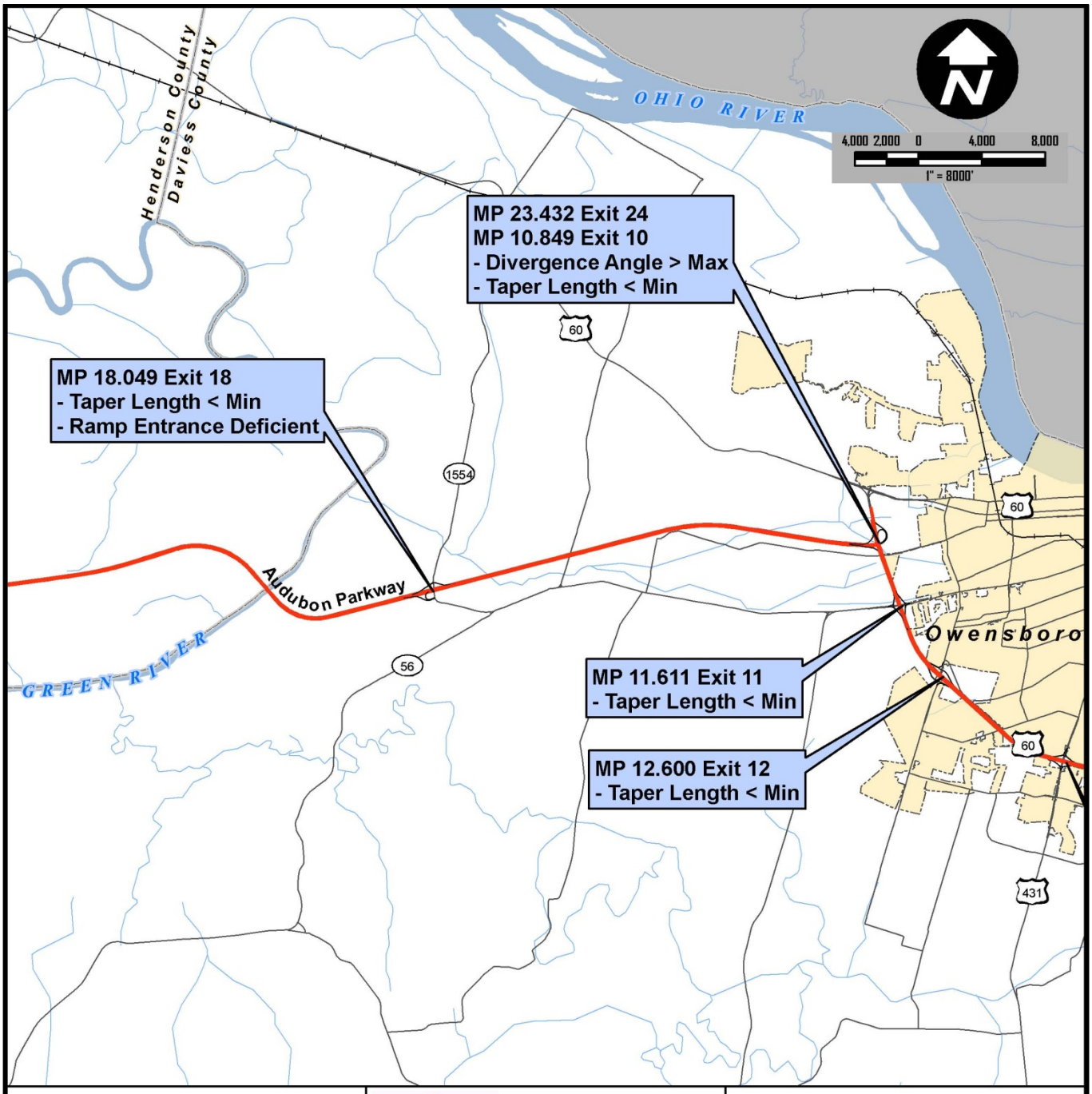
1. Lane Widths

The current AASHTO minimum lane width along an interchange ramp is 15 feet. All of the interchange ramps on the parkways and US 60 meet the minimum requirement ranging in width from 15 to 16 feet. Refer to the **Table 6-1** on page 6-9 for specific interchange ramp lane widths.

2. Shoulder Widths

For normal one-way operation, the sum of the inside and outside paved shoulder widths should not exceed 10 to 12 feet. The desirable inside paved shoulder width is 2 to 4 feet. The desirable outside paved shoulder width is 8 to 10 feet. All of the interchange ramps on the Audubon Parkway, Natcher Parkway, and US 60 have 4-foot paved inside shoulders and 6-foot outside paved shoulders, which meet the minimum AASHTO guidelines for paved shoulder widths.


Henderson
60
Begin Project
MP 0.00 Exit 1
-Taper Length < Min
MP 5.333 Exit 5
- Taper Length < Min
- Ramp Entrance Deficient
1078
812
Edward T. Breathitt Pennyrile Parkway/Future I-69
Audubon Parkway
416
MP 10.141 Exit 10
- Taper Length < Min
- Ramp Entrance Deficient
GREEN RIVER
Henderson County
Daviess County
Robards
N
4,000 2,000 0 4,000 8,000
1" = 8000'
Legend
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
MP 29.0 Exit 29
-Taper Length < Min
Interchange Data
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 6-1
Existing Interchange Conditions
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur

- Mainline
- Ramp
- Updated Interchage

MP 29.0 Exit 29
-Taper Length < Min

Interchange Data

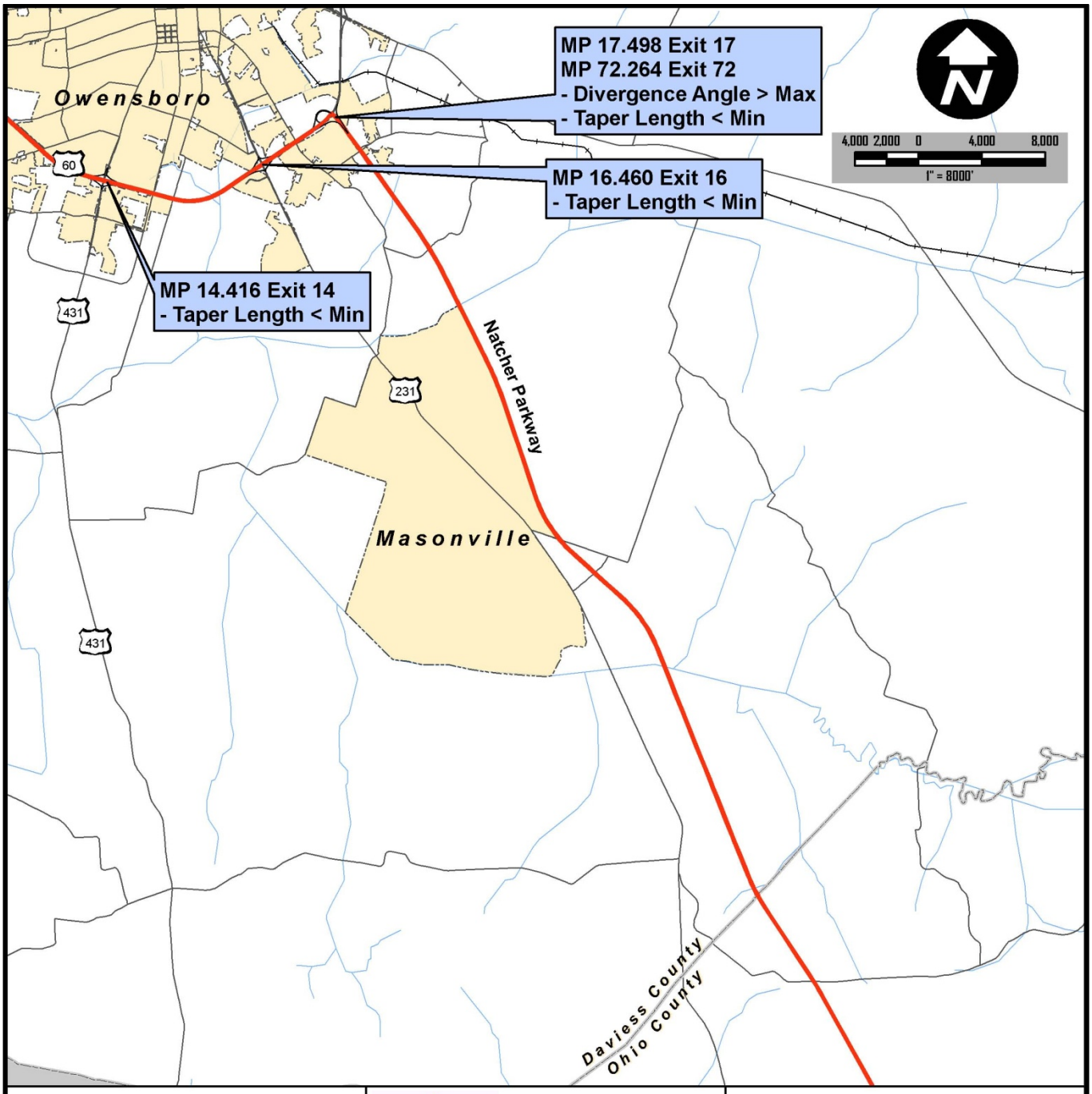
KENTUCKY TRANSPORTATION CABINET

Palmer ENGINEERING

Figure 6-2
Existing Interchange Conditions

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur

Mainline

Ramp

Updated Interchage

MP 29.0 Exit 29
-Taper Length < Min

Interchange Data

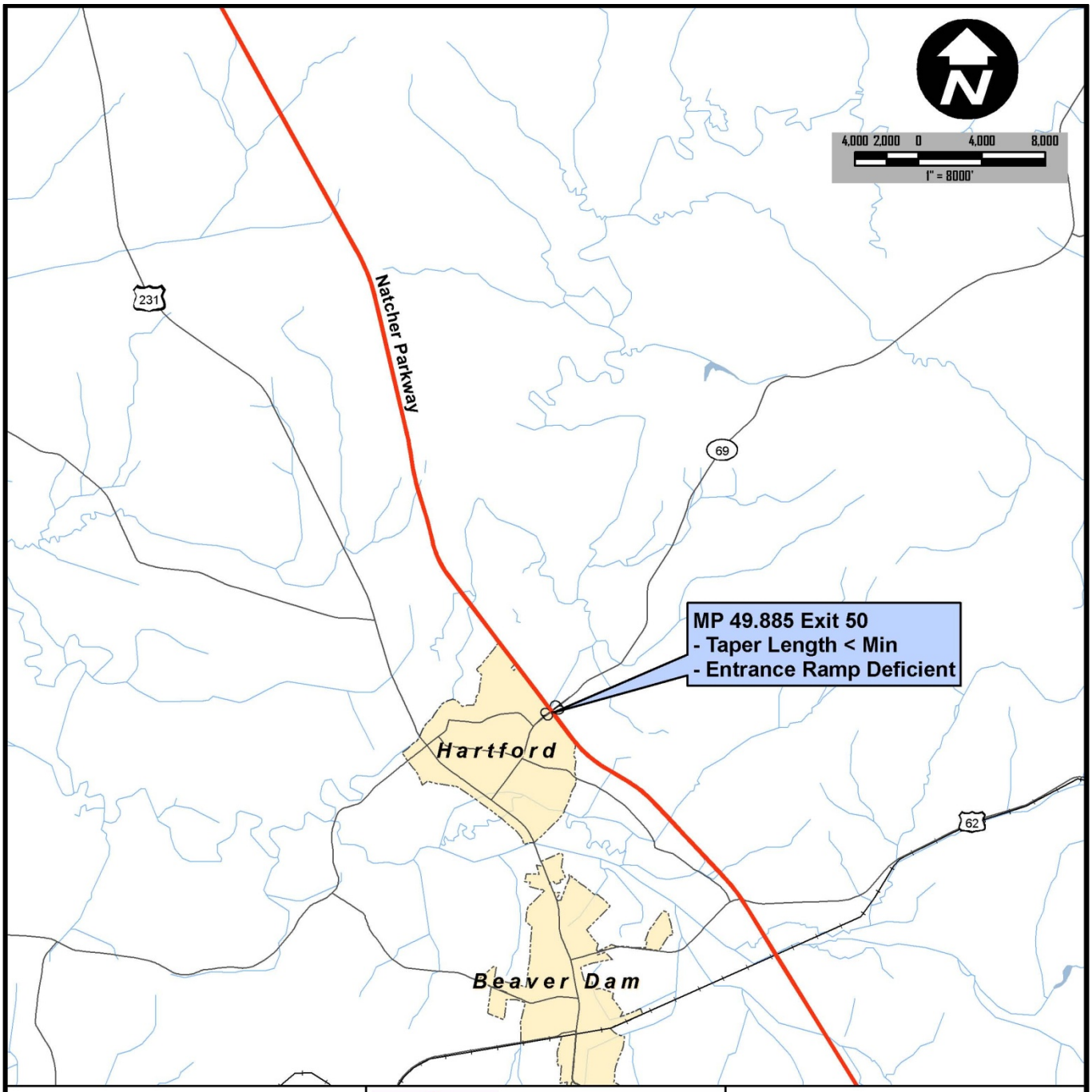
KENTUCKY TRANSPORTATION CABINET

Palmer ENGINEERING

Figure 6-3
Existing Interchange Conditions

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur

Mainline

Ramp

Updated Interchage

MP 29.0 Exit 29
-Taper Length < Min

Interchange Data

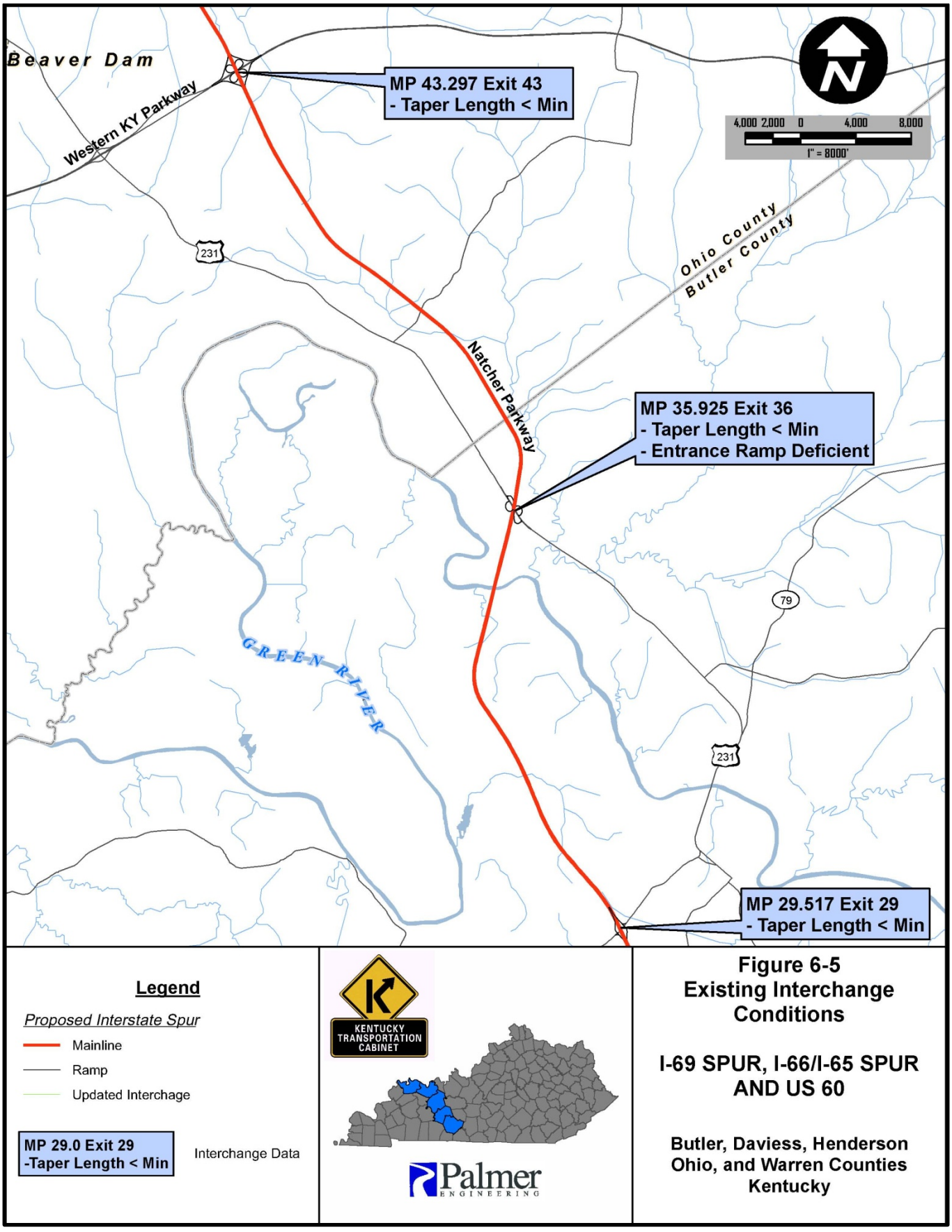
KENTUCKY TRANSPORTATION CABINET

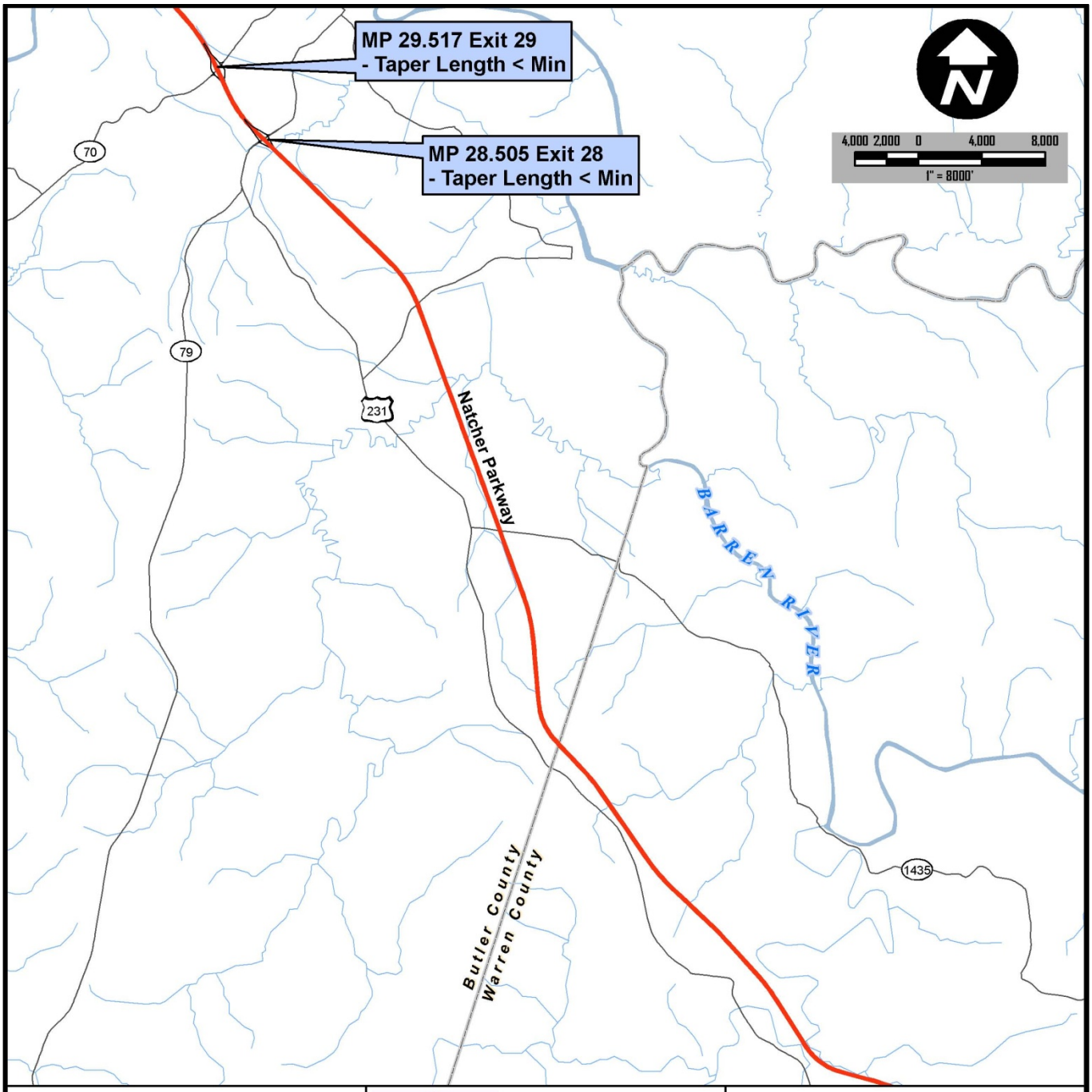
Palmer ENGINEERING

Figure 6-4
Existing Interchange Conditions

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Beaver Dam
Western KY Parkway
MP 43.297 Exit 43
- Taper Length < Min
N
4,000 2,000 0 4,000 8,000
1" = 8000'
231
Ohio County
Butler County
Natcher Parkway
MP 35.925 Exit 36
- Taper Length < Min
- Entrance Ramp Deficient
79
G-R-E-E-N R-I-V-E-R
231
MP 29.517 Exit 29
- Taper Length < Min
Legend
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
MP 29.0 Exit 29
-Taper Length < Min
Interchange Data
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 6-5
Existing Interchange Conditions
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur

Mainline

Ramp

Updated Interchage

MP 29.0 Exit 29 -Taper Length < Min

Interchange Data

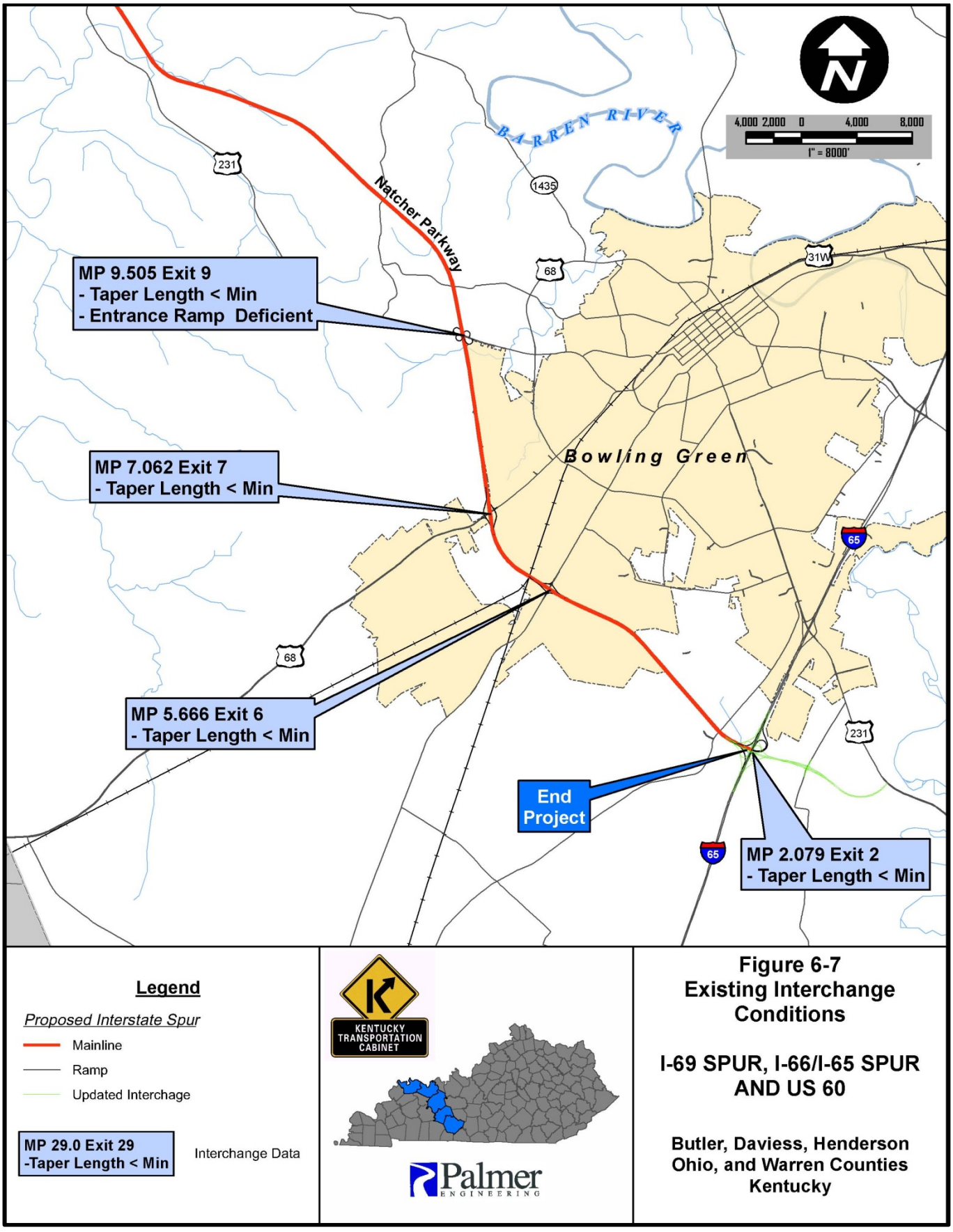
KENTUCKY TRANSPORTATION CABINET

Palmer ENGINEERING

Figure 6-6
Existing Interchange Conditions

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


BARREN RIVER
Natcher Parkway
Bowling Green
231
1435
68
31W
65
4,000 2,000 0 4,000 8,000
1" = 8000'
MP 9.505 Exit 9
- Taper Length < Min
- Entrance Ramp Deficient
MP 7.062 Exit 7
- Taper Length < Min
MP 5.666 Exit 6
- Taper Length < Min
End Project
MP 2.079 Exit 2
- Taper Length < Min
Legend
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
MP 29.0 Exit 29
-Taper Length < Min
Interchange Data
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 6-7
Existing Interchange Conditions
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky

COUNTY	INTERSECTING ROUTE	EXIT NUMBER	MP	RAMP CHARACTERISTICS					MEET INTERSTATE STANDARDS?			REMARKS
				PLAN YEAR	ENTRANCE	EXIT	TYPE	WIDTH	ENTRANCE / EXIT RADIUS [1]	RAMP RADIUS	TAPER	
Audubon Parkway												
Henderson	Pennyrile Parkway	1	0.000	1968	Ramp A		Taper	15	-	-	-	Pennyrile Pwky Trumpet Interchange
						Ramp B	Loop	16	-	-	-	
						Ramp C	Taper	15	Yes	-	No	
					Ramp D		-	15	Yes	-	-	
Henderson	KY 1078	5	5.333	1985	Ramp A		Parallel	15	No	-	Yes	KY 1078 Diamond Interchange
						Ramp B	Taper	15	No	Yes	No	
					Ramp C		Parallel	15	No	-	Yes	
						Ramp D	Taper	15	No	Yes	No	
Henderson	KY 416	10	10.141	1969	Ramp A		Loop	16	No	Yes	No	KY 416 (Previous Toll Plaza)
						Ramp B	Loop	16	No	Yes	No	
						Ramp C	Loop	16	No	Yes	No	
					Ramp D		Loop	16	No	Yes	No	
Daviess	KY 1554	18	18.049	1983		Ramp A	Taper	15	No	Yes	No	KY 1554 Interchange
					Ramp B		Loop	15	No	Yes	Yes	
					Ramp C		Parallel	15	No	-	Yes	
						Ramp D	Taper	15	No	-	No	
Daviess	US 60	24	23.432	1961		Ramp A	-	15	-	-	-	US 60 Trumpet Interchange
					Ramp B		Loop	15	-	-	-	
						Ramp C	Taper	15	Yes	Yes	No	
					Ramp D		-	15	Yes	-	-	
Natcher Parkway												
Warren	I-65	2	2.079	2009		Ramp 1	Loop	16	Yes	Yes	-	I-65 Full Cloverleaf Interchange
					Ramp 2		Loop	16	Yes	Yes	-	
						Ramp 3	Loop	16	Yes	Yes	-	
					Ramp 4		Loop	16	Yes	Yes	-	
					Ramp 5		Taper	15	Yes	Yes	Yes	
						Ramp 6	-	15	Yes	Yes	-	
					Ramp 7		-	15	Yes	Yes	-	
						Ramp 8	Taper	15	Yes	Yes	No	
Warren	US 31W	6	5.666	1971	Ramp A		Taper	15	Yes	-	No	US 31W Diamond Interchange
						Ramp B	Taper	15	Yes	-	No	
					Ramp C		Taper	15	Yes	-	No	
						Ramp D	Taper	15	Yes	-	No	
Warren	US 68	7	7.062	1971	Ramp A		Taper	15	Yes	-	No	US 68 Diamond Interchange
						Ramp B	Taper	15	Yes	Yes	No	
					Ramp C		Taper	15	Yes	-	Yes	
						Ramp D	Taper	15	Illegible	Yes	No	

Table 6-1 Interchange Geometrics

COUNTY	INTERSECTING ROUTE	EXIT NUMBER	MP	RAMP CHARACTERISTICS					MEET INTERSTATE STANDARDS?			REMARKS
				PLAN YEAR	ENTRANCE	EXIT	TYPE	WIDTH	ENTRANCE / EXIT RADIUS [1]	RAMP RADIUS	TAPER	
Natcher Parkway (continued)												
Warren	US 231	9	9.505	1971		Ramp A	Loop	16	No	Yes	No	US 231 (Previous Toll Plaza)
					Ramp B		Loop	16	No	Yes	No	
						Ramp C	Loop	16	No	Yes	No	
					Ramp D		Loop	16	No	Yes	No	
Butler	US 231	28	28.505	1970	Ramp A		Taper	15	Yes	-	No	US 231 Diamond Interchange
						Ramp B	Taper	15	Yes	-	No	
					Ramp C		Taper	15	Yes	-	No	
						Ramp D	Taper	15	-	Yes	No	
Butler	KY 70	29	29.517	1995	Ramp A		Parallel	15	Yes	-	Yes	KY 70 Diamond Interchange
						Ramp B	Taper	15	Yes	Yes	No	
					Ramp C		Parallel	15	Yes	-	Yes	
						Ramp D	Taper	15	Yes	Yes	No	
Butler	US 231	36	35.925	1970	Ramp A		Loop	16	No	Yes	No	US 231 (Previous Toll Plaza)
						Ramp B	Loop	16	No	Yes	No	
					Ramp C		Loop	16	No	Yes	No	
						Ramp D	Loop	16	No	Yes	No	
Ohio	Western Kentucky Parkway	43	43.297	1970	Ramp A		Loop	16	No	Yes	-	Western Kentucky Parkway Full Cloverleaf Interchange
						Ramp B	Loop	16	No	Yes	-	
					Ramp C		Loop	16	No	Yes	-	
						Ramp D	Loop	16	No	Yes	-	
						Ramp E	Taper	15	Yes	Yes	No	
					Ramp F		Parallel	15	Yes	Yes	No	
						Ramp G	Taper	15	Yes	Yes	No	
					Ramp H		Parallel	15	Yes	Yes	Yes	
Ohio	KY 69	50	49.885	1970	Ramp A		Loop	16	No	Yes	No	KY 69 (Previous Toll Plaza)
						Ramp B	Loop	16	No	Yes	No	
					Ramp C		Loop	16	No	Yes	No	
						Ramp D	Loop	16	No	Yes	No	
Daviess	US 60	72	72.264	1970		Ramp A	-	15	-	-	-	US 60 Trumpet Interchange
					Ramp B		Loop	16	-	-	-	
						Ramp C	Taper	15	Yes	-	No	
					Ramp D		-	15	-	-	-	

Table 6-1 Interchange Geometrics (continued)

COUNTY	INTERSECTING ROUTE	EXIT NUMBER	MP	RAMP CHARACTERISTICS					MEET INTERSTATE STANDARDS?			REMARKS
				PLAN YEAR	ENTRANCE	EXIT	TYPE	WIDTH	ENTRANCE / EXIT RADIUS [1]	RAMP RADIUS	TAPER	
US 60												
Daviess	Audubon Parkway	10	10.849	1969	Ramp A		Taper	15	Yes	Yes	-	Audubon Parkway Trumpet Interchange
						Ramp B	Loop	15	Yes	Yes	No	
					Ramp C		Parallel	15	Yes	-	No	
						Ramp D	Taper	15	Yes	Yes	-	
Daviess	KY 81	11	11.611	1969	Ramp A		Parallel	15	Yes	-	No	KY 81 Diamond Interchange
						Ramp B	Taper	15	Yes	-	No	
						Ramp C	Taper	15	Yes	-	No	
					Ramp D		Parallel	15	Yes	-	No	
Daviess	Carter Road	12	12.6	1995		Ramp A	Taper	15	Yes	Yes	No	Carter Road Diamond Interchange
					Ramp B		Parallel	15	Yes	-	Yes	
						Ramp C	Taper	15	Yes	Yes	No	
					Ramp D		Parallel	15	Yes	-	Yes	
Daviess	US 431	14	14.416	1968	Ramp A		Parallel	15	Yes	-	No	US 431 Diamond Interchange
						Ramp B	Taper	15	Yes	-	No	
						Ramp C	Taper	18	Yes	-	No	
					Ramp D		Parallel	18	Yes	-	No	
Daviess	US 231	16	16.46	1967	Ramp A		Parallel	18	Yes	-	No	US 231 Diamond Interchange
						Ramp B	Taper	18	Yes	-	No	
						Ramp C	Taper	18	Yes	-	No	
					Ramp D		Parallel	18	Yes	-	Yes	
Daviess	Natcher Parkway	17	17.498	1970	Ramp A		Taper	15	Yes	Yes	Yes	Natcher Parkway Trumpet Interchange
						Ramp B	Loop	16	Yes	Yes	No	
					Ramp C		Taper	15				
						Ramp D	Taper	15	Yes	-	No	

[1] Based on design speed and superelevation provided. Design speed calculated from current AASHTO 10% superelevation table. Reference Appendix D for design speed values.

Table 6-1 Interchange Geometrics (continued)

C. Alignment Geometry

1. Horizontal Alignment

The minimum horizontal radius for a directional ramp in rural and urban areas is 444 feet. The minimum horizontal radius for rural and urban loop ramps is 134 feet (25 mph design speed). For rural areas, the minimum horizontal radius for a ramp is 314 feet (35 mph design speed) and 134 feet (25 mph design speed) in urban areas. For the interchanges on the parkways and US 60, minimum ramp and loop radius are met for all interchanges. Refer to **Appendix D** for interchange data.

2. Superelevation Rate

From review of the As-built plans, the superelevation for the ramps, if provided, appears to meet the criterion for a maximum superelevation rate. Refer to **Appendix D** for superelevation data collected.

3. Vertical Alignment

a. Vertical Grade

AASHTO guidelines designate a maximum vertical grade from 5% to 7% for all ramp types in both rural and urban areas. Of the legible information provided on the As-built plans, this minimum recommendation is met for all ramps on the parkways and the US 60 Connection. The KY 70 interchange (Exit 29) in Butler County on the Natcher Parkway is the only interchange that has a vertical grade greater than 5%. The ramp at this interchange has a vertical grade of 5.26%. The information provided on the As-built plans is located in **Appendix D**.

b. Vertical Length of Curve

For this study, the minimum length of curve was calculated on the vertical grades of the approaching ramp alignment and the recommended rate of vertical curvature for either a provided ramp design speed or the minimum design speed. All of the analyses were completed for the entire length of the ramp. **Table 6-2** provides the locations, actual vertical length of curve, and calculated minimum vertical length of curve of those that do not meet the criteria. The vertical curves located at Exits 6 and 28 on the Natcher Parkway are located at the ramp terminal. The vertical curves at the ramp terminal require further analyses to determine if they meet the appropriate design speed. This data is provided in **Appendix D.**

COUNTY	INTERSECTING ROUTE	EXIT	RAMP	RAMP TERMINAL	DESIGN SPEED (MPH)		LENGTH OF VERTICAL CURVE (FT)	
					AS-BUILT PLAN	MINIMUM	REQUIRED [1]	ACTUAL [2]
Audubon Parkway								
Henderson	Pennyrile Pkwy	1	C	No	50	-	483	350
Daviess	US 60	24	C	No	50	-	350	300
Natcher Parkway								
Warren	US 31 W	6	B	Yes	-	35	245	200
Butler	US 231	28	A	Yes	-	35	254	200
			D	Yes	-	35	263	200
Ohio	Western KY Pkwy	43	E	No	50	-	365	300
US 60 Connection								
Daviess	Natcher Pwky	7	C	No	50	-	444	350
			D	No	50	-	374	300

[1] Calculated length of curve based on vertical grades and design speed provided or minimum design speed.
[2] Length of curve provided in As-built plans

Table 6-2 Ramp Vertical Curve

c. Stopping Sight Distance

Stopping sight distance was evaluated on the vertical curvature for the ramps. The minimum stopping sight distance with the corresponding ramp type minimum design speed or provided ramp design speed was compared to the calculated stopping sight distance. The following table provides the locations, actual stopping sight distance, and calculated stopping sight distance. The vertical curves located at Exits 6 and 28 are located at the ramp terminal. The vertical curves at the ramp terminal require further analyses to determine if they meet the appropriate design speed. This data is provided in **Appendix D**.

COUNTY	INTERSECTING ROUTE	EXIT	RAMP	RAMP TERMINAL	DESIGN SPEED (MPH)		MINIMUM STOPPING SIGHT DISTANCE (FT)	
					AS-BUILT PLAN	MINIMUM	REQUIRED [1]	ACTUAL
Audubon Parkway								
Henderson	Pennyrile Pkwy	1	C	No	50	-	425	328
Daviess	US 60	24	C	No	50	-	425	409
Natcher Parkway								
Warren	US 31 W	6	B	Yes	-	35	250	216
Butler	US 231	28	A	Yes	-	35	250	209
			D	Yes	-	35	250	204
Ohio	Western KY Pkwy	43	E	No	50	-	425	375
US 60 Connection								
Daviess	Natcher Pwky	7	C	No	50	-	425	351
			D	No	50	-	425	365

[1] Minimum stopping sight distance based on design speed provided or minimum design speed.
[2] Calculated stopping sight distance based on vertical grades and provided or minimum design speed.

Table 6-3 Ramp Stopping Sight Distance

4. Divergence Angle

The recommended divergence angle of the alignment break for a taper exit per AASHTO is two to five degrees. The divergence angle was not provided or illegible on most of the As-built plans. If not provided in the As-built plans, aerial mapping was used to estimate the existing divergence angle for the parkways and US 60 Connection interchange exit ramps. The following exit ramps had divergence angle estimates exceeding 5 degrees:

- US 60, Exit 17 (MP 17.498), Natcher Parkway, Westbound (Loop)
- US 60, Exit 10 (MP 10.849), Audubon Parkway, Westbound (Loop)

D. Speed-Change Lanes and Weaving Characteristics

Speed-change lanes and traffic weaving situations may be the two most important factors affecting safety at interchanges. The following discussion is a summary of the As-built ramp geometry and configuration when compared to the current AASHTO guidelines for speed-change lanes and designs for traffic weaving.

1. Speed-Change Lanes

Speed-change lane design for an entrance and exit ramp is either a parallel type or taper type. The recommended taper rate for a taper type entrance is 50:1 between the outer edge of the acceleration lane and the edge of the through traffic lane. The entrance length of a ramp for a parallel type entrance is dependent on the mainline design speed. Current practice for entrance ramp speed is 70% of the mainline design speed. The rural interstate design speed of 70 mph results in an entrance ramp speed of 49 mph. An urban interstate design speed of 50 mph results in an entrance ramp speed of 35 mph. However, it is recommended to use a taper type entrance if the acceleration length is greater than 1300 feet. When a parallel entrance type is used, the taper length rate should be 25:1 from the downstream taper to the mainline.

An exit ramp can have a parallel or taper type configuration. The taper type ramp alignment is generally designed with an alignment break at the outer edge of the pavement. The minimum

divergence angle of the taper type alignment break is two to five degrees. The exit parallel type begins with a taper rate of 20:1, and the deceleration length of the parallel lane is dependent on the design speed of the mainline roadway and ramp design speeds. Exiting traffic can be assumed to be traveling 70% of the mainline design speed.

The design speed for entrance and exit ramp curves was calculated based on the superelevation provided in the As-built plans. Most of the interchange ramps have a superelevation greater than 8% but less than 10%; therefore, the current AASHTO 10% maximum superelevation tables were referenced for calculating the design speed. The previous toll plaza interchanges located at Exit 10 (KY 1078) on the Audubon Parkway and Exits 9 (US 231), 36 (US 231), and 50 (KY 69) on the Natcher Parkway do not meet the recommended ramp design speed. Additionally on the Audubon Parkway, Exits 5 (KY 1078) and 18 (KY 1554) interchanges do not meet the recommended ramp design speed. Data is provided in **Appendix D**.

Since the original construction, some of the interchange ramps on the Audubon Parkway, Natcher Parkway and US 60 have been improved. However, a majority of the existing ramps on the parkway do not meet the minimum guideline of 50:1 entrance tapers, and existing ramps have exit tapers less than the minimum 20:1 taper. According to guidelines from AASHTO, the minimum deceleration length for exit ramps to a stop condition is 615 feet. All diamond interchange exit ramps on the Audubon Parkway, Natcher Parkway, and US 60 meet the minimum deceleration length.

For this study, a minimum of 413 feet of taper length for an exit taper ramp was used for comparison. This length comes from using the maximum divergence angle of 5 degrees and 36 feet of ramp separation from the mainline.

AASHTO recommends a 50:1 – 70:1 uniform taper for the entrance taper ramps. The entrance taper length used was 900 feet for an entrance taper ramp.

2. Weaving Characteristics

Three interchanges on the Natcher Parkway and one interchange on the Audubon Parkway previously operated as toll booth plazas. These interchanges do not meet the minimum weaving length distance recommended for a cloverleaf interchange. On the Natcher Parkway, these interchanges are located at Exit 9 – Bowling Green - US 231 (MP 9.505) in Warren County; Exit 36 – Morgantown / Cromwell - US 231 (MP 35.925) in Butler County; and Exit 50 Hartford / Beaver Dam (MP 49.885) in Ohio County. The interchange on the Audubon Parkway is located at Exit 10 – Niagara / Hebbardsville - KY 416 (MP 10.141) in Daviess County. These four interchanges were initially designed for toll collection stations. The full cloverleaf configurations included short weaving sections of approximately 220-400 feet. The toll plazas have since been suspended.

In addition to the interchanges mentioned, another weaving segment appears on the Natcher Parkway. The segment is located within the full cloverleaf interchange at the Western Kentucky Parkway Exit 43. Traffic counts were provided by KYTC, and measurements were taken in the field for the weaving analysis. The weaving analysis was conducted utilizing the Highway Capacity Software and current *Highway Capacity Manual 2010*. The current level of service (LOS) was calculated based on 2011 traffic volumes. The future LOS was calculated based on the 2040 projected traffic growth. The analysis resulted in LOS A for the current (2011) traffic and LOS A for the future (2040) projected traffic.

According to the *AASHTO Green Book*, when a full cloverleaf is on a freeway, collector-distributor roads should be considered if the sum of the traffic on two adjoining cloverleaf loops approaches 1,000 vehicles per hour (vph). According to the traffic counts, the northbound Natcher Parkway weaving volume is 143 vph. The southbound Natcher Parkway weaving volume is 85 vph.

E. Interchange Crash Data

To further analyze the interchange operations, crashes at interchanges were collected and analyzed. **Table 6-4** shows the types of crashes occurring within a 0.1 mile section on either side of the intersecting route at each interchange.

					Mainline Crashes by Type [1]							
Exit	MP	County	Intersecting Route	Ramp [2]	Rear End	Fixed Object	Animal	Side Swipe	Ran Off Road	Other	Total [3]	Fatalities
Audubon Parkway												
1	0.00	Henderson	Pennyrile Pkwy	9	0	0	0	0	0	0	0	0
5	5.33	Henderson	KY 1078	1	0	0	1	0	0	1	2	0
10	10.14	Henderson	KY 416	0	1	2	3	0	2	1	9	0
18	18.05	Daviess	KY 1554	1	0	3	0	0	2	0	5	0
24	23.43	Daviess	US 60	2	0	2	0	0	0	1	3	0
US 60												
10	10.85	Daviess	Audubon Pkwy	7	1	0	0	0	0	0	1	0
11	11.61	Daviess	KY 81	25	1	0	0	0	0	0	1	0
12	12.60	Daviess	Carter Road	37	1	2	0	0	0	0	3	0
14	14.42	Daviess	US 431	89	3	3	0	1	0	3	10	0
16	16.46	Daviess	US 231	105	2	0	2	3	1	0	8	0
17	17.50	Daviess	Natcher Pkwy	17	0	1	0	2	0	0	3	0
Natcher Parkway												
2	2.08	Warren	I-65	74	1	2	0	0	0	1	4	1
6	5.69	Warren	US 31W	16	0	3	0	0	0	0	3	0
7	7.08	Warren	US 68	16	0	1	1	1	1	1	5	0
9	9.52	Warren	US 231	26	4	4	0	4	0	2	14	0
28	28.52	Butler	US 231	4	0	1	0	1	0	0	2	0
29	29.53	Butler	KY70	1	0	0	0	0	0	0	0	0
36	49.02	Butler	US 231	1	1	2	0	1	0	1	5	0
43	43.31	Ohio	Western KY Pkwy	5	0	0	1	0	0	0	1	0
50	49.89	Ohio	KY 69	5	1	0	0	0	0	3	4	0
72	72.26	Daviess	US 60	0	0	0	0	0	0	1	1	0

[1] Number of crashes in period studied (2006-2010), within 0.1 mile on either side of intersection route (excluding ramp-related crashes).
[2] Ramp-related crashes
[3] Total number of crashes excluding ramp-related crashes

Table 6-4 Interchange Crash Data

As previously noted in **Sections** 4 and **5** of **Chapter** III, one High Crash Rate Segment (CRF =>1.0) is located on the Audubon Parkway between MP 10.1 and MP 18.0. No High Crash Rate Segments were identified on US 60 or the Natcher Parkway. Two interchanges fall within the High Crash Rate Segment on the Audubon Parkway.

- Exit 10, KY 416 (previous toll plaza), in Henderson County had 5 crashes. None of these crashes were ramp related;
- Exit 18, KY 1554, in Henderson County had 6 crashes; 1 was ramp related.

F. Interchange Spacing

The current minimum spacing between interchanges on an interstate for rural areas is three miles and one mile for urban areas. This spacing is measured between the centerline of intersecting routes. The minimum interchange spacing criteria is met for the interchanges along the Audubon Parkway. On the Natcher Parkway, the interchanges at Exit 28 (MP 28.505) and Exit 29 (MP 29.517) are spaced closer than the minimum for rural areas. On US 60, the minimum interchange spacing for urban areas is not met between Exit 10 (MP 10.849) and Exit 11 (MP 11.611) and between Exit 11 (MP 11.611) and Exit 12 (MP 12.600).

G. Interchange Control of Access

Interchange control of access is the distance measured from the ramp termini to the adjacent commercial or residential access. The measurement of control of access according to KYTC standards is from the end of the ramp termini radius or taper to the centerline of the adjacent commercial or residential access. The recommended interchange control of access for an urban area is 100 feet and 300 feet for rural areas. **Table 6-5** illustrates the interchange control of access distance.

EXIT	RURAL/ URBAN	INTERSECTION ROUTE	QUADRANT	DISTANCE (FT)
Audubon Parkway				
5	RURAL	KY 1078	Southeast	230
18	RURAL	KY 1554	Southwest	201
			Northwest	180
Natcher Parkway				
29	RURAL	KY 70	Northeast	152
36	RURAL	US 231	Southeast	282
US 60				
12	URBAN	Carter Road	Northwest	50

Table 6-5 Interchange Control of Access

H. Interchange Configuration

Currently, the Audubon Parkway and Natcher Parkway have several interchanges that are inconsistent with common practice for interstate interchange configuration.

1. System Interchanges

Currently, the Natcher Parkway and Western Kentucky Parkway (**Figure 6-8**) Interchange is a full cloverleaf interchange, which meets the recommendation for the two fully controlled access facilities interchange. However, with the implementation of converting the Western Kentucky Parkway (west of the interchange) and Natcher Parkway (south of the interchange), to I-66 the cloverleaf is inconsistent with AASHTO recommendations for a systems interchange. Currently, the ramps and loop ramps within the interchange are one lane.

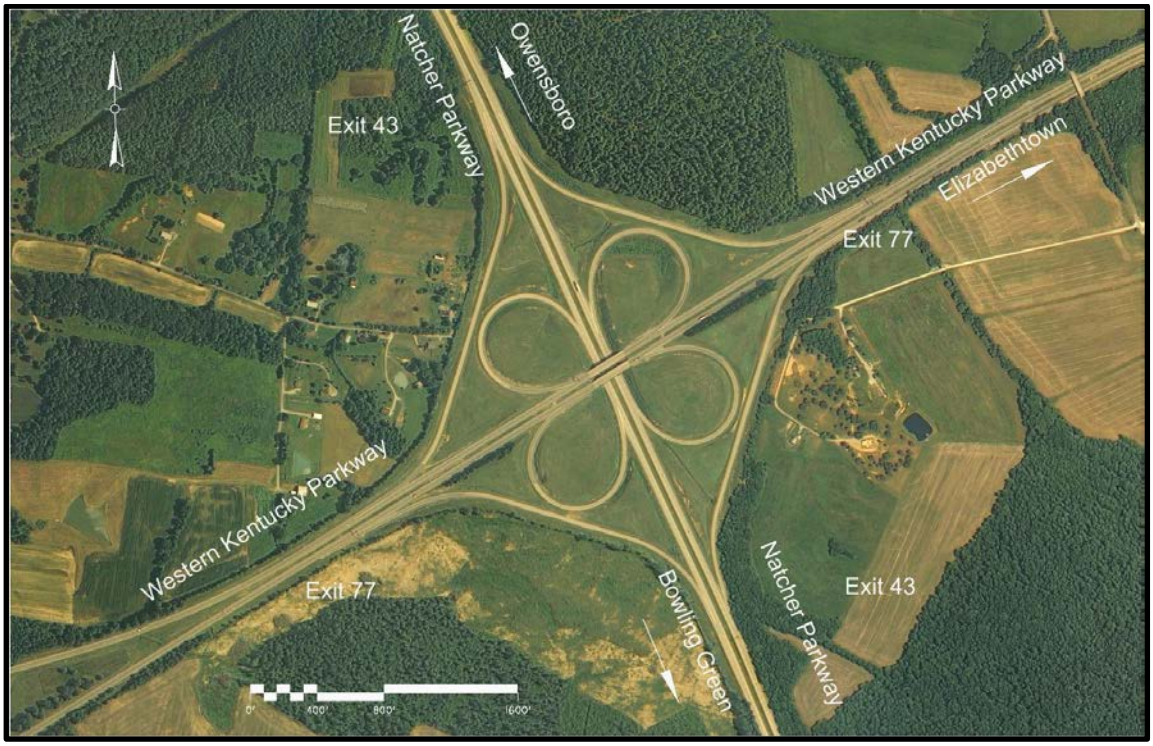


Figure 6-8 Natcher Parkway / Western Kentucky Parkway – Exit 43

In 2011, the Natcher Parkway and I-65 trumpet interchange was updated to a full cloverleaf interchange as part of extending the Natcher Parkway two miles from I-65 to US 231. Collector-distributor roads were constructed along I-65. **Figure 6-9** illustrates the new constructed full cloverleaf interchange which meets the requirement for the two fully controlled access facilities. In 2004, KYTC completed an I-66 corridor study that recommended potential corridors for routing I-66 through or around Bowling Green. (Refer to **Chapter XII** for study overview.)

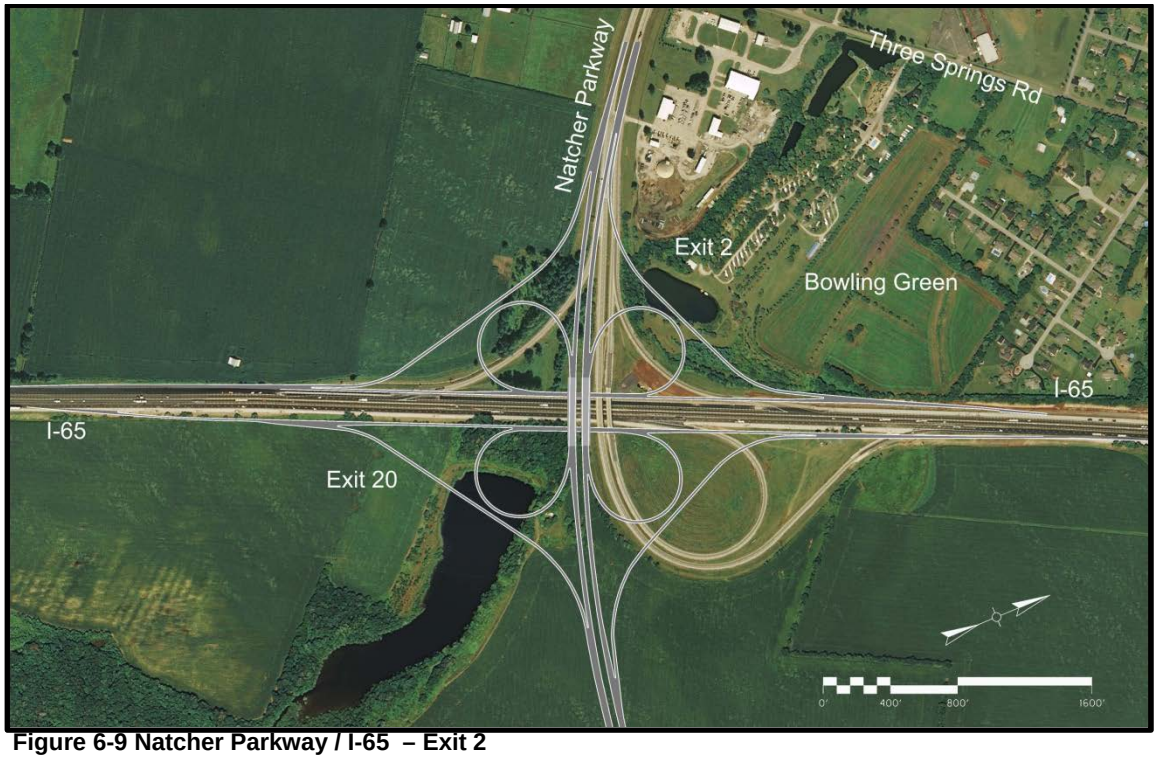


Figure 6-9 Natcher Parkway / I-65 – Exit 2

The Natcher Parkway and Audubon Parkway terminate at US 60 (**Figure 6-10** and **6-11**) with trumpet interchange configurations. The trumpet interchange meets the recommendation for two fully controlled access facilities. The implementation of designating US 60 as I-69 or I-66/I-65 spur is discussed further in **Chapter XIII Improvement Strategies and Development Costs.**

Figure 6-10 Audubon Parkway / US 60 Trumpet Interchange

Figure 6-11 Natcher Parkway / US 60 Trumpet Interchange

2. Service Interchanges

Four service interchanges inconsistent with AASHTO recommendations are the previous toll plazas located at Exit 10 on the Audubon Parkway and Exits 9, 36, and 50 on the Natcher Parkway (see figures below). As previously mentioned, all of these interchanges have less than the minimum weaving distance.

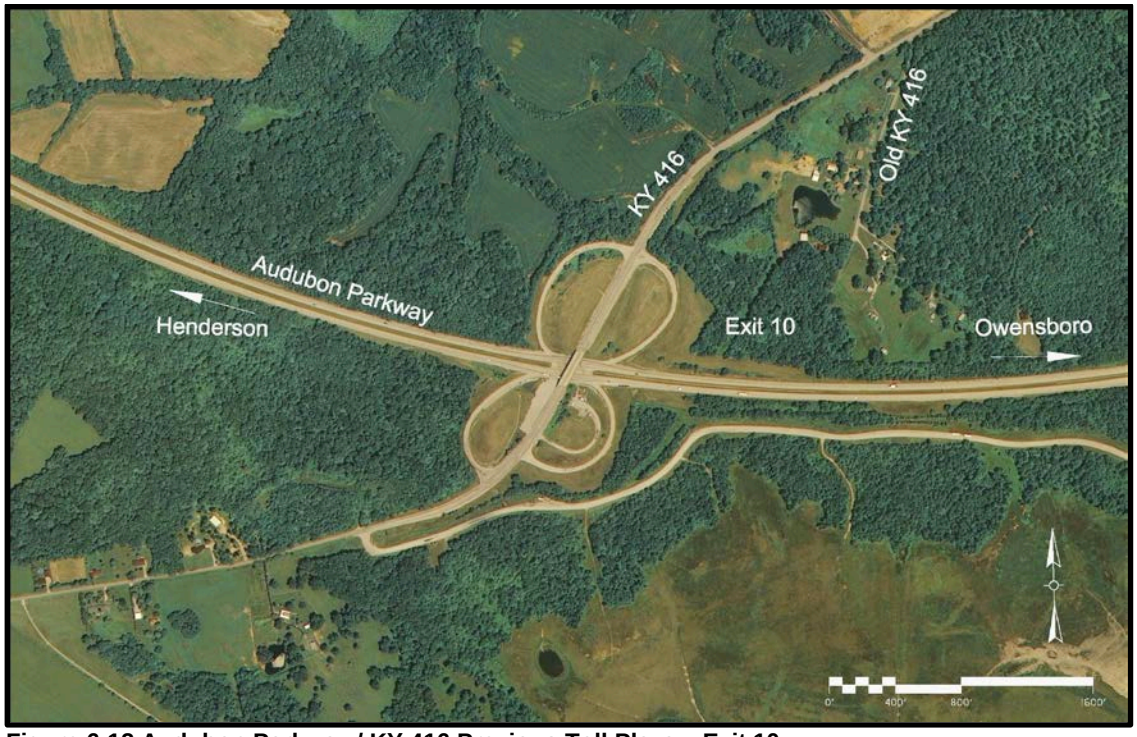


Figure 6-12 Audubon Parkway / KY 416 Previous Toll Plaza – Exit 10

Figure 6-13 Natcher Parkway / US 231 Morgantown Road Previous Toll Plaza – Exit 9

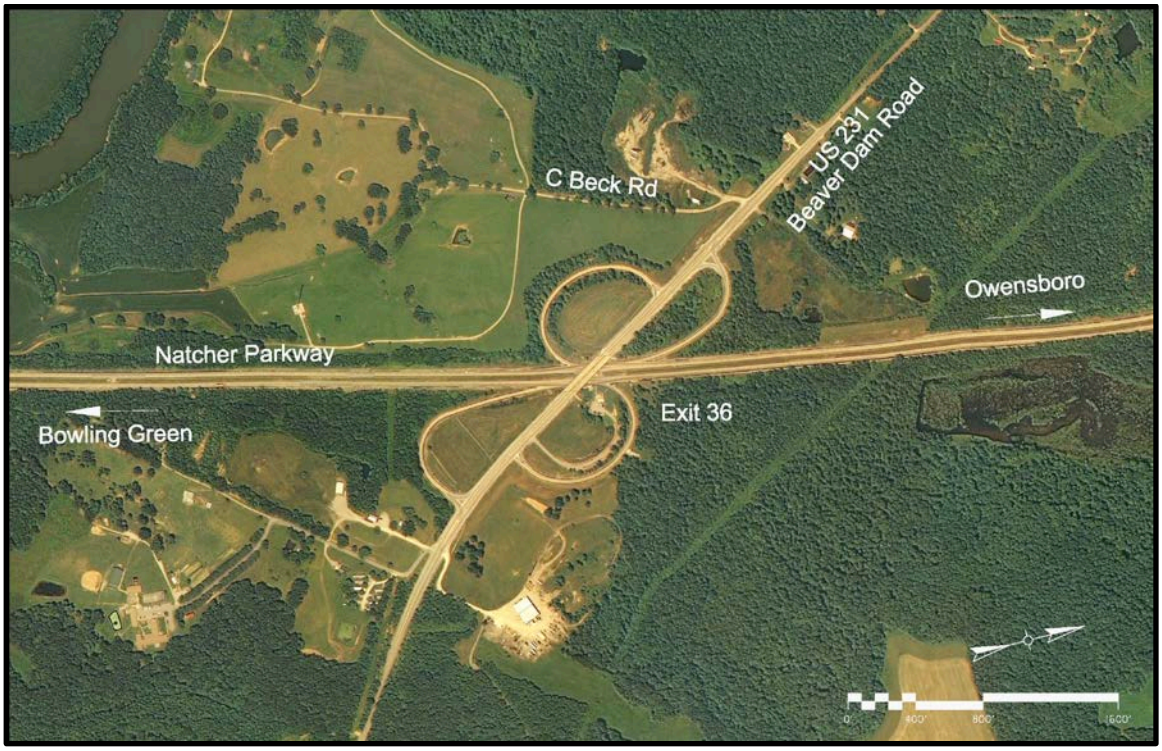


Figure 6-14 Natcher Parkway / US 231 Beaver Dam Road Previous Toll Plaza – Exit 36

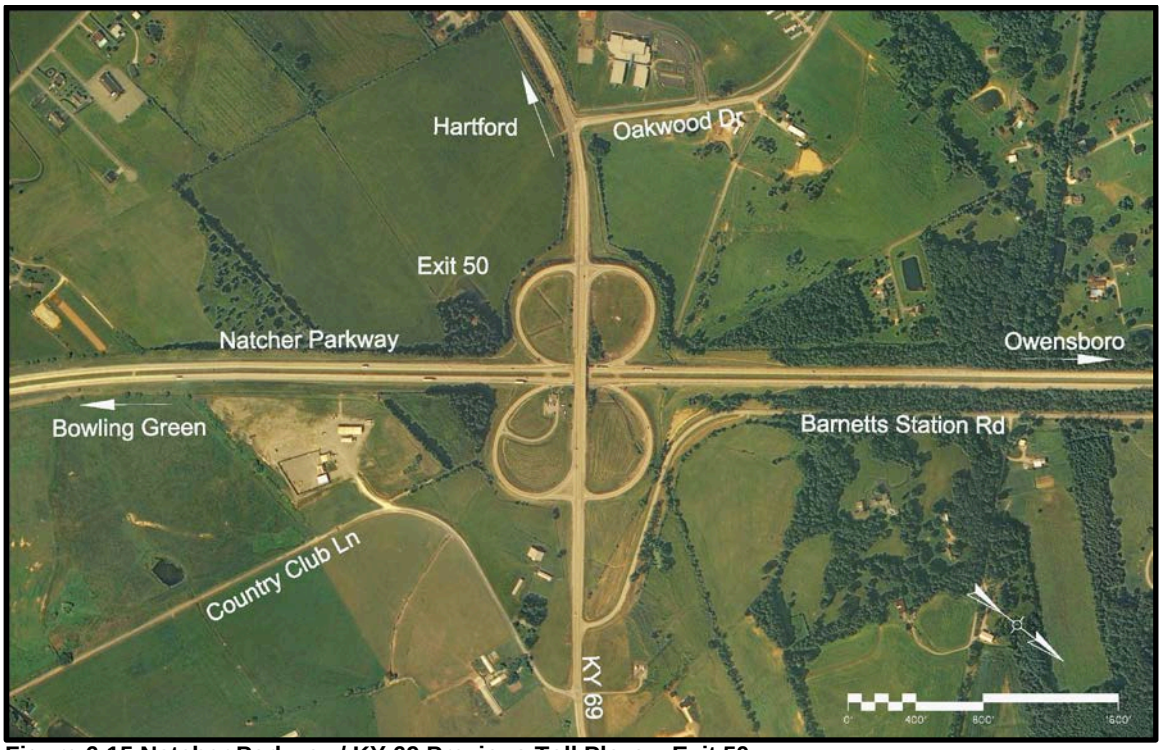


Figure 6-15 Natcher Parkway / KY 69 Previous Toll Plaza – Exit 50

VII. KEY FINDINGS OF EXISTING CONDITIONS OVERVIEW

As discussed in previous chapters, in some cases the Audubon Parkway, Natcher Parkway, and US 60 lack geometric compliance with current AASHTO guidelines. AASHTO minimum guidelines are provided in **Table 7-1** below. The parkways and US 60 provide the basic geometric characteristics of an interstate highway, such as full control of access, two travel lanes in each direction, 12-foot lanes, 4-foot inside paved shoulders, 10-foot outside paved shoulders, 36 foot rural and urban medians, 70 mph rural design speed, and 50 mph urban design speed. However, the Audubon Parkway, Natcher Parkway, and US 60 lack compliance with the dimensions of other design features. **Figures 7-1** through **7-7** summarize deficiency locations for the project corridor. Each deficiency is labeled on the figures and described in **Table 7-2** on page 7-9 in more detail**.**

Chapter VIII Potential Improvement Alternatives and Development Costs presents three improvement strategies studied to address the deficiencies identified on the Audubon Parkway, Natcher Parkway, and US 60. The strategies are No Build, Necessary Upgrades and Spot Safety Improvements, and Fully Compliant Reconstruction. Refer to **Chapter VIII** for details and costs for the strategies. **Table 7-2** identifies the range of improvements associated with the Necessary Upgrades and Spot Safety Improvements and Fully Compliant Reconstruction strategies.

Area Type	Rural			Urban			Urban/Rural		
Design Element	**Mainline**	**Ramps**	**Loops**	**Mainline**	**Ramps**	**Loops**	**Directional**	**Entrance**	**Exit**
Design Speed (MPH) (8-1, 8-2, 10-89, 10-90) [2]	70	35	25	50	25	25	40		
Level of Service (8-2) [3]		C			D				
Driving Lane Width (8-2) [3]	12'	15'	15'	12'	15'	15'			
Inside Shoulder Width (8-3, 10-102) [3]									
4-lane freeway & ramps	4'	2'-4'	2'-4'	4'	2'-4'	2'-4'	1'-6'		
6-lane, Truck DDHGV <= 250				10'					
6-lane, Truck DDHGV > 250				12'					
Outside Shoulder Width (8-3, 10-102) [3]									
Turck DDHV <= 250	10'	8'-10'	8'-10'	10'	8'-10'	8'-10'	8'-10'		
Turck DDHV > 250	12'			12'					
Median Width (8-7, 8-10) [4] [1]	36'			10'					
Over Freeway Vertical Bridge Clearance (8-4)	16'-00"								
Over Freeway Vertical Sign Truss Clearance (8-4)	17'-00"								
Bridge Width (Horizontal) ADT>2000 [5]	Traveled Lanes + Shoulders (approach roadway width)								
Bridge Width (Horizontal) Length > 200' [2]	Traveled Lanes + 3.5' each side								
Design ADT (vehicle per day)	> 6,000	750-1,500		> 6,000	750-1,500				
Clear Zone (Fill Slope 1V:4H or flatter) [3]	30'-46'	10' - 14'		20' - 28'	10'-14'				
Clear Zone (Cut Slope 1V:3H or flatter) [3]	22'-30'	12' - 14'		14'-22'	12'-14'				
Superelevation (8-3) [4]	+/- 8%								
Horizontal Curvature Minimum Radius (8% max SE) (3-47)	1810'	314'	134'	758'	134'	134'	444'		
Minimum Runoff (8% max SE) (3-65)	240'	155'	137'	192'	137'	137'	166'		
Minimum Runout (8% max SE) (3-65)	60'	39'	34'	48'	34'	34'	41'		
Maximum Grade (8-3, 10-93)	4%	5%-7%	5%-7%	5%	5%-7%	5%-7%	4%-6%		
Stopping Sight Distance (3-4)	730'	250'	155'	425'	155'	155'	305'		
Taper Ratio (10-107)								50:1	
Divergence Angle (10-112)									2°-5°

Note: Page number references from AASHTO's A Policy on Geometric Design of Highways and Streets, 2011 are provided in parenthesis. Page number references from AASHTO's A Policy on Design Interstate System, 2005 are provided in brackets.

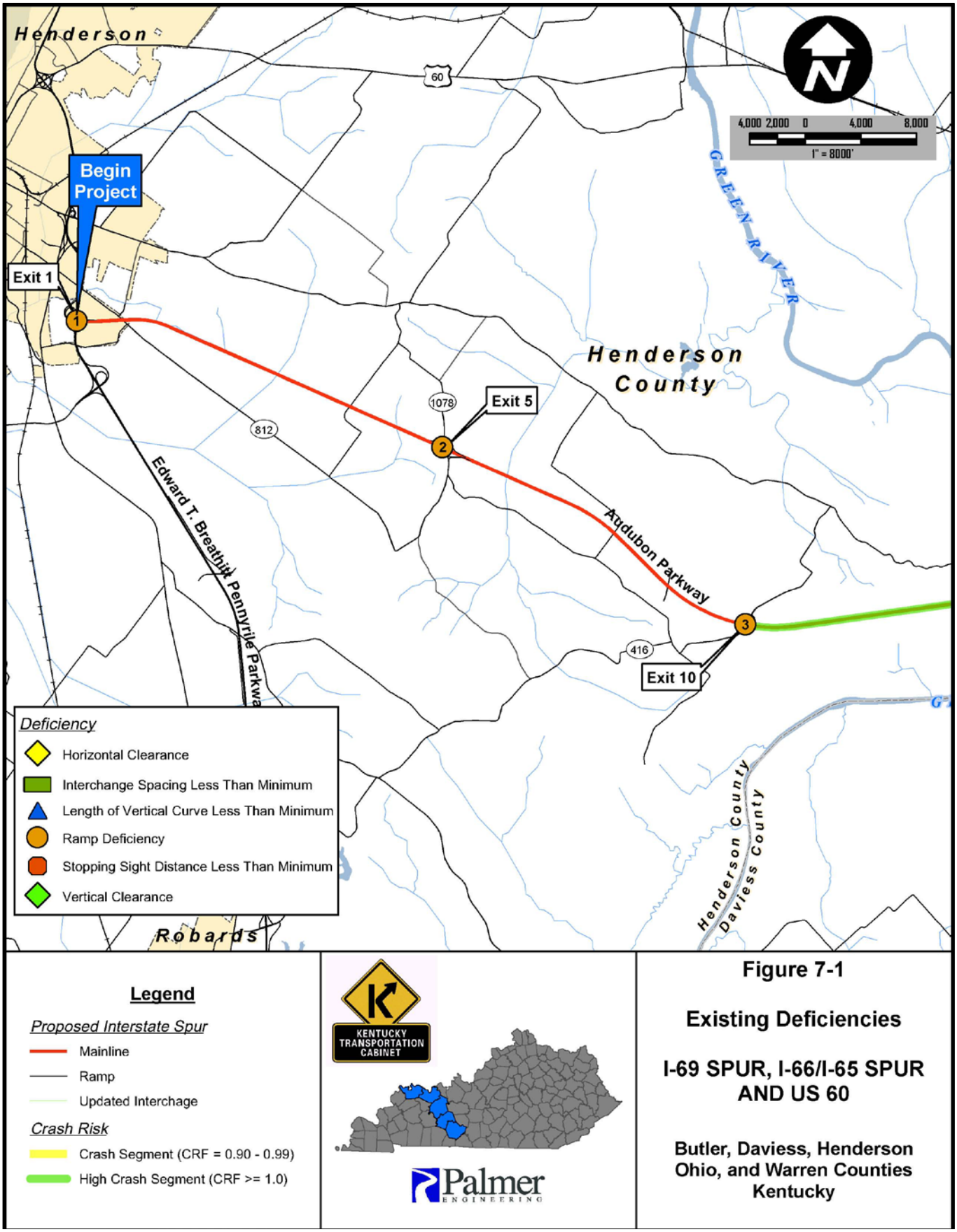
[1] AASHTO's A Policy on Design Standards Interstate System, 2005 states 36' minimum depressed median in rural areas. AASHTO's A Policy on Geometric Design of Highways and Streets, 2011 specifies 50'.

[2] This item is referenced in the AASHTO A Policy on Design Standards Interstate System, 2005.

[3] Information on clear zones is provided in AASHTO's *Roadside Design Guide Current Edition* .

[4] Common KYTC Practice is 8% maximum superelevation. KYTC has used 10% maximum superelevation on past projects including the Natcher Parkway and Audubon Parkway

Table 7-1 AASHTO Minimum Guidelines


Henderson
60
Begin Project
Exit 1
1
1078
Exit 5
812
2
Edward T. Breathitt Pennyrile Parkway
Audubon Parkway
3
416
Exit 10
Henderson County
G R E E N R I V E R
4,000 2,000 0 4,000 8,000
1" = 8000'
Deficiency
Horizontal Clearance
Interchange Spacing Less Than Minimum
Length of Vertical Curve Less Than Minimum
Ramp Deficiency
Stopping Sight Distance Less Than Minimum
Vertical Clearance
Robards
Henderson County
Daviess County
Legend
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
Crash Risk
Crash Segment (CRF = 0.90 - 0.99)
High Crash Segment (CRF >= 1.0)
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 7-1
Existing Deficiencies
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky

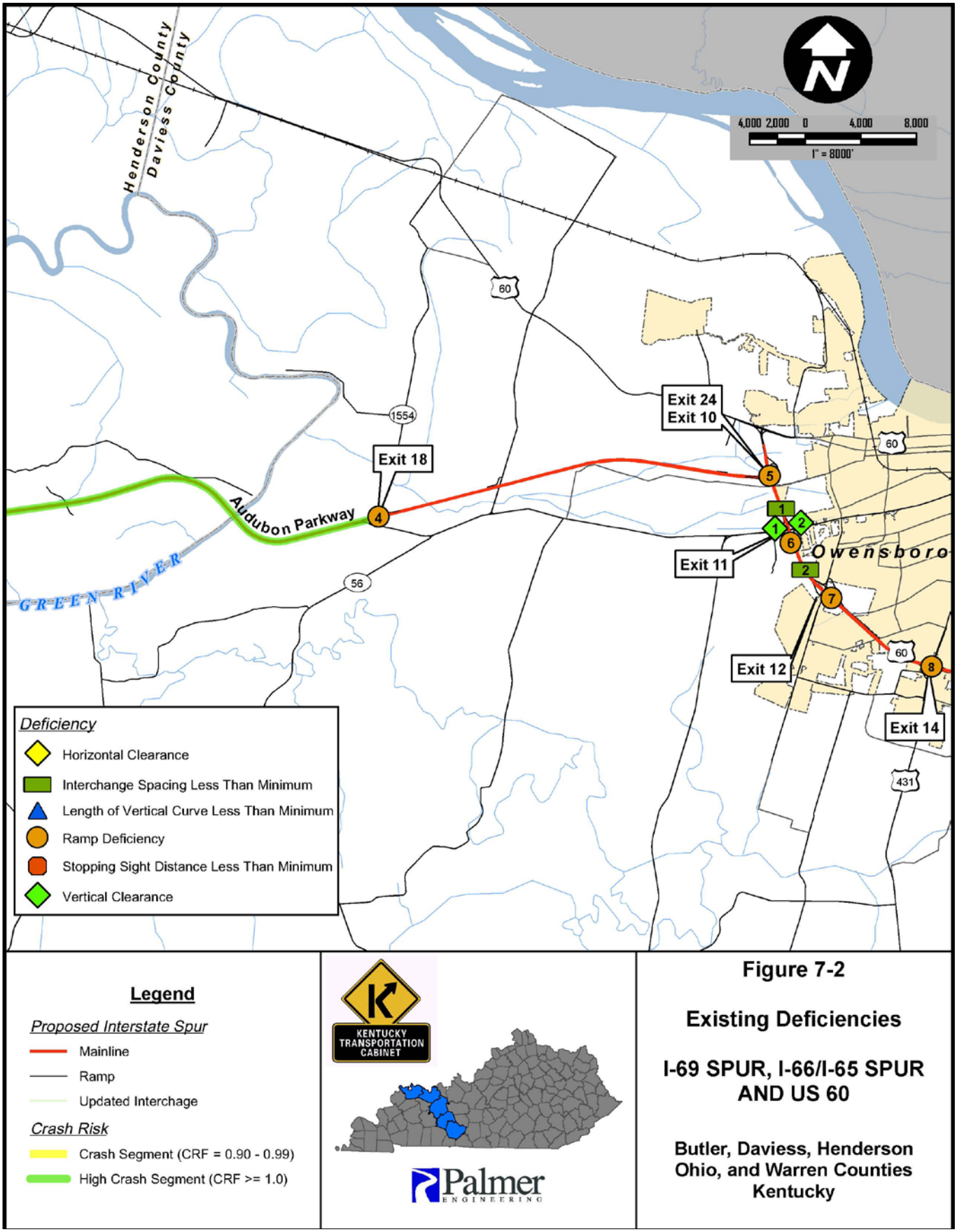
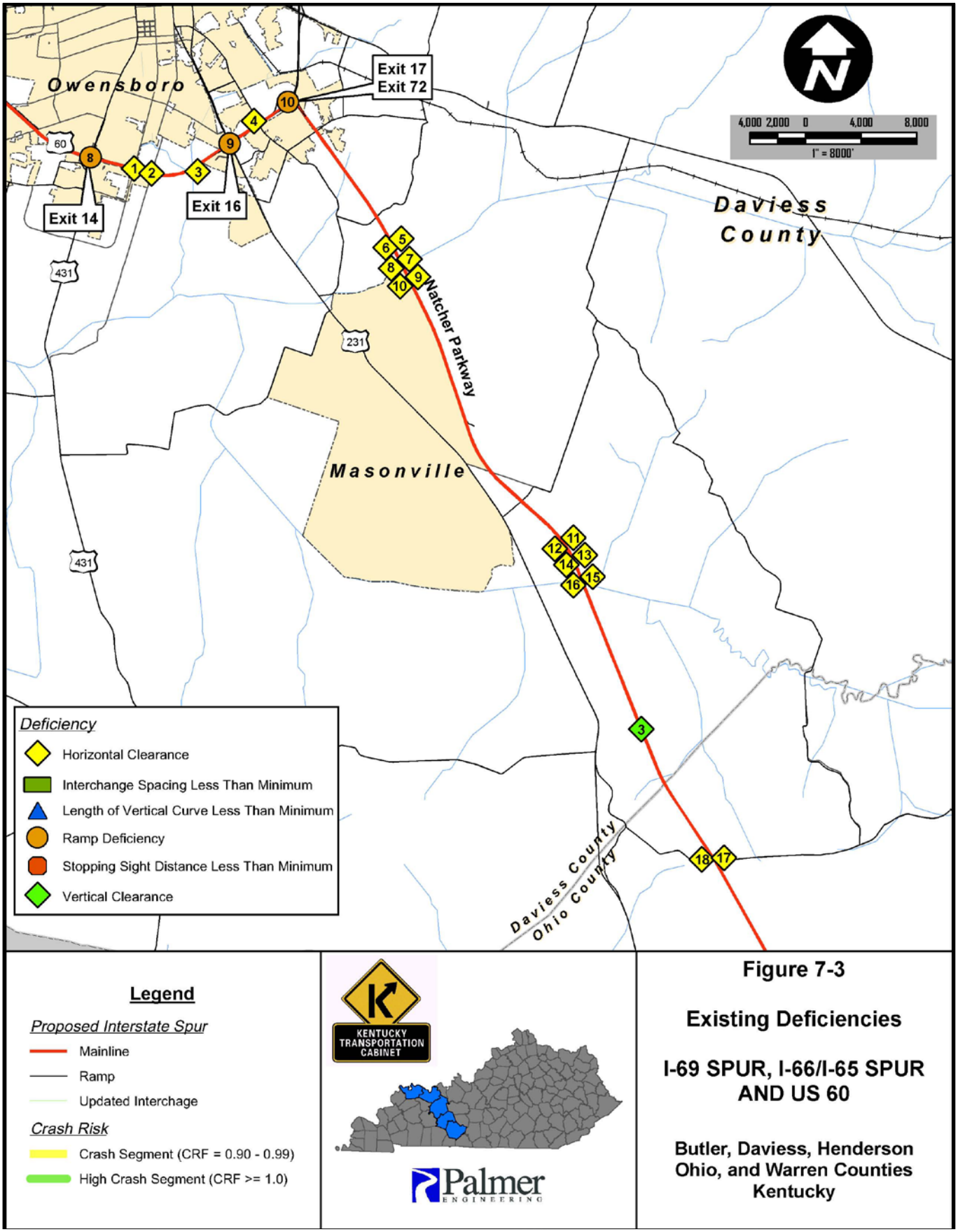


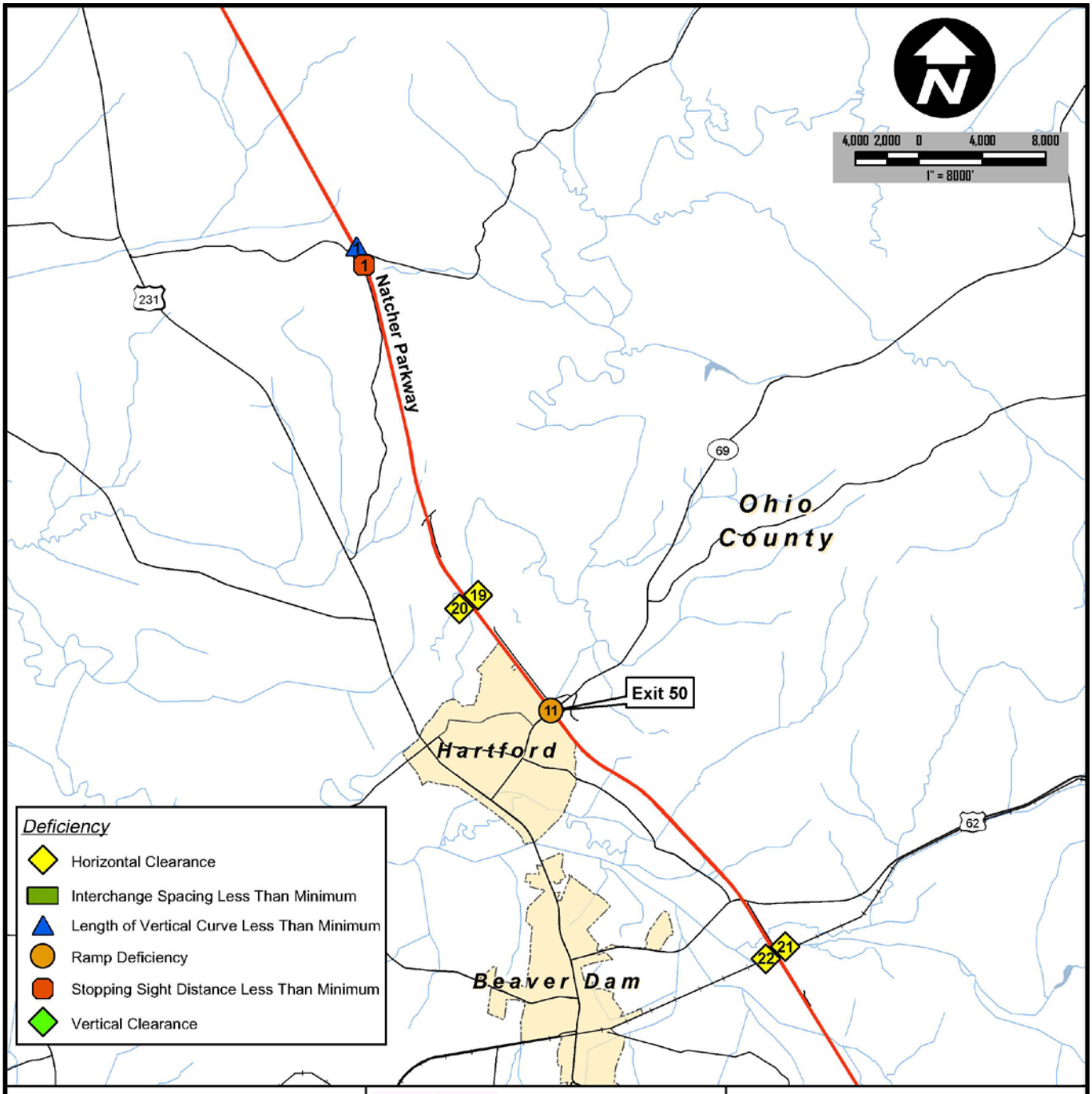
Figure 7-2

Existing Deficiencies

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Owensboro
Exit 17
Exit 72
Exit 14
Exit 16
Daviess County
Watcher Parkway
Masonville
60
431
231
4,000 2,000 0 4,000 8,000
1" = 8000'
Deficiency
Horizontal Clearance
Interchange Spacing Less Than Minimum
Length of Vertical Curve Less Than Minimum
Ramp Deficiency
Stopping Sight Distance Less Than Minimum
Vertical Clearance
Daviess County
Ohio County
Legend
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
Crash Risk
Crash Segment (CRF = 0.90 - 0.99)
High Crash Segment (CRF >= 1.0)
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 7-3
Existing Deficiencies
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur
- Mainline
- Ramp
- Updated Interchage

Crash Risk
- Crash Segment (CRF = 0.90 - 0.99)
- High Crash Segment (CRF >= 1.0)

KENTUCKY TRANSPORTATION CABINET

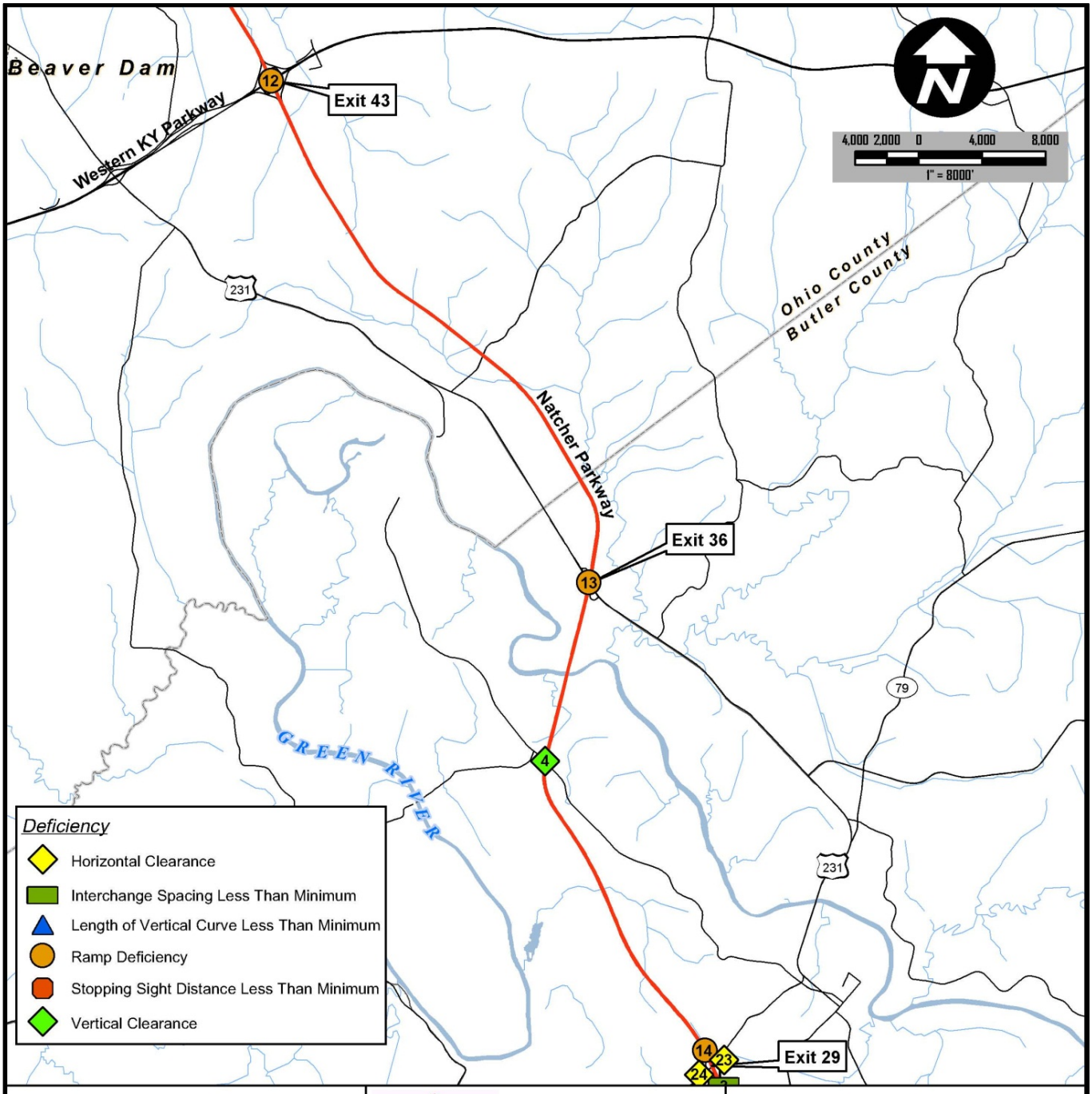
Palmer ENGINEERING

Figure 7-4

Existing Deficiencies

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur
- Mainline
- Ramp
- Updated Interchage

Crash Risk
- Crash Segment (CRF = 0.90 - 0.99)
- High Crash Segment (CRF >= 1.0)

KENTUCKY TRANSPORTATION CABINET

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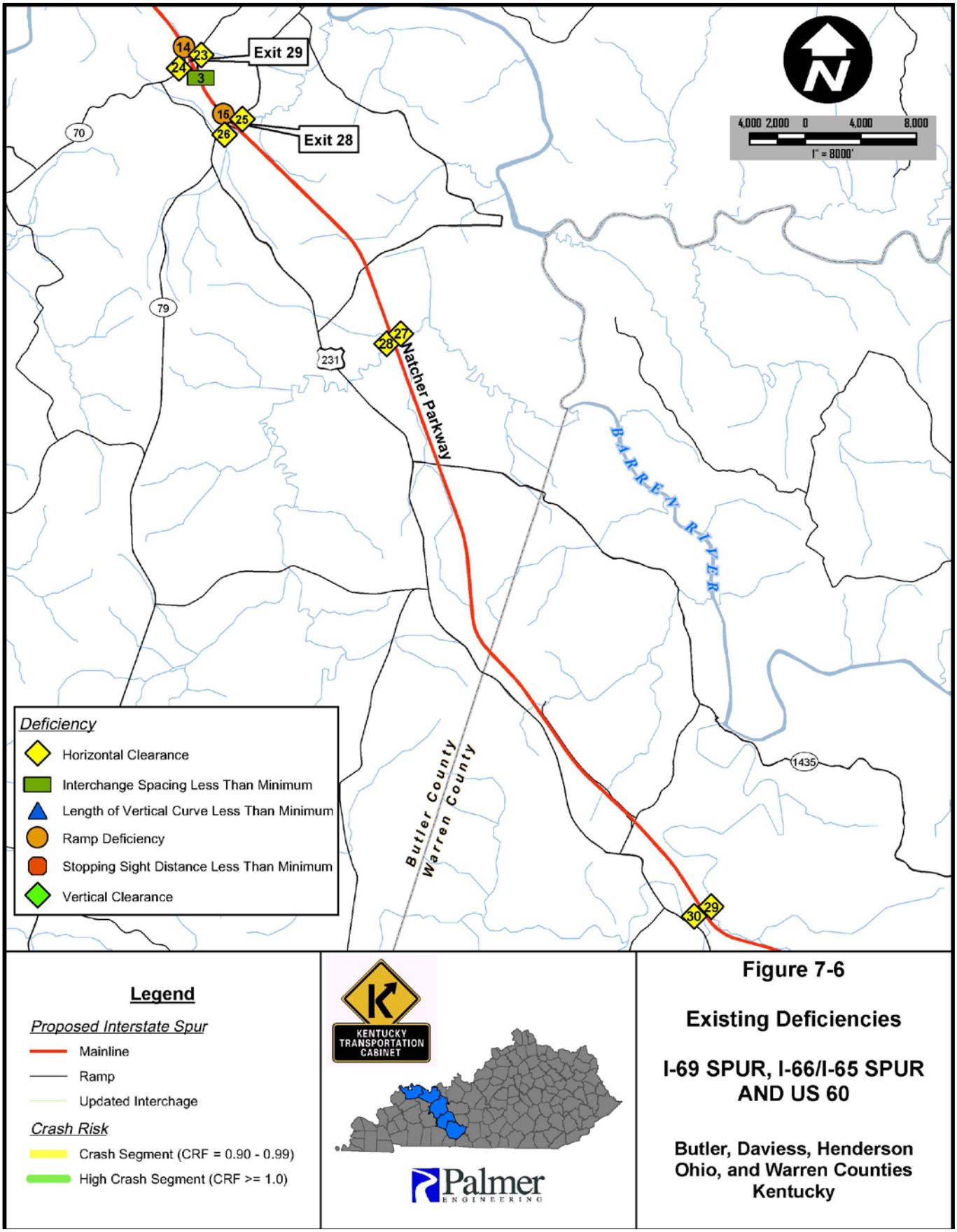
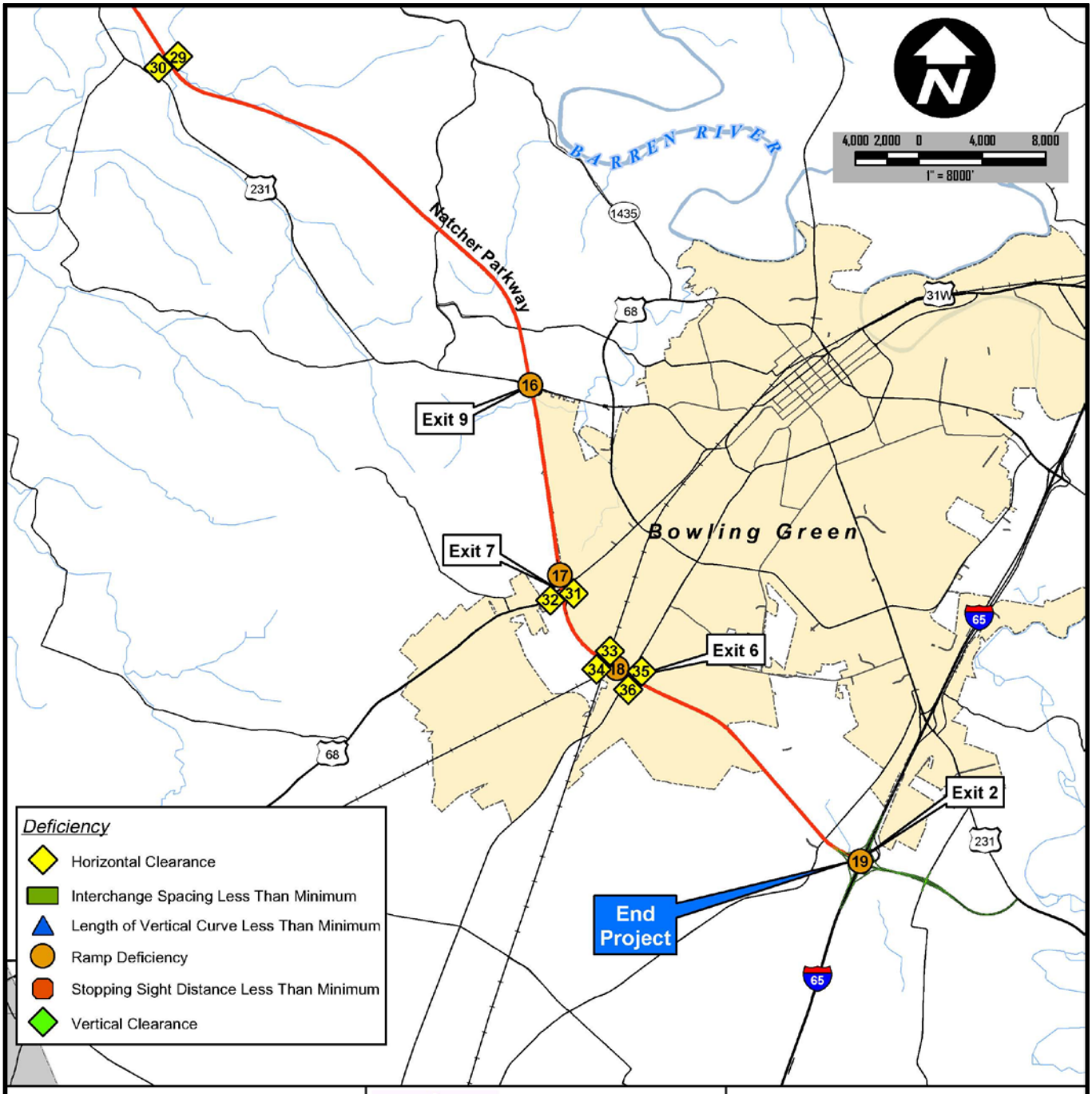
Figure 7-5

Existing Deficiencies

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky


Exit 29
Exit 28
14
23
24
3
15
25
26
70
79
231
27
28
Natcher Parkway
BARREN RIVER
Butler County
Warren County
1435
29
30
4,000 2,000 0 4,000 8,000
1" = 8000'
Deficiency
Horizontal Clearance
Interchange Spacing Less Than Minimum
Length of Vertical Curve Less Than Minimum
Ramp Deficiency
Stopping Sight Distance Less Than Minimum
Vertical Clearance
Legend
Proposed Interstate Spur
Mainline
Ramp
Updated Interchage
Crash Risk
Crash Segment (CRF = 0.90 - 0.99)
High Crash Segment (CRF >= 1.0)
KENTUCKY TRANSPORTATION CABINET
Palmer ENGINEERING
Figure 7-6
Existing Deficiencies
I-69 SPUR, I-66/I-65 SPUR AND US 60
Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky



Legend

Proposed Interstate Spur
- Mainline
- Ramp
- Updated Interchage

Crash Risk
- Crash Segment (CRF = 0.90 - 0.99)
- High Crash Segment (CRF >= 1.0)

KENTUCKY TRANSPORTATION CABINET

Palmer ENGINEERING

Figure 7-7

Existing Deficiencies

I-69 SPUR, I-66/I-65 SPUR AND US 60

Butler, Daviess, Henderson Ohio, and Warren Counties Kentucky

Table 7-2 Deficiencies Summary

Deficiency Type	Milepoint	Deficiency Description	Range of Improvement		
			Note	Necessary Upgrades and Spot Safety Improvement	Fully Compliant Reconstruction
Audubon Parkway - Henderson / Daviess Counties					
1	Exit 1	Taper Length < Min		Pending alignment decision of SIU 5	
2	Exit 5	Taper Length < Min; Ramp Entrance Deficient		Upgrade ramp deficiencies to meet interstate standards	
		Interchange control of access less than 300' minimum	I	Control of access extended/retained	Improve to meet interstate standards
Barrier Wall Deficiency	6.223 6.223	Barrier wall does not meet current standard		Replace barrier railing/barriers that do not meet minimum standards	
3	Exit 10	Taper Length < Min; Ramp Entrance Deficient; Previous Toll Plaza		Upgrade interchange to meet interstate standard	
Barrier Wall Deficiency	15.839	Barrier wall does not meet current standard		Replace barrier railing/barriers that do not meet minimum standards	
4	Exit 18	Taper Length < Min; Divergence Angle > Max;		Upgrade ramp deficiencies to meet interstate standards	
		Interchange control of access less than 300' minimum	I	Control of access extended/retained	Improve to meet interstate standards
Barrier Wall Deficiency	22.701 22.701	Barrier wall does not meet current standard		Replace barrier railing/barriers that do not meet minimum standards	
5	Exit 24 / Exit 10 (US 60)	Divergence Angle > Max; Taper Length < Min		Upgrade ramp deficiencies to meet interstate standards	
US 60 - Daviess County				Improvements to US 60 are dependent on route designation option - See Chapter VIII	
1	11.230	Interchange spacing less than 1 mile minimum	II	Requires Design Variance Approval	Improve to meet interstate standards
6	Exit 11	Taper Length < Min		Upgrade ramp deficiencies to meet interstate standards	
1	11.611	Vertical clearance = 15.61' (16' minimum)		Upgrade vertical clearance deficiencies to meet interstate standards	
2	11.611	Vertical clearance = 15.31' (16' minimum)		Upgrade vertical clearance deficiencies to meet interstate standards	
2	12	Interchange spacing less than 1 mile minimum	II	Requires Design Variance Approval	Improve to meet interstate standards
Barrier Wall Deficiency	12.011 12.011	Barrier wall does not meet current standard		Replace barrier railing/barriers that do not meet minimum standards	
7	Exit 12	Taper Length < Min		Upgrade ramp deficiencies to meet interstate standards	
		Interchange control of access less than 100' minimum	I	Control of access extended/retained	Improve to meet interstate standards
Barrier Wall Deficiency	13.564 13.564	Barrier wall does not meet current standard		Replace barrier railing/barriers that do not meet minimum standards	
8	Exit 14	Taper Length < Min		Upgrade ramp deficiencies to meet interstate standards	
Barrier Wall Deficiency	14.416 14.416	Barrier wall does not meet current standard		Replace barrier railing/barriers that do not meet minimum standards	
1	15.026	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier wall does not meet current standard		Replace barrier railing/barriers that do not meet minimum standards	

(**Table 7-2** continued on following page)

Table 7-2 (Continued) Deficiencies Summary

Deficiency Type	Milepoint	Deficiency Description	Range of Improvement		
			Note	Necessary Upgrades and Spot Safety Improvement	Fully Compliant Reconstruction
US 60 - Daviess County				Improvements to US 60 are dependent on route designation option - See Chapter VIII	
2	15.272	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier wall does not meet current standards		Replace barrier railing/barriers that does not meet current standard	
Barrier Wall Deficiency	15.272	Barrier wall does not meet current standards		Replace barrier railing/barriers that do not meet current standard	
3	15.842	Horizontal Clearance = 34' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
9	Exit 16	Taper Length < Min		Upgrade ramp deficiencies to meet interstate standards	
4	16.943	Horizontal Clearance = 33.8' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
10	Exit 17 / Exit 72 (Natcher)	Divergence Angle > Max; Taper Length < Min		Upgrade ramp deficiencies to meet interstate standards	
Natcher Parkway - Daviess / Ohio / Butler / Warren Counties					
5	69.846	Horizontal Clearance = 30.5' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
6	69.846	Horizontal Clearance = 30.5' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
7	69.522	Horizontal Clearance = 30.5' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
8	69.522	Horizontal Clearance = 30.5' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
9	69.327	Horizontal Clearance = 30.5' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
10	69.327	Horizontal Clearance = 30.5' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
11	65.028	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier wall does not meet current standards		Replace barrier railing/barriers that do not meet current standard	
12	65.028	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier wall does not meet current standards		Replace barrier railing/barriers that do not meet current standard	
13	64.835	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier wall does not meet current standards		Replace barrier railing/barriers that do not meet current standard	

(**Table 7-2** continued on following page)

Table 7-2 (Continued) Deficiencies Summary

Deficiency Type	Milepoint	Deficiency Description	Range of Improvement		
			Note	Necessary Upgrades and Spot Safety Improvement	Fully Compliant Reconstruction
Natcher Parkway - Daviess / Ohio / Butler / Warren Counties					
14	64.835	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier wall does not meet current standards		Replace barrier railings/barriers that do not meet current standard	
15	64.485	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier wall does not meet current standards		Replace barrier railings/barriers that do not meet current standard	
16	64.485	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier wall does not meet current standards		Replace barrier railings/barriers that do not meet current standard	
3	62.352	Vertical clearance = 15.96' (16' minimum)		Upgrade overpass vertical clearance to meet 16 foot vertical clearance	
17	60.328	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier wall does not meet current standards		Replace barrier railings/barriers that do not meet current standard	
18	60.328	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier wall does not meet current standards		Replace barrier railings/barriers that do not meet current standard	
19	51.491	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier wall does not meet current standards		Replace barrier railings/barriers that do not meet current standard	
20	51.491	Horizontal Clearance = 30' (Note bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier wall does not meet current standards		Replace barrier railings/barriers that do not meet current standard	
1	53.800	Length of Vertical Curve = 800' (829' calcuated minimum)		Improve vertical curve to meet current standard	
1	53.800	Stopping Sight Distance = 710' (730' minimum)		Improve vertical curve to meet current standard	
11	Exit 50	Taper Length < Min; Entrance Ramp Deficient; Previous Toll Plaza		Upgrade interchange to meet interstate standard	
Barrier Wall Deficiency	46.645 46.645	Barrier wall does not meet current standards		Replace barrier railings/barriers that do not meet current standard	
Barrier Wall Deficiency	46.146 46.146	Barrier wall does not meet current standards		Replace barrier railings/barriers that do not meet current standard	
21	45.88	Horizontal Clearance = 30' (Note: Bridge is over 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier wall does not meet current standards		Replace barrier railings/barriers that do not meet current standard	

(**Table 7-2** continued on following page)

Table 7-2 (Continued) Deficiencies Summary

Deficiency Type	Milepoint	Deficiency Description	Range of Improvement		
			Note	Necessary Upgrades and Spot Safety Improvement	Fully Compliant Reconstruction
Natcher Parkway - Daviess / Ohio / Butler / Warren Counties					
22	45.88	Horizontal Clearance = 30' (Note: Bridge is over 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier Wall does not meet current standard		Replace barrier railings/barriers that do not meet current standard	
12	Exit 43	Taper Length < Min		Upgrade ramp deficiencies to meet interstate standards	
13	Exit 36	Taper Length < Min; Entrance Ramp Deficient; Interchange control of access less than 300' minimum; Previous Toll Plaza		Upgrade interchange to meet interstate standard	
Barrier Wall Deficiency	34.816 (NB & SB)	Barrier Wall does not meet current standard		Replace barrier railings/barriers that do not meet current standard	
4	33.741	Vertical clearance = 15.76' (16' minimum)		Upgrade overpass vertical clearance to meet 16 foot vertical clearance	
23	29.533	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
24	29.533	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
14	Exit 29	Taper Length < Min		Upgrade ramp deficiencies to meet interstate standards	
		Interchange control of access less than 300' minimum	I	Control of access extended/retained	Improve to meet interstate standards
3	29.000	Interchange spacing less than 3 mile minimum	II	Requires Design Variance Approval	Improve to meet interstate standards
15	Exit 28	Taper Length < Min		Upgrade ramp deficiencies to meet interstate standards	
25	28.523	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
26	28.523	Horizontal Clearance = 30' (Note: Bridge is less than 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
27	24.723	Horizontal Clearance = 30' (Note: Bridge is over 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier Wall does not meet current standard		Replace barrier railings/barriers that do not meet current standard	
28	24.723	Horizontal Clearance = 30' (Note: Bridge is over 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier Wall does not meet current standard		Replace barrier railings/barriers that do not meet current standard	
29	15.627	Horizontal Clearance = 30' (Note: Bridge is over 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier Wall does not meet current standard		Replace barrier railings/barriers that do not meet current standard	

(**Table 7-2** continued on following page)

Table 7-2 (Continued) Deficiencies Summary

Deficiency Type	Milepoint	Deficiency Description	Range of Improvement		
			Note	Necessary Upgrades and Spot Safety Improvement	Fully Compliant Reconstruction
Natcher Parkway - Daviess / Ohio / Butler / Warren Counties					
30	15.627	Horizontal Clearance = 30' (Note: Bridge is over 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier Wall does not meet current standard		Replace barrier railings/barriers that do not meet current standard	
16	Exit 9	Taper Length < Min; Entrance Ramp Deficient; Previous Toll Plaza		Upgrade interchange to meet interstate standard	
17	Exit 7	Taper Length < Min		Upgrade ramp deficiencies to meet interstate standards	
31	7.083	Horizontal Clearance = 30' (Note: Bridge is over 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier Wall does not meet current standard		Replace barrier railings/barriers that do not meet current standard	
32	7.083	Horizontal Clearance = 30' (Note: Bridge is over 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier Wall does not meet current standard		Replace barrier railings/barriers that do not meet current standard	
33	6.003	Horizontal Clearance = 30' (Note: Bridge is less 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier Wall does not meet current standard		Replace barrier railings/barriers that do not meet current standard	
34	6.003	Horizontal Clearance = 35.1' (Note: Bridge is less 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier Wall does not meet current standard		Replace barrier railings/barriers that do not meet current standard	
18	Exit 6	Taper Length < Min		Upgrade ramp deficiencies to meet interstate standards	
35	5.686	Horizontal Clearance = 30' (Note: Bridge is over 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier Wall does not meet current standard		Replace barrier railings/barriers that do not meet current standard	
36	5.686	Horizontal Clearance = 30' (Note: Bridge is over 200' long)	III	Requires Design Exception Approval	Upgrade horizontal clearance to meet interstate standards
		Barrier Wall does not meet current standard		Replace barrier railings/barriers that do not meet current standard	
19	Exit 2	Taper Length < Min		Upgrade ramp deficiencies to meet interstate standards	
Audubon Parkway / US 60 / Natcher Parkway					
Guardrail Trailing End Treatments	Appendix D	Guardrail Trailing End Treatments do not meet current standard. Reference Appendix D for locations		Upgrade guardrail trailing end treatments to meet current standard	

(**Table 7-2** Notes continued on following page)

Table 7-2 Notes

I: The existing access control will be further studied for safety and operational considerations. Existing access control will be retained or extended based on the study.

II: Interchange spacing that does not meet interstate standard will require further safety and operational analyses. Significant improvements may be necessary based on further study.

III: Based on the findings of the crash analyses, a crash history does not appear to be associated with mainline bridge width deficiency. However, additional study is needed before a decision on retaining the substandard bridge width can be made.

A. Operational Considerations and Safety

The following is a summary of the key findings related to the operational considerations and the safety of the Audubon Parkway, US 60, and Natcher Parkway:

- Crash Analysis: For the crash analysis, a high crash segment was defined as having a critical crash rate factor greater than or equal to one. Crash segments with a critical crash rate factor between 0.9 and 0.99 are also identified in the report.
- Crash Analysis – Audubon Parkway: Compared to other Kentucky parkways, one segment in Henderson/Daviess County (MP 10.141 – 18.049) has a critical crash rate between 0.9 and 0.99.
- Crash Analysis – Audubon Parkway as an Interstate: Compared to Kentucky interstates, rather than state parkways, one high crash segment was identified along the Audubon Parkway located in Henderson/Daviess County (MP 10.141 – MP 18.049). The segment has a critical crash rate factor of 1.13.
- Additional Findings Related to Crash Analysis: Four crashes coded as *median cross-over* or *head-on* collisions occurred on the Natcher Parkway during the study period (2006-2010). No *median cross-over* or *head-on collisions* were recorded on the Audubon Parkway or US 60 during the study period. Two fatal crashes on the Audubon Parkway, one fatal crash on US 60, and eight fatal crashes on the Natcher Parkway were recorded during the study period (2006-2010).
- Current Traffic (2011): The current traffic (2011) for the Audubon Parkway ranges from 9,450 vehicles per day (vpd) near Henderson to 10,590 vpd near the US 60 interchange in Owensboro. On US 60, the traffic volumes range from 19,200 vpd near the Audubon Parkway interchange to 32,400 vpd between the US 231 and US 431 interchanges. On the Natcher Parkway, the traffic volumes range from 7,940 vpd at the Western Kentucky Parkway interchange to 20,400 vpd near the I-65 interchange in Bowling Green.
- Truck Percentages (2011): The existing truck percentages on the Audubon Parkway range from 19.5% at Owensboro to 21.1% at Henderson, Kentucky. On US 60, the truck percentages range from 10.1% to 12.4%. The existing truck percentages on the Natcher Parkway range from 19.9% in Morgantown to 32.9% north of the Western Kentucky Parkway interchange in Ohio and Daviess Counties.
- Future Traffic (2040) without Interstate Spur Designations: The projected annual growth rates range from 2.1% to 2.3% along the Audubon Parkway, from 1.5% to 2.3% on US 60 and from 0.9% to 3.1% on the Natcher Parkway. The growth rates resulted in a range from 18,400 vpd to 20,500 vpd on the Audubon Parkway, 36,100 vpd to 49,900 vpd on US 60, and 10,800 vpd to 49,500 vpd on the Natcher Parkway.
- Future Traffic (2040) with Interstate Spur Designations: The projected annual growth rates range from 2.3% to 2.6% along the Audubon Parkway, from 1.8% to 2.5% on US 60 and from 1.1% to 3.6% on the Natcher Parkway. The projected growth rates resulted in traffic volumes ranging from 19,500 vpd to 22,300 vpd on the Audubon Parkway, 38,200 vpd to 54,400 vpd on US 60, and 11,500 vpd to 56,900 vpd on the Natcher Parkway.
- Truck Percentages (2040): Future truck volumes were not forecast for this project.
- Level of Service (2011): The Audubon Parkway, Natcher Parkway, and US 60 currently operate at LOS C or better, which is acceptable to the AASHTO guidelines.
- Level of Service (2040): The Audubon Parkway is expected to operate at LOS B or better with or without interstate spur designation. US 60 is expected to operate at LOS D or better with or without interstate spur designation. The rural sections of the Natcher

Parkway are expected to operate at LOS B or better with or without interstate spur designation. The urban sections of the Natcher Parkway are expected to operate at LOS D or better without interstate spur designation and LOS E or better with interstate spur designation.

B. Mainline Geometry/Typical Section

The following is a summary of the key findings related to the Audubon Parkway, Natcher Parkway, and US 60 geometry and typical sections:

- Design Speed: The Audubon Parkway, US 60, and Natcher Parkway meet or exceed the minimum design speed guidelines for interstate highways in rural and urban areas.
- Lane Width: The lane width on the Audubon Parkway, US 60, and Natcher Parkway meet the minimum AASHTO guidelines for interstate design.
- Outside Shoulder Width: The Audubon Parkway, Natcher Parkway, and US 60 meet the AASHTO minimum outside shoulder width based on the current truck DDHV.
- Inside Shoulder Width: The AASHTO minimum inside shoulder width is met on the Audubon Parkway, Natcher Parkway, and US 60.
- Median Width: The Audubon Parkway, Natcher Parkway, and US 60 meet the rural 36-foot AASHTO minimum median width in rural areas and the 10-foot AASHTO minimum median width in urban areas.
- Clear Zones: Based on the provided information and limited field reviews, it is not possible to evaluate the applicability of the current design standards for clear zone on the Audubon Parkway, Natcher Parkway, and US 60. The fill and cut slopes provided in the typical sections vary from 1V:2H to 1V:4H, the median ditch slope varies from 1V:3H to 1V:12H, and the outside ditch slope is between 1V:3H and 1V:4H.
- Guardrail Placement and Condition: The guardrail leading end treatments on the Audubon Parkway, Natcher Parkway, and US 60 meet the current standards. Dome guardrail trailing end treatments on the Audubon Parkway, Natcher Parkway, and US 60 do not meet current standards. An evaluation of guardrail placement is not possible based on the information provided on the As-built plans.
- Superelevation: From the review of As-built plans, horizontal curves along the Audubon Parkway, Natcher Parkway, and US 60 appear to comply with the AASHTO criteria.
- Horizontal Alignment: The horizontal curvature for the Audubon Parkway, Natcher Parkway, and US 60 is acceptable and in compliance with the current AASHTO design guidelines.
- Vertical Alignment: All of the vertical curves along the Audubon Parkway and US 60 meet the current AASHTO guidelines. One vertical curve on the Natcher Parkway (MP 53.800) does not meet the guideline for the minimum length of vertical curves.
- Stopping Sight Distance: The minimum stopping sight distance guideline is not met for one vertical curve on the Natcher Parkway: MP 53.800.

C. Bridges and Overpasses

The following is a summary of the key findings related to the bridges and overpasses on the Audubon Parkway, Natcher Parkway, and US 60:

- Lateral Clearance – Audubon Parkway: All of the mainline bridges on the Audubon Parkway meet the minimum lateral clearance. (The bridges at the Pennyrile Parkway and US 60 interchanges are not included.)
- Lateral Clearance – US 60: Four of the mainline bridges on US 60 do not meet the minimum lateral clearance requirement. (The bridges at the Audubon Parkway and Natcher Parkway are not included.)
- Lateral Clearance – Natcher Parkway: Of the 39 mainline bridges on the Natcher Parkway, 32 do not meet the minimum lateral clearance. (The bridges at the US 60 interchanges are not included.)
- Vertical Clearance – Audubon Parkway: All of the overpass bridges meet the minimum 16 foot vertical clearance requirement.

- Vertical Clearance – US 60: One overpass bridge does not meet the minimum 16-foot vertical clearance requirement (MP 11.611). The clearance is not met on the eastbound and westbound lanes on US 60.
- Vertical Clearance – Natcher Parkway: Of the 26 overpass bridges on the Natcher Parkway, 2 do not meet the minimum 16-foot vertical clearance requirement. They are located at MP 62.352 and MP 33.741.
- Functional Adequacy: Seventeen mainline bridges and culverts are identified as functionally obsolete; nine overpass bridges are identified as functionally obsolete.
- Sufficiency Rating: All Audubon Parkway, Natcher Parkway, and US 60 mainline and overpass bridges have a sufficiency rating greater than 60.0. Three culverts have a sufficiency rating less than 60.0.

D. Interchanges and Ramps

The following is a summary of the key findings related to the interchanges and ramps on the Audubon Parkway, Natcher Parkway, and US 60:

- Design Speed: Design speed for a majority of the interchange ramps was not provided on the as-built plans.
- Lane Width: Lane widths for the interchange ramps range from 15 feet to 16 feet, which is compliant with AASHTO guidelines.
- Shoulder Width: All of the interchange ramps on the Audubon Parkway, Natcher Parkway, and US 60 have 4-foot paved inside shoulders and 6-foot paved outside shoulders, which meet current practice.
- Horizontal Alignment: The minimum horizontal radius is met on all interchange ramps that were provided on the As-built plans.
- Vertical Alignment - Vertical Grade: The minimum vertical grade is met on all interchange ramps that were provided on the As-built plans.
- Vertical Alignment - Vertical Length of Curve: Eight ramp vertical curves do not meet the requirement for minimum length of curve that was calculated based on the minimum ramp design speed. On the Audubon Parkway, these ramps are located at the Pennyrile Parkway interchange (Exit 1) and US 60 interchange (Exit 24). On the Natcher Parkway, these ramps are located at the US 31 W interchange (Exit 6), the US 231 interchange (Exit 28) and the Western Kentucky Parkway interchange (Exit 43). On US 60, the Natcher Parkway and US 60 interchange also has vertical curves that do not meet the calculated minimum length of curve.
- Vertical Alignment - Stopping Sight Distance: Eight vertical curve ramps do not meet the minimum stopping sight distance requirement that was calculated based on the minimum ramp design speed. The vertical curves that do not meet the minimum stopping sight distance are located at the interchanges previously mentioned for vertical length of curve.
- Superelevation: Based on review of As-built plans, existing ramps appear to satisfy the AASHTO criteria for superelevation.
- Speed-Change Lanes: Many of the existing ramps on the Audubon Parkway, Natcher Parkway, and US 60 do not meet the minimum criteria for acceleration and deceleration lengths.
- Weaving Characteristics: The weaving situation within the Natcher Parkway and Western Kentucky Parkway will operate at LOS A in the northbound and southbound directions with future interstate spur traffic projections. The interchanges at Exits 9, 36, and 50 on the Natcher Parkway and Exit 10 on the Audubon Parkway are cloverleaf interchanges with weaving within the interchange.
- Interchange Spacing: On US 60, two locations do not meet the minimum interchange spacing. The interchange spacing between the Audubon Parkway interchange (Exit 10) and the KY 81 interchange (Exit 11) is less than one mile. The interchange spacing between the KY 81 interchange (Exit 11) and the Carter Road interchange (Exit 12) is also less than one mile. On the Natcher Parkway, one location does not meet the minimum interchange spacing requirements. The two interchanges (Exits 28 and 29) in Butler County are within three miles of each other.

- Interchange Control of Access: Two interchanges (Exit 5 and Exit 18) on the Audubon Parkway do not meet the minimum interchange control of access requirement. The minimum interchange control of access requirement is also not met at Exit 12 on US 60, and Exits 28 and 36 on the Natcher Parkway.
- Interchange Configuration: Currently, the Audubon Parkway and Natcher Parkway have four service interchanges that do not meet the recommended interstate interchange configuration. On the Audubon Parkway, the interchange is located at Exit 10. The remaining three interchanges are on the Natcher Parkway located at Exit 9, Exit 36, and Exit 50. These four interchanges were locations for toll plazas before tolls were removed from the route.

E. Design Feature Deficiency and Crash History Analysis

To further evaluate the impact of the roadway feature deficiencies on safety, a crash analysis was conducted to verify whether the deficiency has an impact on safety.

1. Mainline Geometry/Typical Section

a. Vertical Alignment – Minimum Vertical Curves, Minimum Stopping Sight Distance

A rolling crash analysis was conducted for an identified vertical alignment deficiency at MP 53.800 on the Natcher Parkway. The crashes were analyzed in 0.3 mile segments with reference given to the vertical alignment deficiency. From 2006 to 2010, 3 crashes occurred between MP 53.500 and 53.800, which result in a critical crash rate of 0.43. Based on the analysis, there is not a crash history associated with the vertical alignment deficiency.

2. Bridges/Overpasses

a. Bridge Width – Mainline Bridges

A crash analysis was conducted for narrow mainline bridge deficiencies. The crashes were analyzed in 0.3 mile segments with reference given to each bridge location. **Table 7-3** on pages 7-20 through 7-22 illustrates the findings of analysis. Based on the analysis and study period (2006-2010) there was a crash history within the studied range of two mainline bridges on the Natcher Parkway. The police reports of these crashes were evaluated to determine if the bridge width deficiency was associated with the crash history.

i. Natcher Parkway – Mainline Bridge – MP 15.627

The critical crash rate factor is greater than 1.0 between MP 15.327 and MP 15.627. The following table provides additional information for the 8 crashes that occurred within MP 15.327 and 15.627. The roadway condition was slippery when 5 of these crashes occurred. Two of the crashes were related to an animal and a tire blowout. Based on the analysis, the crash history does not appear to be associated with the bridge width.

MP	Time	Collision Type	Classification	Roadway Condition / Environmental Factor	Collision Description
15.370	22:40	Collision with Animal	Single Vehicle	Dry / Animals Action	Vehicle hit deer
15.408	20:09	Ran Off Roadway (1 vehicle with/Earth Embankment/Ditch)	Single Vehicle	Ice / Slippery Surface	Vehicle lost control
15.461	11:30	Collision with Fixed Object Non-Intersection	Single Vehicle	Ice / Slippery Surface	Vehicle lost control
15.464	1:02	Other Roadway or Mid-Block Collision	Single Vehicle	Dry / None Detected	Tire blew
15.489	7:00	Collision with Fixed Object Non-Intersection	Single Vehicle	Snow-Slush / Slippery Surface	Vehicle left the roadway
15.580	4:57	Ran Off Roadway (1 vehicle with/Earth Embankment/Ditch)	Single Vehicle	Wet / Slippery Surface	Minimum visibility due to heavy rain and fog
15.588	9:30	Ran Off Roadway (1 vehicle with/Earth Embankment/Ditch)	Single Vehicle	Dry / None Detected	Vehicle lost control
15.599	18:57	Other Collision on Shoulder	Angle	Ice / Slippery Surface	Vehicle lost control

ii. Natcher Parkway – Mainline Bridge – MP 60.328
The critical crash rate factor is greater than 1 between MP 60.028 and MP 60.428. The following table provides additional information for the 11 crashes that occurred within MP 60.028 and MP 60.428. The roadway condition was slippery when 4 of these crashes occurred. One of the crashes was attributed to an object in the roadway. One of the crashes occurred because the driver fell asleep. Based on the analysis, the crash history is not apparent to be associated with the bridge width.

MP	Time	Collision Type	Classification	Roadway Condition / Environmental Factor	Collision Description
60.107	18:43	Collision with Fixed Object Non-Intersection	Single Vehicle	Wet / Slippery Surface	Vehicle lost control due to weather conditions
60.137	10:26	Ran Off Roadway (1 vehicle with/Earth Embankment/Ditch)	Single Vehicle	Wet / None Detected	Vehicle lost control due to heavy rain
60.176	12:02	Ran Off Roadway (1 vehicle with/Earth Embankment/Ditch)	Single Vehicle	Dry / None Detected	Vehicle lost control
60.190	15:25	Sideswipe Collision - Same Direction	Sidewipe-Same Direction	Wet / None Detected	Vehicle wheel broke causing sideswipe
60.199	10:24	Other Roadway or Mid-Block Collision	Rear End	Dry / Construction Work Zone	Traffic momentarily stopped due to construction
60.200	7:40	Collision with Fixed Object Non-Intersection	Single Vehicle	Ice / Slippery Surface	Vehicle slid due to slippery surface
60.202	7:40	Ran Off Roadway (1 vehicle with/Earth Embankment/Ditch)	Single Vehicle	Ice / Slippery Surface	Vehicle slid due to slippery surface
60.211	3:12	Ran Off Roadway (1 vehicle with/Earth Embankment/Ditch)	Single Vehicle	Dry / None Detected	Abandoned crashed vehicle Undetermined cause
60.255	10:30	Collision with a Non-Fixed Object	Single Vehicle	Wet / Debris In Roadway	Vehicle hit driveshaft
60.280	14:52	Collision with Fixed Object Non-Intersection	Single Vehicle	Dry / None Detected	Driver fell asleep
60.294	18:45	Ran Off Roadway (1 vehicle with/Earth Embankment/Ditch)	Single Vehicle	Ice / Slippery Surface	Vehicle lost control due to slippery surface on bridge

F. Project Urban Limits

The project urban limits identified in the study were determined based on traffic volumes, functional classification, urban boundaries, and character of service. The urban boundaries referenced were based on 2010 Census data. The following discussions describe the characteristics of the project routes through Bowling Green and Owensboro.

1. Bowling Green

Bowling Green, KY has a population (2010) of 58,067 and 24,712 housing units, according to the U.S. Census Bureau. The total area of Bowling Green is 37.78 square miles, and its population density per square mile of land area is 1,537.0. Bowling Green is the county seat of Warren County. The population (2010) of Warren County is 113,972. Warren County has 47,223 housing units.

According to KYTC, the functional classification of the Natcher Parkway in Bowling Green is an Urban Freeway and Expressway. This designation for the segment of the Natcher Parkway (MP 2.08 - MP 10.22) is from I-65 for approximately 8 miles to the west. The segment bisects the southwestern borders of the city limits for more than 5 miles.

This portion of the Natcher Parkway was designed with the intention to serve Bowling Green as an urban expressway. The interchanges are spaced a minimum of 1.4 miles. The traffic volumes are more than doubled along some of the urban sections of the Natcher Parkway as compared to the rural sections to the north of Bowling Green. Based on the crash analysis, the Critical Crash Rate Factor ranges from 0.25 to 0.45 along the urban section of the Natcher Parkway when analyzed as an urban interstate. For this study, the urban section of the Natcher

Parkway is classified as an urban expressway and was analyzed based on the urban geometric criterion.

2. Owensboro

According to the U.S. Census Bureau, Owensboro, KY, the county seat of Daviess County, has a population (2010) of 57,265 and 26,072 housing units. The total area of Owensboro is 19.09 square miles and its population density per square mile of land area is 2,999.7. The population (2010) of Daviess County is 96,656, with 41,452 housing units.

According to KYTC, the functional classification of the Wendell Ford Expressway (US 60) is an Urban Freeway and Expressway. This segment of US 60 (MP 10.849-MP 17.498) extends from the Audubon Parkway for approximately 6.6 miles east to the Natcher Parkway.

Originally, this portion of US 60 was designated as the US 60 Bypass and US 60 passed through downtown Owensboro. The US 60 Bypass was designed with the intention to serve Owensboro as an urban expressway connecting the Audubon Parkway and Natcher Parkway. The US 60 Bypass was originally designed to rural criteria but the urban limits of Owensboro have now expanded beyond the bypass. For this study, US 60 is classified as an urban expressway and was analyzed based on the urban geometric criterion.

3. Henderson

Henderson, KY, the county seat of Henderson County, has a population (2010) of 28,757 and 13,171 housing units, according to the U.S. Census Bureau. The total area of Henderson is 15.30 square miles and its population density per square mile of land area is 1,879.5. The population (2010) of Henderson County is 46,250, with 20,320 housing units.

According to KYTC, the functional classification of the Audubon Parkway in Henderson County is Rural Principal Arterial. This segment of the Audubon Parkway (MP 0.000 - MP 24.000) extends from the Edward T. Breathitt (Pennyrile) Parkway for approximately 24 miles east to US 60 in Owensboro.

G. Long-Range Planning - Identified Projects

Projects were identified for long-range planning for the Audubon Parkway, Natcher Parkway, and US 60. In addition to KYTC, the local agencies that have identified long range projects along the Audubon Parkway, Natcher Parkway, and US 60 are the Bowling Green - Warren County Metropolitan Planning Organization (MPO), Barren River Area Development District (BRADD), Green River Area Development District (GRADD), Owensboro - Daviess County MPO, and Evansville (Indiana) MPO. The Evansville MPO study area encompasses the City of Henderson, KY. The following long-range projects and descriptions were identified from the local agency long range transportation plans.

- Natcher Parkway: US 231 Interchange Improvement
  The US 231 and Natcher Parkway interchange (Exit 9) is at the location for an old toll plaza. The project has been identified to improve safety and capacity of the existing interchange. This project is in the KYTC 2012 Highway Plan.
- Natcher Parkway: New interchange at KY 626
  The new interchange would be located in the vicinity of the KY 626 (Highland Church Road) overpass on the Natcher Parkway. The new interchange would improve access on the Natcher Parkway for western Warren County and eastern Butler County. This project is currently inactive.
- Natcher Parkway: New interchange at KY 764 or KY 142
  The new interchange would be located in the vicinity of KY 764 or KY 142 and Natcher Parkway. The new interchange would provide access for emergency vehicles onto the parkway and would allow for access for new development in the southern Daviess County.
- Natcher Parkway: New interchange at Elrod Road
  The new interchange would be located in the vicinity of the Elrod Road overpass (MP 3.4 to MP 4.0) on the Natcher Parkway. This project is in the KYTC 2012 Highway Plan.

- Natcher Parkway: I-66 Corridor and Bowling Green Outer Beltline
  The I-66 Corridor and Bowling Green Outer Beltline project is discussed in the following section.
- Owensboro: Outer Loop
  The Owensboro-Daviess County MPO identified the Outer Loop highway project in the 2040 Metropolitan Transportation Plan. The Outer Loop begins at US 60 East and ends at Carter Road.

H. I-66 Corridor Planning Study / Bowling Green Outer Beltline

In 1997, the Kentucky Transportation Center completed the *Southern Kentucky Corridor (I-66) Economic and Justification and Financial Feasibility Final Report.* This report determined I-66 was economically justified and economically feasible in Kentucky. In 2001, the Kentucky Transportation Cabinet (KYTC) initiated the *Southern Kentucky Corridor (I-66) Planning Study* to identify and evaluate alternative interstate corridors for the I-66 Corridor between the William H. Natcher Parkway and the Louie B. Nunn (Cumberland) Parkway. During the early phases of the study it was determined to jointly study another future project within the Bowling Green area, the Bowling Green Outer Beltline, because of similarity and compatibility. The purpose of The *Outer Beltline Study* was to identify and evaluate alternative freeway corridors to accommodate the transportation needs of the Bowling Green urban area. According to these reports, the KYTC and the Federal Highway Administration (FHWA) determined these studies could be conducted jointly, but the corridor concepts for each project would be evaluated independently. **Figure 7-8** on the following page illustrates the project study area as provided in the reports.

Through a series of corridor screenings based on engineering, traffic, geotechnical and environmental considerations and public and agency input, each study recommended corridors for I-66 and Outer Beltline. **Figure 7-9** on the following page illustrates the recommended corridors and beltlines as provided in the *Bowling Green Outer Beltline Planning Study.*

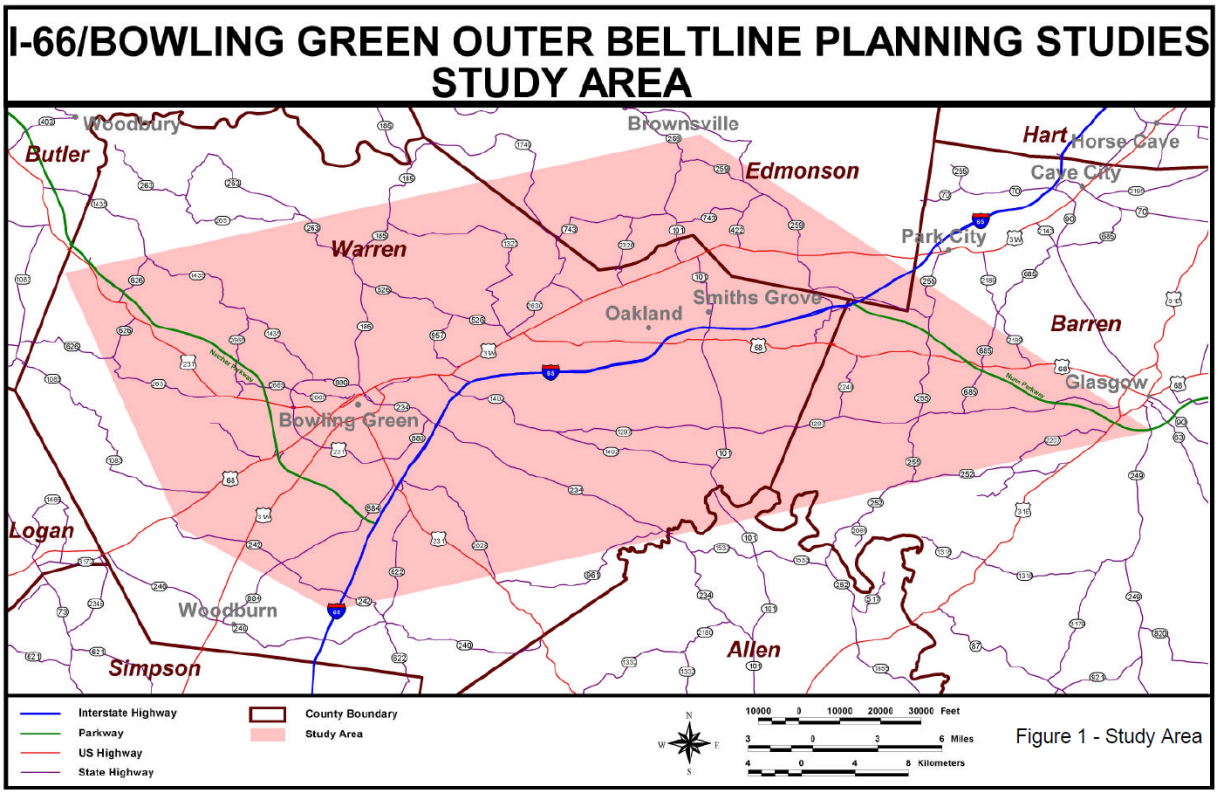


Figure 7-8 Southern Kentucky (I-66) and Bowling Green Outer Beltline Planning Studies Study Area

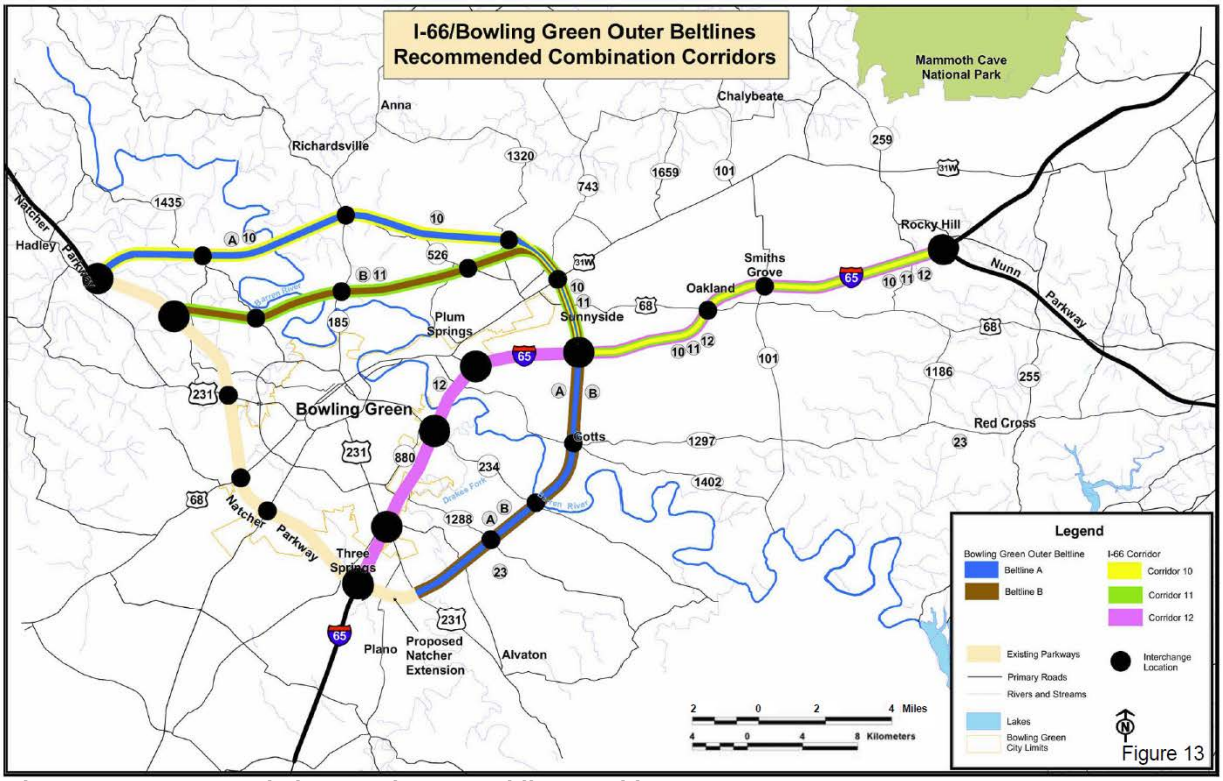


Figure 7-9 Recommended I-66 and Outer Beltline Corridors

MP	Begin MP	End MP	ADT	Avg Crash Rate	Critical Crash Rate	Avg Fatality Rate	Critical Fatality Rate	Crashes				HMVM	Rates per HMVM				Critical Crash Rate Factor	Critical Fatality Rate Factor
								Fatal	Injury	PDO	Total		Fatal	Injury	PDO	Total		
US 60																		
15.026	14.726	15.026	28,200	98	166.14	0.4	7.78	0	1	9	10	0.15	0.00	6.48	58.29	64.77	0.39	0.00
	14.826	15.126	28,200	98	166.14	0.4	7.78	0	4	10	14	0.15	0.00	25.91	64.77	90.68	0.55	0.00
	14.926	15.226	28,200	98	166.14	0.4	7.78	0	6	12	18	0.15	0.00	38.86	77.72	116.58	0.70	0.00
	15.026	15.326	28,200	98	166.14	0.4	7.78	0	6	15	21	0.15	0.00	38.86	97.15	136.01	0.82	0.00
15.272	14.972	15.272	28,200	98	166.14	0.4	7.78	0	7	12	19	0.15	0.00	45.34	77.72	123.06	0.74	0.00
	15.072	15.372	28,200	98	166.14	0.4	7.78	0	5	11	16	0.15	0.00	32.38	71.25	103.63	0.62	0.00
	15.172	15.472	28,200	98	166.14	0.4	7.78	0	3	14	17	0.15	0.00	19.43	90.68	110.11	0.66	0.00
	15.272	15.572	28,200	98	166.14	0.4	7.78	0	0	10	10	0.15	0.00	0.00	64.77	64.77	0.39	0.00
15.842	15.542	15.842	28,200	98	166.14	0.4	7.78	0	0	6	6	0.15	0.00	0.00	38.86	38.86	0.23	0.00
	15.642	15.942	28,200	98	166.14	0.4	7.78	1	1	10	12	0.15	6.48	6.48	64.77	77.72	0.47	0.83
	15.742	16.042	28,200	98	166.14	0.4	7.78	1	2	9	12	0.15	6.48	12.95	58.29	77.72	0.47	0.83
	15.842	16.142	28,200	98	166.14	0.4	7.78	1	4	11	16	0.15	6.48	25.91	71.25	103.63	0.62	0.83
16.943	16.643	16.943	30,900	98	162.95	0.4	7.32	0	1	7	8	0.17	0.00	5.91	41.38	47.29	0.29	0.00
	16.743	17.043	30,900	98	162.95	0.4	7.32	0	2	9	11	0.17	0.00	11.82	53.20	65.02	0.40	0.00
	16.843	17.143	30,900	98	162.95	0.4	7.32	0	3	8	11	0.17	0.00	17.73	47.29	65.02	0.40	0.00
	16.943	17.243	30,900	98	162.95	0.4	7.32	0	4	6	10	0.17	0.00	23.64	35.47	59.11	0.36	0.00
Natcher Parkway																		
5.686	5.386	5.686	20,380	98	178.82	0.4	9.76	0	0	2	2	0.11	0.00	0.00	17.92	17.92	0.10	0.00
	5.486	5.786	20,380	98	178.82	0.4	9.76	0	0	3	3	0.11	0.00	0.00	26.89	26.89	0.15	0.00
	5.586	5.886	20,380	98	178.82	0.4	9.76	0	0	4	4	0.11	0.00	0.00	35.85	35.85	0.20	0.00
	5.686	5.986	20,380	98	178.82	0.4	9.76	0	0	5	5	0.11	0.00	0.00	44.81	44.81	0.25	0.00
6.003	5.703	6.003	18,540	98	182.97	0.4	10.44	0	0	7	7	0.10	0.00	0.00	68.96	68.96	0.38	0.00
	5.803	6.103	18,540	98	182.97	0.4	10.44	0	1	7	8	0.10	0.00	9.85	68.96	78.81	0.43	0.00
	5.903	6.203	18,540	98	182.97	0.4	10.44	0	1	8	9	0.10	0.00	9.85	78.81	88.66	0.48	0.00
	6.003	6.303	18,540	98	182.97	0.4	10.44	0	1	7	8	0.10	0.00	9.85	68.96	78.81	0.43	0.00
7.083	6.783	7.083	18,540	98	182.97	0.4	10.44	0	2	3	5	0.10	0.00	19.70	29.55	49.26	0.27	0.00
	6.883	7.183	18,540	98	182.97	0.4	10.44	0	2	4	6	0.10	0.00	19.70	39.41	59.11	0.32	0.00
	6.983	7.283	18,540	98	182.97	0.4	10.44	0	1	5	6	0.10	0.00	9.85	49.26	59.11	0.32	0.00
	7.083	7.383	18,540	98	182.97	0.4	10.44	0	0	4	4	0.10	0.00	0.00	39.41	39.41	0.22	0.00

Crash Rate Segment (CRF - 0.9 - 0.99) | High Crash Rate Segment (CRF >= 1.0) | Critical Fatality Rate Factor > 0.9

Table 7-3 Narrow Bridge Crash Analysis

MP	Begin MP	End MP	ADT	Avg Crash Rate	Critical Crash Rate	Avg Fatality Rate	Critical Fatality Rate	Crashes				HMVM	Rates per HMVM				Critical Crash Rate Factor	Critical Fatality Rate Factor
								Fatal	Injury	PDO	Total		Fatal	Injury	PDO	Total		
Natcher Parkway (continued)																		
15.627	15.327	15.627	10,200	51	137.80	0.7	18.77	0	1	7	8	0.06	0.00	17.91	125.35	143.25	1.04	0.00
	15.427	15.727	10,200	51	137.80	0.7	18.77	0	2	5	7	0.06	0.00	35.81	89.53	125.35	0.91	0.00
	15.527	15.827	10,200	51	137.80	0.7	18.77	0	2	3	5	0.06	0.00	35.81	53.72	89.53	0.65	0.00
	15.627	15.927	10,200	51	137.80	0.7	18.77	0	1	2	3	0.06	0.00	17.91	35.81	53.72	0.39	0.00
24.723	24.423	24.723	10,200	51	137.80	0.7	18.77	0	0	0	0	0.06	0.00	0.00	0.00	0.00	0.00	0.00
	24.523	24.823	10,200	51	137.80	0.7	18.77	0	0	0	0	0.06	0.00	0.00	0.00	0.00	0.00	0.00
	24.623	24.923	10,200	51	137.80	0.7	18.77	0	0	0	0	0.06	0.00	0.00	0.00	0.00	0.00	0.00
	24.723	25.023	10,200	51	137.80	0.7	18.77	0	0	1	1	0.06	0.00	0.00	17.91	17.91	0.13	0.00
28.523	28.223	28.523	10,180	51	137.89	0.7	18.80	0	0	1	1	0.06	0.00	0.00	17.94	17.94	0.13	0.00
	28.323	28.623	10,180	51	137.89	0.7	18.80	0	1	2	3	0.06	0.00	17.94	35.88	53.83	0.39	0.00
	28.423	28.723	10,180	51	137.89	0.7	18.80	0	1	1	2	0.06	0.00	17.94	17.94	35.88	0.26	0.00
	28.523	28.823	10,180	51	137.89	0.7	18.80	1	2	0	3	0.06	17.94	35.88	0.00	53.83	0.39	0.95
29.533	29.233	29.533	11,300	51	133.04	0.7	17.45	0	0	0	0	0.06	0.00	0.00	0.00	0.00	0.00	0.00
	29.333	29.633	11,300	51	133.04	0.7	17.45	0	0	0	0	0.06	0.00	0.00	0.00	0.00	0.00	0.00
	29.433	29.733	11,300	51	133.04	0.7	17.45	0	0	0	0	0.06	0.00	0.00	0.00	0.00	0.00	0.00
	29.533	29.833	11,300	51	133.04	0.7	17.45	0	0	0	0	0.06	0.00	0.00	0.00	0.00	0.00	0.00
45.880	45.580	45.880	8,900	51	144.60	0.7	20.72	0	0	2	2	0.05	0.00	0.00	41.04	41.04	0.28	0.00
	45.680	45.980	8,900	51	144.60	0.7	20.72	0	0	3	3	0.05	0.00	0.00	61.57	61.57	0.43	0.00
	45.780	46.080	8,900	51	144.60	0.7	20.72	0	0	3	3	0.05	0.00	0.00	61.57	61.57	0.43	0.00
	45.880	46.180	8,900	51	144.60	0.7	20.72	0	0	2	2	0.05	0.00	0.00	41.04	41.04	0.28	0.00
51.491	51.191	51.491	9,830	51	139.59	0.7	19.28	0	3	3	6	0.05	0.00	55.74	55.74	111.48	0.80	0.00
	51.291	51.591	9,830	51	139.59	0.7	19.28	0	1	4	5	0.05	0.00	18.58	74.32	92.90	0.67	0.00
	51.391	51.691	9,830	51	139.59	0.7	19.28	0	0	4	4	0.05	0.00	0.00	74.32	74.32	0.53	0.00
	51.491	51.791	9,830	51	139.59	0.7	19.28	0	0	1	1	0.05	0.00	0.00	18.58	18.58	0.13	0.00
60.328	60.028	60.328	9,830	51	139.59	0.7	19.28	0	2	9	11	0.05	0.00	37.16	167.23	204.39	1.46	0.00
	60.128	60.428	9,830	51	139.59	0.7	19.28	0	2	8	10	0.05	0.00	37.16	148.65	185.81	1.33	0.00
	60.228	60.528	9,830	51	139.59	0.7	19.28	0	0	4	4	0.05	0.00	0.00	74.32	74.32	0.53	0.00
	60.328	60.628	9,830	51	139.59	0.7	19.28	0	0	2	2	0.05	0.00	0.00	37.16	37.16	0.27	0.00
64.485	64.185	64.485	9,830	51	139.59	0.7	19.28	0	2	3	5	0.05	0.00	37.16	55.74	92.90	0.67	0.00
	64.285	64.585	9,830	51	139.59	0.7	19.28	0	2	2	4	0.05	0.00	37.16	37.16	74.32	0.53	0.00
	64.385	64.685	9,830	51	139.59	0.7	19.28	0	0	1	1	0.05	0.00	0.00	18.58	18.58	0.13	0.00
	64.485	64.785	9,830	51	139.59	0.7	19.28	0	0	0	0	0.05	0.00	0.00	0.00	0.00	0.00	0.00

Crash Rate Segment (CRF - 0.9 - 0.99) | High Crash Rate Segment (CRF >= 1.0) | Critical Fatality Rate Factor > 0.9

Table 7-3 Narrow Bridge Crash Analysis (continued)

MP	Begin MP	End MP	ADT	Avg Crash Rate	Critical Crash Rate	Avg Fatality Rate	Critical Fatality Rate	Crashes				HMVM	Rates per HMVM				Critical Crash Rate Factor	Critical Fatality Rate Factor
								Fatal	Injury	PDO	Total		Fatal	Injury	PDO	Total		
Natcher Parkway (continued)																		
64.835	64.535	64.835	9,830	51	139.59	0.7	19.28	0	0	0	0	0.05	0.00	0.00	0.00	0.00	0.00	0.00
	64.635	64.935	9,830	51	139.59	0.7	19.28	0	0	1	1	0.05	0.00	0.00	18.58	18.58	0.13	0.00
	64.735	65.035	9,830	51	139.59	0.7	19.28	0	1	2	3	0.05	0.00	18.58	37.16	55.74	0.40	0.00
	64.835	65.135	9,830	51	139.59	0.7	19.28	0	2	3	5	0.05	0.00	37.16	55.74	92.90	0.67	0.00
65.028	64.728	65.028	9,830	51	139.59	0.7	19.28	0	1	2	3	0.05	0.00	18.58	37.16	55.74	0.40	0.00
	64.828	65.128	9,830	51	139.59	0.7	19.28	0	2	3	5	0.05	0.00	37.16	55.74	92.90	0.67	0.00
	64.928	65.228	9,830	51	139.59	0.7	19.28	0	3	3	6	0.05	0.00	55.74	55.74	111.48	0.80	0.00
	65.028	65.328	9,830	51	139.59	0.7	19.28	0	3	3	6	0.05	0.00	55.74	55.74	111.48	0.80	0.00
69.327	69.027	69.327	9,830	51	139.59	0.7	19.28	0	1	2	3	0.05	0.00	18.58	37.16	55.74	0.40	0.00
	69.127	69.427	9,830	51	139.59	0.7	19.28	0	1	2	3	0.05	0.00	18.58	37.16	55.74	0.40	0.00
	69.227	69.527	9,830	51	139.59	0.7	19.28	0	1	1	2	0.05	0.00	18.58	18.58	37.16	0.27	0.00
	69.327	69.627	9,830	51	139.59	0.7	19.28	0	1	4	5	0.05	0.00	18.58	74.32	92.90	0.67	0.00
69.522	69.222	69.522	9,830	51	139.59	0.7	19.28	0	1	1	2	0.05	0.00	18.58	18.58	37.16	0.27	0.00
	69.322	69.622	9,830	51	139.59	0.7	19.28	0	1	4	5	0.05	0.00	18.58	74.32	92.90	0.67	0.00
	69.422	69.722	9,830	51	139.59	0.7	19.28	0	2	4	6	0.05	0.00	37.16	74.32	111.48	0.80	0.00
	69.522	69.822	9,830	51	139.59	0.7	19.28	0	1	4	5	0.05	0.00	18.58	74.32	92.90	0.67	0.00
69.846	69.546	69.846	9,830	51	139.59	0.7	19.28	0	1	3	4	0.05	0.00	18.58	55.74	74.32	0.53	0.00
	69.646	69.946	9,830	51	139.59	0.7	19.28	0	0	2	2	0.05	0.00	0.00	37.16	37.16	0.27	0.00
	69.746	70.046	9,830	51	139.59	0.7	19.28	0	1	1	2	0.05	0.00	18.58	18.58	37.16	0.27	0.00
	69.846	70.146	9,830	51	139.59	0.7	19.28	0	1	4	5	0.05	0.00	18.58	74.32	92.90	0.67	0.00

Crash Rate Segment (CRF - 0.9 - 0.99) | High Crash Rate Segment (CRF >= 1.0) | Critical Fatality Rate Factor > 0.9

Table 7-3 Narrow Bridge Crash Analysis (continued)

VIII. IMPROVEMENT STRATEGIES AND DEVELOPMENT COSTS

This chapter describes a range of improvement strategies to address the deficiencies identified on the Audubon Parkway, Natcher Parkway, and US 60. As discussed in **Chapter I,** the primary purpose of this strategic corridor study is to review the existing conditions along the Audubon Parkway, Natcher Parkway, and US 60 to identify locations that do not meet current Association of State Highway Transportation Officials (AASHTO) and Federal Highway Administration (FHWA) highway design guidelines and related criteria. Evaluations include the degree to which these criteria are not met, their impact on safety and capacity, and identify options for making improvements to address identified deficiencies. Therefore, the development of a new alignment was not among alternatives considered.

The range of improvement strategies under consideration is No Build, Necessary Upgrades and Spot Safety Improvements, and Fully Compliant Reconstruction. These strategies represent incremental levels of infrastructure investment needed to implement I-69 Spur and I-66/I-65 Spur in Central and Western Kentucky. The range of improvements for these strategies is provided in **Table 7-2** for the deficiencies identified in the study.

- **No Build** – The Audubon Parkway, Natcher Parkway, and US 60 would continue to provide connectivity for the future interstate spur traffic but would not meet interstate criteria. The Audubon Parkway, Natcher Parkway, and US 60 would remain as they currently exist without the interstate spur designation. This alternative would not require any additional funding for the construction related to upgrading the facilities to current interstate standards.
- **Necessary Upgrades and Spot Safety Improvements** - Key safety and operational concerns would be addressed. Under this improvement strategy the Audubon Parkway, Natcher Parkway, and US 60 would be upgraded to meet some, but not all current interstate standards. Design exceptions and variances would be required for those design features that do not meet current criteria or standards. Design exceptions and design variances would require further study to determine if a design exception is deemed appropriate by the KYTC and the FHWA. New infrastructure and improvements along the parkways and US 60 would be proposed to upgrade necessary features and improve safety for those locations that are not addressed by design exceptions and variances.
- **Fully Compliant Reconstruction** – This improvement strategy would involve improvements within existing right of way or with minimum right of way acquisition necessary for making the existing parkways and US 60 fully compliant with minimum AASHTO criteria for interstate routes.

Based on the study, there are four possible interstate route designation options for the Audubon Parkway, Natcher Parkway, and US 60. Options for I-66 Spurs specifically are not included because at this time no active KYTC I-66 projects are within the study area. These possible interstate route designation options are presented below.

- **Option 1** – **I-69 Spur** (**Page 8-3**): This option designates the I-69 Spur to follow along the Audubon Parkway from Henderson to the US 60 interchange in Owensboro. The interstate spur would begin at I-69 south of Henderson and would terminate at the US 60 interchange in Owensboro. At the time of this report, the I-69 alignment through Henderson is under evaluation, and the intersecting location with the Audubon Parkway is undetermined. The Audubon Parkway cannot be designated as an interstate spur until it connects with a route that has been designated as I-69.

- **Option 2 – I-66/I-65 Spur** (**Page 8-4**): This option designates the I-66/I-65 Spur along the Natcher Parkway from I-65 in Bowling Green to the US 60 interchange in Owensboro. The I-66/I-65 Spur would begin at the existing I-65 and Natcher Parkway interchange and terminate at the existing Natcher Parkway and US 60 interchange at the east side of Owensboro.

- **Option 3 - I-69 Spur including US 60** (**Page 8-5**): The third option designates the Audubon Parkway and US 60 as I-69 Spur. Similar to Option 1, the I-69 Spur would follow along the Audubon Parkway from south of Henderson to the US 60 interchange in Owensboro. The spur would continue along US 60 and terminate at the US 60 and Natcher Parkway interchange on the east side of Owensboro. At the time of this report, the I-69 alignment through Henderson is under evaluation, and the intersecting location with the Audubon Parkway is undetermined. The Audubon Parkway and US 60 cannot be designated as an interstate spur until the Audubon Parkway connects with a route that has been designated as I-69.

- **Option 4 - I-66/I-65 Spur including US 60** (**Page 8-6**): This option designates the Natcher Parkway and US 60 as I-66/I-65 Spur. Similar to Option 2, the I-66/I-65 spur would follow along the Natcher Parkway from I-65 in Bowling Green to the US 60 interchange in Owensboro. The spur would continue on US 60 and terminate at the US 60 and Audubon Parkway interchange on the west side of Owensboro.

A. Improvement Costs

The following pages provide the interstate route designation options graphic and preliminary costs for implementing the Necessary Upgrades and Spot Safety Improvement and Fully Compliant improvement strategies. **Figures 8-5** through **8-13** provide potential interchange improvements for the interstate route designation options.

Option 1: I-69 Spur – Audubon Parkway

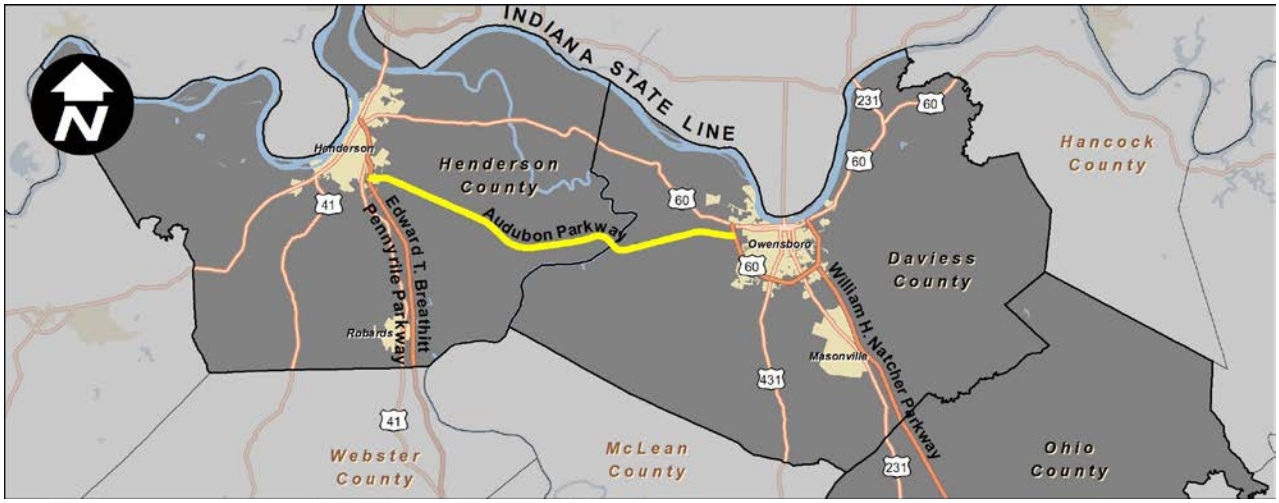


Figure 8-1 Option 1: I-69 Spur – Audubon Parkway

Item	Location / Report Reference	Unit	2013 Cost	
			Necessary Upgrades and Spot Safety Improvements	Fully Compliant Reconstruction
Upgrade Guardrail Trailing End Treatment Deficiencies	*Ref. Appendix D*	Location	$1,290	
Mainline Structures (Upgrade Guardrail/Approaches/Railings)	*Ref.Tables 5-2 & 7-2*	Foot	$200	
Mainline Structures (Widen Deficient Bridges)	*Ref. Tables 5-2 & 7-2*	Square Foot	[1]	$110
Interchanges				
Interchange Ramp Improvements [2]	*Ref. Tables 6-1 & 7-2*	Interchange	Variable	
Former Toll Plaza Location - Upgrade Deficiencies				
Audubon Parkway Exit 10	*Ref. Table 6-1; Figures 6-1 & 8-8*	Interchange	$8,200,000	
Interchange Control of Access	*Ref. page 6-16 & Table 7-2*	Total	[3]	$510,000
Design and Environmental	15% of Construction Costs			
Right-of-Way and Utilities	30% of Construction Costs			

[1] Requires Design Exception

[2] Item includes improving the ramp tapers to meet minimum interstate standards

[3] Control of access retained/extended

Table 8-1 Option 1: Unit Costs

Segment	Length (miles)	Design & Environmental (million)	ROW and Utilities (million)	Construction Costs (million)			Total Costs [1] (million)
				Roadwork	Mainline & Overpass Structures	Interchanges	
Henderson to Owensboro (Audubon Parkway) MP 0.0 - MP 23.4	23.4	$1.45 - $1.53	$2.90 - $3.05	$0.07	$0.94	$8.63 - $9.14	$13.99 - $14.73

Necessary Upgrades and Spot Safety Improvement Strategy

Fully Compliant Reconstruction Strategy

[1] Cost for routine maintenance is not depicted in estimate

Table 8-2 Option 1: Preliminary Cost Estimate

Option 2: I-66/I-65 Spur – Natcher Parkway

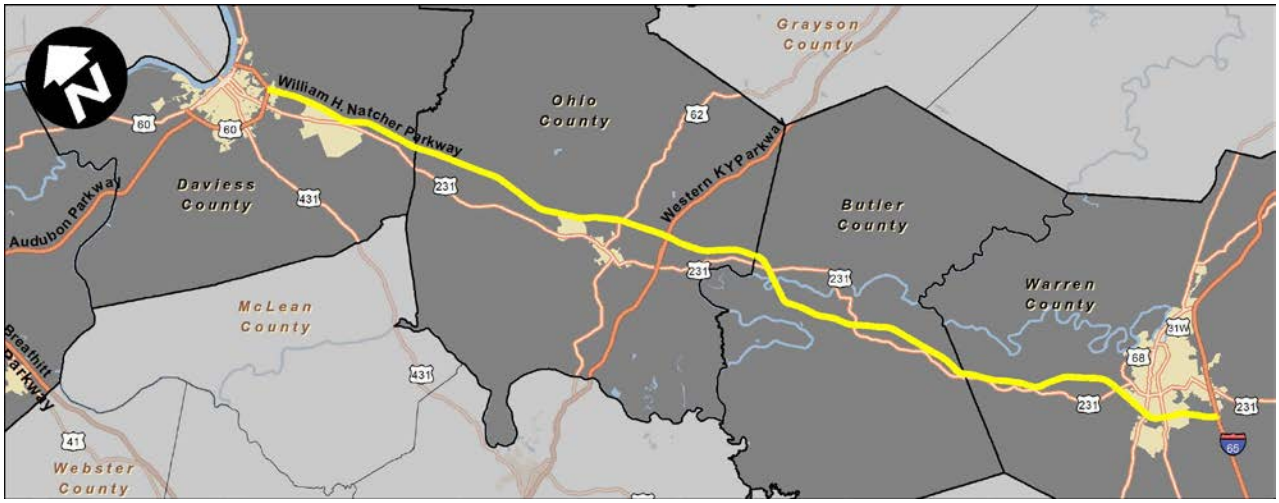


Figure 8-2 Option 2: I-66/I-65 Spur – Natcher Parkway

Item	Location / Report Reference	Unit	2013 Cost	
			Necessary Upgrades and Spot Safety Improvements	Fully Compliant Reconstruction
Upgrade Guardrail Trailing End Treatment Deficiencies	*Ref. Appendix D*	Location	$1,290	
Mainline Structures (Upgrade Guardrail/Approaches/Railings)	*Ref.Tables 5-2 & 7-2*	Foot	$200	
Mainline Structures (Widen Deficient Bridges)	*Ref. Tables 5-2 & 7-2*	Square Foot	[1]	$110
Overpass Structures (Upgrade Vertical Clearance Deficiencies)	*Natcher Pky MP 33.741 & MP 62.352 Ref. Tables 5-3 & 7-2*	Total	$100,000	
Correct Vertical / Stopping Sight Distance Deficiency	*Natcher Pky MP 53.800*	Location	$160,000	
Interchanges				
Interchange Ramp Improvements [2]	*Ref. Tables 6-1 & 7-2*	Interchange	Variable	
Former Toll Plaza Location - Upgrade Deficiencies				
Natcher Parkway Exit 9	*Ref. Table 6-1; Figures 6-7 & 8-5*	Interchange	$15,600,000	
Natcher Parkway Exit 36	*Ref. Table 6-1; Figures 6-5 & 8-6*	Interchange	$12,200,000	
Natcher Parkway Exit 50	*Ref. Table 6-1; Figures 6-4 & 8-7*	Interchange	$12,800,000	
Auxiliary Lane (Interchange Spacing)				
Natcher Parkway Exit 28 and 29	*Ref. page 6-15 & Table 7-2*	Total	[2]	$2,720,000
Interchange Control of Access	*Ref. page 6-16 & Table 7-2*	Total	[3]	$450,000
Design and Environmental	15% of Construction Costs			
Right-of-Way and Utilities	30% of Construction Costs			

[1] Requires Design Exception

[2] Item includes improving the ramp tapers to meet minimum interstate standards

Table 8-3 Option 2: Unit Costs

Segment	Length (miles)	Design & Environmental (million)	ROW and Utilities (million)	Construction Costs (million)			Total Costs [1] (million)
				Roadwork	Mainline & Overpass Structures	Interchanges	
Owensboro to Western KY Parkway (Natcher Parkway) MP 37.1 - MP 72.2	35.1	$2.16 - $2.50	$4.32 - $5.00	$0.08 - $0.08	$1.28 - $3.56	$13.01	$20.85 - $24.15
Western KY Parkway to Bowling Green (Natcher Parkway) MP 11.0 - MP 37.1	26.1	$2.04 - $2.68	$4.07 - $5.35	$0.00 - $2.88	$1.07 - $2.01	$12.49 - $12.94	$19.67 - $25.41
Bowling Green (Natcher Parkway) MP 2.0 - MP 11.0	9.0	$2.66 - $2.68	$5.32 - $5.35	$0.00 - $0.00	$1.63 - $1.75	$16.08	$25.69 - $25.86
Total	70.2	$6.86 - $7.86	$13.71 - $15.70	$0.08 - $2.96	$3.98 - $7.32	$41.58 - $42.03	$66.21 - $75.87

Necessary Upgrades and Spot Safety Improvement Strategy

Fully Compliant Reconstruction Strategy

[1] Cost for routine maintenance is not depicted in estimate

Table 8-4 Option 2: Preliminary Cost Estimate

Option 3: I-69 Spur – Audubon Parkway & US 60

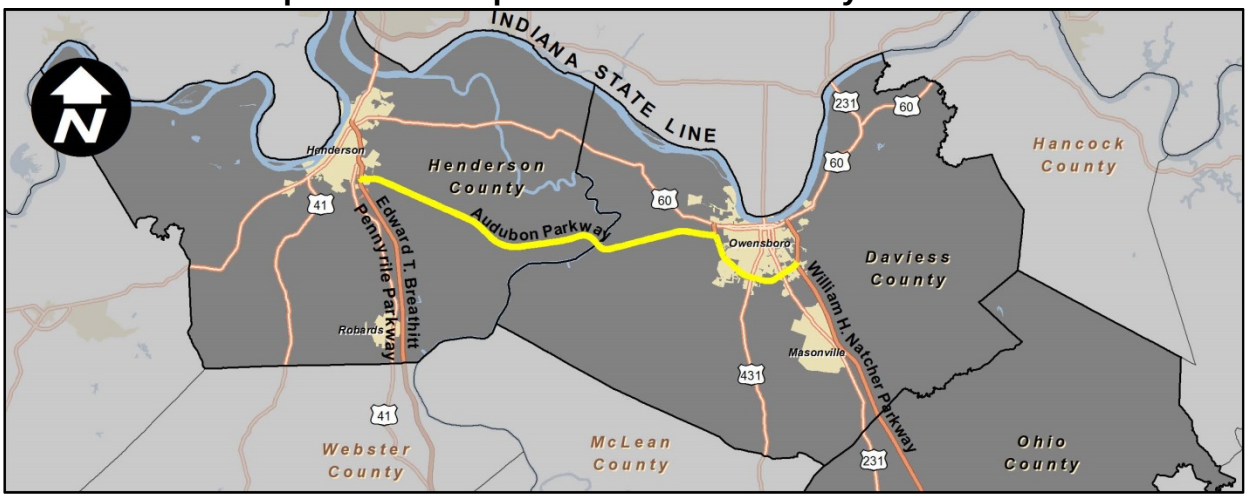


Figure 8-3 Option 3: I-69 Spur – Audubon Parkway & US 60

Item	Location / Report Reference	Unit	2013 Cost	
			Necessary Upgrades and Spot Safety Improvements	Fully Compliant Reconstruction
Upgrade Guardrail Trailing End Treatment Deficiencies	*Ref. Appendix D*	Location	$1,290	
Mainline Structures (Upgrade Guardrail/Approaches/Railings)	*Ref.Tables 5-2 & 7-2*	Foot	$200	
Mainline Structures (Widen Deficient Bridges)	*Ref. Tables 5-2 & 7-2*	Square Foot	[1]	$110
Overpass Structures (Upgrade Vertical Clearance Deficiencies)	*US 60 MP 11.611 Ref. Tables 5-3 & 7-2*		$150,000	
Interchanges				
Interchange Ramp Improvements [2]	*Ref. Tables 6-1 & 7-2*	Interchange	Variable	
Former Toll Plaza Location - Upgrade Deficiencies				
Audubon Parkway Exit 10	*Ref. Table 6-1; Figures 6-1 & 8-8*	Interchange	$8,200,000	
US 60 and Audubon Parkway Interchange Upgrade	*Ref. Figures 8-9, 8-10 & 8-11*		$33,716,000	
Auxiliary Lane (Interchange Spacing)				
US 60 Exit 10 and 11	*Ref. page 6-15 & Table 7-2*	Total	[2]	$5,270,000
US 60 Exit 11 and 12	*Ref. page 6-15 & Table 7-2*	Total	[2]	$2,890,000
Interchange Control of Access	*Ref. page 6-16 & Table 7-2*	Total	[3]	$740,000
Design and Environmental	15% of Construction Costs			
Right-of-Way and Utilities	30% of Construction Costs			

[1] Requires Design Exception

[2] Item includes improving the ramp tapers to meet minimum interstate standards

Table 8-5 Option 3: Unit Costs

Segment	Length (miles)	Design & Environmental (million)	ROW and Utilities (million)	Construction Costs (million)			Total Costs [1] (million)
				Roadwork	Mainline & Overpass Structures	Interchanges	
Henderson to Owensboro (Audubon Parkway) MP 0.0 - MP 23.4	23.4	$1.45 - $1.53	$2.90 - $3.05	$0.07	$0.94	$8.63 - $9.14	$13.99 - $14.73
Owensboro (US 60) MP 10.8 - MP 17.5	6.7	$5.30 - $6.71	$10.59 - $13.42	$0.01 - $8.16	$0.77 - $1.19	$34.51 - $42.94	$51.18 - $59.38
Total	30.1	$6.75 - $8.24	$13.49 - $16.47	$0.08 - $8.23	$1.71 - $2.13	$43.14 - $52.08	$65.17 - $87.15

Necessary Upgrades and Spot Safety Improvement Strategy

Fully Compliant Reconstruction Strategy

[1] Cost for routine maintenance is not depicted in estimate

Table 8-6 Option 3: Preliminary Cost Estimate

Option 4: I-69 Spur – Natcher Parkway & US 60

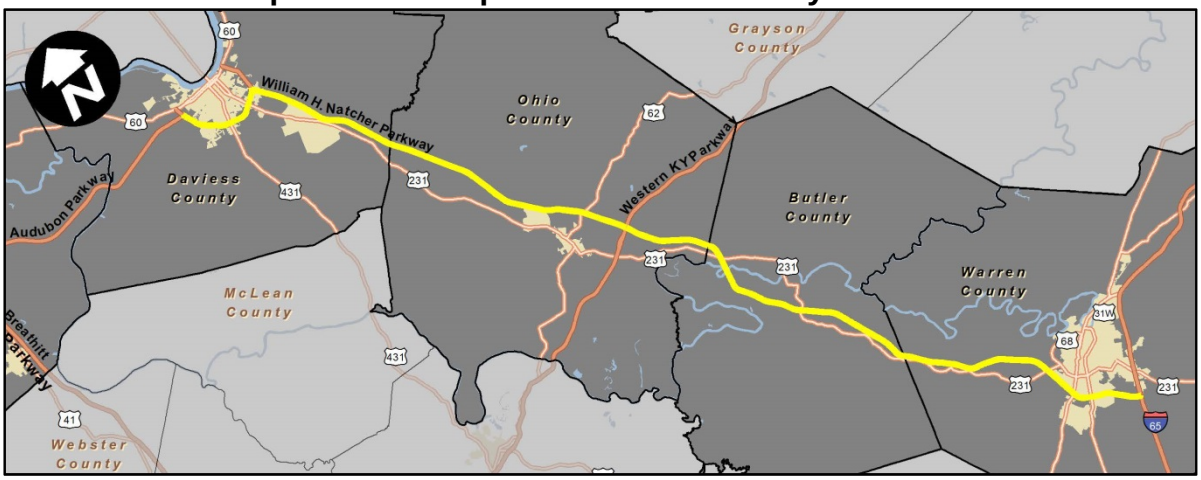


Figure 8-4 Option 4: I-66/I-65 Spur – Natcher Parkway & US 60

Item	Location / Report Reference	Unit	2013 Cost	
			Necessary Upgrades and Spot Safety Improvements	Fully Compliant Reconstruction
Upgrade Guardrail Trailing End Treatment Deficiencies	*Ref. Appendix D*	Location	$1,290	
Mainline Structures (Upgrade Guardrail/Approaches/Railings)	*Ref.Tables 5-2 & 7-2*	Foot	$200	
Mainline Structures (Widen Deficient Bridges)	*Ref. Tables 5-2 & 7-2*	Square Foot	[1]	$110
Overpass Structures (Upgrade Vertical Clearance Deficiencies)	*US 60 MP 11.611* *Natcher Pky MP 33.741 & MP 62.352* *Ref. Tables 5-3 & 7-2*		$250,000	
Correct Vertical / Stopping Sight Distance Deficiency	*Natcher Pky MP 53.800*	Location	$160,000	
Interchanges				
Interchange Ramp Improvements [2]	*Ref. Tables 6-1 & 7-2*	Interchange	Variable	
Former Toll Plaza Location - Upgrade Deficiencies				
Natcher Parkway Exit 9	*Ref. Table 6-1; Figures 6-7 & 8-5*	Interchange	$15,600,000	
Natcher Parkway Exit 36	*Ref. Table 6-1; Figures 6-5 & 8-6*	Interchange	$12,200,000	
Natcher Parkway Exit 50	*Ref. Table 6-1; Figures 6-4 & 8-7*	Interchange	$12,800,000	
US 60 and Natcher Parkway Interchange Upgrade	*Ref. Figures 8-12 & 8-13*	Interchange	$41,913,000	
Auxiliary Lane (Interchange Spacing)				
Natcher Parkway Exit 28 and 29	*Ref. page 6-15 & Table 7-2*	Total	[1]	$2,720,000
US 60 Exit 10 and 11	*Ref. page 6-15 & Table 7-2*	Total	[2]	$5,270,000
US 60 Exit 11 and 12	*Ref. page 6-15 & Table 7-2*	Total	[2]	$2,890,000
Interchange Control of Access	*Ref. page 6-16 & Table 7-2*	Total	[3]	$1,190,000
Design and Environmental	15% of Construction Costs			
Right-of-Way and Utilities	30% of Construction Costs			

[1] Requires Design Exception

[2] Item includes improving the ramp tapers to meet minimum interstate standards

Table 8-7 Option 4: Unit Costs

Segment	Length (miles)	Design & Environmental (million)	ROW and Utilities (million)	Construction Costs (million)			Total Costs [1] (million)
				Roadwork	Mainline & Overpass Structures	Interchanges	
Owensboro (US 60) MP 10.8 - MP 17.5	6.7	$5.30 - $6.71	$10.59 - $13.42	$0.01 - $8.16	$0.77 - $1.19	$34.51 - $42.94	$51.18 - $59.38
Owensboro to Western KY Parkway (Natcher Parkway) MP 37.1 - MP 72.2	35.1	$2.16 - $2.50	$4.32 - $5.00	$0.08 - $0.08	$1.28 - $3.56	$13.01	$20.85 - $24.15
Western KY Parkway to Bowling Green (Natcher Parkway) MP 11.0 - MP 37.1	26.1	$2.04 - $2.68	$4.07 - $5.35	$0.00 - $2.88	$1.07 - $2.01	$12.49 - $12.94	$19.67 - $25.41
Bowling Green MP 2.0 - MP 11.0	9.0	$2.66 - $2.68	$5.32 - $5.35	$0.00 - $0.00	$1.63 - $1.75	$16.08	$25.69 - $25.86
Total	76.9	$12.16 - $14.57	$24.30 - $29.12	$0.09 - $11.12	$4.75 - $8.51	$76.09 - $84.97	$117.39 - $148.29

Necessary Upgrades and Spot Safety Improvement Strategy

Fully Compliant Reconstruction Strategy

[1] Cost for routine maintenance is not depicted in estimate

Table 8-8 Option 4: Preliminary Cost Estimate

Table 8-9 below summarizes the costs of the four options described herein. The estimated costs provided do not include the cost associated with a new I-69 and I-69 Spur interchange. It is estimated to cost between $14.0 million and $14.7 million to designate the Audubon Parkway as I-69 Spur with Option 1. Designating the Natcher Parkway as I-66/I-65 is estimated to cost between $66.2 million and $75.9 million with Option 2. It is estimated to cost between $65.2 million and $87.2 million to designate the Audubon Parkway and US 60 as I-69 Spur with Option 3. Designating the Natcher Parkway and US 60 as I-66/I-65 Spur is estimated to cost between $117.4 million and $148.3 million with Option 4.

Interstate Designation Option	Interstate Miles	Cost [1] (million)			Cost per Mile (million)		
1. I-69 Spur - Audubon Parkway	**23.4**	$13.99	-	$14.73	$0.60	-	$0.63
2. I-66/I-65 Spur - Natcher Parkway	**70.2**	$66.21	-	$75.87	$0.94	-	$1.08
3. I-69 Spur - Audubon Parkway & US 60	**30.1**	$65.17	-	$87.15	$2.17	-	$2.90
4. I-66/I-65 Spur - Natcher Parkway & US 60	**76.9**	$117.39	-	$148.29	$1.53	-	$1.93
	Necessary Upgrades and Spot Safety Improvement Strategy						
	Fully Compliant Reconstruction Strategy						
[1] Cost for routine maintenance is not depicted in estimate							

Table 8-9 Interstate Route Designation Option Preliminary Cost Estimate Summary

1. Potential Interchange Improvements/Reconstruction

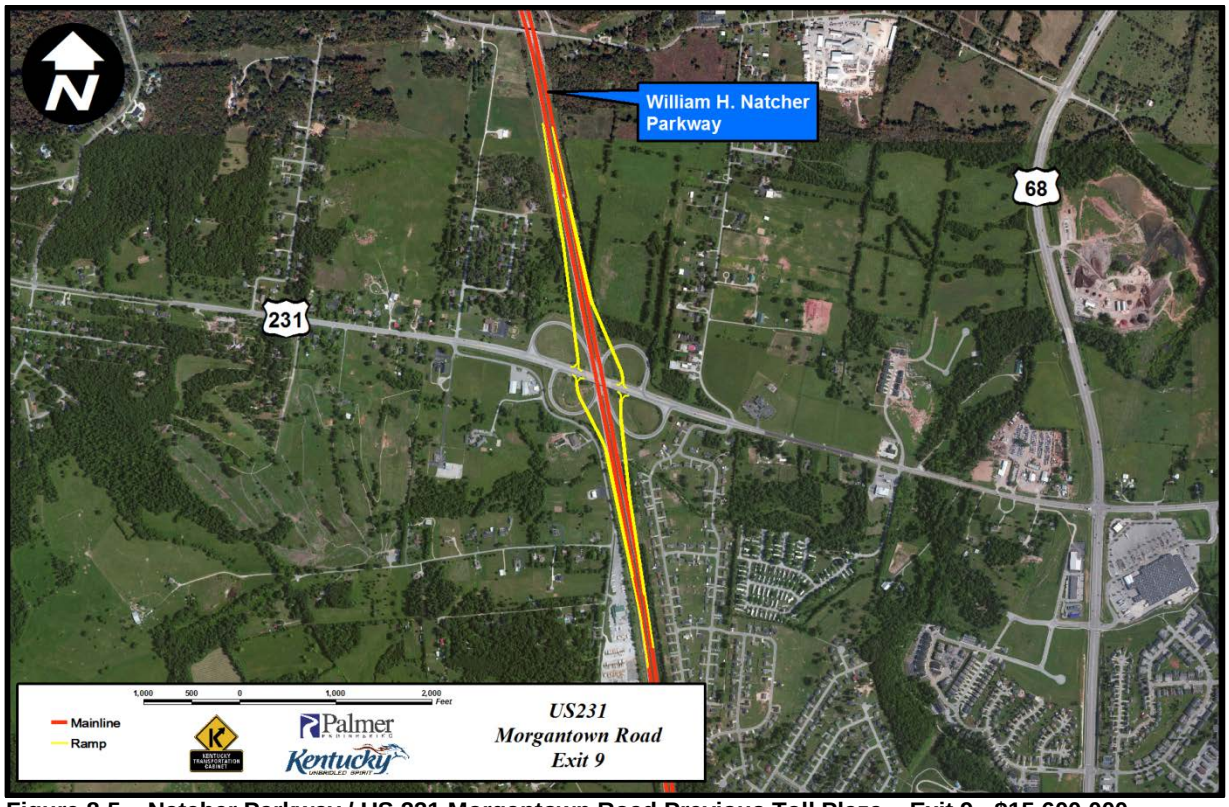


Figure 8-5 – Natcher Parkway / US 231 Morgantown Road Previous Toll Plaza – Exit 9: $15,600,000

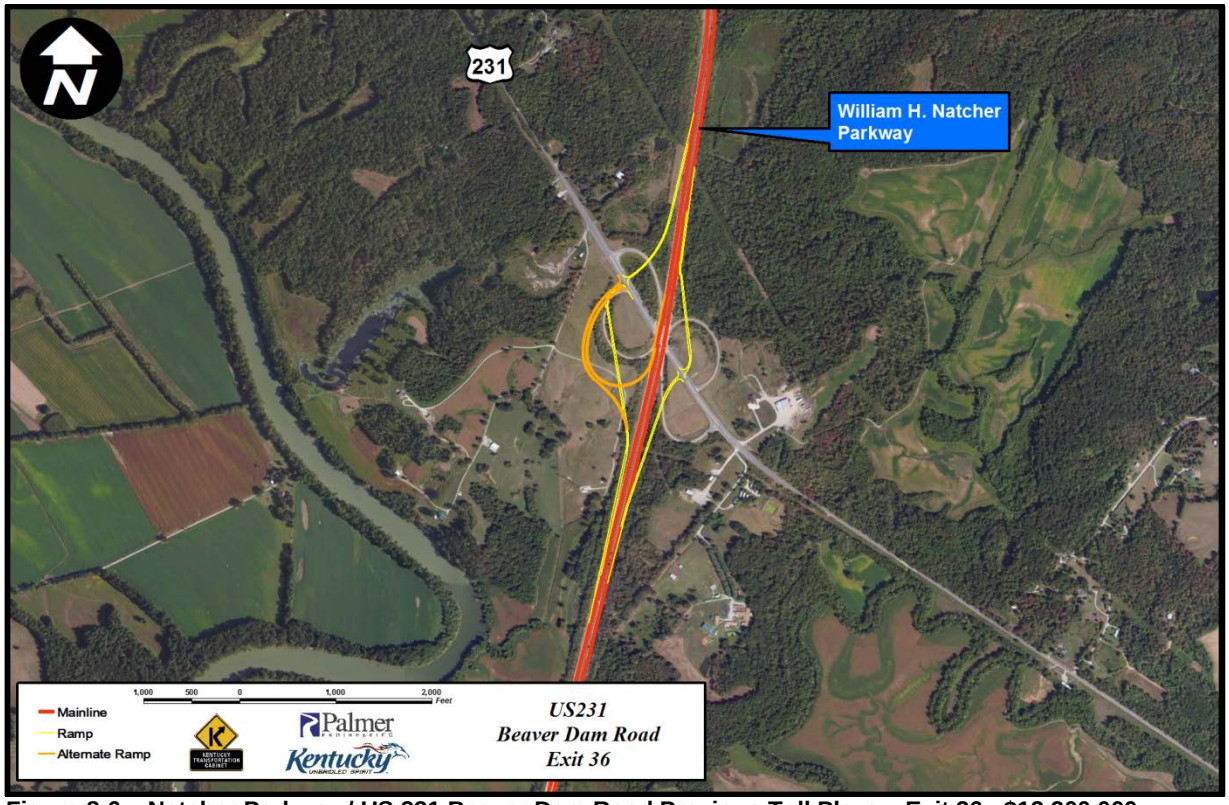


Figure 8-6 – Natcher Parkway / US 231 Beaver Dam Road Previous Toll Plaza – Exit 36: $12,200,000

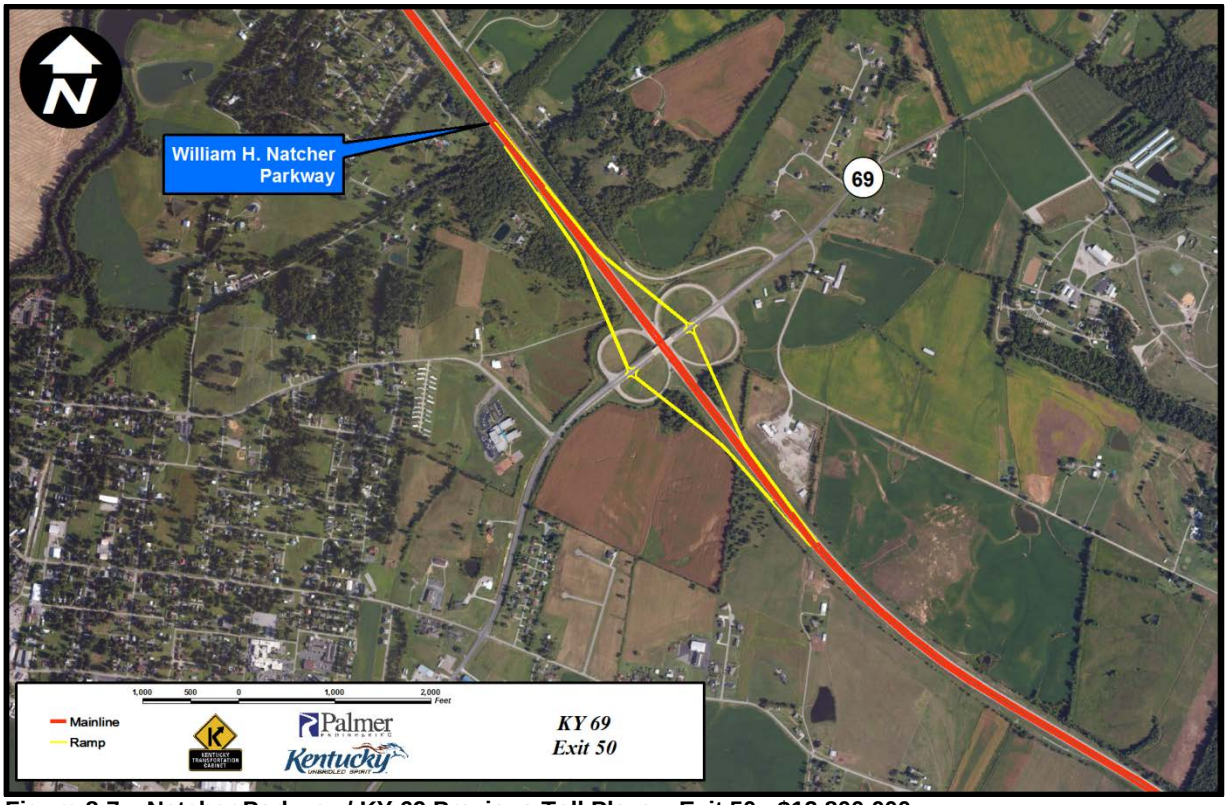


Figure 8-7 – Natcher Parkway / KY 69 Previous Toll Plaza – Exit 50: $12,800,000

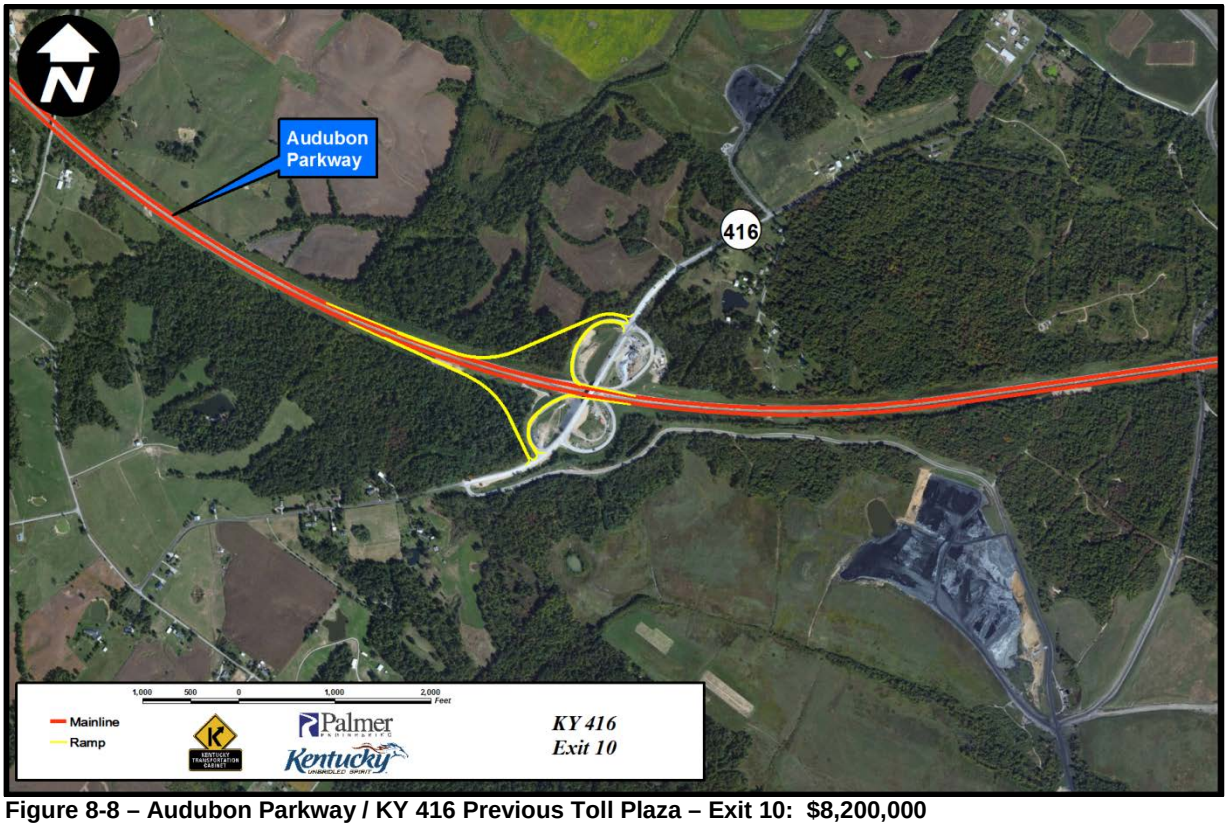


Figure 8-8 – Audubon Parkway / KY 416 Previous Toll Plaza – Exit 10: $8,200,000

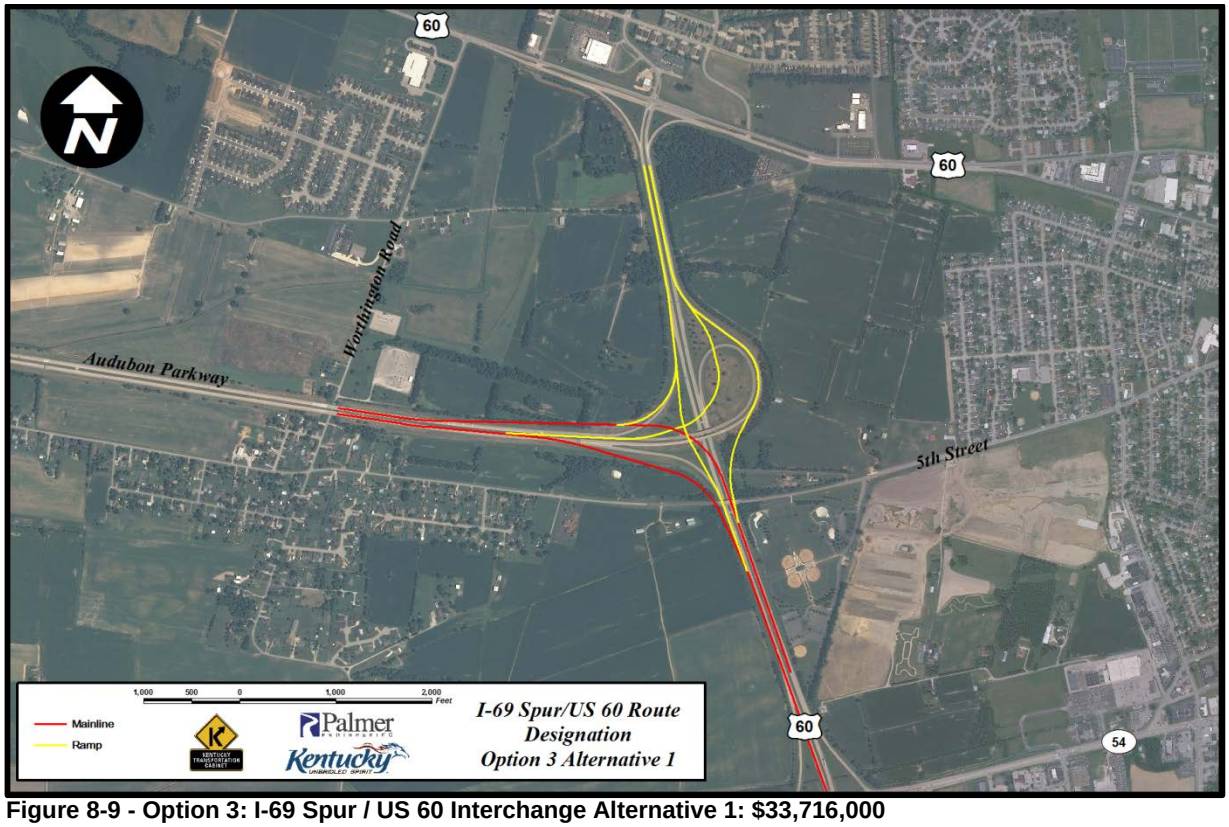


Figure 8-9 - Option 3: I-69 Spur / US 60 Interchange Alternative 1: $33,716,000

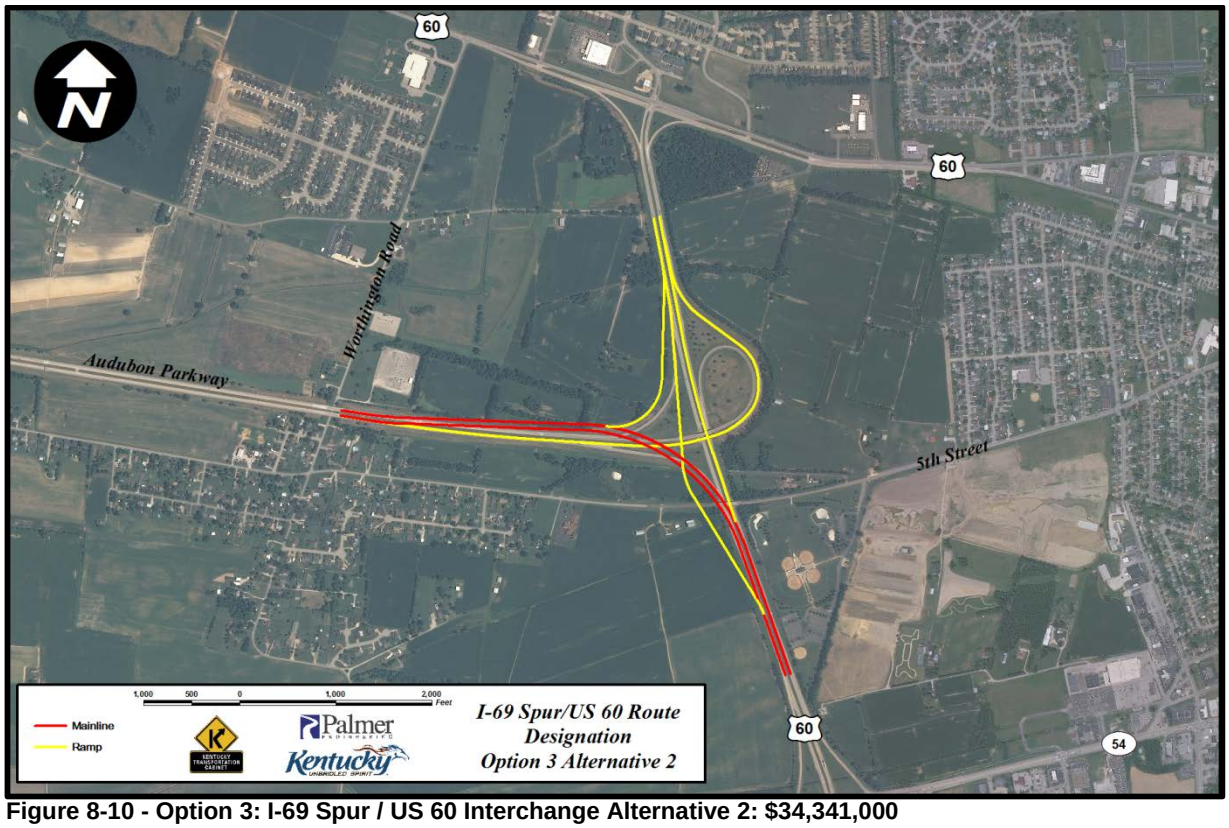


Figure 8-10 - Option 3: I-69 Spur / US 60 Interchange Alternative 2: $34,341,000

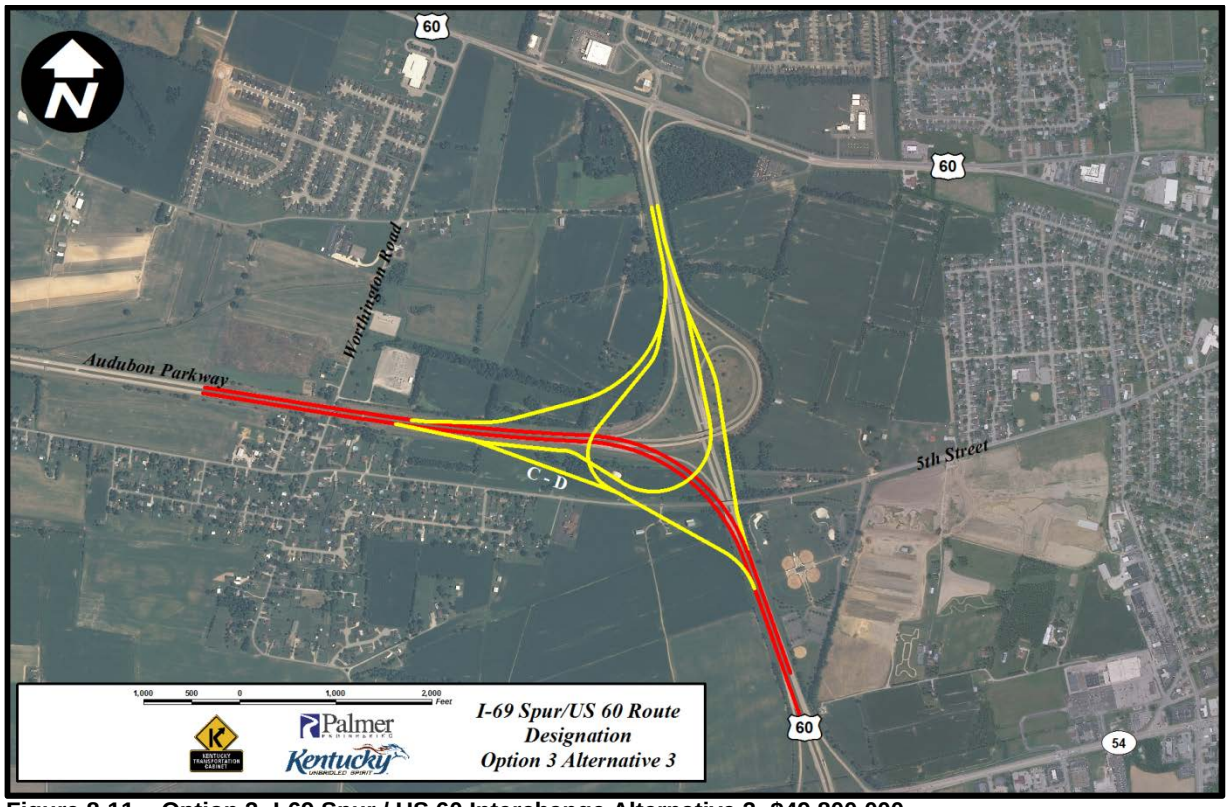


Figure 8-11 – Option 3: I-69 Spur / US 60 Interchange Alternative 3: $49,800,000

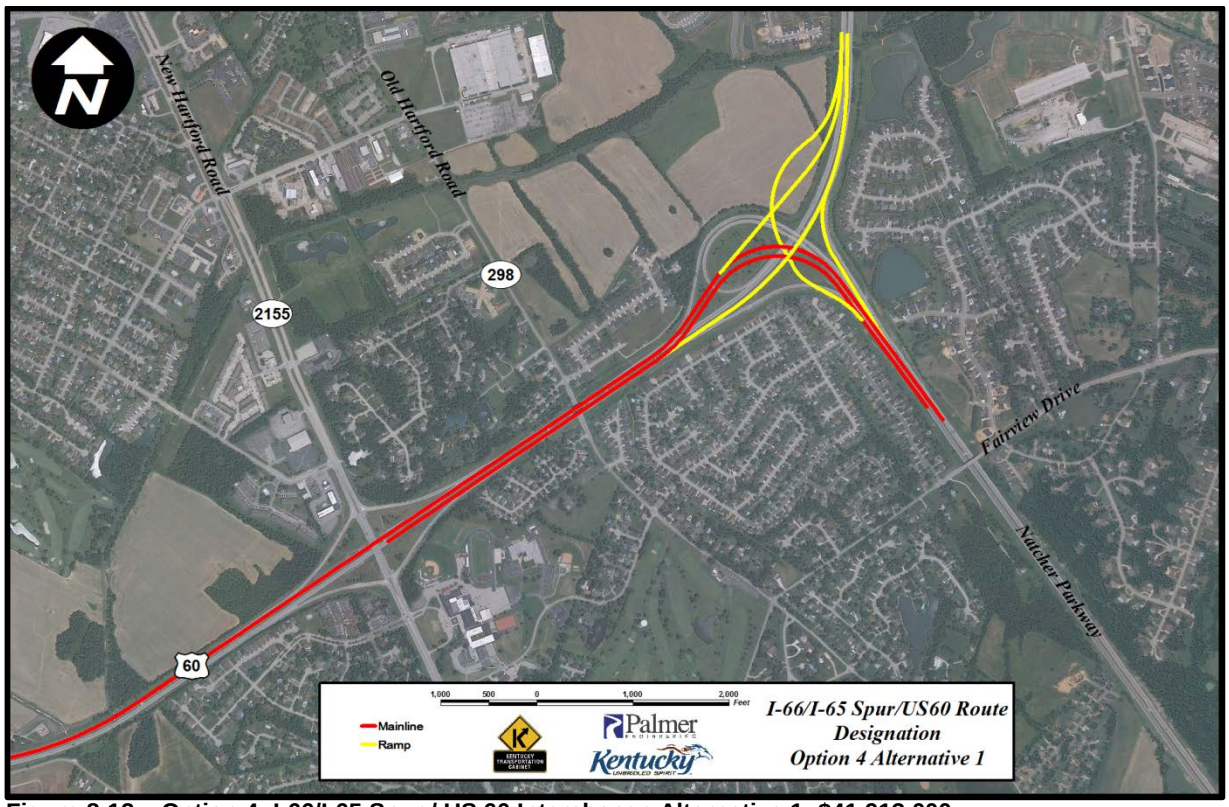


Figure 8-12 – Option 4: I-66/I-65 Spur / US 60 Interchange Alternative 1: $41,913,000

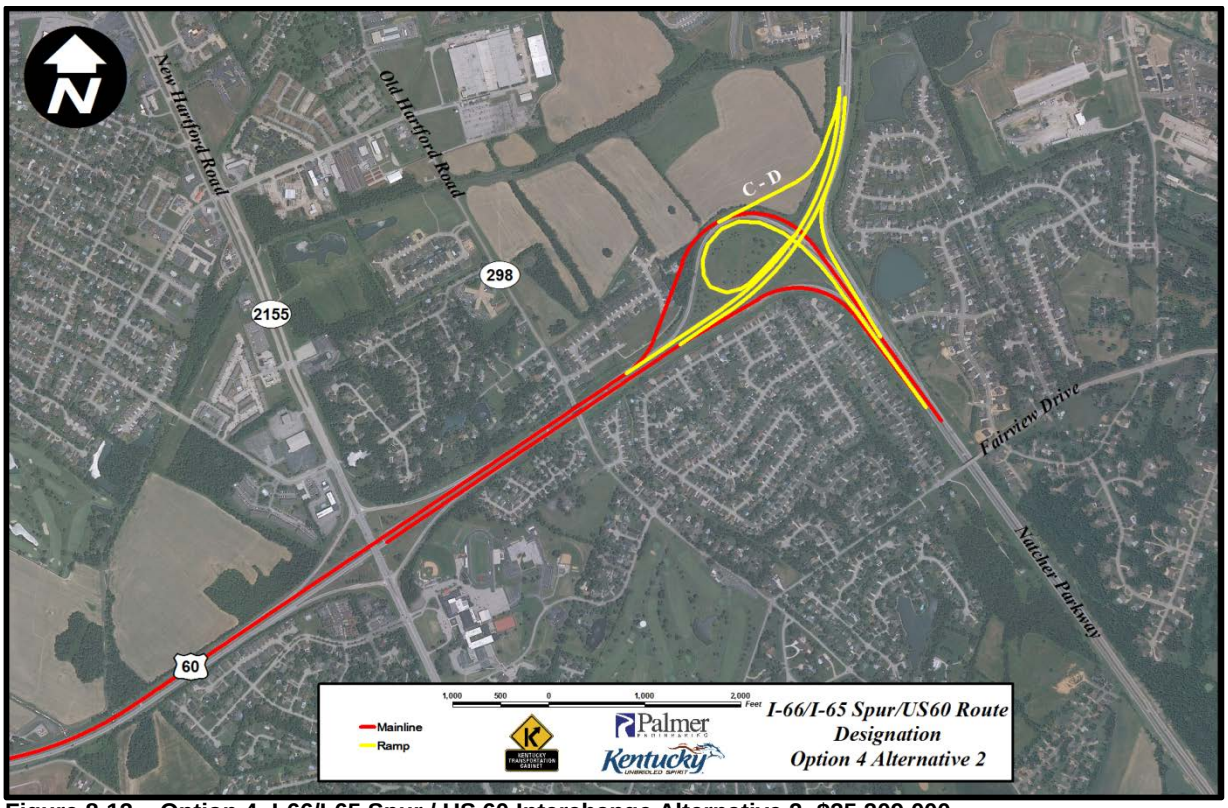


Figure 8-13 – Option 4: I-66/I-65 Spur / US 60 Interchange Alternative 2: $35,209,000

IX. SUMMARY

As previously discussed in **Chapter I,** the FHWA has identified thirteen design features that are important to the operational and safety performance of a highway. These controlling design features compiled are commonly known as the *13 controlling criteria*. A formal written design exception is required when any of the 13 criteria are not met on the National Highway System (NHS). The Interstate System is part of the NHS. The *13 controlling criteria* are listed below:

1. Design speed
2. Lane width
3. Shoulder width
4. Bridge width
5. Horizontal alignment
6. Superelevation
7. Vertical alignment
8. Grade
9. Stopping sight distance
10. Cross slope
11. Vertical clearance
12. Lateral offset to obstruction
13. Structural capacity

Design features that deviate from common practice but are not included in the *13 controlling criteria* will be termed design variance. There are two categories for design variances. A design variance is a design feature that (1) varies from the current AASHTO criteria but is not part of the *13 controlling criteria* or (2) a design feature that varies from common practice but is not part of the *13 controlling criteria*.

Design exceptions and variances require a formal detailed analysis for safety and operational consideration. FHWA requires an application for any design exceptions and design variances as documentation for the design exception process and decision.

FHWA provides the following fundamental activities for the design exception process:

- Determine the Costs and Impacts of Meeting Design Criteria
- Develop and Evaluate Multiple Alternatives
- Evaluate Risk
- Evaluate Mitigation Measures
- Document, Review, and Approve
- Monitor and Evaluate In-Service Performance

The designation of the Natcher Parkway, Audubon Parkway, and/or US 60 as an interstate spur may be accomplished by implementing the necessary improvement strategies in coordination with the Federal Highway Administration. Information presented herein is a ***first look planning-level study*** to identify deficiencies and impediments for interstate spur designation and to identify a range of improvement strategies needed to upgrade the Audubon Parkway, Natcher Parkway, and US 60 to satisfy applicable interstate criteria. After further analysis of the identified deficiencies, KYTC will need to recommend strategies to the Federal Highway Administration to bring the deficiencies into compliance with interstate criteria. Available options include addressing the required improvements through construction, requesting design exceptions/variances, committing to future improvements as part of the on-going maintenance and operation of the facility. It is anticipated that some combination of these approaches will be used. Thus, as projects for implementation of improvement strategies are initiated, additional engineering analyses and studies will be needed to further refine the specifics for improvements and to document the recommendations.

For example, the following may be areas for further analysis:

- Operational Considerations – Roadway conditions not shown in crash data may be contributing to crash history. Additional analyses during preliminary engineering may provide additional insight that could refine the scope of needed improvements at a given location.
- Mainline Geometry and Typical Section – Analyses for mainline geometry and typical section were evaluated using As-built plans supplemented with limited field reviews of existing conditions. Actual design features may require further verification with detailed field surveys of the roadway cross-section during preliminary engineering for implementing improvement strategies.
- Interchanges and Ramps – Most of the interchange ramps are deficient, and some design features were illegible on the As-built plans. Therefore, as interchanges are identified for improvement, geometric features (i.e. superelevation rate, horizontal and vertical alignments, design speed, etc.) should be further analyzed.

A. Summary of Route Options

As presented in the report, there are four possible interstate designation options for the Natcher Parkway, Audubon Parkway, and US 60. The following discussion provides a summary of the four options:

Options 1 and 3 designate the Audubon Parkway as I-69 Spur. The interstate spur would begin at I-69 south of Henderson and follow the Audubon Parkway to Owensboro. The specific location of the I-69 alignment at Henderson is undetermined. In order to designate a route as interstate, it must meet interstate standards and connect to an interstate. Therefore, I-69 must be designated and connected to the Audubon Parkway in order to designate the Audubon Parkway as I-69 Spur. The final location of the I-69 alignment could significantly increase the preliminary cost estimates presented in this report. The costs presented in this report include only improvements to the existing Audubon Parkway and Breathitt Parkway and do not include a new interchange for I-69 and I-69 Spur.

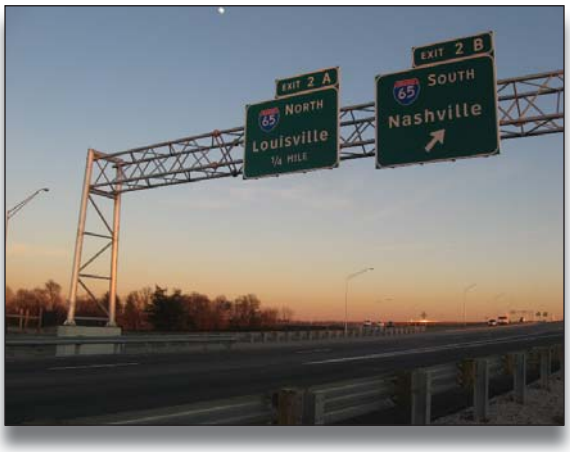
As previously noted, Interstate Designation Option 1 designates the Audubon Parkway as I-69 and would travel from I-69 in Henderson to the existing Audubon Parkway and US 60 interchange. This option is estimated to cost between $14.0 million and $14.7 million.

Option 2 designates the I-66/I-65 Spur along the Natcher Parkway from I-65 in Bowling Green to the US 60 interchange in Owensboro. The I-66/I-65 Spur would begin at the existing I-65 and Natcher Parkway interchange and terminate at the existing Natcher Parkway and US 60 interchange on the east side of Owensboro. This option is estimated to cost between $66.2 million and $75.9 million. Over half of the improvement costs are associated with improving the former toll plaza interchanges at Exits 9, 36, and 50 to meet interstate standards.

Option 3 designates the Audubon Parkway and US 60 as I-69 Spur. The I-69 Spur would follow the Audubon Parkway from I-69 south of Henderson to the Audubon Parkway and US 60 interchange in Owensboro. The I-69 Spur would continue east on US 60 and terminate at the Natcher Parkway and US 60 interchange. Option 3 is estimated to cost between $65.2 million and $87.2 million to designate the Audubon Parkway and US 60 as an interstate spur, with the US 60 portion estimated to cost between $51.2 million and $59.4 million. The existing Audubon Parkway and US 60 interchange is a trumpet interchange adjacent to Jack Fisher Park, which will likely be impacted with necessary improvements to the interchange and US 60. The trumpet interchange does not meet current interstate standards and is configured to serve US 60 as the main movement. The westbound US 60 to westbound Audubon Parkway movement exits via a one-lane loop ramp, and the eastbound Audubon Parkway to eastbound US 60 movement exits via a one-lane exit ramp. These movements require two through lanes to meet interstate criteria. Improving the existing US

60 and Audubon Parkway interchange to meet interstate standards is estimated to cost between $33.7 and $49.8 million.

Option 4 designates the Natcher Parkway and US 60 as I-66/I-65 Spur and is estimated to cost between $117.4 million and $148.3 million. I-66/I-65 Spur would follow the Natcher Parkway from the I-65 interchange in Bowling Green to the US 60 interchange on the east side of Owensboro. The spur would continue west on US 60 and terminate at the existing US 60 and Audubon Parkway interchange. Designating US 60 as I-66/I-65 Spur would require improvements to the existing US 60 and Natcher Parkway trumpet interchange. Currently, the trumpet interchange is configured to serve US 60 as the main movement. At the interchange, the northbound Natcher Parkway to westbound US 60 is reduced from two lanes to one lane and the eastbound US 60 to southbound Natcher Parkway exits via a one-lane ramp. The US 60 and Natcher Parkway interchange is essentially surrounded by residential development, which will be greatly impacted with the necessary improvements to the interchange and US 60 to meet interstate criteria. Improving the existing US 60 and Natcher Parkway interchange to meet interstate standards is estimated to cost between $35.2 and $41.9 million.



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