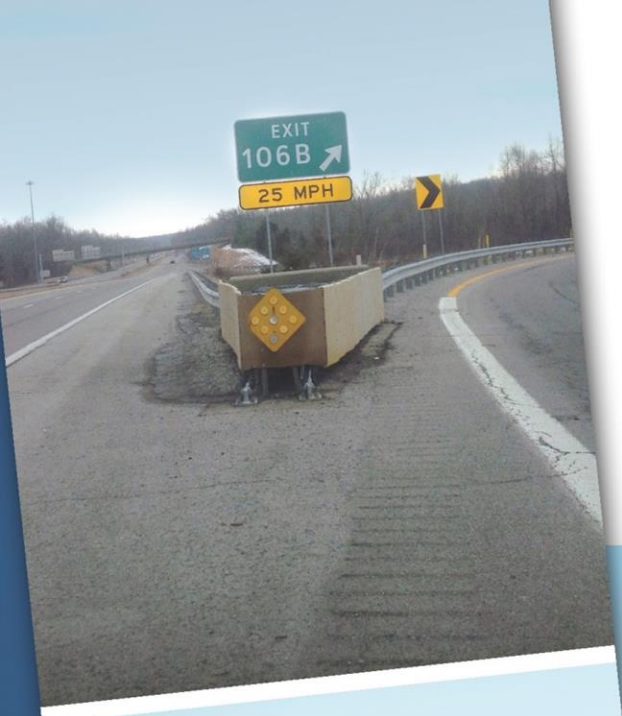

Corridor Study for

Interstate Deficiencies from I-24 to I-69 / Western Kentucky Parkway

January 2015

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PENNYRILE
PARKWAY
Kentucky
UNBRIDLED SPIRIT

Prepared for
KYTC Division of Planning and
District 2 - Madisonville

KENTUCKY
TRANSPORTATION
CABINET

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Executive Summary

Introduction

The Kentucky Transportation Cabinet (KYTC) initiated an interstate deficiencies study to identify and evaluate potential improvement options to upgrade the Edward T. Breathitt (formerly the Pennyrile) Parkway to interstate standards for inclusion into the interstate system. The study area limits are from I-24 in Christian County approximately 34 miles north to the I-69/Wendell H. Ford Western Kentucky Parkway (I-69/WKP) interchange in Hopkins County (see Figure ES 1, p. ES 2).

I-24 south of Hopkinsville extends east-west and I-69 northwest of Hopkinsville extends southwest to due north toward Henderson, Kentucky. The Edward T. Breathitt Parkway (hereinafter ETB Parkway), a fully controlled access facility, would provide interstate connectivity to both of these interstate facilities. Twenty-seven miles of the ETB Parkway was constructed as a 70-miles-per-hour (mph) rural, rolling terrain facility in the 1960s. The remaining seven miles of the ETB Parkway from I-24 north into Hopkinsville (Mile Point [MP] 0.000 to MP 7.500) was constructed from years 2010 to 2011 and opened in March 2011 as a rural arterial. Although a fully controlled access facility, with some segments that have been rehabilitated over time to improve safety, the ETB Parkway needs additional safety improvements. There is a segment between MP 4.800 (southern ramps of Lovers Lane) and MP 11.697 (KY 1682 underpass) that is now classified as urban.

Project Meetings

There were two Local Officials/Stakeholders' Meetings and two Project Team Meetings as a part of this study. With input from these four meetings, it was confirmed that the purpose of this project is to improve safety and to provide for interstate connectivity from I-24 south of Hopkinsville in Christian County to the recently designated I-69 (formerly the Western Kentucky Parkway) in Hopkins County. The stated goals are to make improvements within the existing right-of-way as much as possible, while minimizing environmental impacts to the agricultural characteristics and other environmental features of the area; and making Hopkinsville more economically competitive by being connected to the future I-69 with an interstate spur, built to current interstate standards, rather than the historical parkway standards.

Study Considerations

The ETB Parkway corridor was evaluated for deficiencies based on the current KYTC and Federal Highway Administration (FHWA) interstate design standards and guidelines (see Table ES 1, p. ES 3). Applicable references are listed as follows:

- "A Policy on Geometric Design of Highways and Streets, 4th Edition" (American Association of State Highway and Transportation Officials, 2011 Edition)
- "AASHTO Roadside Design Guide" (American Association of State Highway and Transportation Officials, 4th Edition 2011)

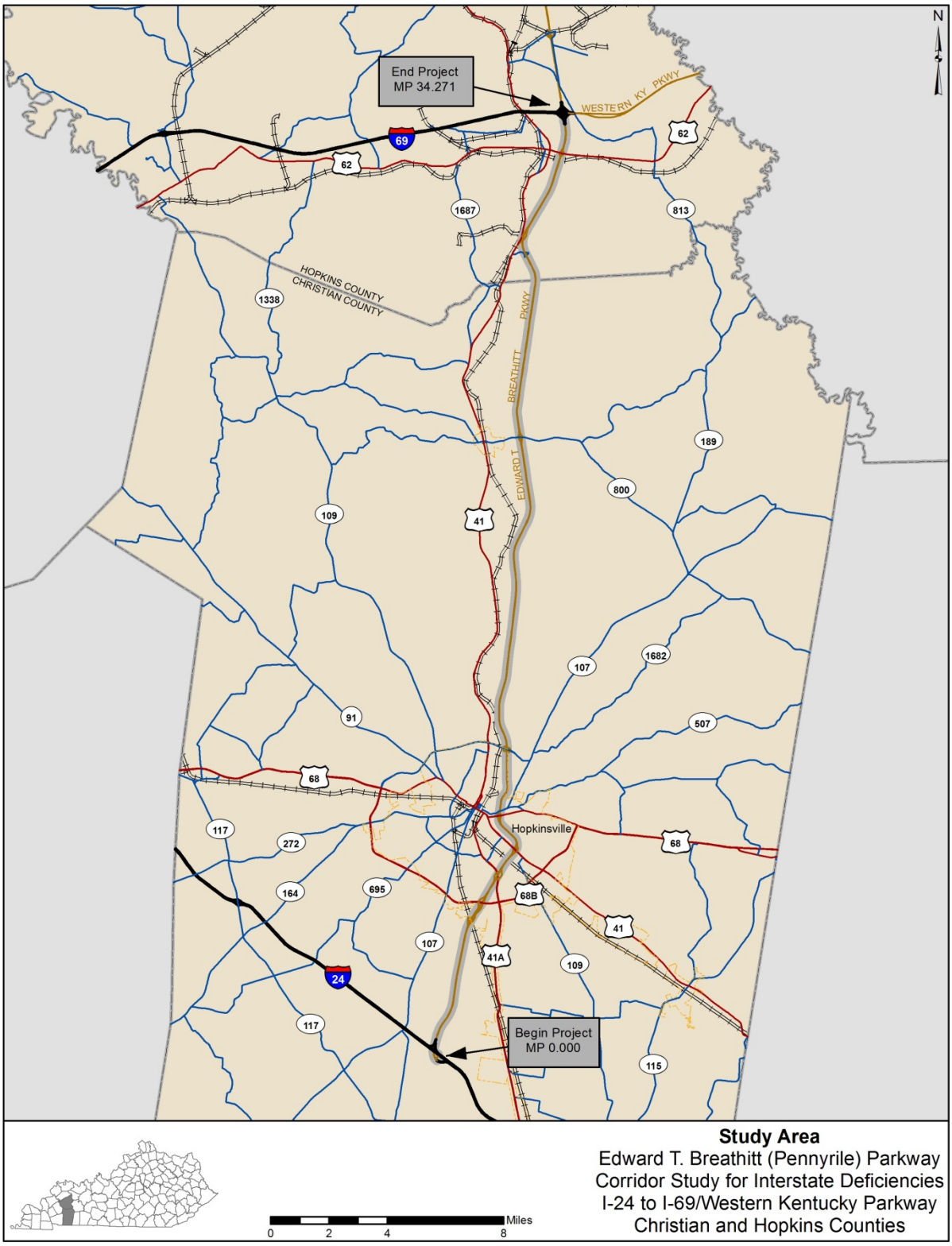


Figure ES 1: Study Area

Table ES 1: Design Criteria for Inclusion into the Interstate System

Area Type			Rural			Urban			Urban/Rural		
Design Element	**2011 AASHTO GUIDE[1]**	**2005 AASHTO POLICY[2]**	**Mainline**	**Ramps**	**Loops**	**Mainline**	**Ramps**	**Loops**	**Directional**	**Entrance**	**Exit**
Design Speed (MPH)	8-1, 8-5, 10-89, 10-89	2	70	35	25	50	25	25	40		
Level of Service (Desirable)	10-89, 2-67	3	B			C					
Driving Lane Width	8-2, 10-102	3	12'	14’	15'	12'	14’	15’			
Inside Shoulder Width	8-3, 10-102	3									
4-lane freeway & ramps	8-3, 8-10, 10-102	3	4'	2'-4'	2'-4'	4'	2'-4'	2'-4'	1'-6'		
Outside Shoulder Width	8-3, 10-102	3									
Truck DDHV <= 250	8-3, 10-102	3	10'	8'-10'	8'-10'	10'	8'-10'	8'-10'	8'-10'		
Truck DDHV > 250	8-3, 10-102	3	12'			12'					
Median Width	8-7, 8-10	4	36'			10'					
Structures											
Over Freeway Vertical Bridge Clearance	8-4		16'								
Over Freeway Vertical Sign Truss Clearance	8-4		17'								
Bridge Width (Horizontal) < 200’ to remain in place		5	Traveled Lanes + 3.5’ inside shoulder and 10’ outside shoulder								
Bridge Width (Horizontal), Length > 200' [1] to remain in place		5	Traveled Lanes + 3.5' shoulders								
Design ADT (vehicles per day)			> 6,000	750-1,500		> 6,000	750-1,500				
Clear Zone (Fill Slope 1V:4H or flatter)	Roadside Design Guide	4	30'-46'	10'-14'		20'-28'	10'-14'				
Clear Zone (Cut Slope 1V:3H or flatter)	Roadside Design Guide		22'-30'	10'-12'		14'-22'	10'-12'				
Superelevation (505) [3]	8-3		+/-8%								
Horizontal Curvature Minimum Radius (8% max SE)[3]	3-47		1810'	314'	134'	758'	134'	134'	444'		
Maximum Grade (upgrade for ramps)	8-4, 10-92		4%	5%-7%	5%-7%	5%	5%-7%	5%-7%	4%-6%		
Stopping Sight Distance	3-4		730'	250'	155'	425'	155'	155'	305'		
Divergence Angle	10-112										2°-5°
Minimum Acceleration Lengths for Ent. Term.	10-110		Variable and Depends on Design Speed of Entrance								
Minimum Deceleration Lengths for Exit Term.	10-115		Variable and Depends on the Design Speed of Exit Curve								
Interchange Spacing	10-68	5	1-mile urban, and 3-mile rural								
Access Control	10-7	2	100 feet urban (300 feet desirable) and 300 feet rural (600 feet desirable)								

[1] Page number references from AASHTO's *A Policy on Geometric Design of Highways and Streets*, 2011
[2] Page number references from AASHTO's A Policy on Design Standards Interstate System, January 2005
[3] Common KYTC Practice is 8% maximum superelevation. KYTC has used 10% maximum superelevation on past projects

- "Highway Capacity Manual" (Transportation Research Board, 2010 Edition)
- Manual of Uniform Traffic Control Devices, Millennium Edition" (Institute of Transportation Engineers, 2009 Edition with Revision Numbers 1 and 2 incorporated, dated May 2012)
- "A Policy on Design Standards Interstate System" (American Association of State Highway and Transportation Officials, 2005)
- Kentucky Transportation Cabinet Highway Design Manual (KYTC, Current Edition)
- Kentucky Transportation Center Analysis of Traffic Crash Data in Kentucky (2008-2012) Research Report KTC-13-13/KSP2-11-1

Also used in the existing conditions analysis of the ETB Parkway were the following:

- As-Built plans provided by KYTC
- KYTC's Division of Planning's Highway Inventory System (HIS) database, http://datamart.business.transportation.ky.gov/EDSB_SOLUTIONS/HISEXTRACTS/default.aspx, referred to as HIS
- Kentucky State Police's Kentucky Collision Analysis for the Public, http://crashinformationky.org/KCAP/KYOPS/SearchWizard referred to as KSP's Collision Database
- As-Built Bridge plans, National Bridge Inventory Kentucky Inventory and Appraisal Reports (NBIS), KYTC Bridge Inspection Reports (BIR), all provided by KYTC
- Field visits

Study Activities

The planning process included a review of the existing conditions along the ETB Parkway to identify locations that do not meet current American Association of State Highway and Transportation Officials (AASHTO) and FHWA interstate highway design guidelines. Evaluations included identifying which criteria were not met and the potential impact of the deficiencies on safety and capacity, and options for making improvements to address identified deficiencies. The overall activities included the following:

- Conduct an inventory of existing conditions and define problem areas.
- Establish purpose and goals.
- Propose and analyze alternative improvement options.
- Prepare cost estimates.
- Prioritize improvements.
- Conduct public involvement throughout the study process.
- Recommend solutions.
- Document study process and results.

Key Findings

Currently, the ETB Parkway operates similarly to an interstate highway though there are areas where it lacks compliance with current FHWA and AASHTO interstate guidelines. The ETB Parkway provides the basic geometric characteristics of an interstate highway, such as full control of access, two travels lanes in each direction, 12-foot-wide lanes, 10-foot-wide outside paved shoulders, 36-foot-wide rural medians, 70-mph rural design speed, and 50-mph urban design speed. However, the parkway lacks compliance with other design features.

Operational Considerations and Safety

The following is a summary of the key findings related to the operational considerations and the safety of the ETB Parkway from I-24 to I-69/WKP interchange:

- **Crash Segment Analysis as a Parkway:** For the crash analysis, a high-crash segment was defined as having a Critical Crash Rate Factor (CCRF) greater than or equal to 1.0. There were no crash segments with a CCRF between 0.89 and 0.99. There are three high-crash segments that are all in Christian County (MP 0.587 to MP 4.80, MP 5.759 to MP 7.500, and MP 11.697 to MP 22.641) where the Actual Crash Rate exceeds the Critical Crash Rate of 1.0.
- **Crash Segment Analysis as an Interstate:** The ETB Parkway analyzed as an interstate has one additional segment (MP 22.641 to MP 32.861) where the CCRF approaches 1.0 (0.95).
- **Crash Spot Analysis as a Parkway:** There are 29 spots that have a CCRF >1.0 and some of these spots overlap. There are 15 additional spots that have a CCRF that approached 1.0 (< 0.89 CCRF < 1.0).
- **Additional Findings Related to Crash Analysis:** There were three crashes coded as median cross-over or head-on collisions and seven fatal crashes during the study period (2008-2012). Neither the fatal crashes nor the head on crashes were in a concentrated area.
- **Commercial Vehicle Standards:** If this corridor becomes an interstate, the weight limitations would have a maximum gross vehicle weight of 80,000 pounds.
- **Current Traffic (2013):** The current traffic volumes range from 8,700 vehicles per day (vpd) (south of US 68 Bypass in Hopkinsville) to 17,200 vpd in Hopkinsville between US 41 (Exit 8) and US 68 (Exit 9).
- **Truck Percentages (2013):** The existing truck percentages on the ETB Parkway range from 15.0% from US 41 in Hopkinsville north to I-69 to 22% between Lovers Lane (Exit 5) and I-24 (MP 0.000).
- **Future Traffic (2040) as a Parkway:** The projected annual growth rate is 1%. This rate results in traffic volumes ranging from 10,700 (vpd) (south of US 68 Bypass in Hopkinsville) to 23,100 vpd in Hopkinsville between US 41 (Exit 8) and US 68 (Exit 9).
- **Future Traffic (2040) as an Interstate:** The future traffic with interstate designation is not expected to increase over the projected normal growth. The only changes for forecasted traffic expected to occur would be if the US 41 interchange (Exit 30) is converted to a full

interchange. This would reduce the projected traffic volumes by 600 vpd between I-69 (Exit 34) and US 62 (Exit 33), and 700 vpd between US 41 (Exit 30) and US 62 (Exit 33).

- **Truck Percentages (2040):** Future truck volumes are not expected to increase over the projected normal growth. The future truck volumes range from 18% to 25%.
- **Level of Service (2013):** The ETB Parkway currently operates at level of service (LOS) A.
- **Level of Service (2040) as a Parkway or Interstate:** The ETB Parkway is expected to operate at an LOS A with interstate designation and the full buildout of all Segments of Independent Utility for I-69 in Kentucky.

Mainline Geometry/Typical Section

The following is a summary of the key findings related to the ETB Parkway geometry and typical section:

- **Design Speed:** The ETB Parkway meets or exceeds the minimum design speed guidelines for interstate highways in rural and urban areas.
- **Lane Width:** The lane width on the ETB Parkway meets the minimum AASHTO guidelines for interstate design.
- **Outside Shoulder Width:** The ETB Parkway meets the AASHTO minimum outside shoulder width based on the current truck directional design hourly volume (DDHV).
- **Inside Shoulder Width:** The ETB Parkway does not comply with the minimum AASHTO design guidelines for inside paved shoulder widths. The AASHTO minimum inside paved shoulder width is 4 feet. The ETB Parkway has a 3-foot-wide inside paved shoulder with the exception of the newer section from MP 0.000 (end of the I-24 ramp) to the CSX Railroad Bridge north of US 41A (MP 7.500) which has 4-foot inside paved shoulders.
- **Striping Issue:** The ETB Parkway from MP 29.561 to MP 34.271 southbound, currently has a striping issue that makes the lane widths and outside shoulder widths less than minimum; however, the inside paved shoulder width is more than adequate in places. This discrepancy is due to striping that appears to be shifted toward the outside. This will be corrected if the inside shoulder width is widened to 4 feet. If not, then, restriping may be required to provide the appropriate lane widths and outside shoulder widths.
- **Median Width:** The ETB Parkway meets the rural 36-foot AASHTO minimum median width in rural areas and the 10-foot minimum median width in urban areas.
- **Clear Zones:** Without field review, it is not possible to identify all items that may be within the clear zone. However, based on a review of the slopes that are presented in the as-built plans for the corridor, there are ditch slopes between MP 7.500 to MP 34.271 and median slopes from MP 29.568 to MP 34.271 that show as 1V:3H. It was concluded that all slopes on the interstate should be a minimum of 1V:4H, including the median slopes.
- **Guardrail Placement and Condition:** The guardrail from MP 16.000 to MP 30.000 has wooden posts. Because field verification of the height and detailed specifications of the characteristics of the guardrail were outside the scope of this study, it was assumed that the dimension of the round wood post is 7” which is consistent with Kentucky Standard Drawing

RBR-015 for single face application. In a question and answer section on FHWA's website with regard to roadway barriers, the following statement was made: *"Some states use 8" round posts for w-beam guardrail, but there is not sufficient performance information to offer a recommendation on whether they may be substituted for steel or rectangular wood posts."* Therefore, given the FHWA's response with regard to the use of 8" round posts and Kentucky's standard drawing for using 7" round posts, for the purposes of this planning document, stretches of guardrail with round wood posts were considered as non-standard and in need of replacement.

On recent Kentucky interstate rehabilitation and reconstruction projects, the majority of the guardrail has been upgraded throughout the project limits on these types of projects. In addition, because field measurement of the top of guardrail was outside the scope of this study, there may be lengths of guardrail, both along the mainline and ramps, that fall below the recommended height for the top of rail and further verification of compliance is recommended as part of any future 3R project.

- **Superelevation:** From the review of as-built plans, horizontal curves along the ETB Parkway, the superelevation is adequate given the actual superelevation rate of the curves, the applicable friction factors, and actual curve radii.
- **Horizontal Alignment:** A review of as-built plans shows horizontal curves along the ETB Parkway meet minimum standards.
- **Vertical Alignment – sag curves:** Two sag vertical curves do not meet the minimum guidelines for the headlight sight distance.
- **Vertical Alignment – crest curves:** The minimum stopping sight distance for crest curves is met for all vertical crest curves.

Bridges and Overpasses

The following is a summary of the key findings related to the bridges and overpasses on the ETB Parkway:

- **Lateral Clearance:** Of the 16 mainline bridges, four do not meet the minimum lateral clearance requirement: Crab Orchard Creek northbound (MP 30.33) and southbound (MP 30.34), and Old White Plains Road and Creek northbound (MP 32.29) and southbound (MP 32.29), all in Hopkins County.
- **Vertical Clearance:** Of the 19 overpass bridges, one does not meet the minimum 16-foot vertical clearance requirement. It is a reinforced box bridge (15.9 feet) and cannot be raised to meet the vertical clearance. The bridge is identified as 024B00095N and is located at mainline MP 15.511 (KY 2641).
- **Functional Adequacy:** Two mainline bridges at First Street, both northbound and southbound (MP 9.728 and MP 9.730) are identified as functionally obsolete.
- **Structurally Deficient:** One overpass bridge was listed as structurally deficient (024B00099N) but with a sufficiency rating of 74.1.
- **Sufficiency Rating:** All mainline and overpass bridges have sufficiency ratings greater than 60.0.

- **Curbs:** Two mainline bridges, located over Drakes Creek at MP 29.448 (northbound) and MP 29.460 (southbound) have curbs. The northbound ramp over US 41 at Exit 30 also has curbs.
- **Overhead Signs and Trusses:** All overhead signs and trusses meet the minimum 17-foot vertical clearance requirement.

Interchanges and Ramps

The following is a summary of the key findings related to the interchanges and ramps on the ETB Parkway:

- **Design Speed:** Design speed was calculated for all ramps and all meet the minimum design speed.
- **Lane Width:** Lane widths for the interchange ramps range from 14 feet to 18 feet, which is compliant with AASHTO guidelines.
- **Shoulder Width:** The US 41 northbound on-ramp at Exit 30 does not meet the minimum criteria for shoulder width. It has rolled curb for its entire length.
- **Horizontal Alignment:** All ramps meet the minimum radius criteria.
- **Vertical Alignment – Vertical Grade:** The minimum vertical grade is met on all interchange ramps.
- **Vertical Alignment – Sag Curves, Headlight Sight Distance:** All vertical curve ramps meet the minimum headlight sight distance for the appropriate design speed.
- **Vertical Alignment – Crest Curves, Stopping Sight Distance:** All curve ramps meet the minimum stopping sight distance.
- **Guardrail**: Two end treatments on the northbound on-ramp of US 41 at Exit 30 do not meet current criteria.
- **Superelevation:** All ramps meet the minimum superelevation criteria.
- **Speed-Change Lanes:** There are seven ramps that do not meet the minimum criteria for acceleration and deceleration lengths: the four ramps at US 62 (Exit 33), the US 41 northbound on-ramp at Exit 30, and the on ramps at KY 800 (Exit 23). All LOS for these movements are LOS A.
- **Weaving Characteristics:** The KY 1682 (Exit 11) interchange has less than minimum weaving distance and currently operates at LOS A. It is expected to operate at LOS A in the design year 2040.
- **Interchange Spacing:** There are two locations where the minimum interchange spacing requirements are not met: between Lovers Lane (Exit 5) and US 68 Bypass (Exit 6) and between US 62 and I-69. For an urban area, the crossroad-to-crossroad distance rule of thumb is 1 mile. Between Exits 5 and 6 (Lovers Lane and US 68 Bypass) the existing distance is 0.610 mile. The southbound exit ramp at Lover's Lane was constructed as a loop ramp in the southeast quadrant to provide more ramp spacing between the ETB Parkway southbound on ramp from US 68B and the ETB Parkway southbound off ramp at Lover's Lane, and to minimize impacts to an existing subdivision. The northbound ramps between

the two interchanges were braided to ramp spacing/separation. All ramps at both interchange locations meet the *2011 Green Book* minimum ramp spacing criteria. However, the minimum interchange spacing requirements (crossroad to crossroad) as defined are not met. To maximize spacing southbound between US 68B and Lover's Lane, an additional lane may be required. There is not a defined weave (no auxiliary lane) at this location that can be analyzed through the Highway Capacity Manual. The second location, between US 62 and I-69 in Hopkins County, does not meet the minimum ramp spacing criteria of 2 (*2011 Green Book*) or 3 miles (*A Policy on Design Standards Interstate System January 2005*) in a rural area. Based on AASHTO requirements, minimum interchange spacing should be 1 mile in urban areas and 3 miles in rural areas. The existing distance is 1.421 miles. The mainline through both areas has a current LOS (2013) of a design year LOS (2040) of A. All merge and diverge movements are also LOS A.

- **Interchange Control of Access:** Two interchanges do not meet the minimum interchange control of access requirements: US 41A (Exit 7), which has the Fort Campbell Memorial Park parking lot access between the ramp terminals and the northeast quadrant of US 62 (Exit 33).
- **Interchange Configuration:** Currently, the ETB Parkway has two service interchanges that do not meet the recommended interstate interchange configuration: KY 1682 (Exit 11) and US 41 (Exit 30). A system interchange at I-69 (Exit 34) does not meet the recommended interstate interchange configuration for the ramps from the ETB Parkway.
- **I-24 Interchange:** The purpose of this study is to determine the improvements necessary to upgrade 34 miles of the ETB Parkway to interstate standards for inclusion as a spur to I-69. Therefore, the I-24 interchange was evaluated as a system interchange. This section of the ETB Parkway was generally designed as a 70 mph fully controlled access rural arterial facility with free flow movements at the I-24 interchange. Because of the relatively low volume of projected traffic, the need to minimize property impacts, and the high cost associated with constructing a flyover ramp for traffic traveling from I-24 EB to ETB Parkway NB, a 35 mph loop ramp was constructed instead. 35 mph is the minimum required loop radius design speed according to the *2011 Green Book*. The flyover ramp from ETB Parkway SB to I-24 EB transitions from 70 mph on the parkway to 50 mph on the ramp then to 70 mph on I-24. The ramp meets all current design standards. The ETB Parkway SB to I-24 WB ramp and the I-24 WB to ETB Parkway NB meet all current design standards.

Design Feature Deficiency and Crash History Analysis

To further evaluate the impact of the roadway feature deficiencies on safety, a high-level crash analysis utilizing Kentucky State Police (KSP) data was conducted to verify whether the deficiencies have an impact on safety. Again, the CCRF is for both directions, and an evaluation of crash reports may reveal more detail.

Mainline Geometry/Typical Section

a. Shoulder Widths

The ETB Parkway has 17 0.3-mile high-crash locations from MP 7.500 to 34.271, where the shoulder width is less than 4 feet paved. For high-crash location detail, refer to Chapter III.

b. Vertical Alignment – Sag Curves – Headlight Sight Distance

A 0.3-mile rolling crash analysis was conducted for the vertical alignment deficiencies, and the results are provided in **Appendix C**. One sag curve is located within a high-crash spot. The sag curve at MP 32.413 has a vertical curve of 600 feet. Crashes were examined from MP 32.300 to MP 32.527 in attempt to isolate the crash issues. There were eight crashes in this vertical curve over a 5-year period—four occurred in dark conditions, six of them were northbound, three were coded collision with animal, all were single-vehicle crashes, and seven of the eight crashes were on dry pavement.

c. Inadequate Pier Protection

Only one of the seven overpass structures (MP 29.131, McIntosh Chapel, KY 2647) with inadequate pier protection is located in a 0.3-mile spot with a CCRF approaching 1.0. This spot had eight crashes, six of which involved single vehicles. Three crashes were coded “ran off the roadway,” two were “collision with fixed object non-intersection,” and one crash each was “collision with non-fixed object,” “other collisions on shoulder,” and “sideswipe collision - same direction.”

d. Clear Zones

The clear zones’ relationship to high-crash locations are shown on Figure 22 (p. 63). There are six 0.3-mile high-crash spots between MP 29.568 and MP 34.271, where the median slopes do not meet minimum criteria. In addition, there are nine additional 0.3-mile high-crash spots for the stretch of the ETB Parkway where ditch slopes do not meet minimum criteria (MP 7.500 to MP 34.271).

Evaluating median slopes, the ETB Parkway had three head-on collisions over 5 years and the directional analysis from KSP indicated they were coded: “ran off roadway” (MP 15.191), “collision with fixed object non intersection” (MP 16.665), and “vehicle parked position, parking lot or driveway” (MP 10.380). The crashes were not located in a concentrated area and they were in a location where median slopes were 1V:4H.

e. Acceleration

There are six ramps where the length of acceleration is less than the minimum criteria. Of those six, three are located in high-crash locations, as follows:

- US 41 Northbound Entrance Ramp – Actual 450 feet and Minimum 580 feet
- US 62 Southbound Entrance Ramp – Actual 0 feet and Minimum 580 feet
- Southbound I-69 from Southbound ETB Parkway – Actual 450 and Minimum 580 feet

f. Deceleration

There are three ramps where the length of deceleration is less than the minimum criteria. Of those three, one located in a high-crash location and they are as follows:

- US 62 Northbound Exit Ramp – Actual 0 feet and Minimum 340 feet

g. Ramps

After evaluation, all ramps meet minimum typical section, vertical and horizontal criteria to become an interstate with the exception of the US 41 and KY 800 ramps that have rolled curb. These ramps did not exhibit any abnormal crash patterns.

Figures ES 2 and ES 3, (pp. ES 12 and ES 13) illustrate those deficiencies in the corridor and their associated interchange deficiencies. Table ES 2 (p. ES 14) lists the deficiencies and their associated costs, whether each would be a design exception or a design variance, and whether it is located in a 0.3-mile high-crash spot. FHWA has identified 13 design features that are important to the operational and safety performance of a highway. These controlling design features are commonly referred to 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. Design exceptions are typically granted on a case by case basis. The results of this study and associated costs assumed that no design exceptions or variances would be granted.

Design variances would be required for the existing conditions that do not meet current AASHTO or KYTC guidelines but are not design exceptions that are deemed appropriate by the KYTC and the FHWA. Table ES2 identifies whether the improvement would require either a design exception or a variance if the improvement is not implemented. The deficiencies, with the exception of an access control issue in the northwest quadrant of Lovers Lane, are north of MP 7.500.

The total estimated cost to upgrade the ETB Parkway without any design exceptions is $161,629,000. Nearly all improvements are north of MP 7.500.

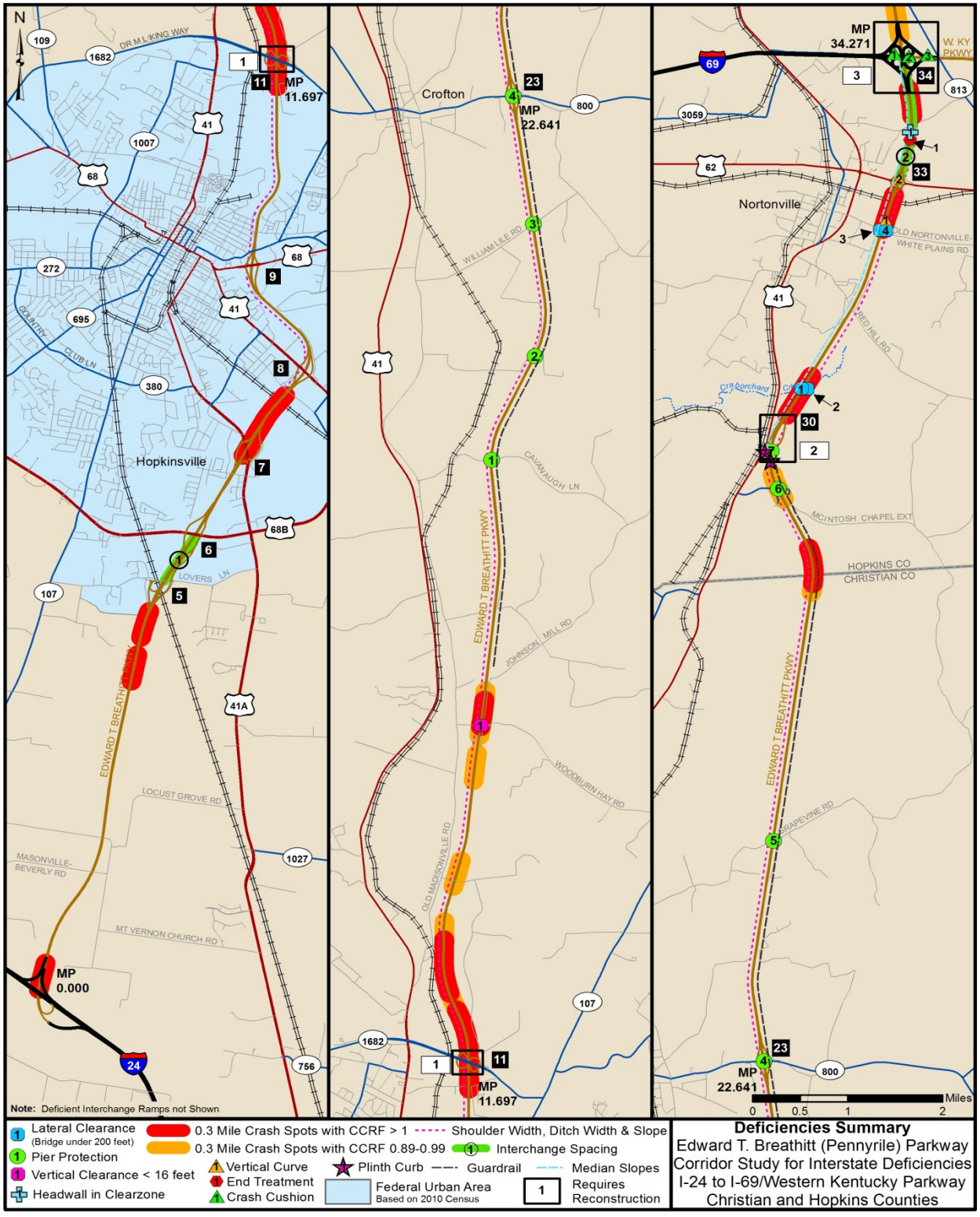


Figure ES 2: Edward T Breathitt Parkway Deficiencies Summary

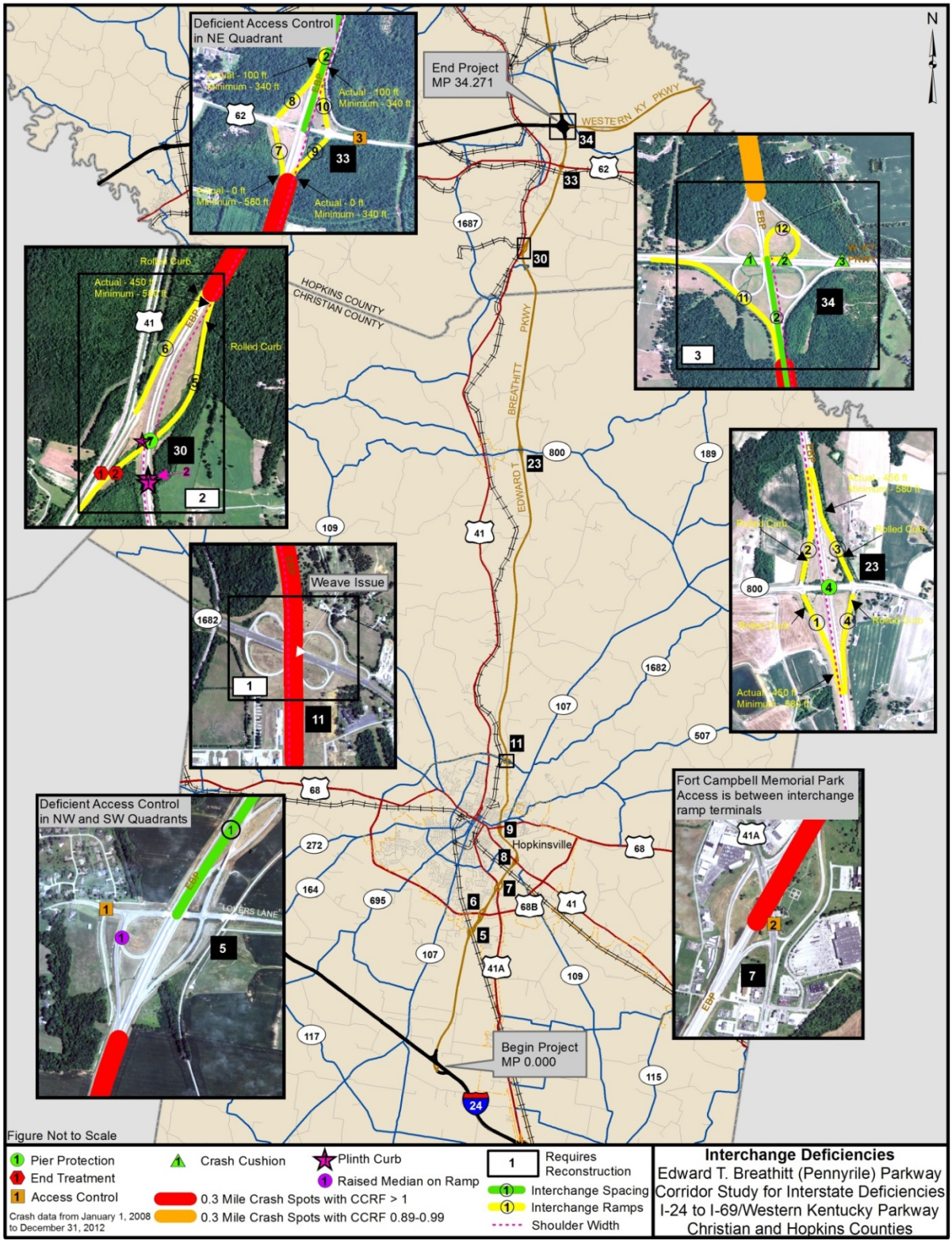


Figure ES 3: Interchange Deficiencies Summary

Table ES 2: Summary of Deficiencies and Costs

Location	Summary Categories	Milepoints or Options	Subtotals	Fully Compliant Reconstruction	Requires a Design Exception	Requires a Design Variance	Within a High Crash 0.3 Mile Spot Yes or No
	STRUCTURES						
	Widen Bridges < 200' with Widths< 38'			$ 738,100			
	Hopkins County						
1	SB Crab Orchard Creek	30.340	$ 191,600		x		Y
2	NB Crab Orchard Creek	30.330	$ 187,300		x		Y
3	NB Old White Plains Rd and Creek	32.290	$ 179,600		x		Y
4	SBOld White Plains Rd and Creek	32.290	$ 179,600		x		Y
	Plinth Curb			$ 243,700			
1	NB Drakes Creek	29.448	$ 62,900			x	N
2	SB Drakes Creek	29.460	$ 62,900			x	N
3	NB Entrance Ramp @ US 41 over EBT	29.550	$ 118,000			x	N
	Vertical Clearance < 16 feet			$ 1,163,700			
	Christian County						
1	KY 2641	15.511	$ 1,163,700		x		Y
	Inadequate Pier Protection			$ 2,448,000			
	Christian County						
1	Cavanaugh Lane (KY 2636)	18.474	$ 334,000		x		N
2	J Knight Road (KY 2640)	19.721	$ 349,000		x		N
3	William Lile Road	21.214	$ 357,000		x		N
4	KY 800	22.649	$ 341,000		x		N
5	Grapevine Road (KY 2637)	25.117	$ 341,000		x		N
	Hopkins County						
6	McIntosh Chapel Road (KY 2647)	29.131	$ 336,000		x		Y
7	NB US 41 On Ramp	29.560	$ 390,000		x		N
	MAINLINE						
	Horizontal		$ -	$ -			
	Vertical			$ 766,900			
1	Sag - MP 32.413	32.413	$ 143,800		x		Y
2	Sag - MP 32.887	32.887	$ 623,100		x		Y
--------	**Widen Inside Shoulders (MP 7.5 to MP 34.247) or**						
	Widen inside shoulders from MP 7.5 to MP 34.271	7.500 - 34.271	$ 8,743,600	$ 8,743,600	x		
	Restripe from MP 29.561 to MP 34.271	29.561 to 34.271	$ 78,400				
1	**Guardrail End Treatment near SB MP 33.4**	SB 33.400		$ 5,000		x	Y
--------	**Upgrade Guardrail (MP 16.00 to MP 30.00)**	16.000 to 30.000		$ 1,621,700		x	Y
	Fix Headwall @ MP near SB MP 33.5	SB 33.500		$ 5,000		x	Y
	Upgrade Median Slopes	29.568 to 34.271		$ 700,000		x	Y
	Upgrade Normal Ditch Slopes Options	7.500 to 34.271					
	Upgrade to 18' - 6:1 slopes on normal roadway ditches (which addresses clear zone):	7.500 to 34.271	$ 3,770,000	$ 3,770,000		x	Y
	Upgrade to 4:1 slopes on normal roadway ditches (and not address clear zone):	7.500 to 34.271	$ 860,000			x	Y
	INTERCHANGES						
	Interchange Crossroad to Crossroad Spacing						
1	**Exit #5- Lovers Lane to Exit #6 - US 68B Options**	5.175 to 5.759					N
	Close Interchange		$ 300,000	$ -		x	
	SB Braided Ramp		$ 14,600,000	$ 14,600,000		x	
2	**Exit 33 (US 62) to Exit 34 (WKP/I-69) Options**	32.861 to 34.271					Y
	Close Interchange or		$ 300,000	$ -		x	
	Complete CD System between Exits #33 and Exit #34		$ 25,000,000	$ 25,000,000		x	Y
	Remove Rolled Curb from Ramps Options	**Total Ramp**	**1st Curve**	$ 1,447,900			
	Exit #30 - US 41 Partial						
5	NB On Ramp	$ 932,000	$ -			x	N
6	SB Exit Ramp	$ 319,700	$ 145,300			x	N
	Exit #23 - KY 800						
2	SB On Ramp	$ 58,100	N/A			x	N
1	SB Exit Ramp	$ 43,600	N/A			x	N
3	NB On Ramp	$ 50,900	N/A			x	N
4	NB Exit Ramp	$ 43,600	N/A			x	N
2 3	**Guardrail End Treatments (US 41 NB Entrance Ramp)**			$ 10,000		x	N
1 2 3	**Remove & Replace Crash Cushions (Exit 34 at Ramps 38A, 38B & 106B)**			$ 27,000		x	N
1	**Raised Median on Ramp (Exit 5 Lovers Lane)**			$ 50,000		x	N
	Access Control			$ 396,200			
1	Exit #5 - Lovers Lane		$ 164,000			x	N/A
2	Exit #7 - US 41A		$ 82,200			x	N/A
3	Exit #33 - US 62		$ 150,000			x	N/A
	Ramps - Accel/Decel			$ 2,640,000			
	Exit #23 - KY 800		$ 179,600				
1	SB On Ramp - Ramp A	$ 89,800				x	N
3	NB On Ramp - Ramp D	$ 89,800				x	N
	Exit #30 - US 41						
5	US 41 NB On Ramp	$ 89,800	$ 89,800			x	N
	Exit #33 - US 62		$ 2,370,600				
7	SB On Ramp - Ramp A	$ 964,400				x	N
8	SB Exit Ramp - Ramp B	$ 151,800				x	N
9	NB Exit Ramp - Ramp C	$ 1,018,200				x	N
10	NB On Ramp - Ramp D	$ 236,200				x	N
	Interchange Reconstruction			$ 48,433,000			
3	**Exit #34 - WKP/I-69**		$ 27,533,000				
12	NB ETB Exit Ramp to WB I-69 Exit - Ramp H	$ 25,000,000				x	Y
11	NB I-69 to SB ETB	$ 2,400,000				x	Y
11	ETB Entrance Ramp from NB I-69 - Ramp A Increase Acceleration	$ 133,000				x	Y
2	**Exit # 30 US 41**	$ 10,400,000	$ 10,400,000			x	N
	Other Option Close Interchange	$ 900,000					
1	**Exit #11 - KY 1682**		$ 10,500,000			x	Y
	Subtotal			$ 111,468,300	$ 13,860,300	$ 97,608,000	
	Estimated Design and Environmental (15%)			$ 16,720,000	$ 2,079,000	$ 14,641,000	
	Estimated Right of Way and Utilities (30%)			$ 33,440,000	$ 4,158,000	$ 29,282,000	
	GRAND TOTAL			**$ 161,628,300**	**$ 20,097,300**	**$ 141,531,000**	

I. INTRODUCTION

The Kentucky Transportation Cabinet (KYTC) has initiated an interstate deficiencies study to identify and evaluate potential improvement options to upgrade the Edward T. Breathitt (formerly the Pennyrile) Parkway to interstate standards for inclusion into the interstate system. The study area limits are from I-24 in Christian County approximately 34 miles north to the I-69/Western Kentucky Parkway (WKP) interchange in Hopkins County (see Figure 1, p. 2).

A. Project History

The Edward T. Breathitt Parkway—herein referred to as the ETB Parkway, also known as EB 9004—connects I-24 at Hopkinsville with US 41 at Henderson nearly 80 miles to the north. It was originally constructed in the 1960s, as the Pennyrile Parkway Toll Road, by extending the north and south termini of the toll-free Madisonville US 41 (at that time) Bypass, which had been constructed a few years earlier. At its northern terminus, the ETB Parkway allows connections to I-64 via I-164 in Evansville, Indiana, as well as to Owensboro via the Audubon Parkway and to southern Illinois via US 60 and KY 56. As noted, the ETB Parkway connects with I-24 at its southern terminus near Hopkinsville. Near its midpoint in Hopkins County, the ETB Parkway interchanges with the I-69/Wendell H. Ford Western Kentucky Parkway (I-69/WKP). Between the WKP and its northern terminus in Henderson, the ETB Parkway has been designated as the future route of I-69. The ETB Parkway was designed in accordance with common geometric practices for a 70-mph rural/urban arterial road (other than freeway) and is functionally classified as a Rural Principal Arterial (Other Freeways and Expressways) between I-24 (MP 0.000) and the southern ramps of Lovers Lane (MP 4.800). This section was opened to traffic in early 2011.

The portion of the ETB Parkway from the southern ramps of Lovers Lane north to approximately the southern end of the CSX Railroad at MP 7.500 was opened to traffic in early April 2010. This segment of the ETB Parkway, as well as the segment north to the KY 1682 underpass, is designated an Urban Principal Arterial (Other Freeways and Expressways) interchange. From the KY 1682 underpass to the I-69/WKP interchange, the ETB Parkway changes to a Rural Principal Arterial. As shown in Table 1 (p. 3) each section is designated on the State Primary Route System (SPRS) as a State Primary Route. According to KYTC's Highway Inventory System (HIS)[1] the ETB Parkway is located on the systems or networks shown in Table 1 and is classified as an AAA truck route allowing for a total weight allowed of 80,000 pounds.

The study corridor passes through the city of Hopkinsville. Hopkinsville, which had a 2012 population estimate of 32,966, is the 6th largest city in Kentucky and the county seat of Christian County (2012 population estimate of 75,427). Regionally, Hopkinsville is served by I-24 to the south and west, and by the ETB Parkway to the north and (now) south.

[1] HIS – KYTC Highway Inventory System - http://datamart.business.transportation.ky.gov/EDSB_SOLUTIONS/HISEXTRACTS/default.aspx -

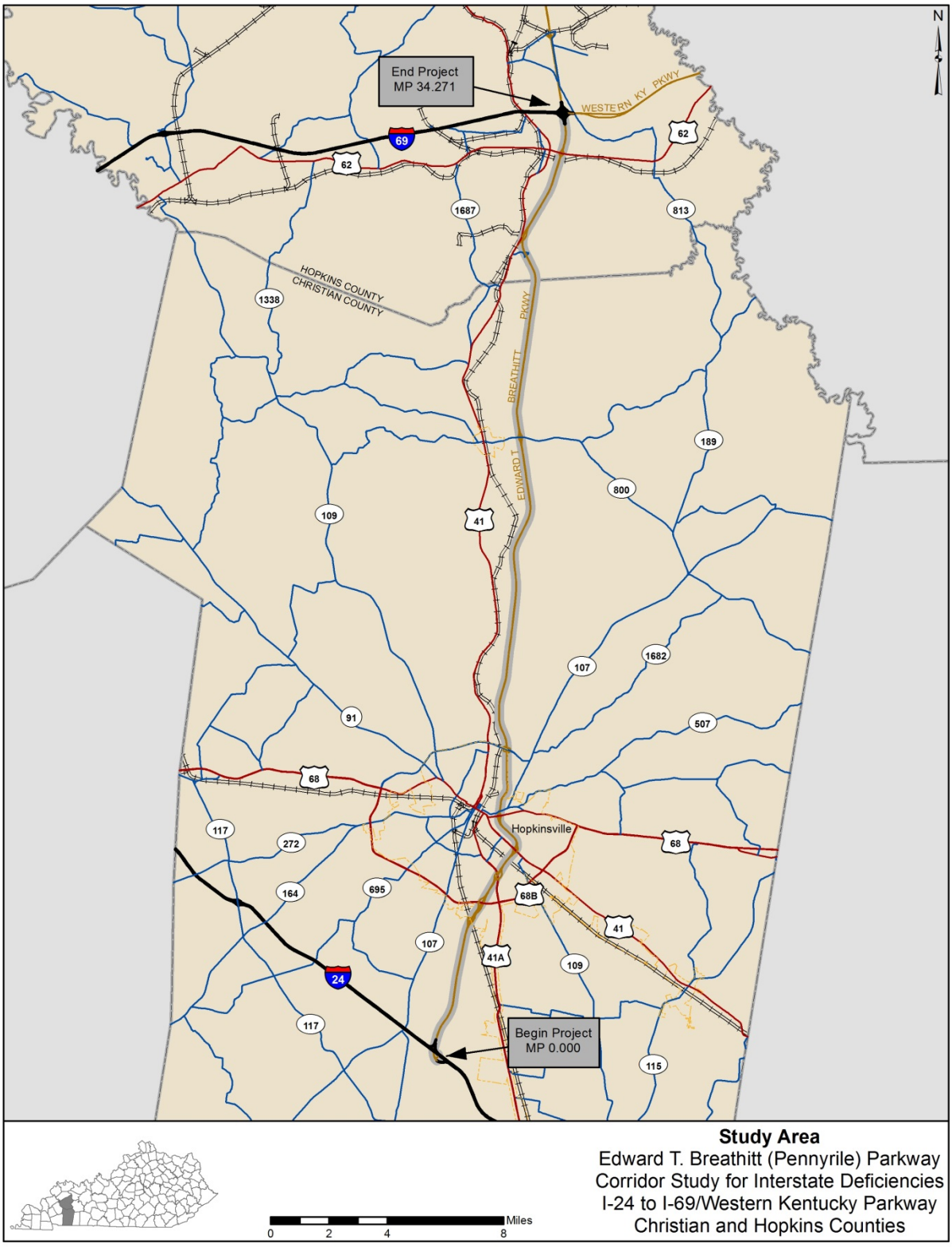


Figure 1: Study Area

Table 1: Highway Systems

County	Begin MP	End MP	State System	National Truck Network	National Highway System	State System	Functional Classification	Truck Weight Class
Christian	0.000	5.175	State Primary (Parkway)	Yes	Yes	Other Freeways And Expressways	Rural Principal Arterial	AAA
Christian	5.175	11.697	State Primary (Parkway)	Yes	Yes	Other Freeways And Expressways	Urban Principal Arterial	AAA
Hopkins	11.697	34.271	State Primary (Parkway)	Yes	Yes	Other Freeways And Expressways	Rural Principal Arterial	AAA

As shown in Figure 2 (below), there are currently four fully controlled access facilities in the project area: two interstates north and south of Hopkinsville—I-69 and I-24, respectively; as well as the WKP and the ETB Parkway in Christian and Hopkins counties.

1. I-24

I-24 is designated a Rural Interstate and is on the State Primary Road System. In the study area it stretches southeast from the Trigg County Line to the Tennessee State Line for approximately 23.5 miles. I-24 West connects Christian County to the Lake Barkley and Kentucky Lake recreation areas approximately 50 miles to the west, while I-24 East provides access to the Nashville Metropolitan Area approximately 60 miles to the south. I-24 also carries the I-69 shield from just west of US 62 to the Julian M. Carroll Parkway.

2. I-69

As a result of the Federal Highway Administration (FHWA) 1995 Corridor 18 Feasibility Study, there were three I-69 Segments of Independent Utility (SIU) for I-69 identified in Kentucky. At the time of this report, Kentucky has 55 miles under shield between the Julian M. Carroll (JCP) and ETB parkways. The segments are defined as follows (see Figure 2):

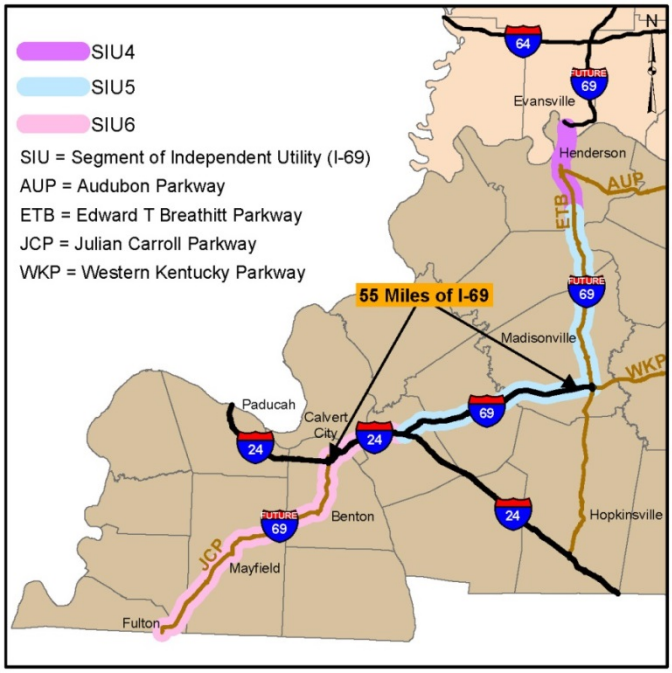


Figure 2: Fully Controlled Access Facilities and I-69

- SIU 4

  I-64/I-164 north of Evansville, Indiana, south to the ETB Parkway at Henderson, Kentucky

- SIU 5

  The ETB Parkway from Henderson, Kentucky, to the interchange with the WKP Parkway

  The WKP to the interchange with I-24

- SIU 6

  I-24 at the WKP to the interchange with the JCP

  The Purchase Parkway to the Tennessee State Line

Each SIU is in varying stages of study, conversion, or completion, as summarized below. The overall goal is having I-69 designated in Kentucky from Fulton north to Henderson, and then across the Ohio River north to connect with I-164 in Evansville, Indiana.

1. **FULTON COUNTY Item 01-25.00 (TN State Line to Exit 1 in Fulton, KY)—**A bi-state project with Tennessee that will connect TN 51 and the Purchase Parkway to form I-69. KY's current estimate for its share of the project is $47 million (**D**esign, **R**ight-of-Way, **U**tility, and **C**onstruction). Kentucky is in the process of entering into a bi-state agreement with Tennessee that will allow the Tennessee Department of Transportation (TDOT) to re-evaluate the current Record of Decision (ROD) from Dyersburg, Tennessee, to Exit 1 in Kentucky with a design change between these two routes. The construction timeline is to be determined.
2. **FULTON, HICKMAN and GRAVES COUNTIES Item 01-26.00 (Exit 1 at Fulton, KY to Exit 21 in Mayfield, KY)—**Modernization of the Purchase Parkway corridor including reconstruction of a cloverleaf interchange (old toll booth location) at Exit 14 in Wingo. The current cost estimate is $16 million (D, R, U and C). The construction timeline is to be determined through a future road plan update with the General Assembly.
3. **GRAVES COUNTY Item 01-193.00 (Exit 21 in Mayfield)—**This project involves the reconstruction of the Purchase Parkway/US 45 Interchange in Mayfield. The objective is to make the Purchase Parkway the through movement for the national and regional traveler. This project influences the Exit 22 interchange so the northern terminus extends to the north side of Exit 22. The current cost estimate is less than $27 million (D, R, U and C). The construction timeline is to be determined through a future road plan update with the General Assembly.
4. **GRAVES AND MARSHALL COUNTIES Item 01-234.00 (Exit 21 in Mayfield to Exit 52 at I24/I69 in Calvert City)—**This project involves the modernization of Purchase Parkway corridor from the tie down of the Mayfield Interchange Reconstruction Project to the tie down of I-24 Interchange Reconstruction Project. The current cost estimate is under $10 million (D and C). The project was let to construction in August 2014 for $8.08 million.
5. **MARSHALL COUNTY Item 01-8101.00 (Exit 43 in Benton)—**This project is the reconstruction of the existing cloverleaf interchange (former toll location) in Benton. The current project cost estimate is approximately $12 million (D, R, U, and C). Construction funds have not been authorized as yet.
6. **MARSHALL COUNTY Item 01-800.00 (Exit 52 at I24/I69 in Calvert City)—**This project is the reconstruction of the Purchase Parkway/I-24 Interchange to create a major fork in interstate system for I-24/I-69. The current cost estimate is under $42 million (D, R, U and C). The construction timeline calls for letting in the fall of 2015.

7. **HOPKINS COUNTY Item 02-225.00 (WKP/ETB Parkway)—**This project involves the reconstruction of the WKP/ETB Parkway interchange to make I-69 the through movement toward Henderson. This project was awarded as a design/build project and is currently under construction with an approximate completion date of late summer 2015 at a total cost of approximately $35 million (D, R, U and C).
8. **HOPKINS, WEBSTER AND HENDERSON COUNTIES Item 02-232.00 (WKP to MP 73.4 on the south side of Henderson)—**This project is the modernization of the ETB Parkway corridor from the WKP to the current MP 73.4 south of Henderson. The current project cost estimate is approximately $18 million (D and C). This project was let to construction in May 2014 for $11.93 million.
9. **HOPKINS COUNTY Item 02-8633.00 (Exit 37 at Morton's Gap)—**This project is the reconstruction of the existing "flopped" diamond interchange to a conventional diamond interchange. The current cost estimate is under $16 million (D, R, U and C). The construction timeline calls for letting this project in early 2015.
10. **WEBSTER COUNTY Item 02-8637.00 (Exit 63 at Sebree)—**This project involves the reconstruction of this interchange (former tollbooth location) to a conventional diamond interchange. The current cost estimate is under $14 million. This project was let to construction in the summer of 2014 for $10.5 million.
11. **HENDERSON COUNTY Item 0.2-8304.00 (Exit 68 just south of Henderson)—**This project is the completion of the half diamond interchange to a full diamond interchange. The current cost estimate is just under $7 million (D, R, U and C). This project was open to traffic on October 28, 2014.

3. Western Kentucky Parkway (WKP)

Currently, the WKP is an east-west route beginning at I-69 in Hopkins County and ending at I-65 in Hardin County. The WKP opened as a toll road in October 1963 connecting US 62 west of Princeton with the Kentucky Turnpike (now I-65) at Elizabethtown. The western terminus was extended to interchange with I-24 near Lake Barkley a few years later. Tolls were removed in 1987. The 136-mile WKP provides connections to Paducah via I-24; Hopkinsville, Madisonville, and Henderson via ETB; Owensboro and Bowling Green via the William H. Natcher Parkway; and Louisville via I-65. Seven of Kentucky's state parks can be conveniently accessed from the WKP. Between I-24 and the ETB, the original WKP has been designated and signed as part of I-69.

B. Additional Projects in the Study Area

Additional projects in either the highway plan or recently let to construction are as follows:

- **KYTC Item Number 02-100.20—**Reconstruct US 41A from Clinic Drive (including Clinic Drive Reconstruction) to the North Entrance of the Mall from MP 13.900 to MP 13.668 in Christian County. Construction $8.66 million.
- **KYTC Item Number 02-8630.00—**Install lighting at the KY 800 interchange (Exit 23 at Crofton). This project has been completed.
- **KYTC Item Number 02-8505.00—**Extend Lovers Lane east to US 41A and make safety improvements. Awarded in July 2014.

- **KYTC Item Number 02-0136.00**—Extend KY 1682 from the ETB Parkway to US 68/KY 80 east of Hopkinsville. (Hopkinsville Northeast Bypass). Design scheduled for 2017.

C. Project Identification Forms

Through the KYTC planning process there have been three Project Identification Forms completed for this study corridor. They are as follows:

- Control Number 02 024 D9004 1.0

  MP 15.465 To MP 15.565; Construction Full Interchange at Woodburn Hay Road to provide better access to the ETB Parkway for Northern Christian County; 2010 cost estimate $6,450,000.

- Control Number 02 024 D9004 4.00

  Planning study to assess what would be necessary to convert ETB Parkway an I-24 Spur to WKP; $250,000.

- Control Number 02 024 D9004 1.50.

  Address safety issues on ETB Parkway from KY 800 south to MP 21.95 (marked low priority due to low crash activity).

D. Study Considerations

Specifically, the planning process for this study included a review of the existing conditions along the ETB Parkway to identify locations that do not meet current American Association of State Highway and Transportation Officials (AASHTO) interstate highway design guidelines. Evaluations included determining which criteria were not met and the potential impact of the deficiencies on safety and capacity, and options for making improvements to address identified deficiencies. The overall activities included the following:

- Conduct an inventory of existing conditions and define problem areas.
- Establish purpose and goals.
- Propose and analyze alternative improvement options.
- Prepare cost estimates.
- Prioritize improvements.
- Conduct public involvement throughout the study process.
- Recommend solutions.
- Document study process and results.

The ETB Parkway was evaluated based on the current design standards and guidelines. Applicable references are listed as follows:

- “A Policy on Geometric Design of Highways and Streets, 4th Edition” (American Association of State Highway and Transportation Officials, 2011 Edition) referred to as the *2011 Green Book*

- "AASHTO Roadside Design Guide" (American Association of State Highway and Transportation Officials, 4th Edition 2011) referred to as the *Roadside Design Guide*
- "Highway Capacity Manual" (Transportation Research Board, 2010 Edition) referred to as the *HCM*
- "Manual of Uniform Traffic Control Devices, Millennium Edition" (Institute of Transportation Engineers, 2009 Edition with Revision Numbers 1 and 2 incorporated, dated May 2012) referred to as the *MUTCD*
- "A Policy on Design Standards Interstate System" (American Association of State Highway and Transportation Officials, 2005) referred to as the *Interstate Standards*
- Kentucky Transportation Cabinet Highway Design Manual (KYTC, January 2006) referred to as the *KYTC Design Manual*
- Kentucky Transportation Center Analysis of Traffic Crash Data in Kentucky (2008-2012) Research Report KTC-13-13/KSP2-11-1 referred to as the *KTC Crash Data Report*

Also used in the existing conditions analysis of the ETB Parkway were the following:

- As-Built plans provided by KYTC
- KYTC's Division of Planning's Highway Inventory System (HIS) database, http://datamart.business.transportation.ky.gov/EDSB_SOLUTIONS/HISEXTRACTS/default.aspx, referred to as HIS
- Kentucky State Police's Kentucky Collision Analysis for the Public, http://crashinformationky.org/KCAP/KYOPS/SearchWizard referred to as KSP's Collision Database
- As-Built Bridge plans, National Bridge Inventory Kentucky Inventory and Appraisal Reports (NBIS), KYTC Bridge Inspection Reports (BIR), all provided by KYTC
- Field visits

The corridor was analyzed based on the list of references to determine the extent to which it meets the current interstate standards. The analysis also included determining whether the ETB Parkway currently satisfies the safety and operational concerns that might be expected from converting the ETB Parkway into an interstate highway.

E. Design Exceptions and Variances

FHWA has identified 13 design features that are important to the operational and safety performance of a highway. These controlling design features are commonly referred to 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 as follows:

- Design speed
- Lane width
- Shoulder width

- Bridge width
- Horizontal alignment
- Superelevation
- Vertical alignment
- Grade
- Stopping sight distance
- Cross slope
- Vertical clearance
- Lateral offset to obstruction
- Structural capacity

In this study, these design features were evaluated for compliance with interstate design criteria. No design exceptions or variances were assumed, rather, a list of improvements was developed that can be selected for implementation or considered in the future for design exceptions.

Design features that deviate from common practice but are not included in the 13 controlling criteria will be considered as a design variance. A design variance is a feature that:

- Varies from the current AASHTO criteria but is not part of the 13 controlling criteria.
- Varies from common practice but is not part of the 13 controlling criteria.

II. PROJECT MEETINGS

As part of this study, local officials and other stakeholders from the project area were engaged to gain input, and to keep them informed as the study progressed. The meeting minutes are located in **Appendix A**.

A stakeholder's meeting was held on April 29, 2014, to present a summary of the project and the purpose of the study, and to garner their input. The planning process for the study included identifying areas of the ETB Parkway that do not comply with interstate standards, as well as to provide the estimated costs required to upgrade it to interstate standards. Evaluations included determining which criteria were not met and the potential impact of the deficiencies on safety and capacity, and options for making improvements to address identified deficiencies. The goal of the project would be to have interstate connectivity from I-69 to I-24. It was explained that improvements could not strictly occur north of Hopkinsville on the older sections of the ETB Parkway, because newer sections may have design issues due to the road's upgrade to interstate standards. The stakeholders and local officials were informed that, based on current traffic forecasts prepared by KYTC, upgrading the ETB Parkway to interstate standards does not generate additional traffic. At this meeting, a high-level first look at 34 miles of the ETB Parkway was presented. Questions, concerns, and discussion items included the following:

- If interchanges were too closely spaced, would one be closed? KYTC stated that perhaps more elaborate ramp designs, such as between Lovers Lane and US 68, may be necessary. Discussions with FHWA will be held at a later date to resolve that issue.

- It was pointed out that crashes at the US 41 southbound exit ramp may have coincided with roadway construction.
- How flexible would FHWA be regarding exceptions to some deficiencies? It was explained that, at this point in the study, it would be assumed that there would be no exceptions to policy or standards; however, future conversations with FHWA will take place regarding this issue.
- Stakeholders stated that businesses would not relocate to the area unless the ETB Parkway is reclassified to an interstate. They also explained that the term "parkway" is thought by many to mean a "scenic route," and not a direct route.

An additional Local Officials/Stakeholder's meeting was held on August 5, 2014, to provide participants with the results of further study of deficiencies and improvement options and costs. They were advised that costs did not include right-of-way and utility costs and the totals could decrease based on whether or not design exceptions are allowed; the purpose of this project is to improve interstate connectivity and improve safety; and enhancing the potential for economic development is a goal of, but not the purpose and need for, the project. Questions, concerns, and discussion items raised by the stakeholders/officials included the following:

- What type of design exceptions have been granted in the past for I-69? KYTC noted that various exceptions have been granted in the past, but FHWA approval of exceptions is not a guarantee and cannot be pursued until the current phase of the project concludes. It was explained that the objective of this report would be to address all potentially needed changes without any design exceptions.
- Could items be removed from the list to reduce costs? It was explained that when maintenance issues are attended to, some of these issues may be addressed.
- Another suggestion was to now pursue the Exit #11 (KY 1682) old tollbooth interchange as a standalone project.
- Is there a requirement to address spots that have a critical rate factor of greater than 1.0? KYTC responded that there is not such a requirement, but that the data is a tool used as an indicator that crashes may not be occurring at random and that a review of the roadway characteristics is warranted. Improvements and costs that are directly associated with crashes would require further analysis that would be done or developed during the design phase.

III. OPERATIONAL CONSIDERATIONS

The current and future operations of the ETB Parkway, functioning as both a parkway and an interstate, were evaluated for the designation as an interstate spur. The evaluation of the operational considerations includes a crash history and traffic analysis.

A. Crash History and Analysis

1. Crash Methodology

The objective of the crash analysis is to identify locations along the ETB Parkway that may be considered high-crash locations based on crash patterns and the Kentucky Transportation Center's Statewide Crash Rates located in *KTC's Crash Data Report* for similar type roadways. A statistical analysis was performed to identify locations that indicate crashes may not be occurring at random and then conduct a high-level analysis conducted to determine a potential cause for those crashes. Those locations are also compared to locations that do not meet today's interstate standards for any correlation to the roadway. A detailed review of Crash Reports was not part of this study.

Five years of crash data (January 1, 2008, to December 31, 2012) extracted from the *KSP's Collision Database* was used to identify sections of the ETB Parkway with Actual Crash Rates exceeding the Critical Crash Rates, indicating a possible need for safety improvements. This range of years was used to correlate with *KTC's Crash Data Report*. As part of the methodology, a Critical Crash Rate was calculated for both segments (greater than 0.3-mile in length) and spots (equal to or less than 0.3-mile in length). A Critical Crash Rate is the maximum crash rate expected to occur on a roadway section, given the statewide Average Crash Rate for that functional road class, the ADT volume, and the roadway section length. The ratio of these two rates (i.e., the Actual Crash Rate to the Critical Crash Rate) produces a Critical Crash Rate Factor (CCRF), a measure of crash frequency for each segment or spot. If the roadway segment or spot's Actual Crash Rate exceeds the Critical Crash Rate (i.e., the CCRF is greater than 1.0), the section is identified as a possible high-crash location. A CCRF greater than 1.0 was used as an indicator that crashes may not be occurring at random.

2. Crash Analysis

The crash analysis (2008 – 2012) involved obtaining crash information from the KSP's Collision Database, and plotting crashes by their mile point and latitude/longitude. There were 153 crashes that were removed from the analysis because they were misidentified (135 crashes plotted on US 41 and 18 randomly located elsewhere). Also, crashes on interchange ramps were removed from this analysis in order to analyze just the mainline corridor. Interchange ramps were analyzed separately and discussed in Chapter VI, *Interchanges and Ramps*. The total number of crashes analyzed for the ETB Parkway corridor was 452 (see **Appendix B**). Table 2 (p. 11) shows the distribution of crash severity for the entire corridor. Table 3 (p. 11) depicts the crashes along the corridor with respect to the manner of directional analysis.

In addition to crash statistics shown in Table 3, crash statistics to note are:

- 81.0% involved single vehicles
- 7 were fatalities
- 34.3% occurred in the dark
- 27.2% were collision with an animal
- 25.7% "ran off roadway"
- 22.8% occurred in wet weather
- 3 were head-on (MP 10.275 SB, MP 15.197 direction not specified, and MP 16.69 NB)

Table 2: ETB Parkway Crashes

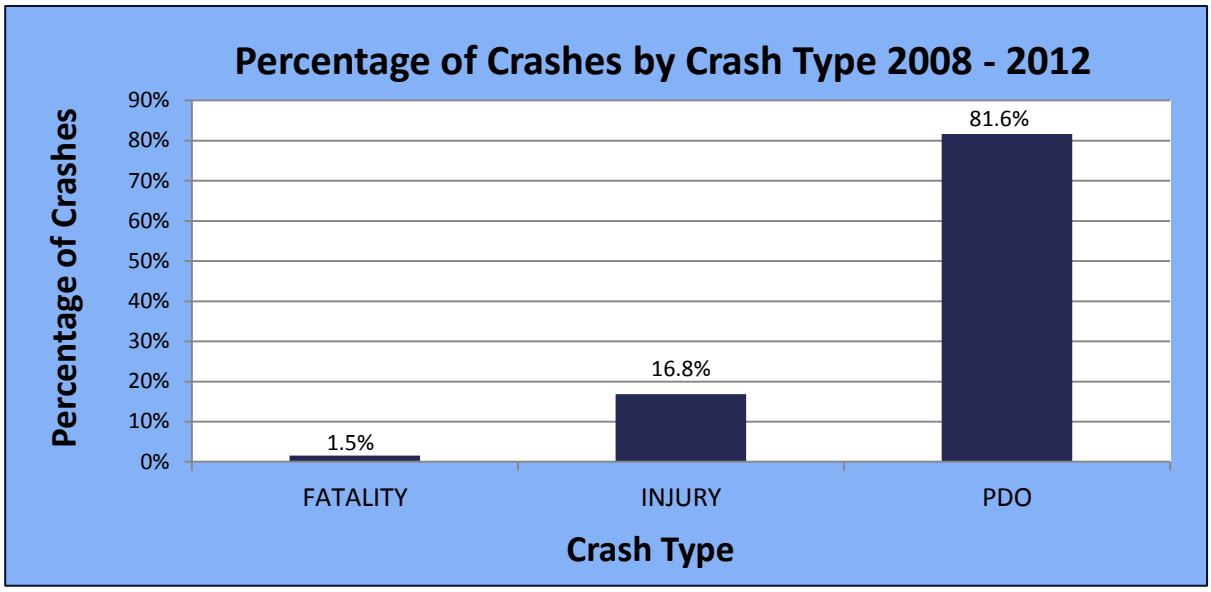
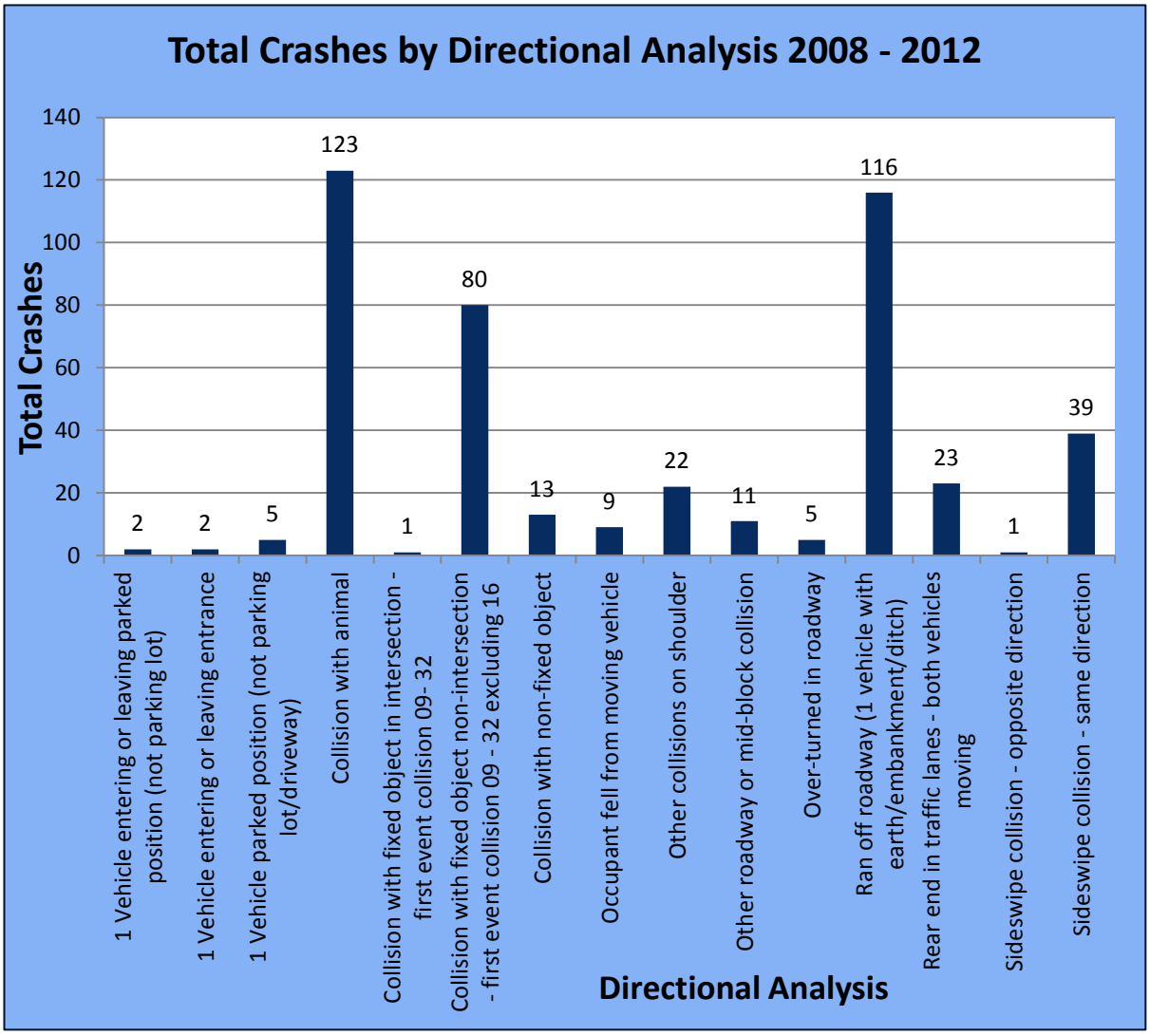


Table 3: Total Crashes by Directional Analysis



3. Analysis as a Parkway

For the analysis of segments, a high-crash segment was defined as having a CCRF greater than or equal to 1.0. A Fatality Crash Rate Factor was calculated to identify segments with a history of fatal crashes. Segments with a Fatal Crash Rate Factor greater than 0.9 were also identified in the analysis. It must be understood that a CCRF calculation represents both directions of the divided roadway. It is also an indicator that crashes may not be occurring at random. However, additional analysis beyond the scope of this study should occur prior to investment in funds to ensure that crashes are occurring as a result of the roadway.

The ETB Parkway was divided into nine segments for analysis. The 2008-2012 five-year statewide crash rate for rural parkways is 64 crashes per one-hundred million vehicle miles (crashes/HMVM) and 93 crashes/HMVM for an urban parkway. It is important to note that only one year of data was available from I-24 to Lovers Lane because it has only been open to traffic since March 1, 2011. Likewise, the section from Lovers Lane to MP 7.500 (southern end of the CSX Railroad) was opened to traffic on April 1, 2010, thereby providing only two years of crash data. Therefore, corresponding average crash rates were utilized for those segments. Based on the limited amount of crash data, crash rates range from 77.828 to 178.166 crashes/HMVM.

a. ETB Parkway Segments

The ETB Parkway was divided into segments (over 0.3-mile in length). These segments were assigned utilizing the classification of the ETB Parkway (whether rural or urban), the number of years the segment has been open to traffic, and the logical termini (interchanges). Then, the statewide crash rate for the roadway segments of those various lengths was assigned. Actual Crash Rates, Critical Crash Rates, Fatal Critical Crash Rate Factors, and CCRFs were calculated for these segments.

Three segments have a CCRF that exceeds 1.0. (See Figure 3, p.13, and Table 4, p.14.) The Fatal Critical Crash Rate Factor is also greater than 1.0 for the first segment from the end of I-24 northbound ramp to the southern ramps at Lovers Lane; however, again, this is an indicator and should be used with caution. The following describes pertinent statistics for each segment:

- **MP 0.587 - MP 4.800:** 18 crashes; 88% involved single vehicles; 31% occurred in wet conditions; 43% involved collision with animals; 31% ran off the roadway; 75% occurred on a straight and level section; there were 2 injury and 2 fatal crashes.
    - A review of the crash report indicated that the fatal crash at MP 1.761 involved a vehicle passing two vehicles on the right in the dark: someone pulled out to pass in front of this vehicle. The initial vehicle swerved to miss the passing vehicle, ran off the roadway, and overturned.
    - The fatal crash at MP 4.716 involved a vehicle that was steered into the median for unknown reasons, then was overcorrected and hit the guardrail, according to the crash report. This crash occurred in daylight on dry pavement.

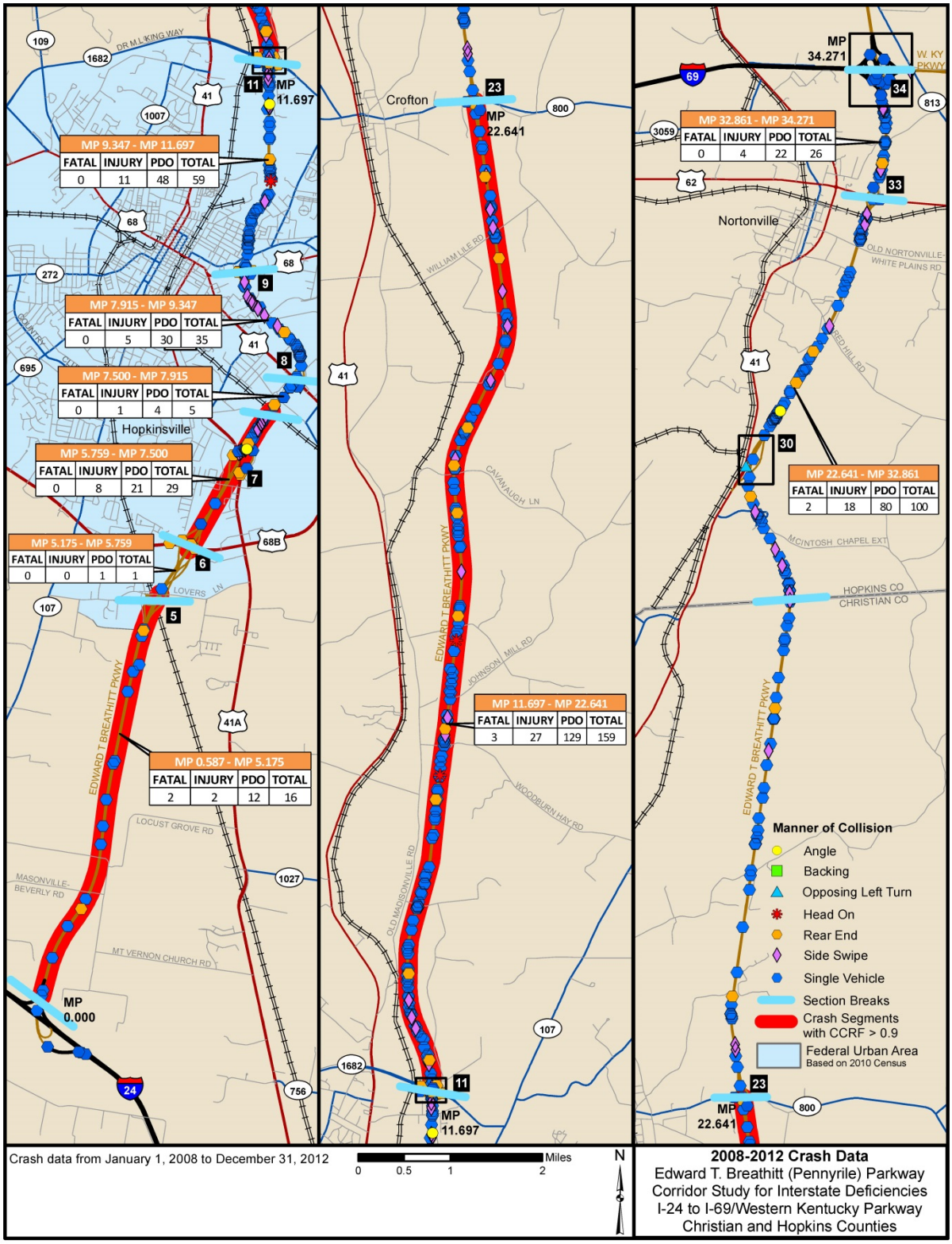


Figure 3: ETB Parkway Crash Segments and Manner of Collision

Table 4: ETB as a Parkway Segment Crash Analysis

County	Begin MP	End MP	Length (Miles)	Average ADT	Number Lanes	Rural / Urban	Functional Class Rate	Average Fatality Rate	CRASHES				HMVM	Rates per HMVM				Critical Crash Rate	Critical Fatality Rate	Critical Crash Rate Factor	Fatality Crash Rate Factor
									Fatal	Injury	PDO	Total		Actual Fatal Rate	Actual Injury Rate	Actual PDO Rate	Actual Total Rate				
Christian	0.587	4.800	4.213	8,087	4	R	62.00	0.70	2	2	14	18	0.124	16.08	16.08	112.58	144.74	123.54	10.83	**1.17**	**1.48**
Christian	4.800	5.175	0.375	8,087	4	U	89.00	0.70	0	0	0	0	0.011	0.00	0.00	0.00	0.00	365.16	66.36	0.00	0.00
Christian	5.175	5.759	0.584	8,549	4	U	91.00	0.50	0	0	1	1	0.036	0.00	0.00	27.44	27.44	233.44	23.76	0.12	0.00
Christian	5.759	7.500	1.741	11,948	4	U	91.00	0.50	0	8	21	29	0.152	0.00	52.68	138.29	190.98	157.35	8.47	**1.21**	0.00
Christian	7.500	7.915	0.415	13,127	4	U	93.00	0.50	0	1	4	5	0.099	0.00	10.06	40.23	50.29	176.81	11.31	0.28	0.00
Christian	7.915	9.347	1.432	13,512	4	U	93.00	0.50	0	5	30	35	0.353	0.00	14.16	84.95	99.11	136.22	4.98	0.73	0.00
Christian	9.347	11.697	2.350	13,250	4	U	93.00	0.50	0	11	48	59	0.568	0.00	19.36	84.47	103.83	126.83	3.80	0.82	0.00
Christian	11.697	22.641	10.944	10,020	4	R	64.00	0.70	3	27	129	159	2.001	1.50	13.49	64.46	79.45	78.82	2.47	**1.01**	0.61
Hopkins	22.641	32.861	10.220	10,497	4	R	64.00	0.70	2	18	100	120	1.958	1.02	9.19	51.08	61.29	78.98	2.50	0.78	0.41
Hopkins	32.861	34.271	1.410	14,154	4	R	64.00	0.70	0	4	22	26	0.364	0.00	10.98	60.40	71.39	99.52	5.64	0.72	0.00

NOTES:

- **HMVM** – Hundred Million Vehicle Miles
- **CCRF** – Critical Crash Rate Factor
- **CCRF>1.0** is an indicator that crashes may not be occurring at random. Those numbers are highlighted in red.

- **MP 5.759 - MP 7.500:** 29 crashes; 34% involved multiple vehicles; 28% occurred in wet conditions; 24% ran off roadway; 59% occurred on straight and level section; and 66% occurred in daylight.
- **MP 11.697 - MP 22.641:** 159 crashes; 82% involved single vehicles; 26% occurred in wet conditions; 26% ran off the roadway; 44% occurred on a straight and grade section; 50% occurred in daylight; and there were 27 injury and 3 fatal crashes.

The fatal northbound crash at MP 15.033 occurred at dawn and involved tread separating from a tire and the driver losing control. At MP 20.258, the fatal northbound crash occurred in daylight hours on dry pavement and involved a driver who ran off the road and overcorrected. The third fatal crash occurred in dark conditions at MP 21.483, where the driver may have fallen asleep traveling southbound, left the side of the road, overcorrected and lost control.

b. ETB Parkway 0.3-Mile Spots

A rolling crash analysis using 0.3-mile spots was performed to pinpoint more specific locations where there may be a crash issue. The average crash rate for 0.3-mile spots was determined. Critical crash rates and subsequent CCRFs were calculated for these spots, the locations of which are shown in Figure 4 (p.16) and detailed in **Appendix C**. A summary of those 0.3-mile spots with a CCRF greater than or equal to 1.0, including potential causation factors, are listed below. As noted previously, for MP 0.0 to MP 4.8, this section has limited statistics since being opened to traffic. As shown, there is some overlap of spots.

- **MP 0.4 - MP 0.7:** 3 crashes; 100% involved single vehicles; 100% occurred in dry conditions; 67% occurred in daylight; and 33% involved collision with animal.
- **MP 4.0 – MP 4.3:** 3 crashes; 100% involved single vehicles; 100% occurred in dry conditions; 67% were on a dark highway in an unlighted section; and 33% were collision with an animal.
- **MP 4.5 – MP 4.8:** 3 crashes; 67% were during wet conditions; 33% involved multiple vehicles; 33% ran off the road; and 33% occurred on a dark highway in an unlighted section. One fatal crash occurred in daylight and dry weather.
- **MP 6.8 - MP 7.1:** 13 crashes; 46% involved single vehicles; 62% occurred on straight and level section; 31% occurred in wet conditions; 23% occurred during dawn; 31% on a dark highway not lighted; 38% involved an injury.
- **MP 6.9 - MP 7.2:** 14 crashes; 57% occurred on straight and level section; 50% occurred during daylight; 43% involved a curve; 36% occurred in wet conditions; 36% involved an injury; 29% involved multiple vehicles; 29% on a dark highway not in a lighted section; 14% involved sideswipe vehicle; 7% ran off the road; 7% collided with a fixed object.
- **MP 7.0 - MP 7.3:** 19 crashes; 74% involved single vehicles; 58% occurred on straight and level sections; 52% occurred during daylight; 37% involved curve and level or curve and grade; 26% involved an injury; 26% wet weather; 21% were collisions with animals; 16% ran off the road; 16% were side swiped same direction; 16% were collisions with a fixed object.
- **MP 7.1 - MP 7.4:** 12 crashes; 67% involved single vehicles; 75% occurred in dry conditions; 75% occurred during daylight; 33% involved sideswipe vehicle; 25% occurred in wet conditions; 25% ran off the road; 25% were side swipe same direction and 25% were collision with animals; 17% occurred on curve and grade sections.

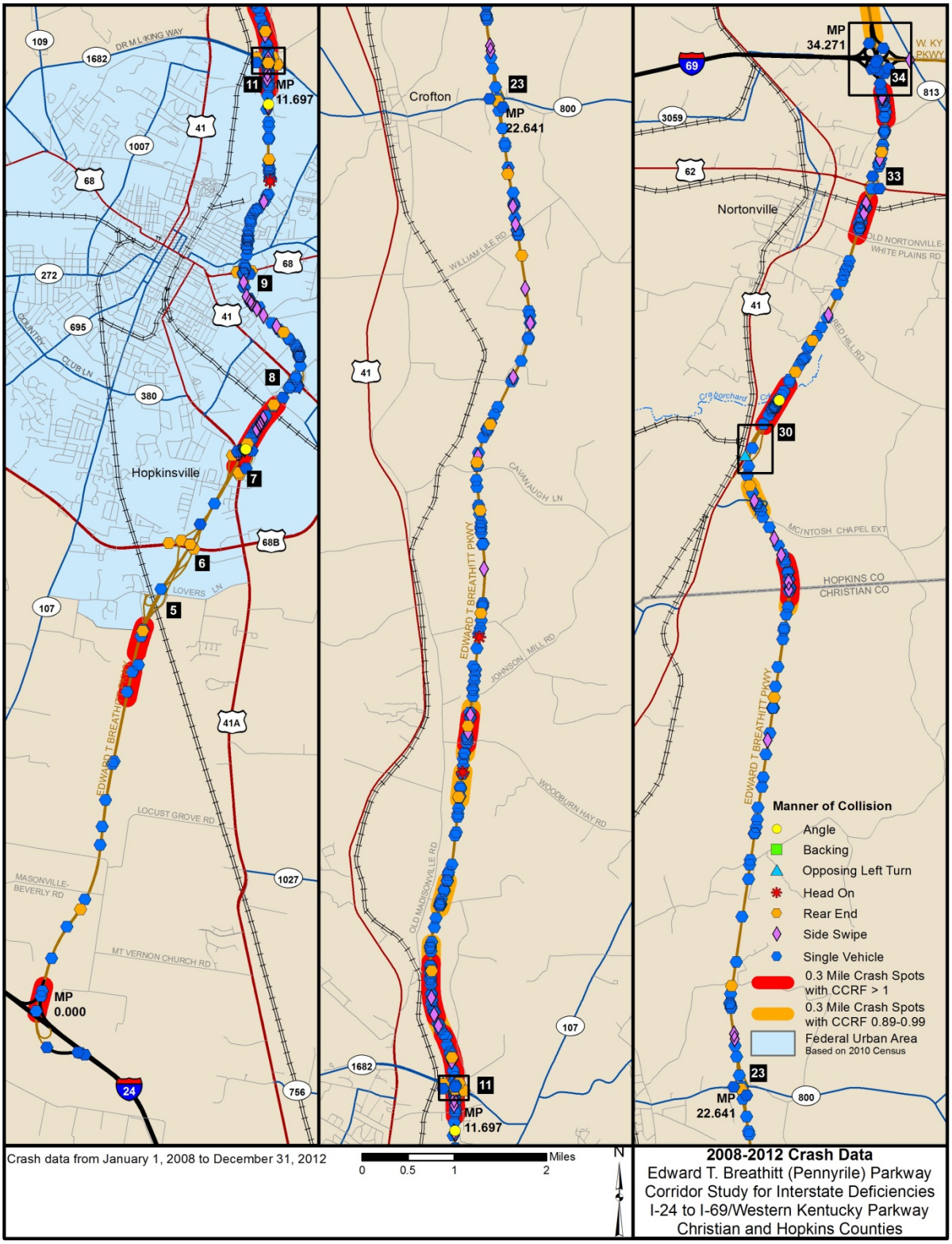


Figure 4: ETB Parkway 0.3-Mile Crash Spots

- **MP 7.2 - MP 7.5:** 12 crashes; 83% occurred on dry road conditions; 75% occurred during daylight; 67% involved single vehicles; 50% on straight and level; 33% involved sideswipe vehicle; 25% ran off roadway; 17% occurred on curve and grade sections.
- **MP 7.3 - MP 7.6:** 9 crashes; 7 occurred on dry road conditions; 2 occurred in ice or slush; 78% occurred during daylight; 45% involved multiple vehicles; 44% occurred on straight and grade section; 33% involved sideswipe vehicles; 33% involved an injury.
- **MP 11.4 - MP 11.7:** 14 crashes; 71% involved single vehicles; 64% were during daylight; 29% occurred on wet road conditions; 21% involved sideswipe vehicles; 21% involved collision with fixed object not at an intersection; 14% occurred on curve and grade section; and 14% involved an injury.
- **MP 11.5 - MP 11.8:** 15 crashes; 73% involved single vehicles; 53% were during daylight; 27% occurred on wet road conditions; 27% involved collision with fixed object not at an intersection; 20% involved sideswipe vehicles; 20% were on a dark highway in an unlighted section; 13% were on a dark highway with lights on; 7% occurred on curve and grade section; and 7% involved an injury.
- **MP 11.8 - MP 12.1:** 9 crashes; 89% occurred when it was dry; 78% involved single vehicles; 67% occurred on a dark highway in an unlighted section; 44% involved collision with an animal; 44% occurred on straight and level grade; 11% involved sideswipes; and 11% occurred on wet road conditions.
- **MP 12.0 - MP 12.3:** 9 crashes; 89% single vehicles, 78% occurred on dry road conditions, 56% occurred on a dark highway in an unlighted section, 33% involved collision with an animal, 33% occurred on straight and grade section, 22% involved an injury, and 11% involved rear-end type crashes.
- **MP 12.5 - MP 12.8:** 9 crashes; 67% involved collision with an animal; 78% were single vehicle crashes; 55% occurred on a dark highway in an unlighted section; 33% occurred on curve and grade section; 22% occurred on wet conditions; and 22% involved an injury.
- **MP 12.7 - MP 13.0:** 9 crashes; 44% involved collision with an animal; 78% involved single vehicles; 55% occurred during daylight; 33% occurred on wet conditions; 33% occurred on curve and grade section; and 11% involved an injury.
- **MP 12.8 - MP 13.1:** 9 crashes; 89% involved single vehicles; 67% occurred during the daylight; 45% occurred on wet conditions; 45% involved collision with an animal; 33% occurred on curve and grade section; and 33% involved an injury.
- **MP 15.5 - MP 15.8:** 9 crashes; 78% single vehicles; 55% occurred on straight and grade sections; 55% occurred on a dark highway in an unlighted section; 33% involved collision with an animals; 11% involved sideswipe crashes in same direction; and 11% occurred on snow/slush roadway conditions.
- **MP 27.9 - MP 28.2:** 8 crashes; 75% involved single vehicle crashes; 38% occurred on wet roadway conditions; 38% occurred on a dark highway not in alighted section; 25% involved collision with a fixed object in a non-intersection location; 25% ran off the roadway; 25% occurred on curve and grade sections; and 25% ran off the road.

- **MP 28.0 - MP 28.3:** 11 crashes; 54% occurred on a dark highway in an unlighted section; 82% involved single vehicles; 38% occurred on curve and grade section; 36% ran off the roadway; 27% occurred on wet roadway conditions; and 18% occurred on snow or slush.
- **MP 28.1 - MP 28.4:** 10 crashes; 50% ran off the roadway; 50% occurred on curve and grade section; 70% occurred on a dark highway in a lighted section; 30% occurred on wet roadway conditions; 30% occurred on snow or slush; 10% involved sideswipe crashes in same direction; and 10 % involved an injury.
- **MP 30.0 - MP 30.3:** 10 crashes; 100% involved single vehicles; 60% involved collision with an animal; 80% occurred on dry roadway conditions; 80% occurred on a dark highway in an unlighted section; and 10% occurred on curve and level section.
- **MP 30.1 - MP 30.4:** 14 crashes; 93% involved single vehicle crashes; 57% involved collision with an animal; 93% occurred on straight and level section; and 64% occurred on a dark highway not in a lighted section.
- **MP 30.2 - MP 30.5:** 13 crashes; 53% collision with animals; 93% involved single vehicles; 53% occurred on a dark highway in an unlighted section; 87% occurred on straight and level sections; and 15% wet roadway conditions.
- **MP 32.3 - MP 32.6:** 11 crashes; 42% occurred on a dark highway in an unlighted section; 92% involved single vehicle crashes; 36% occurred on straight and grade sections; 27% occurred on wet conditions; 27% involved a collision with a fixed object in a non-intersection location; 25% involved collisions with an animals; and 8% occurred on iced roadway conditions.
- **MP 32.4 - MP 32.7:** 10 crashes; 70% were single vehicle crashes; 30% involved sideswipe vehicle crashes; 30% occurred on wet conditions; 60% occurred on straight and grade sections; 60% occurred during daylight; 20% involved a collision with a fixed object in a non-intersection location; and 10% involved injuries.
- **MP 33.6 - MP 33.9:** 12 crashes; 17% involved sideswipe vehicle crashes; 17% occurred on wet conditions; 50% involved collisions with an animals; 25% occurred on curve and grade sections; 25% occurred in the dark; 17% in lighted section.

There are 10 additional 0.3-mile spots that are approaching 1.0 and locations are shown in Figure 4 (p.16). These spots should be monitored; however, they were not analyzed in more detail. Crashes as they relate to parkway deficiencies are summarized on page 60 in *Chapter VII, Summary of Key Findings Existing Conditions Overview*.

4. Analysis as an Interstate

In Kentucky, the average crash rate for a rural interstate facility is lower than that of a parkway facility. The lower average crash rate for a rural interstate facility versus a rural parkway facility affirms that crash rates are not linearly related to traffic volumes. Using the same methodology as that described above, there are three segments that are defined as high-crash rate segments when the ETB Parkway is analyzed as an interstate highway. These locations are the same segments identified in Chapter III, A.3 (*Analysis as a Parkway*).

Table 5 (p. 20) illustrates that there is one additional crash rate segment on the ETB Parkway with a CCRF that would approach 1.0 (0.95). That segment had 120 crashes and is between MP 22.641 and MP 32.861.This segment has the following significant statistics:

- 26% collision with animal
- 65% in dry conditions
- 49% in dark conditions
- 26% “ran off roadway” (1 vehicle with/earth embankment/ditch)
- 15% on ice or snow/slush
- 20% collision with fixed object non-intersection-first event collision
- 19% on wet pavement
- Crashes as they relate to interstate deficiencies are summarized on page 60 in Chapter VII, Summary of Key Findings Existing Conditions Overview.

B. Traffic Operations

A traffic analysis was conducted for the ETB Parkway to identify any current or future traffic operations issues related to increased traffic on the facility from interstate traffic projections. Current and future traffic projections were provided by KYTC with and without designating the ETB Parkway as an interstate between I-24 and the WKP. Traffic projections were not provided for two interchanges: the I-69/Western Kentucky Parkway (WKP)/ETB Parkway (already constructed) and KY 800 (considered remote and would not have weaving issues). Traffic projections for the I-69/WKP/ETB Parkway were based on traffic counts conducted for the *Improve Ramp Configuration of the Existing I-69/WKP/Pennyrile Parkway Interchange, Item No. 2-225.00.* The current (2013), design year (2040), and design year with I-69 open to traffic (2040) are shown in **Appendix D**.

A No-Build scenario was developed that assumed no additional ramps would be constructed at the US 41 partial interchange in Hopkins County at Exit 30. Because it is desirable to have full interchanges for interstate facilities, an alternative scenario was developed that would convert Exit 30 from a partial interchange into a full interchange. There were other proposed changes to the geometry of the Breathitt Parkway including a proposal to reconstruct Exit 11 from its current configuration to a diamond interchange. These other changes are not expected to significantly alter traffic volumes.

Level of Service (LOS) as defined by the Transportation Research Board in the “2010 *Highway Capacity Manual (HCM)”* as an index of the quality of flow in terms of factors such as speed, travel time and delay. LOS is expressed in letters ranging from “A” to “F,” where each LOS represents a range of operating conditions. LOS A represents the best operating conditions and LOS F represents the worst condition (i.e., severe congestion). LOS is the value that corresponds to capacity of the facility, movement or intersection. For freeway or interstate facilities, LOS is evaluated based on the density of vehicles in the area of analysis usually measured in terms of passenger cars per mile per lane (pc/mi/ln). In the case of ramp merge and diverge movements, LOS is typically based upon density of vehicles in the area of the movement considering upstream and downstream ramps.

Table 5: ETB Parkway as an Interstate Segment Crash Analysis

County	Begin MP	End MP	Length (Miles)	Average ADT	Number Lanes	Rural / Urban	Functional Class Rate	Average Fatality Rate	CRASHES				MVM	HMVM	Rates per HMVM				Critical Rate	Critical Fatality Rate	Critical Rate Factor	Fatality Rate Factor
									Fatal	Injury	PDO	Total			Fatal Rate	Injury Rate	PDO Rate	Total Rate				
Christian	0.587	4.800	4.213	8,087	4	R	49.00	0.50	2	2	14	18	2.951755	0.124	16.08	16.08	112.58	144.74	104.15	9.69	**1.39**	**1.66**
Christian	4.800	5.175	0.375	8,087	4	U	93.00	0.50	0	0	0	0	2.951755	0.011	0.00	0.00	0.00	0.00	374.29	62.98	0.00	0.00
Christian	5.175	5.759	0.584	8,549	4	U	101.00	0.30	0	0	1	1	6.24077	0.036	0.00	0.00	27.44	27.44	250.33	21.41	0.11	0.00
Christian	5.759	7.500	1.741	11,948	4	U	101.00	0.30	0	8	21	29	8.72204	0.152	0.00	52.68	138.29	190.98	170.73	7.21	**1.12**	0.00
Christian	7.500	7.915	0.415	13,127	4	U	96.00	0.30	0	1	4	5	23.95751	0.099	0.00	10.06	40.23	50.29	181.07	9.80	0.28	0.00
Christian	7.915	9.347	1.432	13,512	4	U	96.00	0.30	0	5	30	35	24.65986	0.353	0.00	14.16	84.95	99.11	139.89	4.09	0.71	0.00
Christian	9.347	11.697	2.350	13,250	4	U	96.00	0.30	0	11	48	59	24.18125	0.568	0.00	19.36	84.47	103.83	130.36	3.05	0.80	0.00
Christian	11.697	22.641	10.944	10,020	4	R	51.00	0.60	3	27	129	159	18.28723	2.001	1.50	13.49	64.46	79.45	64.25	2.26	**1.24**	0.66
Hopkins	22.641	32.861	10.220	10,497	4	R	51.00	0.60	2	18	100	120	19.1562	1.958	1.02	9.19	51.08	61.29	64.40	2.28	**0.95**	0.45
Hopkins	32.861	34.271	1.410	14,154	4	R	51.00	0.60	0	4	22	26	25.83105	0.364	0.00	10.98	60.40	71.39	82.86	5.28	0.86	0.00

NOTES:

HMVM – Hundred Million Vehicle Miles

CCRF – Critical Crash Rate Factor

CCRF>1.0 are indicators that crashes may not be occurring randomly. Those segments are highlighted in red.

CCRF>0.95 are indicators that crashes are approaching the threshold for concern.

For most design and planning purposes, LOS B is usually the minimum desirable for a rural interstate and LOS C the minimum desirable for an urban interstate because it ensures a comfortable and an acceptable quality of service to facility users. The LOS criteria used to evaluate interstate or freeway facilities, merge, and diverge movements are shown in Table 6. A traffic characteristics summary is shown in Figure 5 (p. 24).

LOS	Freeway	Merge/Diverge
	Density - passenger cars/mile/lane	
A	≤ 11	≤10
B	11 to 18	10 to 20
C	18 to 26	20 to 28
D	26 to 35	28 to 35
E	35 to 45	>35
F	> 45	Demand Exceeds Capacity

1. Current (2013) Traffic Volumes and LOS

The 2013 traffic volumes for this project are based on data from the KYTC's Highway Inventory System (HIS) database and traffic classification counts conducted by KYTC in 2013. Counts on entrance and exit ramps were also conducted in 2013 by Qk4. Truck percentages and directional design hourly volumes (DDHV) were calculated based on the classification counts in 2013. The existing traffic volumes are shown in Table 7, and the complete forecast is located in **Appendix D**.

Existing traffic (2013) ranges from 8,700 vehicles per day (vpd) near the southern terminus of the ETB Parkway and climbs to 17,200 vpd in Hopkinsville. From KY 1682 (Exit 11) north to US 62 (Exit 33), the traffic volumes range from 9,800 to 11,600 vpd. Between Exits 33 (US 62) and 34 (I-69/WKP), 2013 traffic volumes climb to 14,600 vpd.

Where possible, mainline ETB Parkway truck counts were used to estimate the truck percentages while other sections of the ETB Parkway were estimated using the sections of the parkway with available classification count data. Ramp truck percentages were based upon the functional class averages of the cross streets and classification counts conducted as a part of this project. The existing truck percentages on the ETB Parkway range from 15% to 22%, with the highest percentages between I-24 and US 68 Bypass (Exit 6). As shown in Table 7, the 2013 LOS for all sections of the ETB Parkways is LOS A.

Table 7: 2013 Existing Traffic Characteristics

From		To							
Route	Beg. MP	Route	End MP	ADT	DHV	Truck Percentage	LOS	Density	Design Hour v/c Ratio
I24	0.000	Lovers Ln	5.175	9,100	900	22%	A	4.2	0.14
Lovers Ln	5.175	US 68B	5.759	8,700	850	17%	A	4.3	0.13
US 68B	5.759	US 41A	6.826	14,000	1,300	16%	A	6.1	0.19
US 41A	6.826	US 41	7.915	16,200	1,500	15%	A	7.2	0.22
US 41	7.915	US 68	9.347	17,200	1,500	15%	A	7.2	0.22
US 68	9.347	KY 1682	11.697	14,200	1,300	15%	A	5.8	0.19
KY 1682	11.697	KY 800	22.641	9,800	780	15%	A	3.5	0.11
KY 800	22.641	US 41	29.568	11,000	880	15%	A	4.3	0.13
US 41	29.568	US 62	32.850	11,600	930	15%	A	4.5	0.14
US62	32.850	I-69	33.356	14,600	1,100	18%	A	6.7	0.16

2. Future No-Build Traffic Volumes (2040) and LOS

The population growth rates were determined by cross streets of each intersection, historic parkway counts, the KYTC statewide traffic model, and the 2010 U.S. Census projections. The U.S. Census projects Christian County's population to grow at a rate of 2% annually through 2035. Hopkins County's population is projected to remain stable or slightly decrease through to 2035. Each cross street's historic growth rate was examined to determine the rate at which ramps connecting the streets to the Breathitt Parkway might also increase in traffic. The overall increase in ramp traffic drove the increases in Breathitt Parkway traffic and was consistent with the rate of traffic growth predicted by KYTC Kentucky Statewide Model or about 1% annually.

The future (2040) traffic volumes range from 10,700 vpd near the southern terminus of the ETB Parkway and climb to 17,200 vpd in Hopkinsville. From KY 1682 (Exit 11) north to US 62 (Exit 33), the 2010 traffic volumes range from 13,100 to 15,100 vpd. Between Exits 33 (US 62) and 34 (I-69/WKP) traffic volumes approach 18,800 vpd. The future truck percentages on the ETB Parkway range from 18% to 25%, with the highest percentages between I-24 and US 68 Bypass (Exit 6). The future traffic volumes are shown in Figure 5 (p. 24) and Table 8, and the complete forecast is located in **Appendix D**.

The future year 2040 LOS is A for the entire study corridor.

Table 8: 2040 No-Build Scenario Traffic Characteristics

From		To							
Route	Beg. MP	Route	End MP	ADT	DHV	Truck Percentage	LOS	Density	Design Hour v/c Ratio
I24	0.000	Lovers Ln	5.175	12,000	1,200	25%	A	5.7	0.18
Lovers Ln	5.175	US 68B	5.759	10,700	1,000	21%	A	5.2	0.15
US 68B	5.759	US 41A	6.826	15,400	1,400	20%	A	6.7	0.21
US 41A	6.826	US 41	7.915	21,700	2,000	18%	A	9.8	0.3
US 41	7.915	US 68	9.347	23,100	2,000	18%	A	9.8	0.3
US 68	9.347	KY 1682	11.697	18,900	1,700	18%	A	7.7	0.25
KY 1682	11.697	KY 800	22.641	13,100	1,000	18%	A	4.6	0.19
KY 800	22.641	US 41	29.568	14,400	1,200	18%	A	5.9	0.18
US 41	29.568	US 62	32.850	15,100	1,200	18%	A	5.9	0.18
US 62	32.850	I69	34.271	18,800	1,400	18%	A	6.9	0.21

3. Future Build Traffic Volumes (2040) LOS

It appears that there would be no additional traffic generated in association with the designation of the ETB Parkway as an interstate even with the full build out of all Segments of Independent Utility of I-69 in Kentucky. Traffic, especially truck traffic, is already traveling this route. Therefore, the traffic forecasts performed by KYTC Division of Planning show that, if is designated an interstate, the ETB Parkway would not attract additional traffic over the normal expected growth (see Figure 5, p. 24).

In addition, traffic along the parkway north of US 41 (the current partial interchange) was shown to actually decrease if this interchange is reconstructed to a full interchange. The difference in 2040 Build and No-Build traffic projections is shown in Table 9 and illustrated in Figure 5. The complete forecast is located in **Appendix D**.

Table 9: 2040 Build Scenario Traffic Characteristics with a Full Interchange at US 41 (Exit 30)

From		To		ADT	DHV	Truck Percentage	LOS	Density	v/c Ratio
Route	MP	Route	MP						
US 41	29.568	US 62	32.850	14,400	1,200	18%	A	5.9	0.18
US 62	32.850	I69	34.271	18,200	1,400	18%	A	6.9	0.21

4. Directional Design Hourly Volume (DDHV)

Included as part of this study is the directional distribution of traffic during the design hour (DDHV, also referred to as DHV) for both existing and build conditions for the context of minimum outside shoulder widths discussed in Chapter IV (p. 25). As defined in the HCM 2010, DDHV is the traffic volume for the design hour in the peak direction of flow. Table 10 summarizes the DDHV for the ETB Parkway based on current traffic, and forecasted 2040 traffic.

Table 10: Directional Design Hourly Volume (DDHV)

		2013 Existing						2040 Build					
			AM Peak Hour		PM Peak Hour				AM Peak Hour		PM Peak Hour		
			NB	SB	NB	SB	Truck		NB	SB	NB	SB	Truck
MP	MP	DHV	DHV	DHV	DHV	DHV	%	DHV	DHV	DHV	DHV	DHV	%
0.000	5.175	900	459	441	549	351	22%	1,200	612	588	732	468	25%
5.175	5.759	850	289	561	332	519	17%	1,000	340	660	390	610	21%
5.759	6.826	1,300	715	585	585	715	16%	1,400	770	630	630	770	20%
6.826	7.915	1,500	720	780	795	705	15%	2,000	960	1,040	1,060	940	18%
7.915	9.347	1,500	630	870	885	615	15%	2,000	840	1,160	1,180	820	18%
9.347	11.697	1,300	494	806	780	520	15%	1,700	646	1,054	1,020	680	18%
11.697	22.641	780	335	445	413	367	15%	1,000	430	570	530	470	18%
22.641	29.568	880	326	554	458	422	15%	1,200	444	756	624	576	18%
29.568	32.850	930	493	437	474	456	15%	1,200	636	564	612	588	18%
32.850	34.271	1,100	616	484	495	605	15%	1,400	784	616	630	770	18%

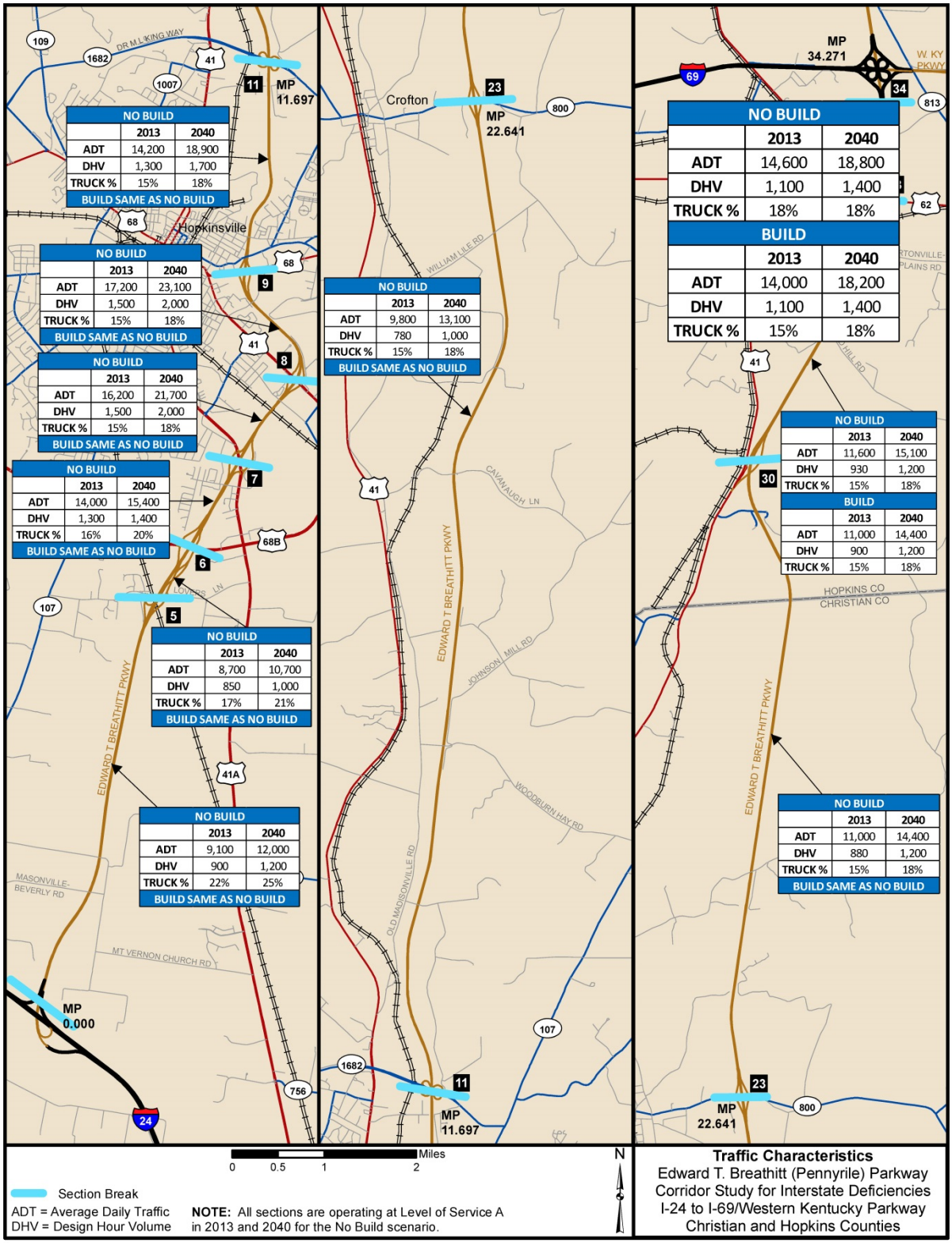


Figure 5: Traffic Characteristics

5. Volume-to-Capacity Ratio Analysis

The volume-to-capacity (v/c) ratio is another measure of traffic performance that reflects mobility and quality of travel of a facility or a section of a facility. The v/c ratio compares traffic volumes with the available capacity of the roadway. For example, a v/c ratio of 1.00 typically indicates the roadway is operating at its capacity. KYTC adopted a Design Policy Memorandum (03-11) dated November 2, 2011, regarding the traffic analysis of multi-lane freeways. It states that the multi-lane facilities targeted v/c ratio for multi-lane facilities is 1.0 in urban areas and 0.90 in rural areas based on design hour volumes.

The v/c ratio in 2040 for the mainline scenarios is between 0.15 and 0.3, illustrating this facility is well under capacity. Calculations are shown in Table 11 (p. 26).

C. ETB Parkway Interchange Ramp Volumes

Each interchange existing Build and No-Build ramp volumes are located in **Appendix D**. Each interchange is discussed in more detail in Chapter VI, *Interchanges and Ramps*.

D. Commercial Vehicle Weight Standards

The ETB Parkway from I-24 to I-69 is a part of the Extended Weight Coal and Coal By-Products Haul Road System; which allows up to 120,000 pounds for a semi-tractor trailer and its maximum weight classification otherwise is 80,000 pounds. If this corridor becomes an interstate, the weight limitations would have a maximum gross vehicle weight of 80,000 pounds.

IV. MAINLINE GEOMETRY / TYPICAL SECTION

In order for the ETB Parkway to be considered for conversion to an interstate, the existing geometric conditions need to be compared to current interstate guidelines set forth by AASHTO. Existing mainline and ramp geometrics were evaluated and compared to the *Interstate Standards*, the *2011 Green Book*, and, where necessary, KYTC policy. The intent of the *2011 Green Book* is to provide guidance for the design of highways and streets. It references a recommended range of values for critical dimensions based on established practices and recent research. The *Interstate Standards* provide minimum values for critical dimensions of interstate design as it relates to the 13 controlling criteria and other items.

The review was based on as-built plans, pavement rehabilitation plans where available, HIS data, and limited field reviews and observations. A field review of the study corridor was conducted to confirm or supplement information previously obtained and to identify additional safety issues within the corridor. Table 12 (p. 27) summarizes the minimum design criteria utilized for this study.

Table 11: 2013 No-Build and 2040 Build v/c Ratios

Termini				2013 No-Build							2040 No-Build						
From MP	From Description	To MP	To Description	Direction	DDHV	Truck Percentage	PHF	Flow Rate	Capacity	v/c Ratio	Direction	DDHV	Truck Percentage	PHF	Flow Rate	Capacity	v/c Ratio
0.000	I-24	5.175	Lovers Lane	Peak	540	22%	0.9	666	4,900	0.14	Peak	720	25%	0.9	900	4,900	0.18
				Non-Peak	360	22%	0.9	444	4,900	0.09	Non-Peak	480	25%	0.9	600	4,900	0.12
5.175	Lovers Lane	5.759	US 68B Overpass	Peak	510	17%	0.9	615	4,900	0.13	Peak	600	21%	0.9	737	4,900	0.15
				Non-Peak	340	17%	0.9	410	4,900	0.08	Non-Peak	400	21%	0.9	491	4,900	0.10
5.759	US 68B Overpass	6.826	US 41A Overpass	Peak	780	16%	0.9	936	4,900	0.19	Peak	840	20%	0.9	1,027	4,900	0.21
				Non-Peak	520	16%	0.9	624	4,900	0.13	Non-Peak	560	20%	0.9	684	4,900	0.14
6.826	US 41A Overpass	7.915	US 41 Overpass	Peak	900	15%	0.9	1,075	4,900	0.22	Peak	1,200	18%	0.9	1,453	4,900	0.3
				Non-Peak	600	15%	0.9	717	4,900	0.15	Non-Peak	800	18%	0.9	969	4,900	0.20
7.915	US 41 Overpass	9.347	US 68 Overpass	Peak	900	15%	0.9	1,075	4,900	0.22	Peak	1,200	18%	0.9	1,453	4,900	0.3
				Non-Peak	600	15%	0.9	717	4,900	0.15	Non-Peak	800	18%	0.9	969	4,900	0.20
9.347	US 68 Overpass	11.697	KY 1682 Underpass	Peak	780	15%	0.9	932	4,900	0.19	Peak	1,020	18%	0.9	1,235	4,900	0.25
				Non-Peak	520	15%	0.9	621	4,900	0.13	Non-Peak	680	18%	0.9	824	4,900	0.17
11.697	KY 1682 Underpass	22.641	KY 800 Underpass	Peak	468	15%	0.9	559	4,900	0.11	Peak	600	18%	0.9	727	4,900	0.15
				Non-Peak	312	15%	0.9	373	4,900	0.08	Non-Peak	400	18%	0.9	484	4,900	0.10
22.641	KY 800 Underpass	29.568	US 41 Underpass	Peak	528	15%	0.9	631	4,900	0.13	Peak	720	18%	0.9	872	4,900	0.18
				Non-Peak	352	15%	0.9	420	4,900	0.09	Non-Peak	480	18%	0.9	581	4,900	0.12
29.568	US 41	32.850	US 62 Underpass	Peak	558	15%	0.9	667	4,900	0.14	Peak	720	18%	0.9	872	4,900	0.18
				Non-Peak	372	15%	0.9	444	4,900	0.09	Non-Peak	480	18%	0.9	581	4,900	0.12
32.850	US 62 Underpass	33.566	I-69 Overpass	Peak	660	18%	0.9	788	4,900	0.16	Peak	840	18%	0.9	1,017	4,900	0.21
				Non-Peak	440	18%	0.9	526	4,900	0.11	Non-Peak	560	18%	0.9	678	4,900	0.14

NOTES:

PHF – Peak Hour Factor
v/c – Volume to Capacity
Flow Rate – Vehicles per hour per lane
Capacity – Capacity for four-lane freeway/expressway in pc/hour/lane
DDHV – Directional Design Hour Volume

Table 12: Design Criteria for Inclusion into the Interstate System

Area Type			Rural			Urban			Urban/Rural		
Design Element	**2011 AASHTO GUIDE[1]**	**2005 AASHTO POLICY[2]**	**Mainline**	**Ramps**	**Loops**	**Mainline**	**Ramps**	**Loops**	**Directional**	**Entrance**	**Exit**
Design Speed (MPH)	8-1, 8-5, 10-89, 10-89	2	70	35	25	50	25	25	40		
Level of Service (Desirable)	10-89, 2-67	3	B			C					
Driving Lane Width	8-2, 10-102	3	12'	14’	15'	12'	14’	15’			
Inside Shoulder Width	8-3, 10-102	3									
4-lane freeway & ramps	8-3, 8-10, 10-102	3	4'	2'-4'	2'-4'	4'	2'-4'	2'-4'	1'-6'		
Outside Shoulder Width	8-3, 10-102	3									
Truck DDHV <= 250	8-3, 10-102	3	10'	8'-10'	8'-10'	10'	8'-10'	8'-10'	8'-10'		
Truck DDHV > 250	8-3, 10-102	3	12'			12'					
Median Width	8-7, 8-10	4	36'			10'					
Structures											
Over Freeway Vertical Bridge Clearance	8-4		16'								
Over Freeway Vertical Sign Truss Clearance	8-4		17'								
Bridge Width (Horizontal) < 200’ to remain in place		5	Traveled Lanes + 3.5’ inside shoulder and 10’ outside shoulder								
Bridge Width (Horizontal), Length > 200' [1] to remain in place		5	Traveled Lanes + 3.5' shoulders								
Design ADT (vehicles per day)			> 6,000	750-1,500		> 6,000	750-1,500				
Clear Zone (Fill Slope 1V:4H or flatter)	Roadside Design Guide	4	30'-46'	10'-14'		20'-28'	10'-14'				
Clear Zone (Cut Slope 1V:3H or flatter)	Roadside Design Guide		22'-30'	10'-12'		14'-22'	10'-12'				
Superelevation (505) [3]	8-3		+/-8%								
Horizontal Curvature Minimum Radius (8% max SE)[3]	3-47		1810'	314'	134'	758'	134'	134'	444'		
Maximum Grade (upgrade for ramps)	8-4, 10-92		4%	5%-7%	5%-7%	5%	5%-7%	5%-7%	4%-6%		
Stopping Sight Distance	3-4		730'	250'	155'	425'	155'	155'	305'		
Divergence Angle	10-112										2°-5°
Minimum Acceleration Lengths for Ent. Term.	10-110		Variable and Depends on Design Speed of Entrance								
Minimum Deceleration Lengths for Exit Term.	10-115		Variable and Depends on the Design Speed of Exit Curve								
Interchange Spacing	10-68	5	1-mile urban, and 3-mile rural								
Access Control	10-7	2	100 feet urban (300 feet desirable) and 300 feet rural (600 feet desirable)								

[1] Page number references from AASHTO’s *A Policy on Geometric Design of Highways and Streets*, 2011
[2] Page number references from AASHTO’s *A Policy on Design Standards Interstate System, January 2005*
[3] Common KYTC Practice is 8% maximum superelevation. KYTC has used 10% maximum superelevation on past projects

A. Terrain

According to the *2011 Green Book*, topography of the land traversed has an influence on the alignment of roads. Topography affects horizontal alignment, and has even a more pronounced effect on vertical alignment. To characterize variations in topography, terrain is generally classified into level, rolling, and mountainous. By the *2011 Green Book* definition, rolling terrain is natural slopes that consistently rise above and fall below the road grade, and occasional steep slopes offer some restriction to normal horizontal and vertical roadway alignment. The *2011 Green Book* further states that, in general, rolling terrain generates steeper grades than level terrain, causing trucks to reduce speeds below those of passenger cars.

According to the Highway Inventory System (HIS) the terrain for the ETB Parkway corridor is flat. However, all archived plans for the corridor utilize “rolling” for terrain. Therefore, to be consistent, rolling terrain was used to analyze the roadway geometry.

B. Design Speed

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, this minimum requirement is met for the ETB Parkway. The following sections and chapters that review mainline geometric conditions of the ETB Parkway use these design speeds.

- 70 mph was used for the rural sections of the ETB Parkway from MP 0.000 (I-24) to MP 4.800 (southern ramps of the interchange at Lovers Lane) and from MP 11.697 (KY 1682) to MP 34.271 (WKP).
- A minimum 50-mph design speed was used for the urban section of the ETB Parkway between MP 4.800 (southern ramps of the interchange at Lovers Lane) and MP 11.697 (KY 1682).

C. Typical Roadway Sections

The ETB Parkway has basically three typical roadway cross-sections. The first section is the most recent construction from the end of the northbound I-24 ramp to (MP 0.587) to CSX Railroad (MP 7.500). The second is representative of the normal typical section shown in as-built plans from MP 7.500 north to the MP 29.568. The third typical section is present from MP 29.568 to the ETB Parkway/I-69 interchange. These typical sections generally represent the existing conditions along the parkway; however, any improvements such as pavement rehabilitation projects made over the life of the parkway may have resulted in changes to information that may not be represented in this study. The typical sections of the ETB Parkway are shown in Figure 6 (p. 29).

1. Lane Widths

The minimum lane width of a freeway facility is 12 feet. The existing lane width for the ETB Parkway mainline is 12 feet from the end of the I-24 northbound ramp to MP 7.500, therefore meeting the minimum AASHTO guidelines for interstate design.

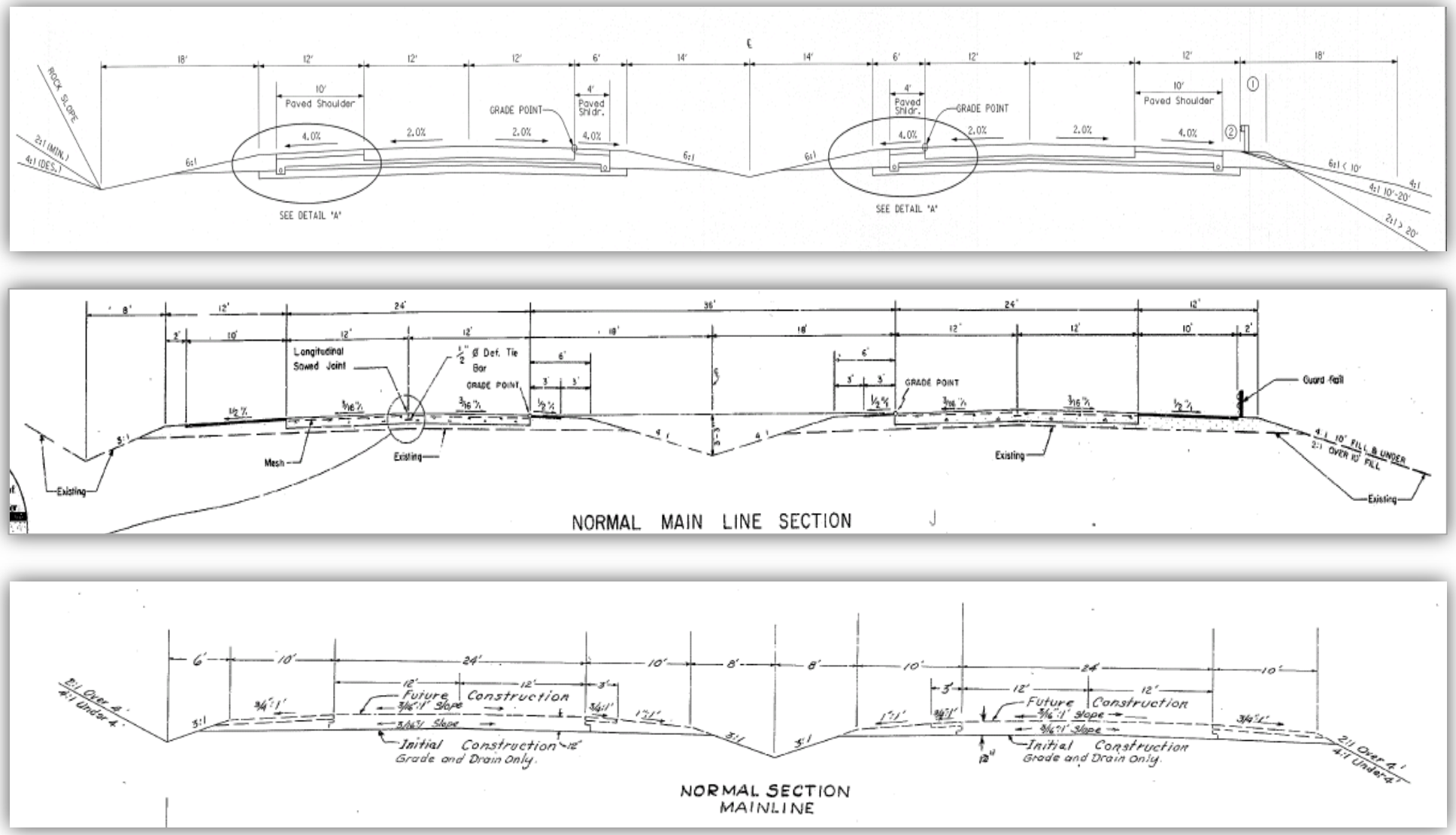


Figure 6: ETB Parkway Normal Typical Sections (from As Built Plans)

The HIS field measurements are usually in the non-Cardinal direction only. Currently, HIS shows the ETB Parkway southbound lanes with 11-foot-wide lanes from MP 29.568 to 34.271; however, spot field measurement checks of the southbound lanes revealed the travel lanes measure between 11 feet 9 inches and 12 feet.

2. Shoulder Widths

The *Interstate Standards* and the *2011 Green Book* both state the following:

"The paved width of the right shoulder shall not be less than 10 feet. Where truck traffic exceeds 250 DDHV, a paved shoulder of 12 feet should be considered. On a four-lane section, the paved width of the left shoulder shall be at least 4 feet."

Based on the existing (2013) DDHV in Chapter III, B.4 (Table 10, p. 23), the ETB Parkway outside paved shoulder width is required to be 10 feet. The ETB Parkway from the I-24 ramp to the southern end of the CSX Railroad at MP 7.500 meets the paved outside and paved inside shoulder widths criteria. However, north of that point in the southbound direction the inside shoulder width paved area measures anywhere from 3 feet 2 inches to 4 feet 6 inches, with an outside shoulder that measures 9 feet 4 inches. Hence, in this area, southbound the lane widths are not 12 feet, the outside shoulder width is not 10 feet and the inside shoulder is not consistently 4 feet. It appears to be a striping issue. The northbound inside shoulder widths measure 3-foot paved. Therefore, the shoulder widths for the length of the ETB Parkway from MP 7.500 north to MP 34.271 in both directions do not comply with the AASHTO guidelines of 4-foot paved shoulders for the inside shoulder width on freeways. It appears there is sufficient roadway width southbound from MP 29.561 to MP 34.271, but the roadway would require restriping in order to achieve the appropriate lane widths and shoulder widths.

3. Median Width and Type

The purpose of a median separation is to provide for driver comfort and safety. The width of a median is defined as the dimension between edges of the traveled way for the roadway in opposing directions of travel, including the width of the inside shoulders. According to the *Interstate Standards*, medians in level or rolling topography shall be at least 36 feet wide. Medians in urban areas shall be at least 10 feet wide. Guidelines contained within the *2011 Green Book* recommend a minimum 50-foot-wide median for a rural interstate and a minimum 10-foot median for a four-lane urban interstate. As shown in Table 13 (p. 31), the ETB Parkway medians are depressed with widths ranging from 36 to 40 feet. This median width and type meet the *Interstate Standards* criteria.

The crash review indicates there are only three cross-over crashes between January 1, 2008, and December 31, 2012. Hence, there is not a significant history or concentration of cross-over collisions on the ETB Parkway.

Table 13: Median Widths and Types

Rural/Urban	County	Begin MP	End MP	Length (Miles)	Median Type	Median Width (ft.)	AASHTO Minimum Median Width
Rural	Christian	0.587	4.80	4.213	Depressed	40	Depressed 36 ft.
Urban	Christian	4.800	5.759	0.959	Depressed	40	Urban 10 ft.
Urban	Christian	5.759	6.826	1.067	Depressed	40	
Urban	Christian	6.826	7.500	0.674	Depressed	40	
Urban	Christian	7.500	7.915	0.415	Depressed	36	
Urban	Christian	7.915	9.347	1.432	Depressed	36	
Urban	Christian	9.347	11.697	2.350	Depressed	36	
Rural	Christian	11.697	12.100	0.403	Depressed	36	Depressed 36 ft.
Rural	Christian	12.100	16.780	4.680	Depressed	36	
Rural	Christian	16.780	22.641	5.861	Depressed	36	
Rural	Christian	22.641	28.095	5.454	Depressed	36	
Rural	Hopkins	28.095	29.568	1.473	Depressed	36	
Rural	Hopkins	29.568	32.861	3.293	Depressed	36	
Rural	Hopkins	32.861	34.271	1.410	Depressed	36	

4. Clear Zones / Foreslopes

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.* In addition to median width and type, the *Interstate Standards* state that foreslopes within the clear zone should not be steeper than 1V:4H and desirably should be 1V:6H or flatter. As shown in Table 14 (p. 32) the segments of the ETB Parkway have median slopes of 1V:3H from MP 29.568 to MP 34.271 and ditch foreslopes of 1V:3H from MP 7.915 to MP 34.271 with eight foot ditches. A foreslope of 1V:4H or flatter is considered recoverable and foreslopes between 1V:3H and 1V:4H are considered traversable, but non-recoverable.

Defining the exact criteria that could be used for determining whether a roadway slope "meets interstate standard" was challenging. Seeking to document a hard and fast rule proved difficult using the *Roadside Design Guide* because this publication was written to allow for flexibility in the design decision-making process.

The *Interstate Standards* provides the clearest direction under the heading "Sideslopes" as they pertain to the interstate system. This publication states: "Foreslopes within the clear zone should not be steeper than 1V:4H and desirably should be 1V:6H or flatter. Where steeper slopes are used within the clear zone, roadside barriers shall be installed where warranted by the criteria in the current edition of the *Roadside Design Guide*."

Table 14: Median Slopes, Outside Slopes and Ditch Widths

Rural/Urban	County	Begin MP	End MP	Length (Miles)	Median Slopes	Outside Slopes & Ditch Widths
Rural	Christian	0.587	5.175	4.588	1V:6H	1V:6H 18'
Urban	Christian	5.175	5.759	0.584	1V:6H	1V:6H 18'
Urban	Christian	5.759	6.826	1.067	1V:6H	1V:6H 18'
Urban	Christian	6.826	7.50000	0.674	1V:6H	1V:6H 18'
Urban	Christian	7.50000	7.915	0.415	1V:4H	1V:3H 8'
Urban	Christian	7.915	9.347	1.432	1V:4H	1V:4H 8'
Urban	Christian	9.347	11.697	2.350	1V:4H	1V:3H 8'
Rural	Christian	11.697	12.100	0.403	1V:4H	1V:3H 8'
Rural	Christian	12.100	16.780	4.680	1V:4H	1V:3H 8'
Rural	Christian	16.780	22.641	5.861	1V:4H	1V:3H 8'
Rural	Christian	22.641	28.095	5.454	1V:4H	1V:3H 8'
Rural	Hopkins	28.095	29.568	1.473	1V:4H	1V:3H 8'
Rural	Hopkins	29.568	32.861	3.293	1V:3H	1V:3H 6'
Rural	Hopkins	32.861	34.271	1.410	1V:3H	1V:3H 6'

Using this guidance, all median, roadway ditch, and fill slopes should be a minimum of 1V:4H if they are located within the clear zone, or otherwise provide barriers if called for by the *Roadside Design Guide*. The *Roadside Design Guide* states that the clear zone for a design speeds of 65 to 70 mph, with an ADT>6,000 vpd and foreslopes of 1V:4H should between 38 to 46 feet.

The aforementioned definition points out that roadway ditch slopes steeper than 1V:4H should be analyzed to see if barrier protection is warranted. Figure 3-6 in the *Roadside Design Guide* clearly shows that 1V:3H to 1V:3H and 1V:4H to 1V:4H median slopes are not preferred. Section 3.3.5 goes on to state: "Drainage channel cross sections that are considered preferable in Figures 3-6 and 3-7 are not obstacles and need not be constructed at or beyond the suggested clear-zone distance for a specific roadway." One can infer from that statement that cross-sections considered not preferable are obstacles and should be constructed at the clear zone distance.

However, the *Roadside Design Guide* also states in Section 3.2.2: "If the foreslope between the roadway and the base of the backslope is traversable (1V:3H or flatter) and the backslope is obstacle-free, it may not be a significant obstacle, regardless of its distance from the roadway."

In conclusion all slopes on the interstate should be a minimum of 1V:4H, including the median slopes. However, if corrections are being made to the slopes, they should provide for the desirable 1V:6H slope. There is also a headwall that currently is not flush at approximately MP 33.500 (southbound).

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 and 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 ETB Parkway meets the current standard.

However, a field review of the existing guardrail end treatments was conducted on the ETB Parkway mainline and interchanges ramps. This review showed that a stretch of the ETB Parkway mainline guardrail has wooden posts and one end treatment (Type 7) does not meet current KYTC standards for the following:

- MP 16.000 to MP 30.000 (northbound and southbound) – wooden posts
- MP 33.400 (southbound end treatment)

Because field verification of the height and detailed specifications of the characteristics of the guardrail were outside the scope of this study, it was assumed that the dimension of the round wood post is 7" which is consistent with Kentucky Standard Drawing RBR-015 for single face application. In a question and answer section on FHWA's website with regard to roadway barriers, the following statement was made: *"Some states use 8" round posts for w-beam guardrail, but there is not sufficient performance information to offer a recommendation on whether they may be substituted for steel or rectangular wood posts."* Therefore, given the FHWA's response with regard to the use of 8" round posts and Kentucky's standard drawing for using 7" round posts, for the purposes of this planning document, stretches of guardrail with round wood posts were considered as non-standard and in need of replacement.

It has been our experience on recent interstate rehabilitation and reconstruction projects the majority of the guardrail is often upgraded throughout the project limits on these 3R (resurfacing, restoration and rehabilitation) projects. In addition, because field measurement of the top of guardrail was outside the scope of this study, there may be lengths of guardrail, both along the mainline and ramps, that fall below the recommended height for the top of rail and further verification of compliance is recommended as part of any future 3R project.

D. Horizontal Alignment

The design of roadway curves should be based on an appropriate relationship between design speed, and curvature and their joint relationships with superelevation and side friction, according to the *2011 Green Book*. This section includes the review of existing superelevation and horizontal curvature for the ETB Parkway and compares them to the current minimum standards.

1. Superelevation Rate

Superelevation is the physical tilting of the roadway to help counteract the centripetal forces developed as a vehicle goes around a curve. It is calculated based on design speed and horizontal curvature of the roadway. Superelevation and friction keep a vehicle from sliding off the roadway while traveling through a curve. 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.

According to *Interstate Standards*, curvature, superelevation, and transition curves must be correlated with the design speed in accordance with the current edition of *2011 Green Book*.

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 *2011 Green Book* for freeway geometric design. The *2011 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 ETB Parkway was constructed on the basis of an 8% and 10% maximum superelevation. The superelevation inventory for the ETB Parkway is contained in **Appendix E**.

Each horizontal curve was analyzed for deficient superelevation based on the radius of each curve, the superelevation at that horizontal curve, and a friction factor of 0.10. Given the friction factor of 0.10 (f_{max}), the superelevation of the horizontal curve (e_{max}) identified on the as-built plans, and the radius of horizontal curvature (R), the following formula was applied to determine the design speed (V) of each horizontal curve:

$$V= SQRT(R*15*(0.01e_{max} + f_{max})$$

Every curve exceeded a 70-mph speed, with the exception of one curve at MP 8.224, which has a calculated design speed of 67.7 mph. This curve is not identified as deficient.

2. Degree of Horizontal Curvature

The current minimum horizontal curvature radius for a design speed of 70 mph for a rural interstate is 1,810 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. All mainline horizontal curves in the corridor meet these minimum criteria.

The actual smallest radius of curve along the corridor is 1,910 feet, and a series of four are located in the urban section between MP 7.300 and MP 10.300. Although this radius is the smallest, it more than meets the current minimum radius of 758 feet for an urban interstate with a design speed of 50 mph. This section was originally designed as rural, and is now classified as urban. This curve has a radius of 3,819 feet. The complete inventory of horizontal curves is located in **Appendix E**.

3. Cross Slopes

According to the *Interstate Standards*, pavement cross slopes shall be a minimum of 1.5% and desirably 2%. Paved shoulders should have a cross slope in the range of 2% to 6% but not less than the cross slope of the adjacent pavement. A review of the as-built plans show the following for cross slopes:

- The new Breathitt Parkway Extension from MP 0.000 to MP 7.500 has 2% cross slopes for the driving lanes and 4% for the shoulders.
- From MP 7.500 to MP 34.271, the existing plans show that the driving lane cross slopes for the majority of the parkway is 1.5%. For the shoulders, the cross slopes show 4.2% (1/2":1').
- There is one 7-mile section (south of US 62 north to the WKP) that shows ¾":1 or 6.25% cross slopes for both inside shoulders and outside shoulders.

Although the reality is that the current actual slopes are likely very variable. During construction, pavers cannot meet that accuracy and over time resurfacing and rehabilitation projects make the cross slopes vary from the as-built plans. This minor difference is just something to note.

E. Vertical Alignment

As stated in Section IV.A, *Terrain* (p.28), the topography of the land traversed has an influence on the alignment of roads and streets. Topography affects horizontal alignment, but has an even more pronounced effect on vertical alignment. The ETB Parkway is considered to have rolling terrain according to the KYTC as-built plans. The vertical inventory is located in **Appendix E**.

1. Vertical Grade

The *Interstate Standards* requires a maximum grade of 4% for rolling terrain for a 70-mph design speed unless in an urban area. Grades up to 1% steeper than the value above may be provided in with crucial right-of-way constraints. According to the as-built plans, the ETB Parkway meets the maximum criteria for both urban and rural sections for rolling terrain. The steepest vertical grade is 3%.

2. Vertical Length of Curve

Vertical curves allow gradual changes between two tangent grades and may be either crest or sag types. Vertical curves should be simple and should result in a design that:

- Enables the driver to see the road ahead.
- Enhances vehicle control.
- Is pleasing in appearance.
- Is adequate for drainage.

a. Crest Vertical Curves – Stopping Sight Distance

A crest vertical curve is introduced when traveling over a hill. The major design control for crest vertical curves is the provision of ample sight distance for the design speed. While the *2011 Green Book* states that research shows that vertical curves with limited sight distance do not necessarily experience frequent crashes, it recommends that all vertical curves should be designed to provide at least the stopping sight distances in Table 3-1 of the *2011 Green Book.* The stopping sight distances are 730 feet for 70 mph and 425 feet for 50 mph.

Minimum lengths of crest vertical curves based on sight distance criteria generally are satisfactory from the standpoint of safety, comfort, and appearance with the exception of ramp exit gores, where longer sight distances should be provided.

According to KYTC as-built plans, all ETB Parkway crest curves meet the minimum stopping sight distance of 730 feet for 70-mph design speed for rural interstates and 425 feet for 50-mph design speed for urban interstates.

b. Sag Curves – Headlight Sight Distance

A sag curve is used when traversing a valley. According to the *2011 Green Book*, at least four different criteria are used in establishing lengths of sag vertical curves:

- Headlight Sight Distance
- Passenger Comfort
- Drainage Control
- General Appearance

Although all four criteria were calculated as part of this review, according to the *2011 Green Book*, in general, the Headlight Sight Distance appears to be the most logical criterion for general use, and the values determined for Stopping Sight Distance are within the limits recognized in current practice. Headlight Sight Distance applies when a vehicle travels a sag vertical curve at night. The portion of the highway lighted ahead is dependent on the position of the headlights and the direction of the light beam. The curve should be long enough that the light beam distance is approximately the same as the stopping sight distance. The use of this criterion to establish design values for a range of lengths of sag vertical curves is recommended by the *2011 Green Book.*

Headlight Sight Distance was reviewed for all sag vertical curves on the ETB Parkway. The Headlight Sight Distance was calculated based on Equations 3-48 and or Equation 3-50 in the *2011 Green Book* utilizing the length of sag vertical curve, the algebraic difference in grades as a percent and the light beam. There are two (2) vertical sag curves that do not meet the recommended vertical length of curve for 70 MPH based on this calculation. These two vertical curves are located at:

- MP 32.413 – Actual 668.8 feet, minimum 730 feet
- MP 32.887 – Actual 541.2 feet; minimum 730 feet

Table 15: EBT Parkway Corridor Structures

Type	Number of Structures
Mainline	32
Overpasses	19
Culverts	5
Total	56

V. BRIDGES AND OVERPASSES

For this study the structural and functional condition of each bridge was compiled utilizing the KYTC Bridge Inspection Report, the National Bridge Inventory and Appraisal Report and, where noted, field inventory. As shown in Table 15, the ETB Parkway has 56 bridge structures. A detailed table of data for these structures is included in **Appendix F**. A mainline bridge is a structure that carries the ETB Parkway traffic over another roadway or terrain feature. An overpass bridge is a structure that carries crossroad traffic over the ETB Parkway.

The concerns for mainline bridge structures on the ETB Parkway and overpass bridge structures passing above the parkway are the lateral widths and vertical height clearance, respectively. The following discussions include lateral and vertical clearance issues to identify structures along the corridor that are deficient under current guidelines. The locations of all structures and the identified deficiencies are shown on Figure 7 (p. 38).

A. Lateral Clearances of Bridges

Lateral clearance is defined as the width of a mainline bridge, measured from curb to curb. The *Interstate Standards* address existing bridges to remain in place when a route is to be incorporated in the interstate system. It states:

> *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:
>
> - The bridge cross section consists of 12-foot lanes, a 10-foot shoulder on the right and a 3.5-foot shoulder on the left;
> - For long bridges, the offset to the face of parapet or bridge rail on both the left and right is 3.5 foot measured from the edge of the nearest traveled lane;
> - Bridge railing shall meet or be upgraded to current standards."

The lateral clearances of the ETB Parkway's mainline bridges were evaluated to determine if they were too narrow to meet current design guidelines. **Appendix F** contains the summary of all mainline, overpass and culvert structures.

1. Bridges less than 200 feet in length

- The minimum width for the ETB Parkway mainline bridges, less than 200 feet, and culverts is 37.5 feet

Table 16 summarizes the length and horizontal width of the ETB Parkway mainline bridges, less than 200 feet that do not meet lateral clearance.

Table 16: Bridges Less than 200 Feet that Do Not Meet Minimum Horizontal Clearance

County	MP	Bridge No.	Direction	Features Intersected	Year Built	Length (Ft)	Width (Ft) (Curb To Curb)
Hopkins	30.33	054B00106R	NB	Crab Orchard Creek	1963	165	34.80
Hopkins	30.34	054B00106L	SB	Crab Orchard Creek	1963	165	34.70
Hopkins	32.29	054B00097R	NB	Old White Plains Rd And Creek	1963	155.80	34.80
Hopkins	32.29	054B00097L	SB	Old White Plains Rd And Creek	1963	155.80	34.80

2. Bridges greater than 200 feet in length

- The minimum width for ETB mainline bridges, greater than 200 feet is 31.0 feet.

All bridges and culverts, greater than 200 feet in length, meet the minimum lateral clearance criterion.

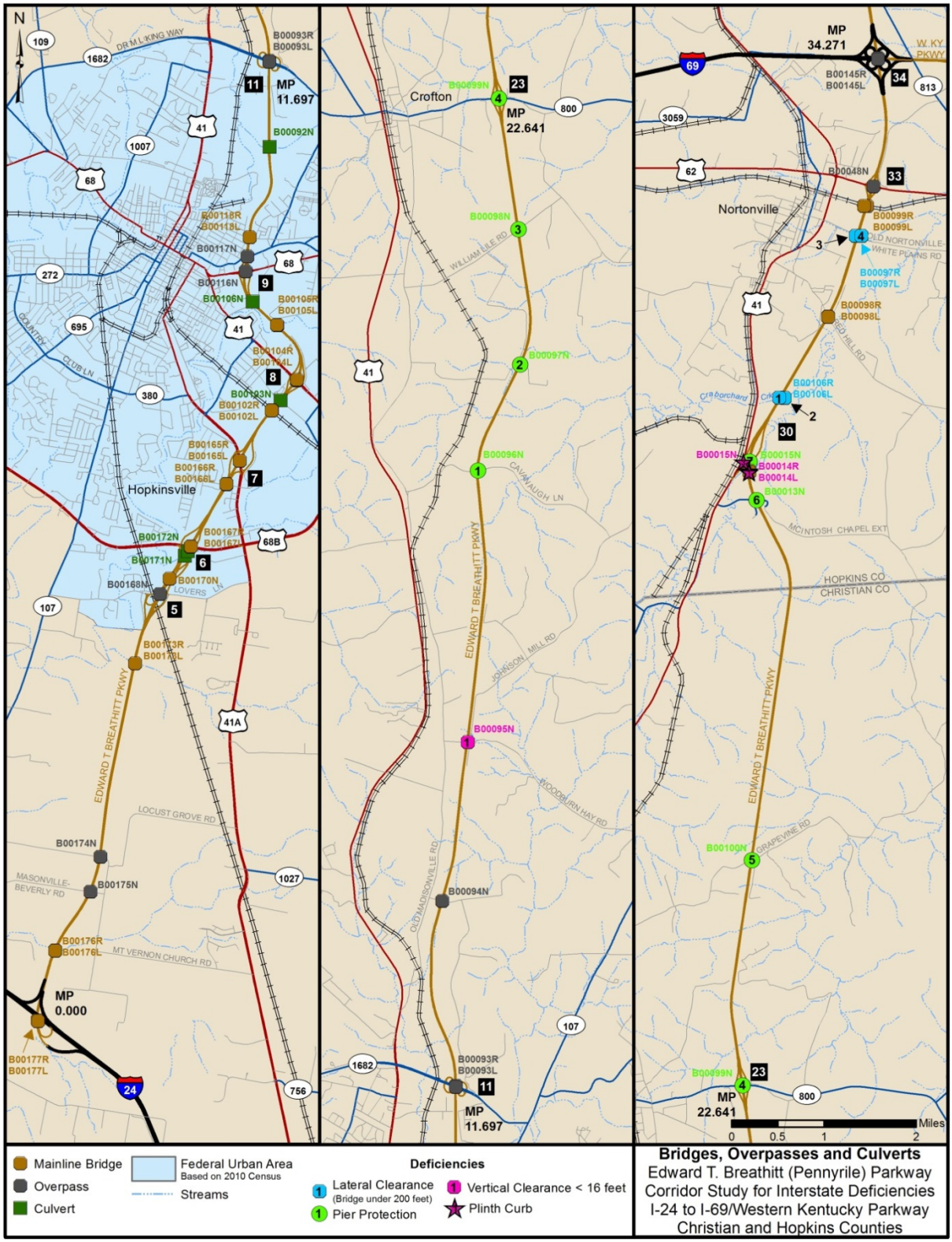


Figure 7: Mainline Bridge Locations: Overpass and Culverts

3. Structures with curbs

In addition to the lateral clearance, mainline bridge side railings/barriers are a concern for bridges on the interstate system. Since the construction of the bridges on the ETB Parkway, side railings/barriers design guidelines have been modified to improve crash worthiness. Two bridges are constructed with a plinth or brush block curb, which does not meet current specifications. In addition, the northbound on-ramp at the US 41 partial interchange has concrete railing and is curbed. Those bridges are listed in Table 17.

Table 17: Bridges with Curbs (Plinth/Brushblock)

County	MP	Bridge No.	Direction	Features Intersected	Year Built	Length (Ft)	Width (Ft) (Curb To Curb)	Sufficiency Rating
Hopkins	29.448	054B00014R	NB	Drakes Creek	1968	157.20	38.1	99.50
Hopkins	29.460	054B00014L	SB	Drakes Creek	1968	157.20	38.2	98.50
Hopkins	29.560	054B00015	NB on Ramp	US 41 Interchange	1968	294.9	24.0	76.10

B. Vertical Clearance of Overpasses

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 the overpass bridges on the ETB Parkway were measured in the field by a survey crew to obtain the most accurate results for this study. The vertical clearances for all overpass bridges are depicted in **Appendix F**. There is one northbound overpass in Christian County with a vertical clearance less than 16 feet (15.9 feet). It is a reinforced box bridge and cannot be raised to meet the vertical clearance:

- MP 15.511 - 024B00095N - KY 2641

Also there are two overpasses in Christian County that measure 16.1 feet in clearance and will need to be monitored closely (along with the above structure at MP 15.511) with future pavement rehabilitation:

- MP 9.517 - 024B00117N - KY 107 7th Street
- MP 13.764 - 024B00094N – CR 1009

C. Crash Worthy Pier Protection

There are currently seven earthen mound bridge pier protections that do not meet current standards. Figure 8 (p. 40) illustrates the pier protection at Cavanaugh Lane in Christian County at MP 18.474.

These earthen mound bridge pier protections are located at the following overpasses shown in Table 18 (p. 41). A review of the bridge plans at these locations revealed that the pier protection is mounded to cover the footer of the pier that protrudes above the normal ground line. If this "mound" is removed, footer protection will be necessary beyond normal guardrail. An example of that protection is shown in Figure 9 (p. 40).

Figure 8: Inadequate Pier Protection - MP 18.474 Cavanaugh Lane (KY 2636)

Figure 9: Example of Pier Protection Necessary for Overpasses Identified in Table 17

Table 18: Bridges with Inadequate Pier Protection

BRIDGE NUMBER	MP	COUNTY	CROSSROAD	COMMENT
024B00096N	18.474	Christian	Cavanaugh Lane (KY 2636)	Inadequate Pier Protection
024B00097N	19.721	Christian	J. Knight Road (KY 2640)	Inadequate Pier Protection
024B00098N	21.214	Christian	William Lile Road (KY 2638)	Inadequate Pier Protection
024B00099N	22.649	Christian	KY 800	Inadequate Pier Protection
024B00100N	25.117	Christian	Grapevine Road (KY 2637)	Inadequate Pier Protection
054B00015N	29.560	Hopkins	NB US 41 On Ramp at Partial Interchange	Inadequate Pier Protection
054B00013N	29.131	Hopkins	McIntosh Chapel Road (KY 2647)	Inadequate Pier Protection

D. Bridges and Culvert Conditions

For this study, the structural and functional condition of each bridge was evaluated utilizing the KYTC Bridge Inspection Report and the National Bridge Inventory and Appraisal Report. A bridge sufficiency rating includes a multitude of factors: inspection results of the structural condition of the bridge, traffic volumes, number of lanes, road widths, clearances, and importance for national security and public use. The sufficiency rating is calculated with a formula defined in *FHWA's Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*. This rating is indicative of a bridge's sufficiency to remain in service. The bridge's sufficiency rating provides an overall measure of the bridge's condition and is used to determine eligibility for federal funds. A bridge sufficiency rating is calculated based on 55% one the structural evaluation, 30% on the obsolescence of its design, and 15% on its importance to the public.

Bridges are considered structurally deficient if significant load carrying elements are found to be in poor condition due to deterioration and determined to be extremely insufficient to the point of causing intolerable traffic interruptions. The fact that a bridge is classified under the federal definition as "structurally deficient" does not imply that it is unsafe. A structurally deficient bridge, when left open to traffic, typically requires significant maintenance and repair to remain in service and eventual rehabilitation or replacement to address deficiencies.

"Functionally obsolete" means that the design of a bridge is not suitable for its current use, for example it could have a lack of safety shoulders or the inability to handle current traffic volume, speed, size, or weight. Sufficiency and inventory ratings along with design loads for bridges on the ETB Parkway are provided in **Appendix F**.

Currently, ETB Parkway's mainline, overpasses, and culverts have a sufficiency rating equal to or greater than 68.8. Only one structure (overpass) has a sufficiency rating near 68, and it is identified as:

- MP 13.764 - 024B00094N - CR 1009 – Sufficiency Rating – 68.8

According to KYTC data, one structure along the corridor is identified as structurally deficient. This structure is an overpass structure, therefore does not impact the designation of the corridor as an interstate. This structure is considered structurally deficient due to the bridge deck. That structure is as follows:

- MP 22.649 - 024B00099N – KY 800 – Sufficiency Rating – 74.10

According to the KYTC, there are only three structures identified as functionally obsolete along the corridor. These mainline structures are as follows:

- MP 9.728 - (First Street) - 024B00118N (due to the clearance under the structure)
- MP 9.730 - (First Street) 024B00118S (due to the clearance under the structure)
- MP 7.657 – (Calvin Drive) - 024B00103N (culvert - (due to the clearance under the structure)

E. Overhead Signs

The minimum vertical clearance for an overhead sign truss is 17.0 feet according to current *MUTCD* guidelines. The vertical clearances of the overhead signs, sign trusses, and cantilever signs on the ETB Parkway were measured in the field by a survey crew and none were found to be less than 17.0 feet. They are identified in Table 19.

Table 19: Overhead Signs and Trusses

County	Direction	MP	Description	Type	Vertical Clearance (ft.)
Christian	SB	0.700	I-24 WB Exit 1	Truss	25.2
Christian	NB	4.480	Fort Campbell Blvd (US 41A) and Lovers Lane Eagle Way (US 68) US 41/US 68 Exit 7	Overhead Truss	24.6
Christian	SB	6.100	Eagle Way Exit	Truss	20.2
Christian	NB	6.403	Exit 7 and 8 US 41 and US 41A	Overhead Truss	23.8
Christian	SB	7.200	US 41/US 68/I-24	Truss	25.2
Christian	NB	7.614	US 68/80 and US 41 Exit 8 and 9	Overhead Truss	22.9
Christian	SB	8.271	US 41A/US 41 Ft Campbell Exit 8	Truss	22.1
Christian	SB	9.375	US 41 Exit 9	Overpass Sign	17.4
Christian	NB	11.700	Dr. ML King Jr. Way Exit 11	Overpass Sign	18.2
Christian	SB	11.744	Dr. Martin Luther King Exit 11	Overpass Sign	19.6
Hopkins	SB	30.000	Exit 30 Hopkinsville South	Truss	22.1
Hopkins	NB	32.650	Exit 33	Cantilever	22.3
Hopkins	NB	33.960	Elizabethtown/Paducah Exit 34A	Truss	23.1
Hopkins	NB	34.240	Ford Parkway Sign Exit 34B	Overpass Sign	20.1
Hopkins	SB	34.300	Elizabethtown 34A	Overpass Sign	19.7

VI. INTERCHANGES AND RAMPS

This chapter summarizes the interchanges and lighting conditions on the ETB Parkway. As shown in Table 20, there are 11 interchanges in the 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 traffic volumes and operation, speed-change lanes, weaving characteristics, interchange crash data, interchange spacing, crossroad control of access, and interchange configuration. Table 20 summarizes the interchanges

taken from the as-built plans with the AASHTO guidelines for the key areas for interchange design. All Design Speed interchange inventories are located in **Appendix G**.

Table 20: ETB Parkway Corridor Interchanges between I-24 and I-69

County	Exit #	MP	Rural/Urban	Intersecting Route	Lighted Yes or No
Christian	0	0.000	Rural	I-24	Yes
Christian	5	5.175	Rural	Lovers Lane	Yes
Christian	6	5.759	Urban	US 68B	Yes
Christian	7	6.826	Urban	US 41A	Yes
Christian	8	7.915	Urban	US 41	No
Christian	9	9.347	Urban	US 68	Yes
Christian	11	11.697	Urban	KY 1682	Yes
Christian	23	22.641	Rural	KY 800	Yes
Hopkins	30	29.568	Rural	US 41	No
Hopkins	33	32.850	Rural	US 62	Yes
Hopkins	34	34.271	Rural	I-69	Yes

A. Design Speed

The *2011 Green Book* provides values for ramp design speeds as related to highway design speed that apply to the sharpest, or controlling, ramp curve, usually on the ramp proper. These speeds do not pertain to the ramp terminals, which should be properly transitioned and provided with speed-change facilities adequate for the highway speed involved.

The ramp design speeds for 70 mph range from 35 mph (lower range) to 60 mph (upper range) with the middle range being 50 mph. Upper range values of design speed generally are not attainable on loop ramps. Ramp design speeds above 30 mph for loops involve large land areas that are rarely available in urban areas. Minimum values usually control, but for highway design speeds above 50 mph, the loop design speed preferably should be no less than 25 mph. Where a ramp joins a major crossroad or street, these guidelines, do not apply.

All ETB Parkway interchange ramps meet the minimum criteria for design speed with the exception of KY 1682, which was not analyzed because it will be a total reconstruction. Some ramps have deficient acceleration or deceleration lengths, and that topic is covered in Chapter VI, Section E.

B. Typical Sections

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

1. Lane Widths

According to KYTC's *Highway Design Manual*, single-lane ramps shall have a minimum pavement width of 15 feet. Pavement widths vary depending on ramp radii, traffic conditions, etc. All of the ETB Parkway interchange ramps meet this criterion with the exception of the following:

- KY 800 - Exit 7 Northbound Entrance Ramp - 14 feet
- KY 800 - Exit 7 Southbound Exit Ramp - 14 feet

The *2011 Green Book*, (Section 10.9.6–*Ramps*) references Table 3-29 for ramp width determination. The ramp width determinations made from this table are based on Case I (one-lane, one-way operation – no provisions for passing stalled vehicle) and Design Traffic Condition "C" (sufficient bus and combination-trucks to govern design). The minimum width shown in this table is 14 feet for a tangent ramp. Since the inside radius of the curve closest to the interstate is substantially greater than the largest curve radius shown in this table (716.18 feet vs. 500 feet listed in the table), it was determined that it was acceptable to use the width shown for the tangent condition. This reduced the minimum required ramp width to 14 feet. However, this width could be further reduced with a stabilized shoulder, based on the note found under the Width Modification for Edge Conditions. That note states: "Lane width for conditions B & C on tangent may be reduced to 12 feet where shoulder is 4 feet or wider." Since a total shoulder width of 10 feet is present on the ramps, the added factor of safety that the wider shoulder provides minimizes any potential concern over a 1-foot difference in ramp width requirement based upon a different interpretation of this table.

Based on the *2011 Green Book* criteria, all ramp widths meet the minimum design speed.

2. Shoulder Widths

For normal one-way operation, according to the *2011 Green Book*, the inside shoulder width should be 2 to 4 feet and paved; and the outside shoulder width should be 8 to 10 feet and paved. The sum of the inside and outside shoulder width is typically between 10 and 14 feet and paved. *KYTC's Highway Design Manual* states single-lane ramp shoulders shall have 6-foot-wide useable shoulders right and 4-foot-wide useable shoulders left.

Table 21: Rolled Curb Present on Ramps

Exit #	Crossroad Route	Ramp # from Existing Plans	Ramp	Curbed	Within the first curve nearest the interstate
30	US 41 Partial	Relocated US 41NB	NB on-ramp	x	See Figure 10
		Relocated US 41 SB	SB off-ramp	x	Yes, see Figure 11
23	KY 800	Ramp C	SB off-ramp	x	No
		Ramp A	SB on-ramp	x	No
		Ramp D	NB on-ramp	x	No
		Ramp B	NB off-ramp	x	No

All ramps meet minimum criteria for shoulder widths.

3. Rolled Curb

The *Interstate Standards* states that the use of curbs shall not be used on the mainline that are not intended for drainage purposes. Some ETB Parkway ramps have a rolled curb and are identified in Table 21. Also denoted are the ramps that have rolled curb within the first curve exiting or entering the ETB Parkway. Refer to the Figures 10 and 11 for the location of ramps with rolled curb that do not meet current standards.

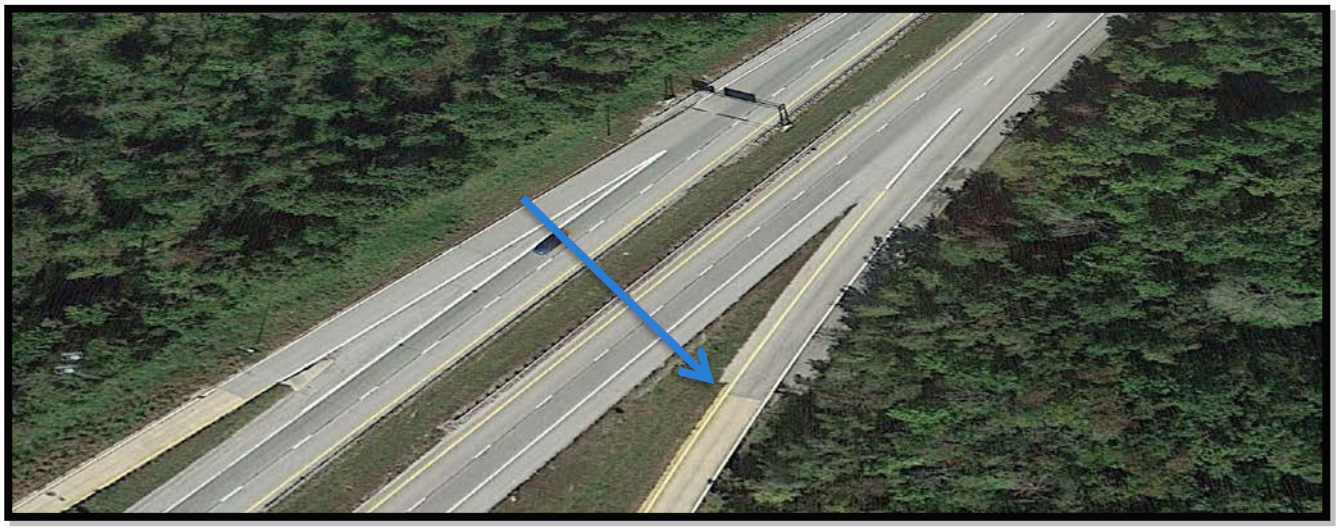


Figure 10: Curb Ends at This Location on US 41 Northbound On-Ramp

Figure 11: Curb Begins at This Location Southbound Off-Ramp of US 41

- US 41 (Christian County)
- US 68
- KY 1682

- US 41 (Hopkins County)
- US 62

All ramp volumes are found in **Appendix D** and calculations are found on a CD in the supporting documentation in the back of this report.

D. Alignment Geometry

1. Horizontal Alignment

The minimum horizontal radii for 40-mph, 35-mph, and 25-mph design speeds are 444 feet, 314 feet, and 134 feet, respectively. For the interchanges on the ETB Parkway, minimum ramp and loop radius are met for all interchanges except for Exit 11 (KY1682). Exit 11 is a previous toll booth interchange. Refer to **Appendix G** for an inventory of interchange horizontal alignment data.

a. Superelevation Rate

From the review of the as-built plans, the superelevations for the ramps, if provided, appear to meet the criterion for a maximum superelevation rate of 10%. Refer to **Appendix G** for an inventory of ramp superelevation data.

b. Cross Slopes

In accordance with the *2011 Green Book*, the cross slope on portions of ramps on tangent normally should be sloped one way at a practical rate ranging from 1.5% to 2% for high type pavements.

All ramp cross slopes according to the as-built plans meet the minimum criteria

.

2. Vertical Alignment

a. Vertical Grade

According to the *2011 Green Book*, ramp grades are not directly related to design speed. However, design speed is a general indication of the quality of design being used. The gradient for a ramp with a high design speed should be flatter than for one with a low design speed. As general criteria, it is desirable that ascending grades on ramps with the following design speeds be limited as noted: 45 to 50 mph, 3% to 5% up grade; 40 mph, 4% to 6% up grade; 25 to 30 mph, 5% to 7% up grade; and 15 to 25 mph, 6% to 8% up grade. However, where appropriate for topographic conditions, grades steeper than desirable may be used. Adequate sight distance is more important than a specific gradient control and should be favored in design. The largest upgrade approaching a stop condition is at the following:

- US 68B Interchange (Exit 9) - Northbound off-ramp – Actual +6.04%

This sag curve preceding the grade has adequate stopping sight distance (meets minimum 50 mph) of 520 feet (minimum is 250 feet).

b. Vertical Curves

As with the mainline, vertical curves are used to allow gradual changes between two tangent grades and may be either crest or sag types. They should result in a design that:

- Enables the driver to see the road ahead.
- Enhances vehicle control.
- Is pleasing in appearance.
- Is adequate for drainage.

An inventory of vertical curves on ramps is located in **Appendix G**.

1) Crest Curves – Stopping Sight Distance

All vertical curves meet the criteria for stopping sight distance for crest curves based on the appropriate design speed for that curve.

2) Sag Curves – Headlight Sight Distance

For this study, the Headlight Sight Distance was calculated for the sag vertical curves along the entrance and exit ramps. The following ramps do not meet the minimum Headlight Sight Distance of 250 feet.

US 62 Exit 33

- Ramp B – Actual 175 feet and Minimum 250 feet
- Ramp C – Actual 208 feet and Minimum 250 feet

However according to *FHWA's Mitigation Strategies for Design Exceptions July 2007*, states that "if lighting is provided at sag vertical curves, a design to the driver comfort criteria may be adequate. The length of sag vertical curves to satisfy the comfort criteria over the typical design speed range results in minimum curve lengths of about half those based on headlight criteria. For sag vertical curves, formal design exceptions are required for curves that meet the comfort criteria but not the headlight criteria, unless lighting is provided." Because the interchange is lighted these sag curves meet the minimum design for driver comfort and therefore, do not require a design exception.

3. Divergence Angle

A divergence angle is the angle at which the ramp leaves the mainline. The recommended divergence angle of the alignment break for a taper exit, per AASHTO, is two to five degrees. Where the divergence angle was provided, all met the minimum criterion.

E. Speed-Change Lanes and Weaving Characteristics

Speed-change lanes and traffic weaving situations are two important factors affecting safety at interchanges. The following is a summary of the geometry of the as-built ramp configurations when compared to the current AASHTO guidelines for speed-change lanes and designs for traffic weaving. The speed-change lanes inventory is located in **Appendix G**.

1. Speed-Change Lanes

Drivers leaving the parkway at an interchange are required to reduce their speed as they exit. Likewise, drivers entering the parkway from a crossroad must accelerate until the desired parkway speed is reached. Because the change in speed is usually substantial, there must be sufficient length to safely accomplish those changes in speeds. Two forms of speed-change lanes are: (1) the taper type, and (2) the parallel type. The taper type provides a direct entry at a flat angle. The parallel type has an added lane for changing speed. The acceleration and deceleration lengths must be of sufficient length to accomplish the change in the speed.

a. Acceleration Lengths

The acceleration length must be sufficient to enable a vehicle to accelerate to near-freeway speed prior to merging. The distance needed for acceleration is governed by the operating speed on the entrance curve of the ramp and the operating speed of the parkway. According to Table 10-3 in the *2011 Green Book*, those lengths (unadjusted for grades) are as follows in Table 22, (p. 49) for a parkway speed of 70 mph (50 mph urban):

The following ramps do not meet the minimum lengths for acceleration, shown in Table 22:

- KY 800 Southbound Entrance Ramp – Actual 450 feet and Minimum 580 feet
- KY 800 Northbound Entrance Ramp – Actual 450 feet and Minimum 580 feet
- US 41 Northbound Entrance Ramp – Actual 450 feet and Minimum 580 feet
- US 62 Southbound Entrance Ramp – Actual 0 feet and Minimum 580 feet
- US 62 Northbound Entrance Ramp – Actual 100 feet and Minimum 580 feet
- SB I-69 to Southbound ETB Parkway – Actual 450 and Minimum 580 feet

Table 22: Acceleration Lengths

Design Speed of Ramp Entrance Curve (mph)	50	45	40	35	30
Minimum Acceleration Length (feet) 70 mph Rural	580	820	1,000	1,230	1,350
Minimum Acceleration Length (feet) 50 mph Urban	-	-	130	350	450

b. Deceleration Lengths

Most vehicles leave the through lane at relatively high speeds. The length available for deceleration may be assumed to extend from a point where the right edge of the wedge is about 12 feet from the right edge of the right through lane to the point of initial curvature of the exit ramp. Deceleration may end in a complete stop, at a crossroad terminal for a diamond interchange; or the critical speed may be governed by the curvature of the ramp roadway. The distance needed for deceleration is governed by the operating speed on the exit curve of the ramp and the operating speed of the parkway. According to Table 10-5 in the *2011 Green Book*, the minimum deceleration lengths for the exit ramps from the parkway utilized in this study are shown in Table 23.

Table 23: Deceleration Lengths

Design Speed of Ramp Exit Curve (mph)	50	45	40	35	30	25
Minimum Deceleration Length (feet) 70 mph Rural	340	390	440	490	520	550
Minimum Deceleration Length (feet) 50 mph Urban	-	175	225	285	315	355

The following ramps do not meet the minimum lengths for deceleration:

- US 62 Southbound Exit Ramp – Actual 100 feet and Minimum 340 feet
- US 62 Northbound Exit Ramp – Actual 0 feet and Minimum 340 feet

It should be noted that the length of the southbound exit ramp at Lovers Lane is 30 feet less than the minimum requirement for 70 mph. However, Lovers Lane is considered urban; therefore, it meets the 50-mph design speed and the minimum criterion.

2. Weaving Characteristics

The ETB Parkway/KY 1682 interchange at Exit 11 (Figure 12) does not meet the minimum weaving distance of 1,000 feet for service interchanges. This interchange was constructed as an interchange where the entering and exiting motorists stopped and paid a toll. The toll booth has since been removed; however, the short weave movements remain. It has been standard practice for KYTC to reconstruct these interchanges to a more standard type interchange. Therefore, the existing geometrics were not analyzed in detail as they were for the other interchanges, except to state that the weave distance is approximately 260 feet. The design year (2040) Build traffic volumes and existing weave distance resulted in an LOS of A (as with all interchange movements analyzed, refer to CD in back of report).

Figure 12: KY 1682 (Exit 11)

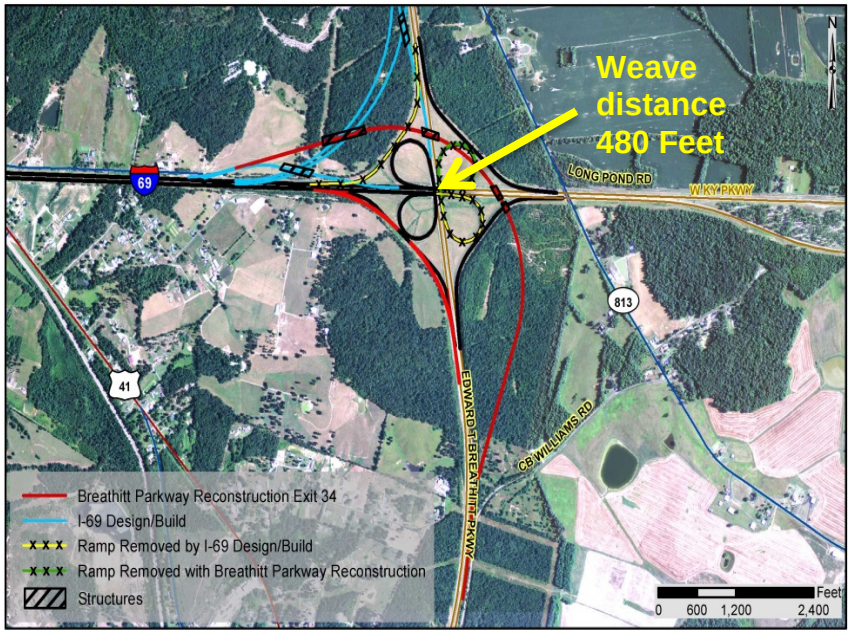


Figure 13: ETB Parkway/I-69/WKP Interchange

The ETB Parkway/I-69/WKP interchange also has a weave distance (480 feet) that does not meet the minimum 1,000 feet for service interchanges. However, this interchange is under reconstruction for I-69, and the movements that do not meet the minimum criterion (southbound I-69 to eastbound WKP and westbound WKP to southbound ETB Parkway) are considered I-69/WKP ramps, which would not be reconstructed as part of this project. This interchange is illustrated in Figure 13.

F. Interchange Crash Data

As stated in Chapter III, interchange crashes were removed from the mainline crashes so that a true representation of the mainline and interchanges would be possible. Table 24 (p. 52) and Figure 14 (p. 53) represent crashes that occurred on any part of the ramps along the ETB Parkway. As shown, the southbound exit ramp at US 41A appears to have more crashes than any other interchange total. A review of the crash reports at this location revealed that most crashes were occurring at the signalized intersection at the end of the ramp and were rear-end crashes. The consistent theme was motorists believing the car in front of them turned right, so they accelerated, but the car in front of them did not turn or move forward, resulting in a rear end crash.

G. Interchange Spacing

As discussed in the *Interstate Standards,* spacing of interchanges has a significant effect on the operation of interstate highways. In areas of concentrated development, proper spacing may be difficult to obtain because of the demand for frequent access. As a rule, minimum spacing should be 1 mile in urban areas, and 3 miles in rural areas, based on crossroad to crossroad spacing. In urban areas, spacing of less than 1 mile may be developed by grade separated ramps or collector-distributor (C/D) roads.

According to the *2011 Green Book* and the KYTC *Highway Design Manual*, a general rule of thumb for minimum interchange spacing is 1 mile in urban areas and 2 miles in rural areas; with the concession that, in urban areas, less than 1 mile may be developed by grade-separated ramps or by adding collector-distributor (C/D) roads. The following interchanges do not meet the crossroad-to-crossroad spacing for either criterion:

- US 62 (Exit 33) to I-69 (Exit 34) in Hopkins County – Actual 1.421 miles and Minimum 2 to 3 miles (see Figure 15, p. 55)
- Lovers Lane (Exit 5) to US 68 Bypass (Exit 6) in Christian County – Actual 0.610 mile and Minimum 1.0 mile (see Figure 16, p. 56)

This latter segment of the ETB Parkway was open to traffic in early 2011. The ETB Parkway northbound from Lovers Lane to the US 68 Bypass has grade-separated ramps that separate the individual ramp movements providing for additional spacing. The southbound exit ramp at Lovers Lane was constructed as a loop ramp with a current ADT of only 400 vpd and a Design Hour Volume (DHV) of 60 to provide for additional ramp spacing (see Figure 14) and to minimize impacts to a nearby subdivision. All merge, diverge, and weave movements for both interchanges operate at LOS A in the current year (2013) and the design year (2040) for the Build and No-Build scenarios, and meet the minimum spacing in Figure 10-68 of the 2011 Green Book (see calculations on CD). The northbound ramps between the two interchanges were braided to provide for ramp spacing/separation. All ramps at both interchange locations meet the 2011 Green Book minimum ramp spacing criteria. However, the minimum interchange spacing requirements (crossroad to crossroad) as defined are not met.

Table 24: Interchange Crash Data by Manner of Collision

EXIT	MP	COUNTY	INTERSECTING ROUTE	RAMP	REAR END	FIXED OBJECT	ANIMAL	SIDE SWIPE	RAN OFF ROAD	COLLISION ON RAMP	1 VEHICLE ENTERING/ LEAVING ENTRANCE	OTHER	TOTAL	FATALITIES	INJURY	PDO	COMMENT
0	0.000	Christian	I-24	4	0	0	0	0	0	0	0	0	4	0	0	0	
5	5.175	Christian	Lovers Lane	0	0	0	0	0	1	0	0	0	1	0	0	1	
6	5.759	Christian	US 68B	4	2	0	0	0	0	0	0	0	6	0	1	1	
7	6.826	Christian	US 41A	35	0	0	0	0	0	0	0	0	35	0	0	0	28 Ramp Crashes in the NW Quad
8	7.915	Christian	US 41	3	0	1	0	0	4	0	0	0	8	0	1	4	
9	9.347	Christian	US 68	7	0	4	0	0	2	0	0	0	13	0	1	5	
11	11.697	Christian	KY 1682	10	1	3	4	2	1	0	0	0	21	0	1	10	
23	22.641	Christian	KY 800	2	1	1	0	0	0	0	0	0	4	0	0	2	
30	29.568	Hopkins	US 41	1	0	0	0	0	0	0	0	1	2	0	0	1	
33	32.850	Hopkins	US 62	2	0	0	0	0	0	0	0	1	3	1	0	0	
34	34.271	Hopkins	I-69/WK PKWY	16	0	0	0	0	0	0	0	0	16	0	0	0	

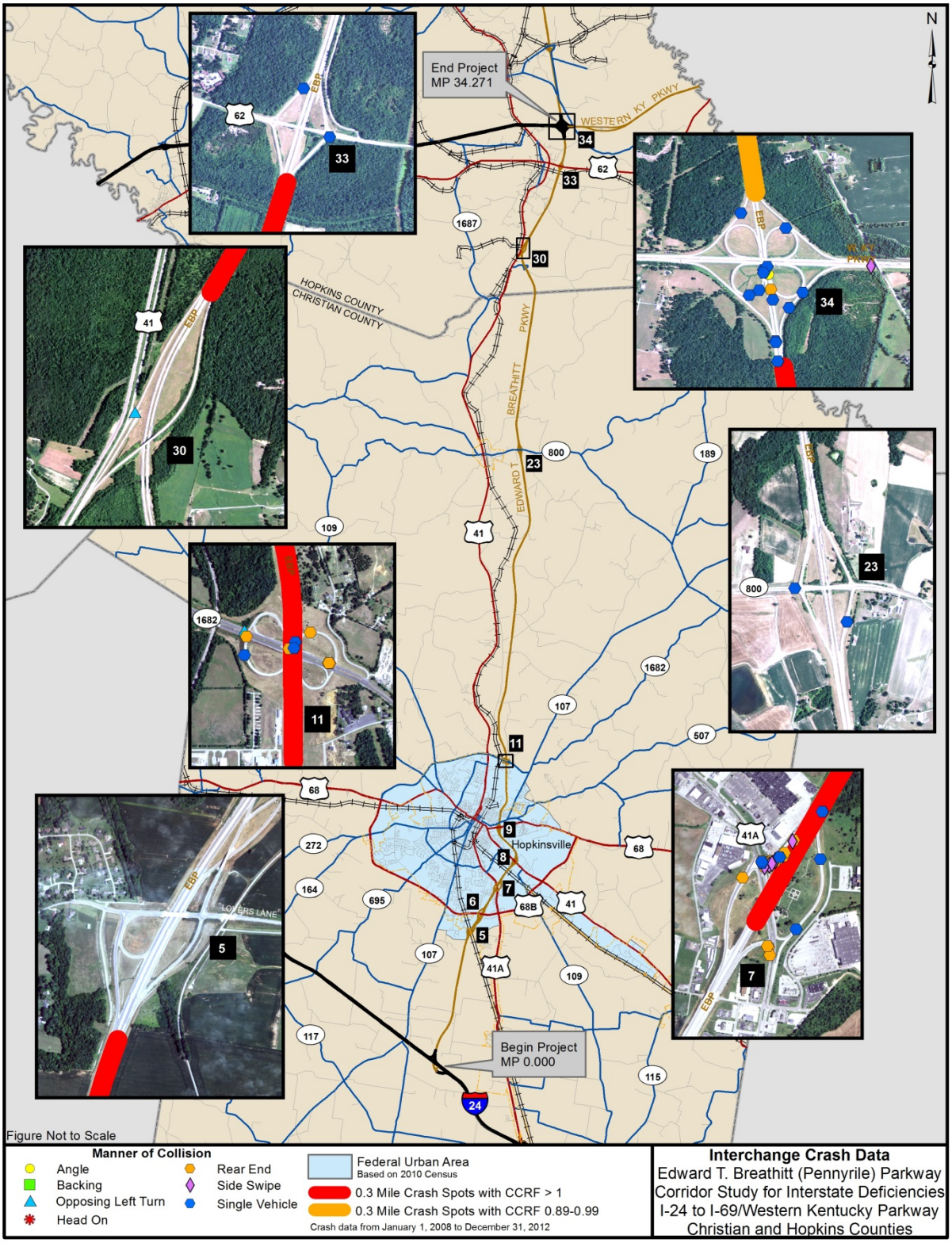


Figure 14: Interchange Crash Data

With the illustrated traffic volumes in Figure 15-16 (pp. 55-56), the merge, diverge, weave, and mainline traffic volumes for the current year (2013) and in the design year (2040) for both the Build and No-Build scenarios operate at a LOS A.

H. Interchange Control of Access

The *Interstate Standards* state that access control shall extend the full length of ramps and terminals on the crossroad. Control should extend beyond the ramp terminal at least 100 feet in urban areas and 300 feet in rural areas. However, in areas of high traffic volume, where exists the potential for development that would create operational or safety problems, longer lengths of access control should be provided.

Access control was measured from aerial photography and not measured in the field. According to the *KYTC Highway Design Manual*, access control should be measured from the end of the interchange ramp radius to the centerline of the closest access point. The limits of access on the crossroad should terminate opposite each other, using the farthest point as control.

The crossroads that appear not to meet the minimum are as follows:

- US 62 – Actual 65 feet in the northeast quadrant, Minimum 300 feet (Figure 17, p. 57)
- US 41A – The Fort Campbell Memorial Park has an entrance and exit with parking located between the two ramp terminals (Figure 18, p. 57)

I. Interchange Configuration

Currently the ETB Parkway has several interchanges that are inconsistent with common practice for interstate interchange configuration.

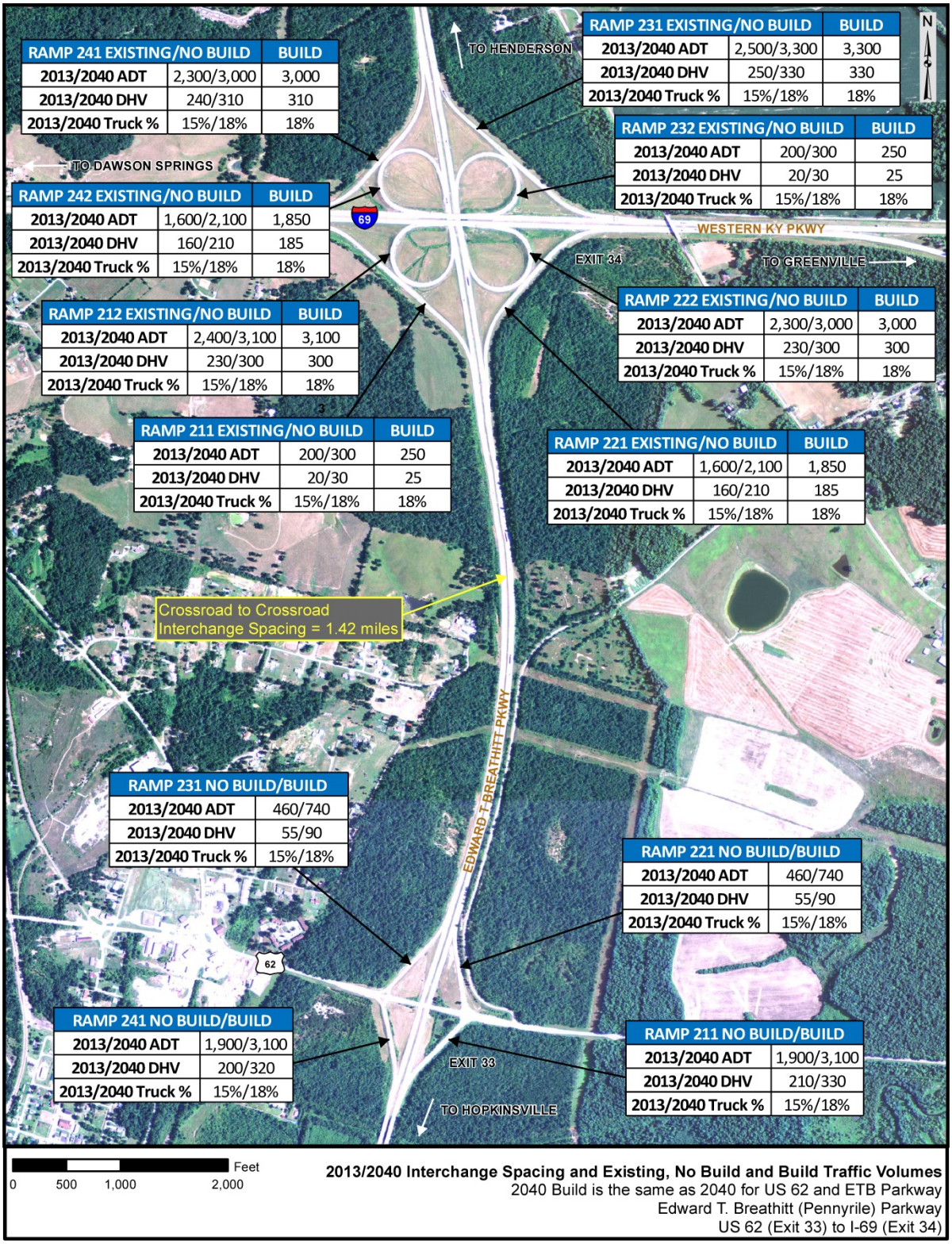


Figure 15: I-69/WKP (Exit 34) to US 62 (Exit 33) Interchange Spacing

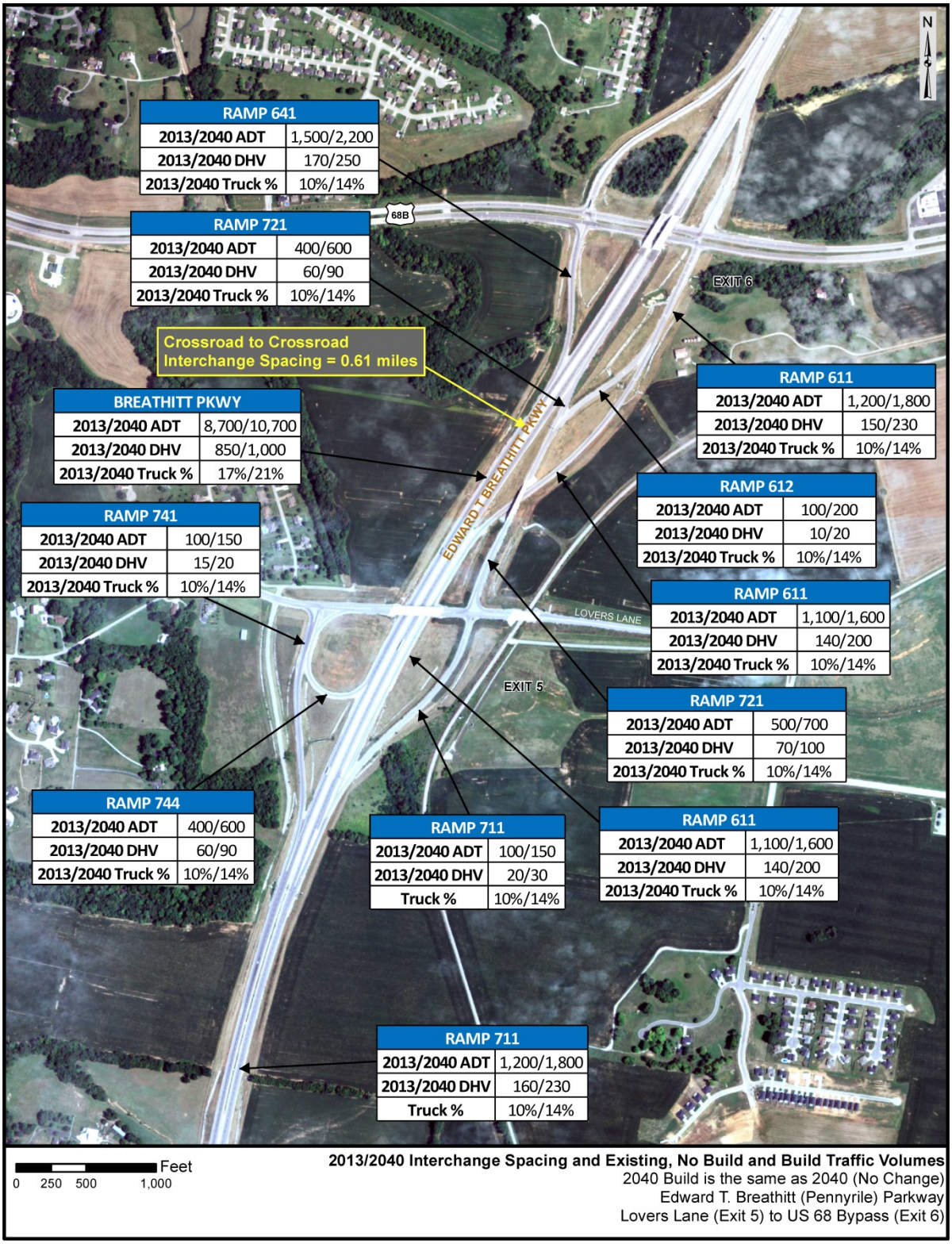


Figure 16: Lover's Lane Interchange Spacing

Figure 17: US 62 Control of Access

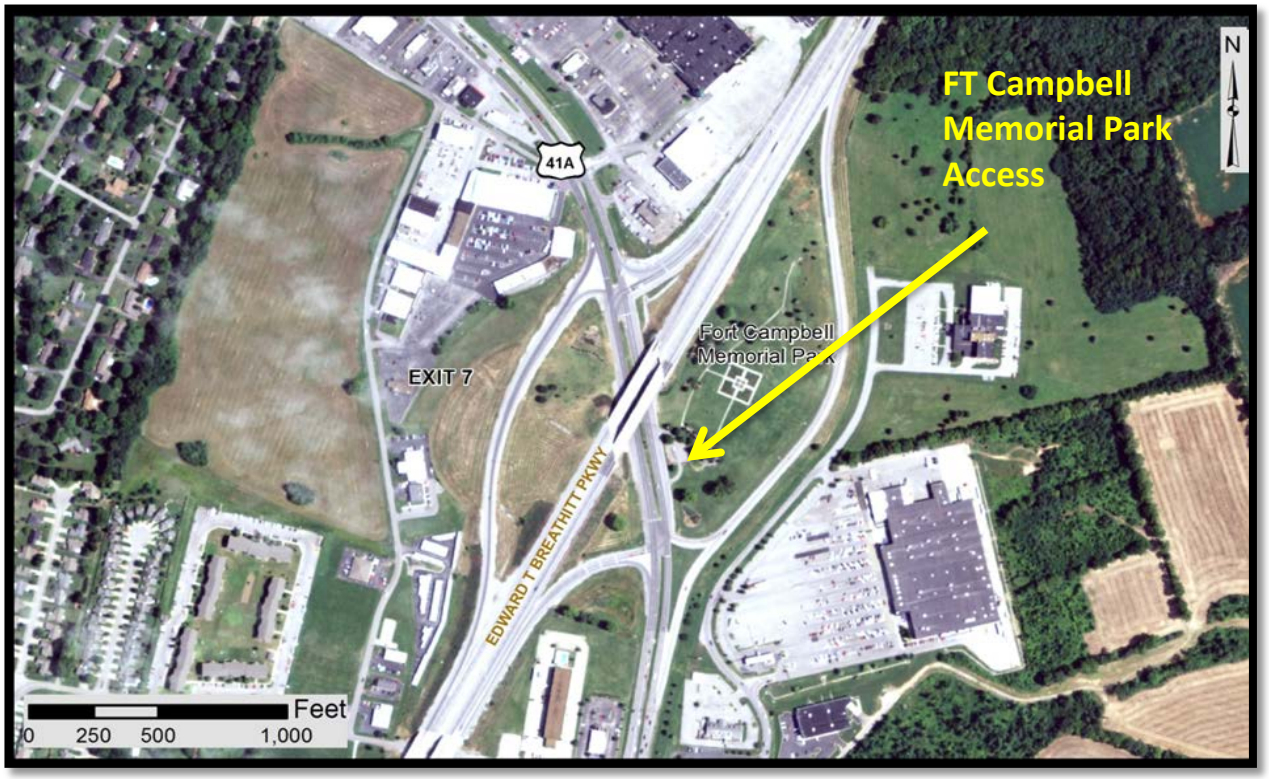


Figure 18: US 41A Control of Access

1. I-69 / ETB Parkway - System Interchange

Currently, the I-69 and ETB Parkway interchange is a full cloverleaf (Figure 19), which meets the recommendation for the two fully controlled access facilities interchange. However, if the ETB Parkway is converted to an interstate, it is possible the cloverleaf will require some modification to make interstate-to-interstate ramps directional.

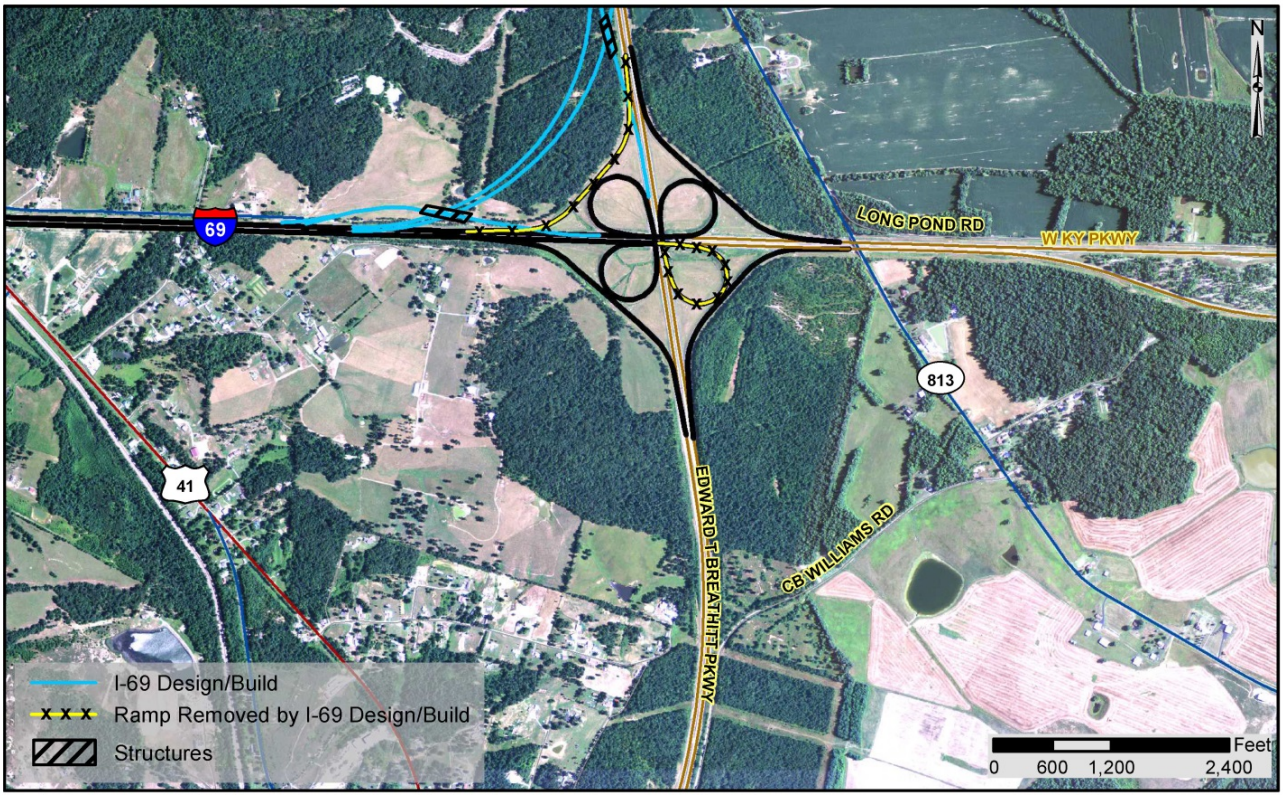


Figure 19: ETB Parkway/I-69/WKP Interchange

2. I-24 Interchange with ETB Parkway – System Interchange

The purpose of this study is to determine the improvements necessary to upgrade 34 miles of the ETB Parkway to interstate standards for inclusion as a spur to I-69. Therefore, the I-24 interchange was evaluated as a system interchange. This section of the ETB Parkway was generally designed as a 70 mph fully controlled access rural arterial facility with free flow movements at the I-24 interchange. Because of the relatively low volume of projected traffic, the need to minimize property impacts, and the high cost associated with constructing a flyover ramp for traffic traveling from I-24 EB to ETB Parkway NB, a 35 mph loop ramp was constructed instead. 35 mph is the minimum required loop radius design speed according to the 2011 Green Book. The flyover ramp from ETB Parkway SB to I-24 EB transitions from 70 mph on the parkway to 50 mph on the ramp then to 70 mph on I-24. The ramp meets all current design standards. The ETB Parkway SB to I-24 WB ramp and the I-24 WB to ETB Parkway NB meet all current design standards.

3. KY 1682 - Service Interchange

As stated in Section VI, E.2, the KY 1682 interchange (Figure 20) has less than the minimum weaving distance. KYTC has been systematically replacing these interchanges as part of parkway interchange improvement projects. This interchange was constructed for entering and exiting motorists to stop and pay a toll. The toll booth has since been removed; however, the short weave movements remain. It has been standard practice for KYTC to reconstruct these interchanges to a more standard type interchange.

Figure 20: KY 1682

4. US 41 Partial Interchange at Exit 30 - Service Interchange

The former Madisonville Bypass, which was later incorporated into the ETB Parkway, ended at US 41. The partial interchange remained in place when the parkway was extended southward (Figure 21, p. 60) It is desirable that all interstate interchanges provide for all movements. This meets driver expectations and improves safety. Another option would be to close Exit 30.

Figure 21: US 41 Partial Interchange

VII. SUMMARY OF KEY FINDINGS EXISTING CONDITIONS OVERVIEW

Currently, the ETB Parkway operates similarly to an interstate highway. As discussed in previous chapters, there are areas where it lacks geometric compliance with current AASHTO guidelines. These AASHTO minimum guidelines are provided in Table 12 (p. 27). The ETB Parkway provides the basic geometric characteristics of an interstate highway, such as full control of access, two travels lanes in each direction, 12-foot-wide lanes, 10-foot-wide outside paved shoulders, 36-foot-wide rural medians, 70-mph rural design speed, and 50-mph urban design speed. However, it lacks compliance with other design features. Figures 22 and 23 (pp. 63-64) summarize the deficiency locations for the project corridor. Each deficiency labeled is described on the legend.

A. Operational Considerations and Safety

The following is a summary of the key findings related to the operational considerations and the safety of the ETB Parkway from I-24 to I-69/WKP interchange:

- **Crash Segment Analysis as a Parkway:** For the crash analysis, a high-crash segment was defined as having a CCRF greater than or equal to one. There were no crash segments with a Critical Crash Rate Factor between 0.89 and 0.99. There are three high-crash segments

that are all in Christian County (MP 0.587 to MP 4.800, MP 5.759 to MP 7.50000, and MP 11.697 to MP 22.641) where the Actual Crash Rate exceeds the Critical Crash Rate.

- **Crash Segment Analysis as an Interstate:** The ETB Parkway analyzed as an interstate has one additional segment (MP 22.641 to MP 32.861) where the CCRF approaches 1.0 (0.95).
- **Crash Spot Analysis as a Parkway:** There are 29 spots that have a CRFF >1.0 and some of these spots overlap. There are 15 additional spots that have a CCRF that approached 1.0(0.89<CCRF 1.0).
- **Additional Findings Related to Crash Analysis**: There were three crashes coded as median cross-over or head-on collisions during the study period (2008-2012). There were seven fatal crashes during the study period (2008-2012). Neither the fatal crashes nor the head on crashes were in a concentrated area.
- **Commercial Vehicle Standards:** If this corridor becomes an interstate, the weight limitations would have a maximum gross vehicle weight of 80,000 pounds.
- **Current Traffic (2013):** The current traffic volumes range from 8,700 vpd (south of US 68 Bypass in Hopkinsville) to 17,200 vpd in Hopkinsville between US 41 (Exit 8) and US 68 (Exit 9).
- **Truck Percentages (2013):** The existing truck percentages on the ETB Parkway range from 15.0% from US 41 in Hopkinsville north to I-69 to 22% between Lovers Lane (Exit 5) and I-24 (MP 0.000).
- **Future Traffic (2040) as a Parkway:** The projected annual population growth rate is 1%. This rate results in traffic volumes ranging from 10,700 vehicles per day (south of US 68 Bypass in Hopkinsville) to 23,100 vpd in Hopkinsville between US 41 (Exit 8) and US 68 (Exit 9).
- **Future Traffic (2040) as an Interstate:** The future traffic with interstate designation is not expected to increase over the projected normal growth. The only changes for build traffic that are expected to occur would be if the US 41 interchange (Exit 30) is converted to a full interchange. This would reduce the projected traffic volumes from 600 vpd between I-69 (Exit 34) and US 62 (Exit 33), and 700 vpd between US 41 (Exit 30) and US 62 (Exit 33).
- **Truck Percentages (2040):** Future truck volumes are not expected to increase over the projected normal growth. The future truck volumes range from 18% to 25%.
- **Level of Service (2013):** The ETB Parkway currently operates at an LOS A.
- **Level of Service (2040) as a Parkway:** The ETB Parkway is expected to operate at an LOS A with and without interstate designation.
- **Level of Service (2040) as an Interstate:** The ETB Parkway is expected to operate at a LOS A with interstate designation and the full buildout of all Segments of Independent Utilities for I-69 in Kentucky.

B. Mainline Geometry/Typical Section

The following is a summary of the key findings related to the ETB Parkway geometry and typical section when analyzed as an interstate:

- **Design Speed:** The ETB Parkway meets or exceeds the minimum design speed guidelines for interstate highways in rural and urban areas.
- **Lane Width:** The lane width on the ETB Parkway meets the minimum AASHTO guidelines for interstate design.
- **Outside Shoulder Width:** The ETB Parkway meets the AASHTO minimum outside shoulder width based on the current truck DDHV.
- **Inside Shoulder Width:** The ETB Parkway does not comply with the minimum AASHTO design guidelines for inside paved shoulder widths. The AASHTO minimum inside paved shoulder width is 4 feet. The ETB Parkway has a 3-foot-wide inside paved shoulder with the exception of the newer section from MP 0.000 (end of the I-24 ramp) to the CSX Railroad north of US 41A (MP 7.500) which has 4-foot inside paved shoulders.
- **Striping Issue:** The ETB Parkway from MP 29.561 to MP 34.271 southbound, currently has a striping issue that makes the lane widths and outside shoulder widths less than minimum, however, the inside paved shoulder width is more than adequate in places. This discrepancy is due to striping that appears to be shifted toward the outside. This will be corrected if the inside shoulder width is widened to 4 feet. If not, then, restriping may be required to provide the appropriate lane widths and outside shoulder widths.
- **Median Width:** The ETB Parkway meets the rural 36-foot AASHTO minimum median width in rural areas and the 10-foot minimum median width in urban areas.
- **Clear Zones:** Without field review it is not possible to identify all items that may be within the clear zone. However, based on a review of the slopes that are presented in the as-built plans for the corridor, there are ditch slopes between MP 7.500 to MP 34.271 and median slopes from MP 29.568 to MP 34.271 that show as 1V:3H. It was concluded that all slopes on the interstate should be a minimum of 1V:4H, including the median slopes.
- **Guardrail Placement and Condition:** The guardrail from MP 16.000 to MP 30.000 has wooden posts. It is approximately 50,000 linear feet. Because field verification of the height and detailed specifications of the characteristics of the guardrail were outside the scope of this study, it was assumed that the dimension of the round wood post is 7” which is consistent with Kentucky Standard Drawing RBR-015 for single face application. In a question and answer section on FHWA’s website with regard to roadway barriers, the following statement was made: “Some states use 8” round posts for w-beam guardrail, but there is not sufficient performance information to offer a recommendation on whether they may be substituted for steel or rectangular wood posts.” Therefore, given FHWA’s response with regard to the use of 8” round posts and Kentucky’s standard drawing for using 7” round posts, for the purposes of this planning document, stretches of guardrail with round wood posts were considered as non-standard and in need of replacement.

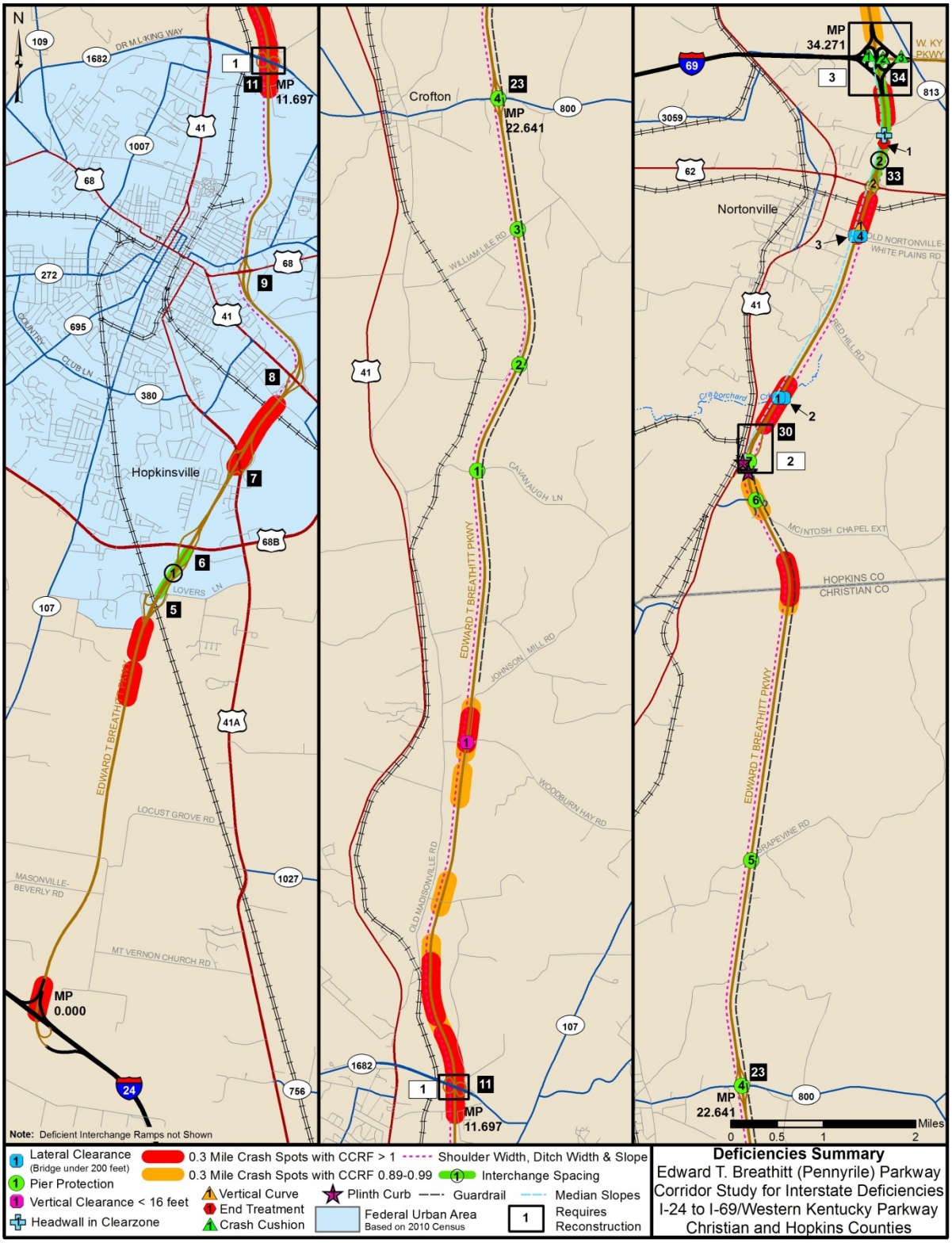


Figure 22: Edward T. Breathitt Parkway Deficiencies Summary

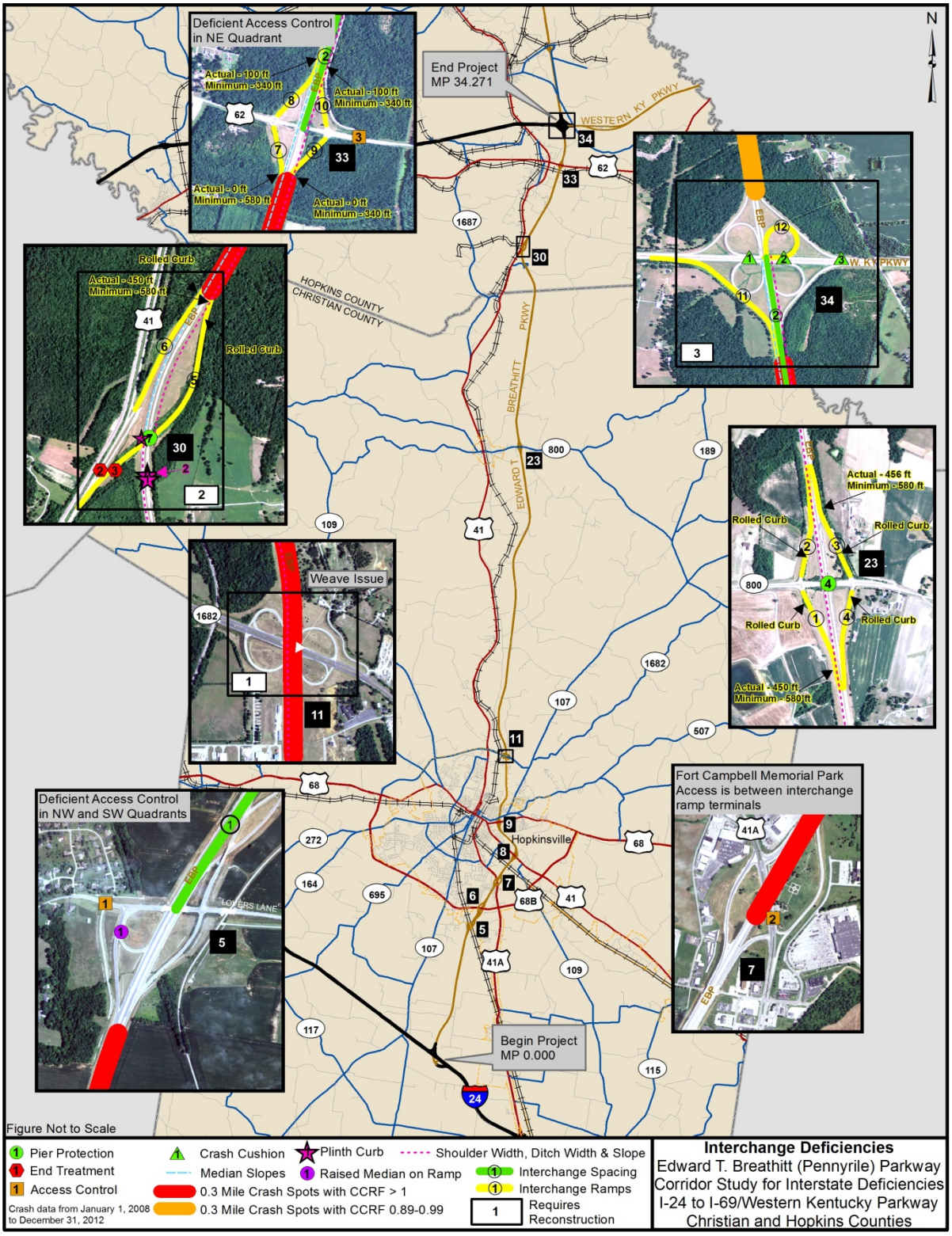


Figure 23: Edward T. Breathitt Parkway Interchange Deficiencies Summary

It has been our experience on recent interstate rehabilitation and reconstruction projects the majority of the guardrail is often upgraded throughout the project limits on these types of projects. In addition, because field measurement of the top of guardrail was outside the scope of this study, there may be lengths of guardrail, both along the mainline and ramps, that fall below the recommended height for the top of rail and further verification of compliance is recommended as part of any future 3R project.

- **Superelevation:** From the review of as-built plans, horizontal curves along the ETB Parkway, the superelevation is adequate given the actual superelevation rate of the curves, the applicable friction factors, and actual curve radii.
- **Horizontal Alignment:** A review of as-built plans shows horizontal curves along the ETB Parkway meet minimum standards.
- **Vertical Alignment – Sag Curves:** Two sag vertical curves do not meet the minimum guidelines for the headlight sight distance. These curves are also located in a high crash spot.
- **Vertical Alignment – Crest Curves:** The minimum stopping sight distance for crest curves is met for all vertical crest curves guideline.

C. Bridges and Overpasses

The following is a summary of the key findings related to the bridges and overpasses on the ETB Parkway and I-24:

- **Lateral Clearance:** Of the 16 mainline bridges, four do not meet the minimum lateral clearance requirement (Crab Orchard Creek, northbound and southbound and Old White Plains Road and Creek, northbound and southbound all in Hopkins County). These bridges are located in a high crash spot.
- **Vertical Clearance:** Of the 19 overpass bridges, one (1) does not meet the minimum 16-foot vertical clearance requirement. This bridge is located at mainline MP 15.511 (KY 2641) and is located in a high crash spot.
- **Functional Adequacy:** Two mainline bridges at First Street both northbound and southbound (MP 9.728 and MP 9.730) are identified as functionally obsolete.
- **Sufficiency Rating:** All mainline and overpass bridges have sufficiency ratings greater than 60.0.
- **Structurally Deficient:** One overpass bridge was listed as structurally deficient (024B00099N) with a sufficiency rating of 74.1 due to the deck conditions.
- **Curbs:** Two mainline bridges located over Drakes Creek at MP 29.448 (northbound) and MP 29.460 (southbound) have curbs. The northbound ramp over US 41 at Exit 30 also has curbs.
- **Overhead Signs and Trusses:** All overhead signs and trusses meet the minimum 17-foot vertical clearance requirement.

D. Interchanges and Ramps

The following is a summary of the key findings related to the interchanges and ramps on the ETB Parkway:

- **Design Speed:** Design speed was calculated for all ramps and all meet the minimum design speed.
- **Lane Width:** Lane widths for the interchange ramps range from 14 feet to 18 feet, which is compliant with AASHTO guidelines.
- **Shoulder Width:** Of the ramps analyzed, the US 41 northbound on ramp at Exit 30 does not meet the minimum criteria for shoulder width. It has rolled curb for its entire length.
- **Horizontal Alignment:** All ramps meet the minimum radius criteria. (Exit 11 was not analyzed.)
- **Vertical Alignment – Vertical Grade:** The minimum vertical grade is met on all interchange ramps.
- **Vertical Alignment – Sag Curves, Headlight Sight Distance:** All vertical curve ramps meet the minimum headlight sight distance for the appropriate design speed.
- **Vertical Alignment – Crest Curves, Stopping Sight Distance:** All curve ramps meet the minimum stopping sight distance.
- **Guardrail:** Two end treatments on the northbound on-ramp of US 41 at Exit 30 do not meet current criteria.
- **Superelevation:** All ramps meet the minimum superelevation criteria.
- **Speed-Change Lanes:** There are seven ramps that do not meet the minimum criteria for acceleration and deceleration lengths: the four ramps at US 62 (Exit 33), the US 41 northbound on-ramp at Exit 30, and the on-ramps at KY 800 (Exit 23). All LOS for these movements are LOS A.
- **Weaving Characteristics**: The KY 1682 (Exit 11) interchange has less than minimum weaving distance and currently operates at LOS A and is expected to operate at LOS A in the design year 2040.
- **Interchange Spacing**: There are two locations where the minimum interchange spacing requirements are not met: between Lovers Lane (Exit 5) and US 68 Bypass (Exit 6) and between US 62 and I-69. For an urban area, the crossroad-to-crossroad distance rule of thumb is 1.0 mile. Between Exits 5 and 6 (Lovers Lane and US 68 Bypass). The existing distance is 0.610 mile. The southbound exit ramp at Lover's Lane was constructed as a loop ramp in the southeast quadrant to provide more ramp spacing between the ETB Parkway southbound on ramp from US 68B and the ETB Parkway southbound off ramp at Lover's Lane, and to minimize impacts to an existing subdivision. The northbound ramps between the two interchanges were braided to provide ramp spacing/separation. All ramps at both interchange locations meet the *2011 Green Book* minimum ramp spacing criteria. However, the minimum interchange spacing requirements (crossroad to crossroad) as defined are not met. To maximize spacing southbound between US 68B and Lover's Lane, an additional

lane may be required. There is not a defined weave (no auxiliary lane) at this location that can be analyzed through the Highway Capacity Manual. The second location, between US 62 and I-69 in Hopkins County, does not meet rural minimum ramp spacing criteria as stated for the *2011 Green Book* or the Highway Design Manual (2 miles), or for Interstate Standards (3 miles). The mainline through both areas has a current (2013) LOS of A, and a design year LOS (2040) of A. All merge and diverge movements are LOS A.

- **Interchange Control of Access:** Two interchanges do not meet the minimum interchange control of access requirements: US 41A (Exit 7), which has the Fort Campbell Memorial Park parking lot access in between the ramp terminals; and the northeast quadrant of US 62 (Exit 33).
- **Interchange Configuration:** Currently, the ETB Parkway has two service interchanges that do not meet the recommended interstate interchange configuration: KY 1682 (Exit 11) and US 41 (Exit 30). A system interchange at I-69 (Exit 34) does not meet the recommended interstate interchange configuration for the ramps from the ETB Parkway.
- **I-24 Interchange:** The purpose of this study is to determine the improvements necessary to upgrade 34 miles of the ETB Parkway to interstate standards for inclusion as a spur to I-69. Therefore, the I-24 interchange was evaluated as a system interchange. This section of the ETB Parkway was generally designed as a 70 mph fully controlled access rural arterial facility with free flow movements at the I-24 interchange. Because of the relatively low volume of projected traffic, the need to minimize property impacts, and the high cost associated with constructing a flyover ramp for traffic traveling from I-24 EB to ETB Parkway NB, a 35 mph loop ramp was constructed instead. 35 mph is the minimum required loop radius design speed according to the *2011 Green Book*. The flyover ramp from ETB Parkway SB to I-24 EB transitions from 70 mph on the parkway to 50 mph on the ramp then to 70 mph on I-24. The ramp meets all current design standards. The ETB Parkway SB to I-24 WB ramp and the I-24 WB to ETB Parkway NB meet all current design standards

E. Design Feature Deficiency and Crash History Analysis

To further evaluate the impact of the roadway feature deficiencies on safety, a high-level crash analysis utilizing Kentucky State Police (KSP) data was conducted to verify whether the deficiencies have an impact on safety. Again, the CCRF is for both directions, and an evaluation of crash reports may reveal more detail.

1. Mainline Geometry/Typical Section

a. Shoulder Widths

The ETB Parkway has 17 0.3-mile high-crash locations from MP 7.500 to 34.271, where the shoulder width is less than 4 feet paved. For high-crash location details, refer to Chapter III.A (p.10).

b. Vertical Alignment – Sag Curves – Headlight Sight Distance

A 0.3-mile rolling crash analysis was conducted for the vertical alignment deficiencies, and the results are provided in **Appendix C**. One sag curve is located within a high-crash spot. The sag curve at MP

32.413 has a vertical curve of 600 feet. Crashes were examined from MP 32.300 to MP 32.527 in attempt to isolate the crash issues. There were eight crashes in this vertical curve over a 5-year period—four occurred in dark conditions, six of them were northbound, three were coded collision with animal, all were single-vehicle crashes, and seven of the eight crashes were on dry pavement.

c. Inadequate Pier Protection

Only one of the seven overpass structures (MP 29.131, McIntosh Chapel, KY 2647) with inadequate pier protection is located in a 0.3-mile spot with a CCRF approaching 1.0. This spot had eight crashes, six of which involved single vehicles. Three crashes were coded "ran off the roadway," two were "collision with fixed object non-intersection," and one crash each was "collision with non-fixed object," "other collisions on shoulder," and "sideswipe collision - same direction."

d. Clear Zones

The clear zones' relationship to high-crash locations are shown on Figure 23 (p. 64). There are six 0.3-mile high-crash spots between MP 29.568 and MP 34.271, where the median slopes do not meet minimum criteria. In addition, there are nine additional 0.3-mile high-crash spots for the stretch of the ETB Parkway where ditch slopes do not meet minimum criteria (MP 7.500 to MP 34.271).

Evaluating median slopes, the ETB Parkway had three head-on collisions over 5 years and the directional analysis from KSP indicated they were coded: "ran off roadway" (MP 15.191), "collision with fixed object non intersection" (MP 16.665), and "vehicle parked position, parking lot or driveway" (MP 10.380). The crashes were not located in a concentrated area and they were in a location where median slopes were 1V:4H.

e. Acceleration

There are six ramps where the length of acceleration is less than the minimum criteria. Of those six, three are located in high-crash locations, as follows:

- US 41 Northbound Entrance Ramp – Actual 450 feet and Minimum 580 feet
- US 62 Southbound Entrance Ramp – Actual 0 feet and Minimum 580 feet
- Southbound I-69 from Southbound ETB Parkway – Actual 450 and Minimum 580 feet

f. Deceleration

There are three ramps where the length of deceleration is less than the minimum criteria. Of those three, one located in a high-crash location and they are as follows:

- US 62 Northbound Exit Ramp – Actual 0 feet and Minimum 340 feet

g. Ramps

After evaluation, all ramps meet minimum typical section, vertical and horizontal criteria to become an interstate with the exception of the US 41 and KY 800 ramps that have rolled curb. These ramps did not exhibit any abnormal crash patterns.

2. Superelevation Crash Analysis

All horizontal curves meet superelevation criteria. Therefore, additional crash causation analysis was not performed.

3. Bridges and Overpasses

A 0.3-mile rolling crash analysis was conducted for the vertical alignment deficiencies and the results are shown in **Appendix C**. The mainline bridges over Old White Plains Road and Creek (MP 30.290) are not located within a spot that has a CCRF>1.0. The two bridges over Crab Orchard Creek (MP 30.330 NB and MP 30.340 SB) are within a 0.3 mile high-crash location.

The crashes located 500 feet each side of the bridges were analyzed for potential causation factors. For the bridge at MP 30.330 northbound, there were 12 crashes within 0.10 mile on either side of the bridges, six of which were coded "collision with animal" and three of which were coded "ran off roadway." Two crashes were on wet pavement, five were in the daylight, six were coded "dark-highway not lighted" (four of those were "collision with animal"), and 11 of 12 involved single vehicles. There was only one crash coded "other roadway or mid-block collision."

For the bridge at MP 30.330, four of 10 crashes were "collision with animal"; three were coded "ran off the roadway," with two of those being in wet roadway conditions; four occurred in "dark – highway not lighted" conditions; and five were in the daylight. There was only one "other roadway or mid-block collision" crash, and one "other collisions on shoulder," which occurred in snow and slush.

VIII. POTENTIAL IMPROVEMENT ALTERNATIVES AND DEVELOPMENT COSTS

This chapter describes a range of alternatives to address the deficiencies identified on the ETB Parkway. These improvements are associated with the costs for upgrading the ETB Parkway to interstate standards.

ETB Parkway interchanges were examined for improvements or total reconstruction:

- KY 1682 – Exit 11: Reconstruct to remove weave and upgrade to new KYTC practice.
- US 41 – Exit 30: Reconstruct to full interchange anticipating that FHWA will not allow a partial interchange.
- I-69/WKP – Exit 34: Upgrade two ETB Parkway ramps to directional ramps.

A. Potential Interchange Reconstruction

1. KY 1682

KY 1682 is proposed as a simple diamond interchange (see Figure 24, p. 72). Other configurations may work; however, because a diamond interchange fits simply, other interchange configurations were not studied. The cost for this interchange was estimated based on the cost of the Sebree (KY 56) interchange with the ETB Parkway in Webster County which was let to construction in June 2014.

2. US 41

US 41 at Exit 30 in Hopkins County is a challenging area due to the configuration of the ramps, existing US 41, and the existing railroad. Several options were considered:

- Option 1: Do nothing (No-Build scenario).
- Option 2: Remove the ramps, close the interchange, and provide access at Exit 33 (US 62).
- Option 3: Leave both ramps in place, and provide for the other two ramps at a KY 2647 interchange to the south.
- Option 4: Reconstruct all four ramps at KY 2647 to the south.
- Option 5: Leave the northbound ramp at the existing location, remove the southbound ramp, and reconstruct three ramps at the KY 2647 to the south. Improve KY 2647 from the new interchange west to ETB Parkway as shown in Figure 25 (p. 73).

As shown in Figure 25, Option 5 is proposed. The northbound on-ramp is very expensive to replace and is in relatively good condition (after removing curbs and widening shoulders). However, during future phases, any of the above options could be considered. Low current and forecasted future usage as well as estimated construction costs for interchange modifications may result in doing nothing or closing the existing partial interchange.

3. I-69 Interchange

Recent construction of the design / build project for the I-69/Ford / ETB Parkway interchange indicates that FHWA prefers directional interstate-to-interstate movements rather than loops. Because a driver expects to exit to an interstate spur (e.g. I-64 to I-265 in Jefferson County or I-75 to I-275 in Grant County) is different from that of continuous I-69 movements such as the I-69 design / build project, it is proposed to remove the NB ETB Parkway to I-69 southbound loop and provide for two directional ramps with a 70-mph design speed. Those are shown in Figure 26 (p. 74) and are as follows:

- Eastbound I-69 to Southbound ETB Parkway
- Northbound ETB Parkway to Westbound I-69

If this project moves forward, this design concept should be coordinated with FHWA early in the process to obtain approval of this concept..

B. Interchange Spacing

Two interchanges do not meet the minimum criteria for crossroad to crossroad spacing. Therefore, the following two locations may require an auxiliary lane or collector distributor road to provide for additional spacing. These two locations would meet the minimum ramp spacing criteria, and the LOS for merge and diverge would be LOS A both in the current year (2013) and the future design year (2040).

- Lovers Lane (Exit 5) to US 68 Bypass (Exit 6) in Christian County – Actual 0.610 mile and Minimum 1.0 mile (see Figure 27, p. 75).

  The northbound ramps between US 68B and Lover's Lane were braided to ramp spacing/separation. To maximize spacing southbound between US 68B and Lover's Lane, an additional lane may be required. There is not a defined weave (no auxiliary lane) at this location that can be analyzed through the Highway Capacity Manual. And again, all ramps at both interchange locations meet the *2011 Green Book* minimum ramp spacing criteria. However, the minimum interchange spacing requirements (crossroad to crossroad) as defined are not met.

- US 62 (Exit 33) to I-69 (Exit 34) in Hopkins County – Actual 1.421 miles and Minimum 2 to 3 miles

The mainline, merge and diverge, between Lovers Lane and the US 68 B interchanges, operate at LOS A both for the current and design year. This section of the ETB Parkway was opened to traffic in the past four years. The merge and diverge for each of the ramps operate at LOS A for both the current and design year. There are low traffic volumes, and the loop at Lovers Lane was designed to avoid impacts to a nearby subdivision. The existing ramps were designed to meet the *2011 Green Book* minimum ramp spacing. There are also no 0.3-mile high-crash spot locations between the two interchanges.

The second location between US 62 and I-69, the mainline and all merge and diverge operate at LOS A. The distance between interchanges meets all minimum ramp spacing criteria. There is one 0.3-mile spot high-crash location (MP 33.6 to MP 33.9) located between the two interchanges. This spot has 12 crashes in a 5-year period with six of the crashes coded "collision with animal." Only two crashes were coded as "ran off road," and one crash was coded "side swipe same direction."

Two concepts were examined to provide for more spacing between the two locations. Those are shown in Figures 27 and 28 (pp. 75 and 76).

C. Interchange Control of Access

There are two locations that do not meet the spacing of 300 feet in an urban area (US 41A Ft Campbell Memorial Park) and 100 feet in a rural area (US 62 frontage road). For US 62, the frontage road would just be reconstructed to meet the minimum spacing of 300 feet. US 41A in an attempt to not relocate the Ft. Campbell Memorial Park, an option was developed to remove the vehicular access (except for maintenance vehicles) and provide new parking area, and sidewalks to the memorial. This option is illustrated in Figure 29 (p. 77).

Figure 24: KY 1682 Interchange Reconstruction Option

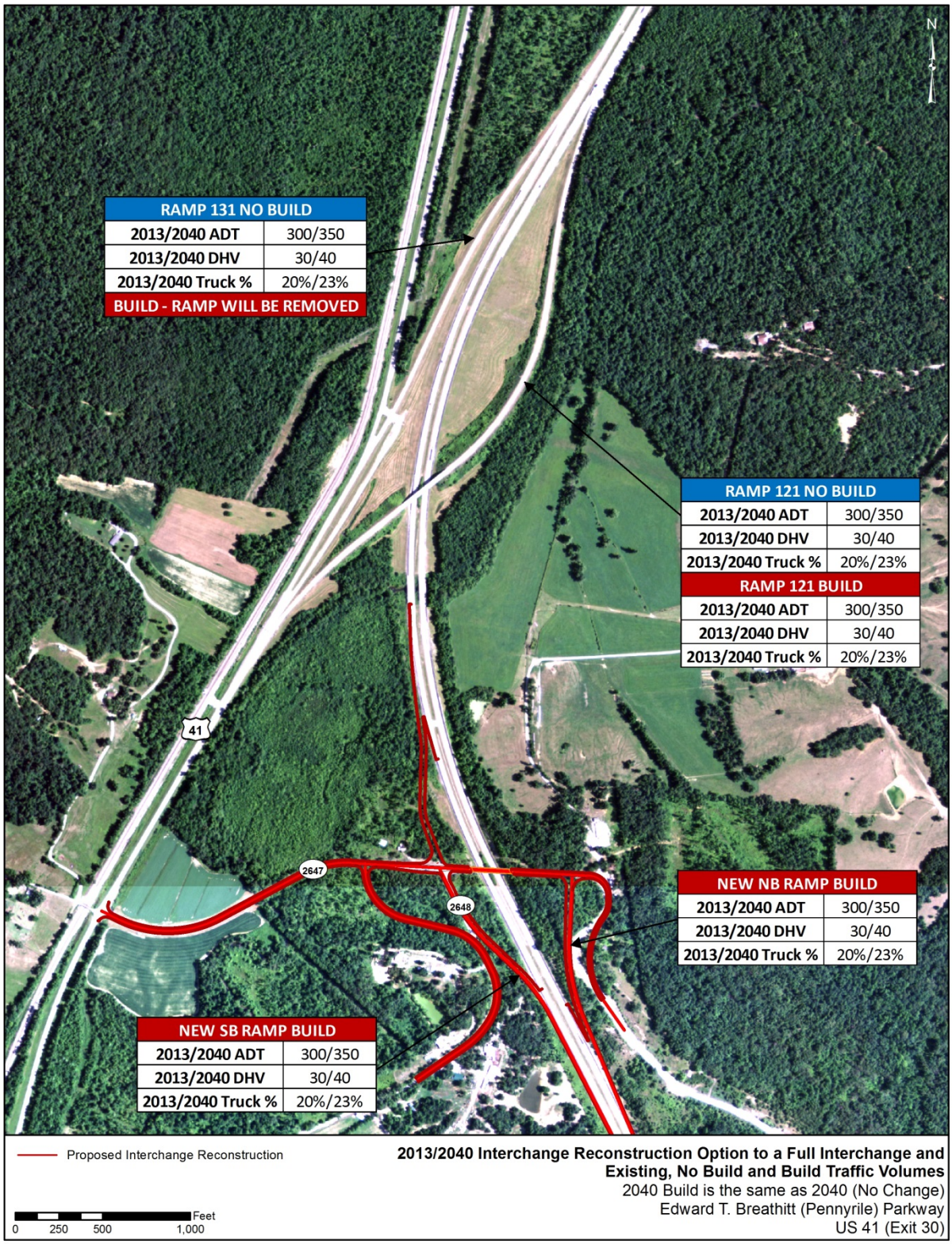


Figure 25: US 41 Interchange Reconstruction Option to a Full Interchange

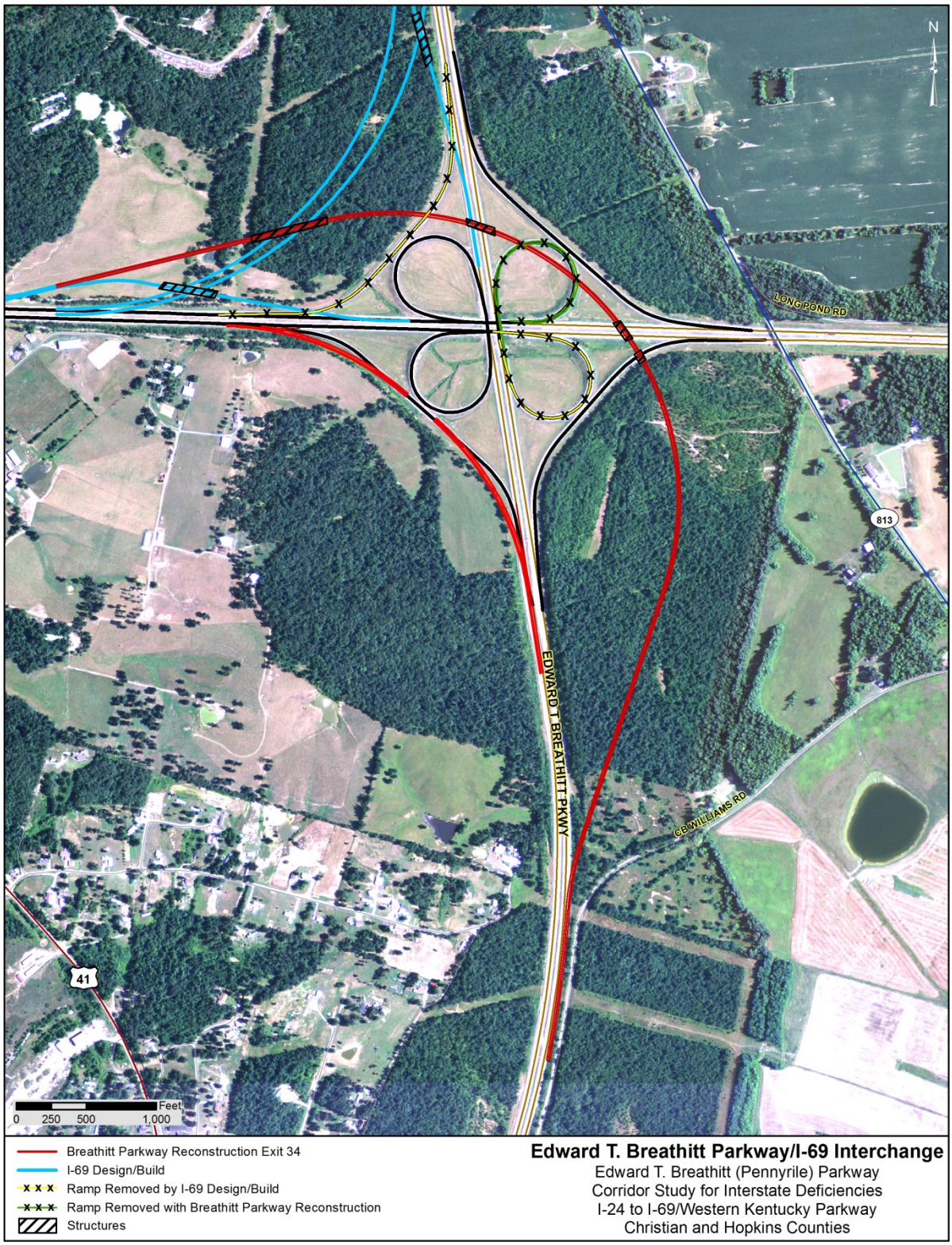


Figure 26: I-69/WKP Interchange Ramps Reconstruction

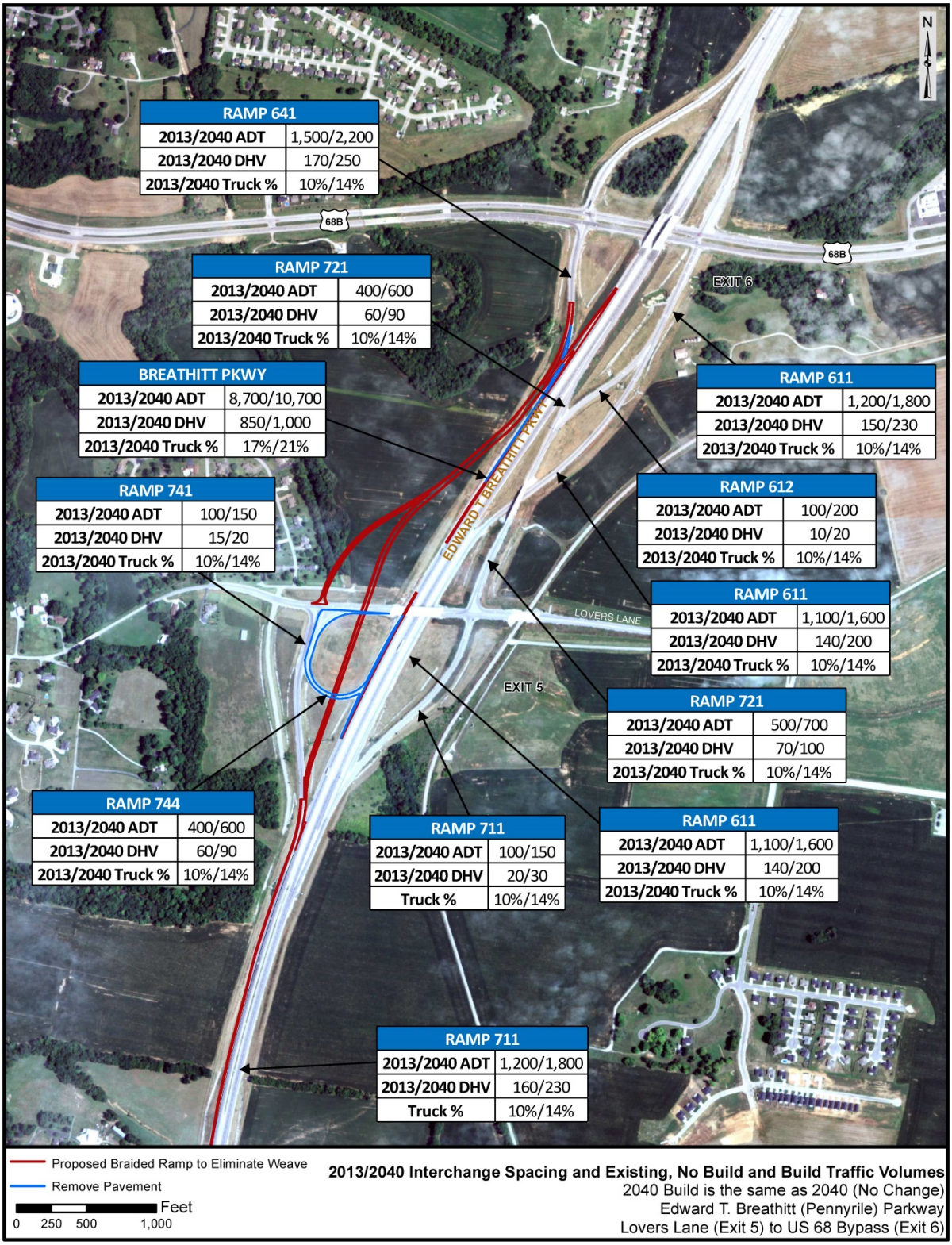


Figure 27: Lovers Lane to US 68B Interchange Spacing and Traffic Volumes with Southbound Ramp Braid

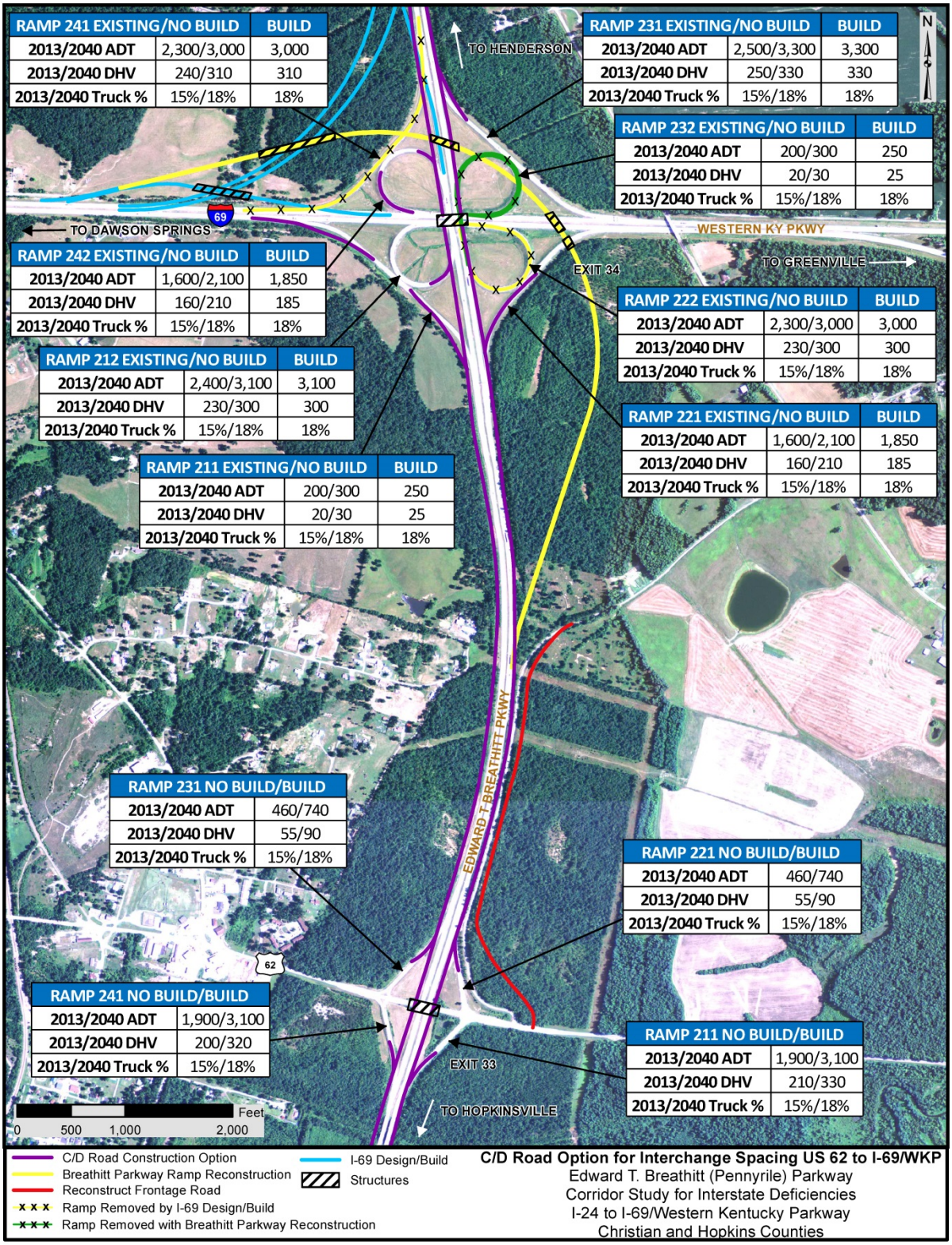


Figure 28: US 62 to I-69/WKP Interchange Spacing and Traffic Volumes with C/D Option

Figure 29: Control of Access Fort Campbell Memorial Park

D. Potential Improvements and Development Costs

For this study, three alternatives were studied: No-Build, Necessary Upgrades and Spot Safety Improvements, and Fully Compliant Reconstruction. Some improvements are illustrated in Figures 27 and 28 (pp. 75-76). The remaining deficiencies and total summary of improvements are summarized in Figures 30-31 (pp. 80-81) Table 25 (p. 82) outlines each improvement, the estimated cost, a symbol referencing the exhibits, and a description of the improvement.

1. No-Build Alternative

The No-Build Alternative would require no investment in the ETB Parkway beyond what is required for normal maintenance.

2. Necessary Upgrades and Spot Safety Improvements Alternative

Key safety and operational concerns would be addressed. The only improvements addressed would be those requiring a design exception from the 13 controlling criteria identified in Chapter IV of this study. Under this alternative, the ETB Parkway would not be upgraded to meet all current interstate standards. Design variances would be required for the existing conditions that do not meet current AASHTO or KYTC guidelines but are not design exceptions that are deemed appropriate by the KYTC and the FHWA. These are shown in Table 25 in the column labeled "Design Variance." The total estimate for this alternative is $20,100,000.

3. Fully Compliant Reconstruction Alternative

This alternative would involve improvements within existing right-of-way, or with minimum right-of-way acquisition needed to make the existing ETB Parkway from I-24 to I-69 meet minimum AASHTO interstate criteria. These improvements are shown in Table 25. This option includes all items under Necessary Upgrades and Safety Improvements and all design variances. This option is outlined in the column labeled "Full Reconstruction." The total for this estimate is $161,628,300. Design variances are $141,531,000 of that total.

4. Design, Environmental, Right of Way and Utility Estimates

Due to the expansive scope of this study, detailed estimates of right-of-way and utility costs were not included. Because the right-of-way for the mainline appears to be as much as 200 feet from centerline in some areas, it may be possible to make many improvements within the existing right-of-way. However, new interchange reconstruction, and control of access issues will necessitate extending beyond the right-of-way limits and may require new right-of-way. Being consistent with other studies of this type, right-of-way and utility costs combined were estimated at 30% of construction costs. Design and environmental analysis costs were estimated as 15% of the construction costs.

5. Conclusions

This study was a review that covered 34 miles of mainline and 11 interchanges. Additional items may arise as each project is initiated. Limited field reviews were performed as part of this study, and additional field reviews may necessitate a change in the list of items. Also, maintenance projects that have taken place since the onset of this study would not be included. The total estimated cost to upgrade the ETB Parkway without any design exceptions is $161,628,300. Nearly all improvements are north of MP 7.500.

IX. SUMMARY OF COST ESTIMATE METHODOLOGY

Planning level cost estimates were developed for each improvement. The following explain a few items in more detail.

- **Vertical Clearance** – A bridge over KY 2641 cannot be "jacked up," therefore, the costs were estimated considering excavating the pavement for 1,000 feet on north and south of the bridge to provide for 16 feet of clearance.
- **Shoulder width** – The estimate was prepared with the concept that the existing three (3) foot paved shoulder would be removed, and at least five (5) feet of shoulder constructed.
- **Mainline Bridge widths** less than 200 feet – The cost estimate were based on a conservative estimate for bridges of $200/sq. ft. to widen to 38 feet plus some roadway and maintenance of traffic costs.
- **Median and ditch slopes** – Both median and ditch slopes were estimated on the basis of desirable 6:1 slopes. The ditch slopes were estimated 18 feet in width addressing clear zone with 6:1 foreslopes and assuming 50% in rock cut based on the existing roadway. Four feet of cut was assumed in the shallow areas, and an average 10 feet for deep cuts. 1V:4H slopes not addressing the clear zone were estimated in the same manner.
- **Inadequate Pier Protection** – In each case, if the mounded pier protection is removed, the footer would protrude above the ground line and provide an obstacle. Therefore, as shown in Chapter IV, a concrete protection at the pier with guardrail and would replace the mounded pier protection
- **Wooden Post Guardrail** – The original linear feet of guardrail (approximately 50,000 feet) that needed replacing, and the leading number, trailing ends, and bridge ties were totaled. An additional 25% was added to the length to anticipate additional guardrail needed that was not foreseen as a part of this study due to limited field review and 25% for any contingencies.
- **Bridge curbs** were estimated using recent bids
- **Acceleration and Deceleration lengths** were estimated on the basis of square feet of pavement to be added. The costs for the southbound on-ramp and the northbound exit ramp at US 62 are estimated higher due to the proximity of the structure over the railroad and Pleasant Run creek.
- **Rolled Curb** removal was estimated for both the curve nearest the ETB Parkway and the entire ramp. The estimate was to remove the curb and replace with 4-foot-wide inside and 6-foot-wide outside shoulders.
- **Interchange Reconstruction** Costs associated with reconstruction of the KY 1682 (Exit 11) interchange were estimated based on the Sebree (KY 56) Interchange in Webster County that was recently let to construction.
- **Commercial Vehicle Standards**: If this corridor becomes an interstate, the width and weight limitations would have a maximum gross vehicle weight of 80,000 pounds.

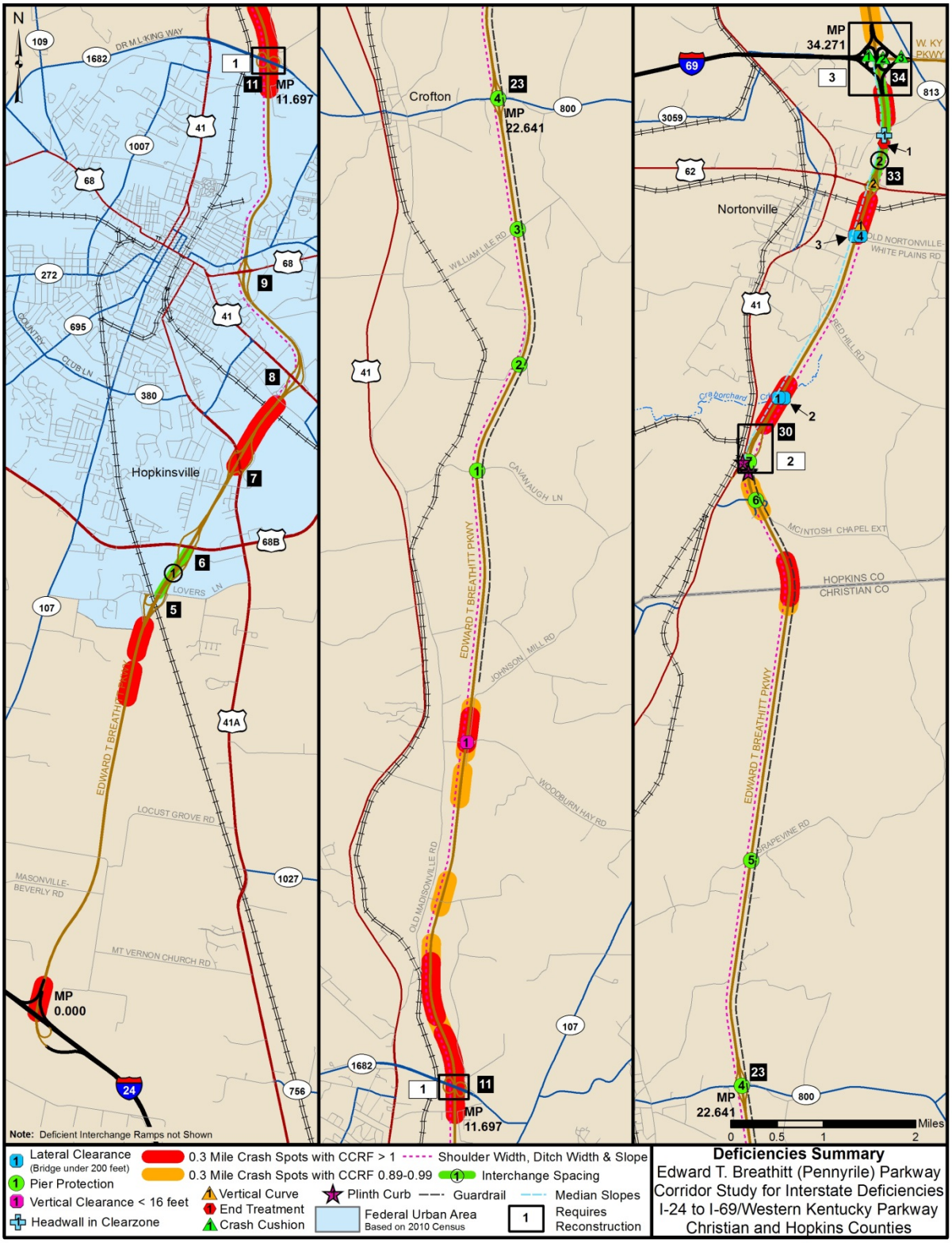


Figure 30: Deficiencies Summary

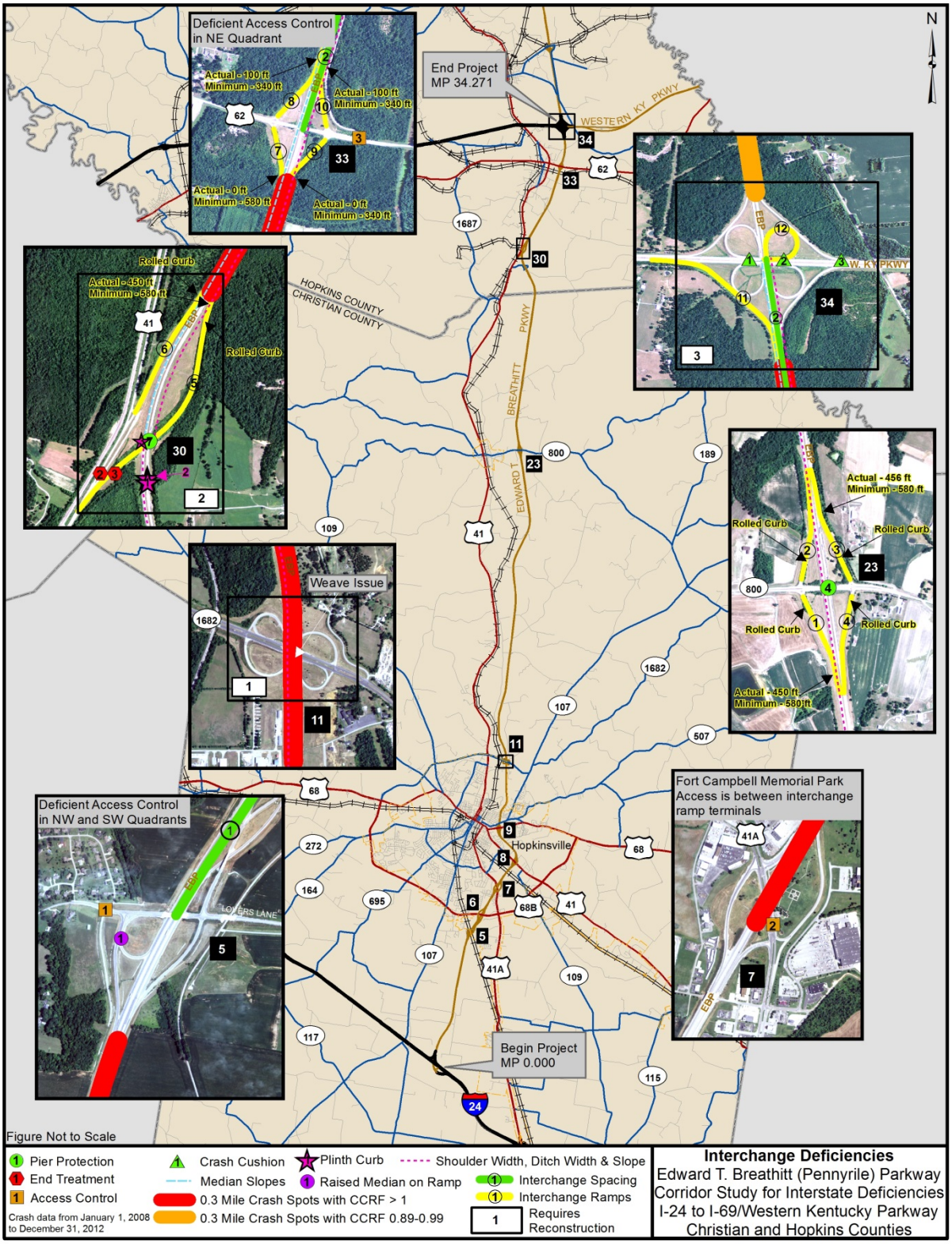


Figure 31: Deficient Interchanges

Table 25: Summary Table of Improvement Options

Location	Summary Categories	Milepoints or Options	Subtotals	Fully Compliant Reconstruction	Requires a Design Exception	Requires a Design Variance	Within a High Crash 0.3 Mile Spot Yes or No
	STRUCTURES						
	Widen Bridges < 200' with Widths< 38'			$ 738,100			
	Hopkins County						
1	SB Crab Orchard Creek	30.340	$ 191,600		x		Y
2	NB Crab Orchard Creek	30.330	$ 187,300		x		Y
3	NB Old White Plains Rd and Creek	32.290	$ 179,600		x		Y
4	SBOld White Plains Rd and Creek	32.290	$ 179,600		x		Y
	Plinth Curb			$ 243,700			
1	NB Drakes Creek	29.448	$ 62,900			x	N
2	SB Drakes Creek	29.460	$ 62,900			x	N
3	NB Entrance Ramp @ US 41 over EBT	29.550	$ 118,000			x	N
	Vertical Clearance < 16 feet			$ 1,163,700			
	Christian County						
1	KY 2641	15.511	$ 1,163,700		x		Y
	Inadequate Pier Protection			$ 2,448,000			
	Christian County						
1	Cavanaugh Lane (KY 2636)	18.474	$ 334,000		x		N
2	J Knight Road (KY 2640)	19.721	$ 349,000		x		N
3	William Lile Road	21.214	$ 357,000		x		N
4	KY 800	22.649	$ 341,000		x		N
5	Grapevine Road (KY 2637)	25.117	$ 341,000		x		N
	Hopkins County						
6	McIntosh Chapel Road (KY 2647)	29.131	$ 336,000		x		Y
7	NB US 41 On Ramp	29.560	$ 390,000		x		N
	MAINLINE						
	Horizontal		$ -	$ -			
	Vertical			$ 766,900			
1	Sag - MP 32.413	32.413	$ 143,800		x		Y
2	Sag - MP 32.887	32.887	$ 623,100		x		Y
--------	**Widen Inside Shoulders (MP 7.5 to MP 34.247) or**						
	Widen inside shoulders from MP 7.5 to MP 34.271	7.500 - 34.271	$ 8,743,600	$ 8,743,600	x		
	Restripe from MP 29.561 to MP 34.271	29.561 to 34.271	$ 78,400				
1	**Guardrail End Treatment near SB MP 33.4**	SB 33.400		$ 5,000		x	Y
----------	**Upgrade Guardrail (MP 16.00 to MP 30.00)**	16.000 to 30.000		$ 1,621,700		x	Y
	Fix Headwall @ MP near SB MP 33.5	SB 33.500		$ 5,000		x	Y
	Upgrade Median Slopes	29.568 to 34.271		$ 700,000		x	Y
	Upgrade Normal Ditch Slopes Options	7.500 to 34.271					
	Upgrade to 18' - 6:1 slopes on normal roadway ditches (which addresses clear zone):	7.500 to 34.271	$ 3,770,000	$ 3,770,000		x	Y
	Upgrade to 4:1 slopes on normal roadway ditches (and not address clear zone):	7.500 to 34.271	$ 860,000			x	Y
	INTERCHANGES						
	Interchange Crossroad to Crossroad Spacing						
1	**Exit #5- Lovers Lane to Exit #6 - US 68B Options**	5.175 to 5.759					N
	Close Interchange		$ 300,000	$ -		x	
	SB Braided Ramp		$ 14,600,000	$ 14,600,000		x	
2	**Exit 33 (US 62) to Exit 34 (WKP/I-69) Options**	32.861 to 34.271					Y
	Close Interchange or		$ 300,000	$ -		x	
	Complete CD System between Exits #33 and Exit #34		$ 25,000,000	$ 25,000,000		x	Y
	Remove Rolled Curb from Ramps Options	**Total Ramp**	**1st Curve**	$ 1,447,900			
	Exit #30 - US 41 Partial						
5	NB On Ramp	$ 932,000	$ -			x	N
6	SB Exit Ramp	$ 319,700	$ 145,300			x	N
	Exit #23 - KY 800						
2	SB On Ramp	$ 58,100	N/A			x	N
1	SB Exit Ramp	$ 43,600	N/A			x	N
3	NB On Ramp	$ 50,900	N/A			x	N
4	NB Exit Ramp	$ 43,600	N/A			x	N
2 3	**Guardrail End Treatments (US 41 NB Entrance Ramp)**			$ 10,000		x	N
1 2 3	**Remove & Replace Crash Cushions (Exit 34 at Ramps 38A, 38B & 106B)**			$ 27,000		x	N
1	**Raised Median on Ramp (Exit 5 Lovers Lane)**			$ 50,000		x	N
	Access Control			$ 396,200			
1	Exit #5 - Lovers Lane		$ 164,000			x	N/A
2	Exit #7 - US 41A		$ 82,200			x	N/A
3	Exit #33 - US 62		$ 150,000			x	N/A
	Ramps - Accel/Decel			$ 2,640,000			
	Exit #23 - KY 800		$ 179,600				
1	SB On Ramp - Ramp A	$ 89,800				x	N
3	NB On Ramp - Ramp D	$ 89,800				x	N
	Exit #30 - US 41						
5	US 41 NB On Ramp	$ 89,800	$ 89,800			x	N
	Exit #33 - US 62		$ 2,370,600				
7	SB On Ramp - Ramp A	$ 964,400				x	N
8	SB Exit Ramp - Ramp B	$ 151,800				x	N
9	NB Exit Ramp - Ramp C	$ 1,018,200				x	N
10	NB On Ramp - Ramp D	$ 236,200				x	N
	Interchange Reconstruction			$ 48,433,000			
3	**Exit #34 - WKP/I-69**		$ 27,533,000				
12	NB ETB Exit Ramp to WB I-69 Exit - Ramp H	$ 25,000,000				x	Y
11	NB I-69 to SB ETB	$ 2,400,000				x	Y
11	ETB Entrance Ramp from NB I-69 - Ramp A Increase Acceleration	$ 133,000				x	Y
2	**Exit # 30 US 41**	$ 10,400,000	$ 10,400,000			x	N
	Other Option Close Interchange	$ 900,000					
1	**Exit #11 - KY 1682**		$ 10,500,000			x	Y
	Subtotal			$ 111,468,300	$ 13,860,300	$ 97,608,000	
	Estimated Design and Environmental (15%)			$ 16,720,000	$ 2,079,000	$ 14,641,000	
	Estimated Right of Way and Utilities (30%)			$ 33,440,000	$ 4,158,000	$ 29,282,000	
	GRAND TOTAL			**$ 161,628,300**	**$ 20,097,300**	**$ 141,531,000**	

X. SUMMARY

As discussed in Chapter I, FHWA has 13 controlling design criteria for design features that are important to the operational and safety performance of a highway. 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 as follows:

- Design speed
- Lane width
- Shoulder width
- Bridge width
- Horizontal alignment
- Superelevation
- Vertical alignment
- Grade
- Stopping sight distance
- Cross slope
- Vertical clearance
- Lateral offset to obstruction
- Structural capacity

The Interstate System is part of the NHS. The design exception process is as follows:

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

This study identified deficiencies that may be addressed to accept the ETB Parkway into the interstate system and the costs associated with those identified deficiencies. After further analysis of the identified deficiencies, KYTC may recommend strategies to FHWA for implementation. Some strategies may include doing nothing, implementing some improvements through regular maintenance activities, constructing smaller projects that will fit into the overall goal (e.g., reconstruction of the KY 1682 [Exit 11] interchange). As projects are identified for implementation, additional analyses and studies may be needed to refine the details for improvements.

An example of the following may be necessary: CCRFs are only an indicator that crashes may not be occurring at random. Before any projects are implemented, a review of crash reports may provide information not readily available in KSP's database. Extensive field reviews were beyond the scope of this study. A more in-depth study to refine cost estimates will be necessary. Field surveys may find conditions different from the as-built plans; therefore, more field work may be appropriate. Many of these improvements can be incorporated into future corridor safety improvements or pavement rehabilitation projects. As those improvements are made, those items can be removed from the list of improvements. Also, interchange reconstruction or improvements could be standalone projects.