

## VI. INTERCHANGES AND RAMPS

This chapter summarizes the interchanges and ramp conditions on the Purchase Parkway. There are 13 interchanges on the Purchase Parkway along the project study corridor. Similar to the mainline geometry guidelines, AASHTO has criteria for minimum standards for interchanges and ramps. These guidelines are design speed, typical sections, and horizontal and vertical alignment. This chapter addresses each of those factors along with speed-change lanes, weaving characteristics, interchange crash data, interchange spacing, control of access, and interchange configuration. **Figures 6-1 through 6-3** and **Table 6-1** summarize the comparison of the interchange and ramp conditions taken from the as-built plans with the AASHTO guidelines for the key areas for interchange design.

### A. Design Speed

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

The design speed for most of the ramps was not available or illegible on the as-built plans.



Weigh station exit ramp at Tennessee state line

### B. Typical Sections

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

#### 1. Lane Widths

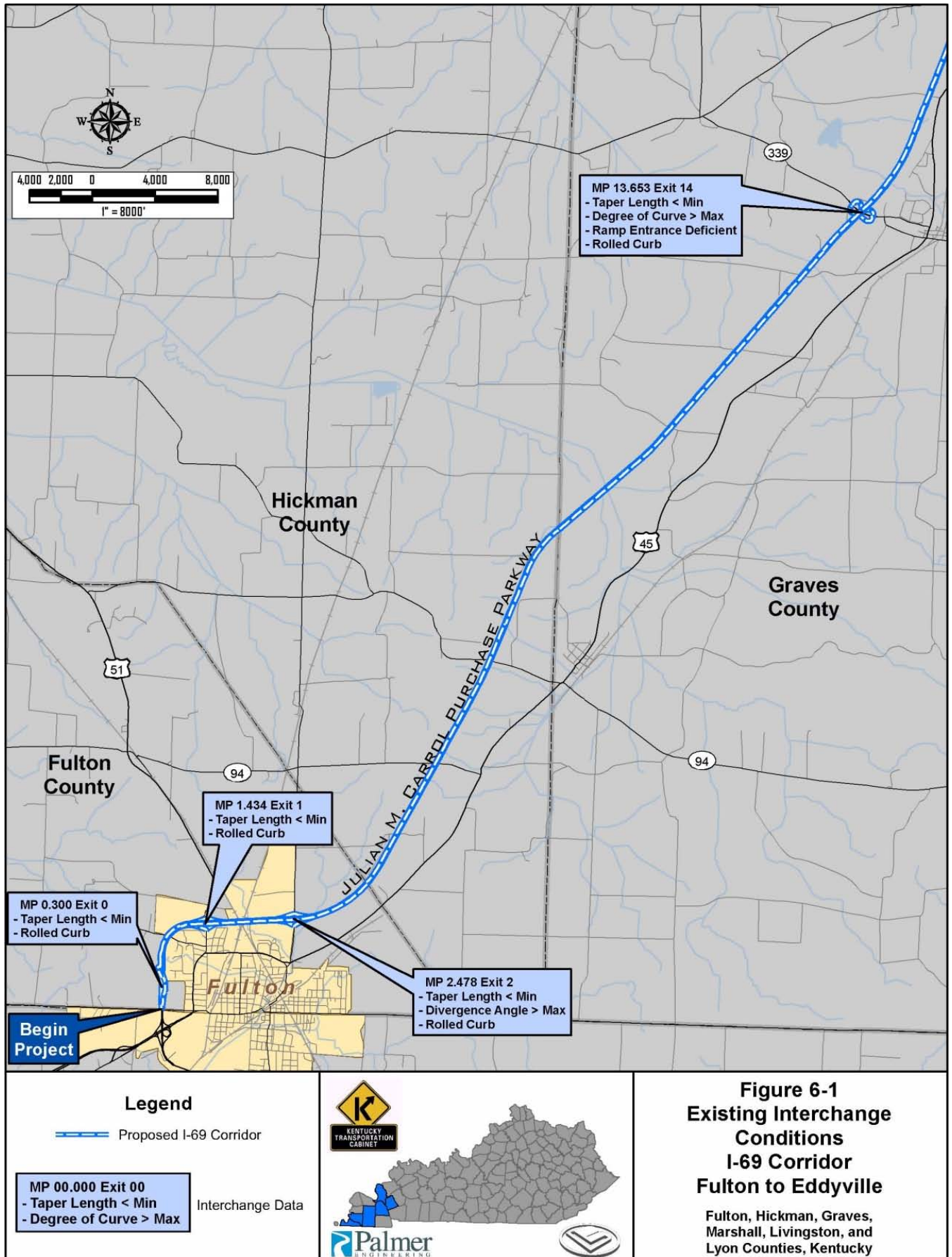
The current AASHTO minimum lane width along an interchange ramp is 15 feet. All of the interchange ramps on the Purchase Parkway meet the minimum requirement ranging in width from 15 to 18 feet. Refer to the **Table 6-1** for specific interchange ramp lane widths.

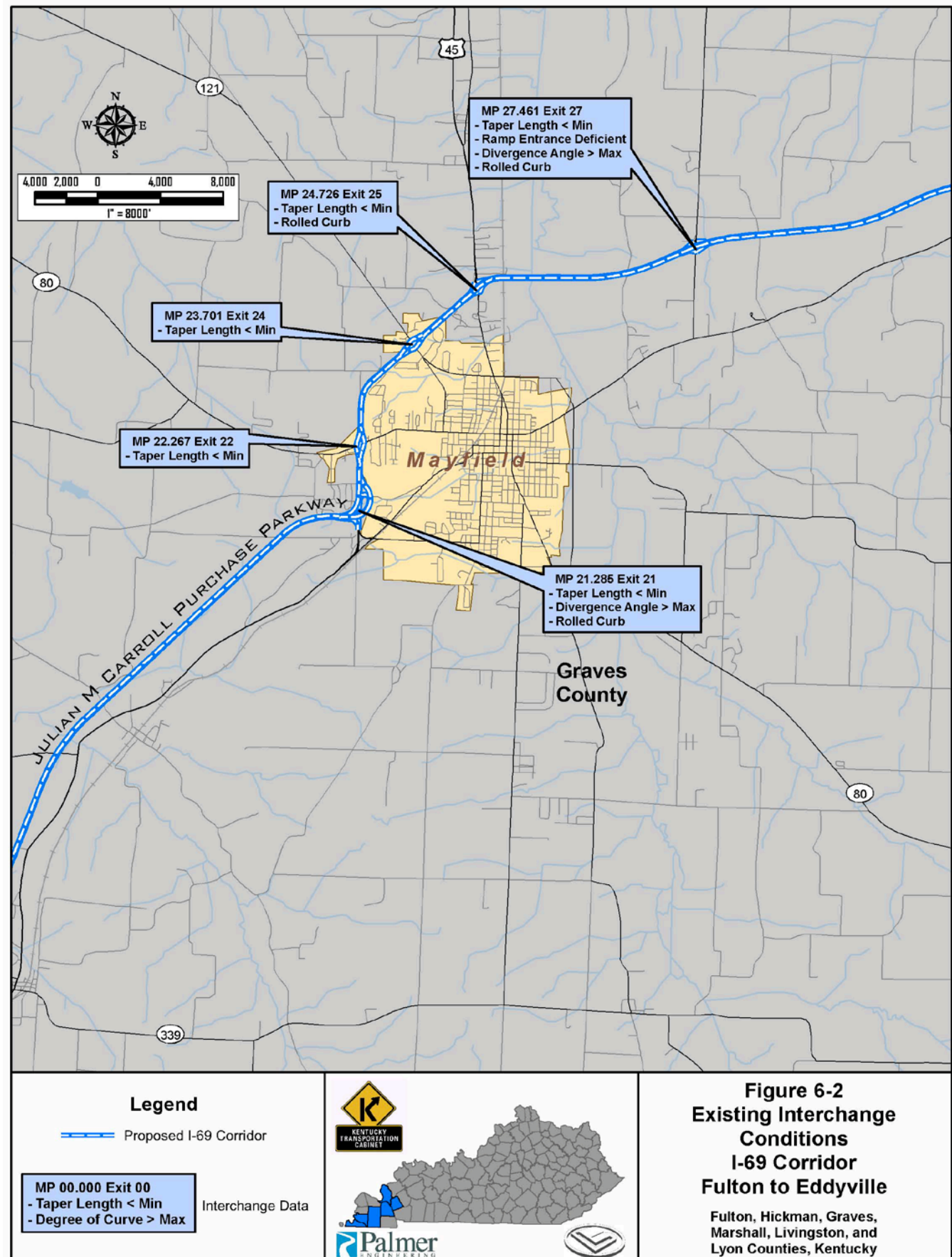
#### 2. Shoulder Widths

For normal one-way operation, the inside shoulder width should be 2 to 4 feet wide and paved and the outside shoulder width should be 8 to 10 feet wide and paved. The sum of the inside and outside shoulder width should not exceed 10 to 12 feet wide and paved. Much of the current interchange ramps have a rolled curb at the edge of the driving lane, therefore they do not meet AASHTO guidelines for shoulder widths. According to the as-built plans, the interchange ramps that do not have a rolled curb have an inside shoulder width of 6 feet and the outside shoulder width ranges from 6 to 10 feet.

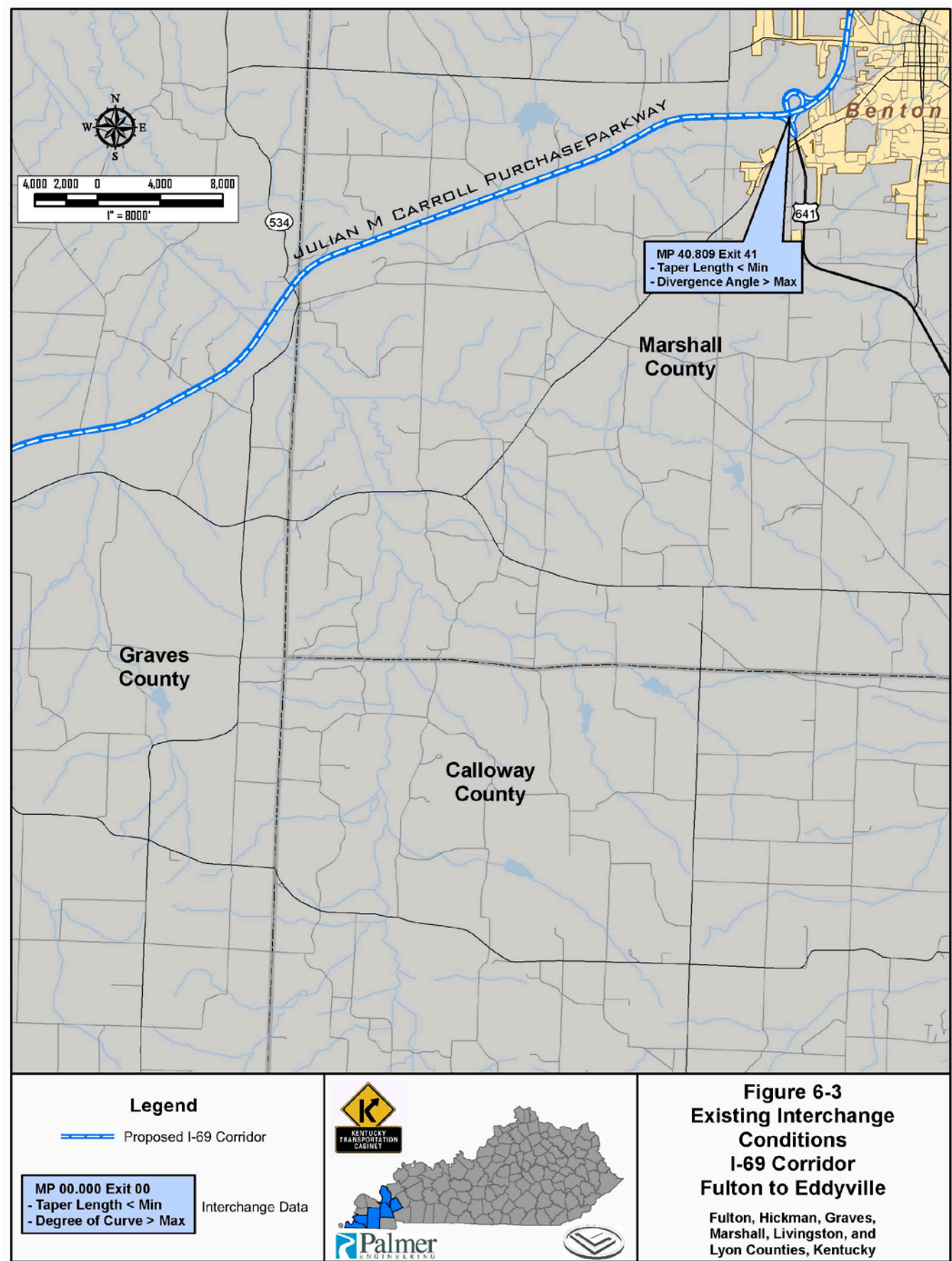
#### 3. Rolled Curb

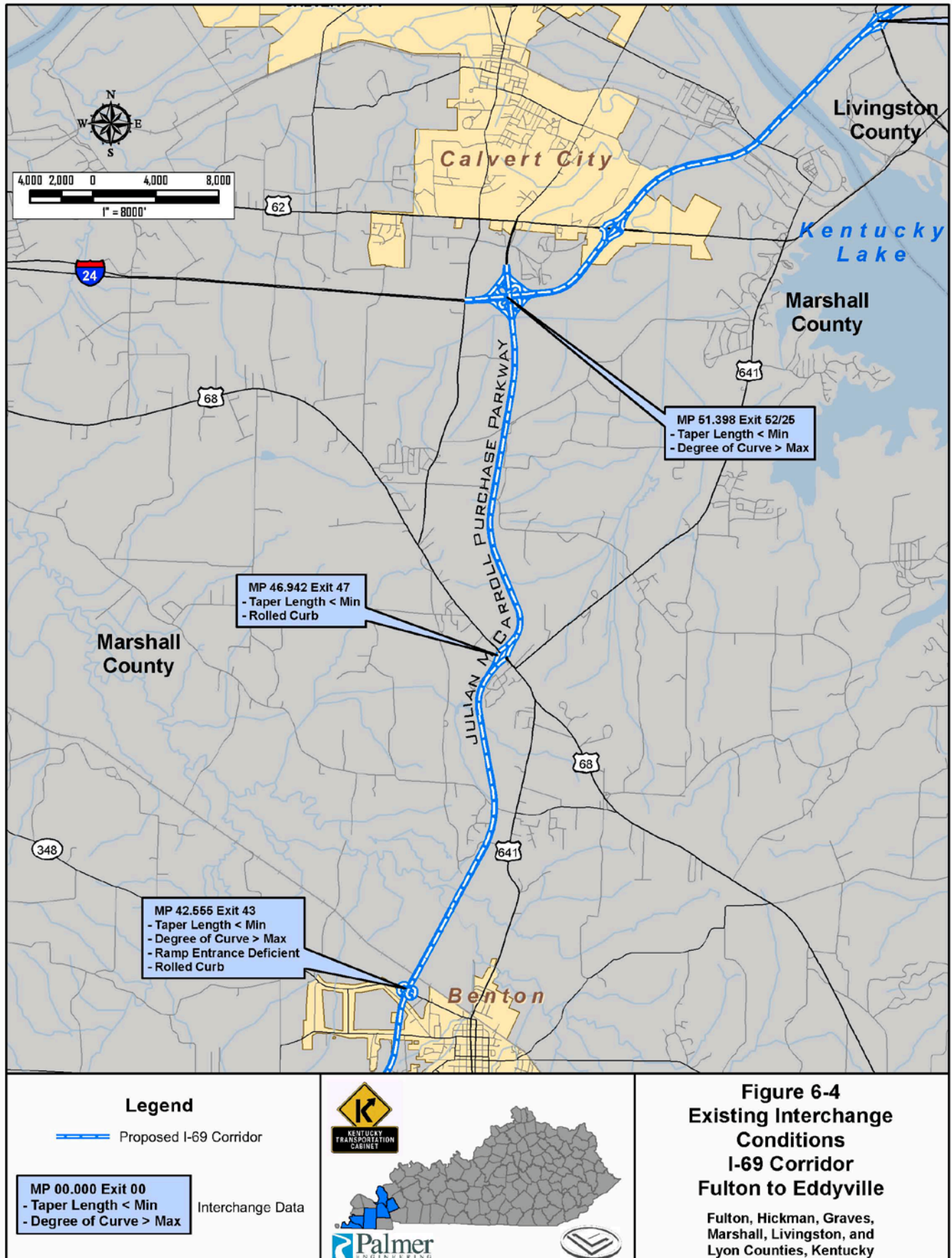
The current standard restricts the use of curb on mainline and ramps that are not intended for drainage purposes. The Purchase Parkway exits that have a rolled curb on the interchange ramps are Exits 0, 1, 2, 14, 21, 25, 27, 43, and 47. Refer to the following figures for the location of ramps with rolled curb that do not meet current standards.











COUNTY	INTERSECTING ROUTE	EXIT NUMBER	MP	PLAN YEAR	RAMP CHARACTERISTICS				MEET INTERSTATE STANDARDS?			REMARKS
					ENTRANCE	EXIT	TYPE	WIDTH	ENTRANCE / EXIT RADIUS <sup>1</sup>	RAMP RADIUS	TAPER <sup>2</sup>	
FULTON	Frontage Road A; Frontage Road B	0	0.300	1966		A (RAMP "A")	Taper	18	Yes	Yes	No	KY 166 and WeighStation
					B (RAMP "B")		Taper	18	Yes	Yes	No	
						C (Ramp "C")	Taper	18	Yes	No	No	
					D (Ramp "D")		Parallel	18	Yes	No	Yes	
FULTON	US 51	1	1.424	1966		A (Ramp "SW")	Taper	18	Yes		No	US 51 Diamond Interchange
					B (Ramp "SE")		Parallel	18	Yes		No	
						C (Ramp "NE")	Taper	18	Yes		No	
					D (Ramp "NW")		Taper	18	Yes	Yes	No	
FULTON	KY 307	2	2.478	1966		A (Ramp "B")	Taper	18	Yes		No	KY 307 Diamond Interchange
					B (RAMP "D")		Parallel	18	Yes	Yes	Yes	
						C (Ramp "C")	Taper	18	Yes	Yes	No	
					D (RAMP "A")		Parallel	18	Yes		Yes	
Graves	KY 339	14	13.653	?		A (Ramp "D")	Loop	18	No	No	No	KY 339 (Previous Toll Plaza)
					B (Ramp "C")		Loop	18	No	No	No	
						C (Ramp "A")	Loop	18	No	No	No	
					D (RAMP "B")		Loop	18	No	No	No	
Graves	MAYFIELD BYPASS	21	21.285	1966		A (RAMP "D")	Taper	18		Yes	Yes	US 45 Trumpet
					C (RAMP "C")		Taper	18	Yes		No	
					D (RAMP "B")		Loop	18	Yes		No	
Graves	KY 80	22	22.267	1961		A (RAMP 1)	N/A	16			N/A	KY 80 Diamond Interchange
					B (RAMP 4)		Taper	16	Yes		No	
						C (RAMP 3)	Taper	16	Yes		No	
					D (RAMP 2)		Taper	16	Yes		No	
Graves	KY 121	24	23.701	2000		A (RAMP "A")	Taper	18	Yes		No	KY 121 Diamond Interchange
					B (RAMP "C")		Parallel	18	Yes	Yes	Yes	
						C (RAMP "D")	Taper	18	Yes		No	
					D (RAMP "B")		Taper	18	Yes	Yes	Yes	
Graves	US 45	25	24.726	1966		A (RAMP "C")	Taper	18		Yes	No	US 45 Diamond Interchange
					B (RAMP "D")		Parallel	18	Yes	Yes	Yes	
						C (RAMP "B")	Taper	18	Tangent		No	
					D (RAMP "A")		Taper	18	Yes	Yes	Yes	
Graves	KY 131	27	27.461	1966/1978(?)		A (Ramp "SW")	Taper	15	No		No	KY 131 Diamond Interchange
					B (Ramp "SE")		Parallel	18	Yes		Yes	
						C (Ramp "NE")	Taper	18	No		No	
					D (Ramp "NW")		Parallel	15	No		Yes	

Table 6-1 Interchange Geometrics for I-69

COUNTY	INTERSECTING ROUTE	EXIT NUMBER	MP	PLAN YEAR	RAMP CHARACTERISTICS				MEET INTERSTATE STANDARDS?			REMARKS
					ENTRANCE	EXIT	TYPE	WIDTH	ENTRANCE / EXIT RADIUS <sup>1</sup>	RAMP RADIUS	TAPER <sup>2</sup>	
Marshall	US 641	41	40.809	1998		A (Ramp "B")	Taper	15	Yes		No	US 641 Trumpet
					B (Ramp "A")		Parallel	18	Yes		Yes	
						C (Ramp "D")	Taper	18	Yes	Yes	No	
					D (Loop "D")		Loop	15	Yes	Yes	Yes	
Marshall	KY 348	43	42.555	1966		A (Ramp "D")	Loop	18	No	No	No	KY 348 (Previous Toll Plaza)
					B (RAMP "B")		Loop	18	No	No	No	
						C (Ramp "A")	Loop	18	No	No	No	
					D (Ramp "C")		Loop	18	No	No	No	
Marshall	US 68	47	46.942	1966		A (Ramp "B")	Taper	18		No	No	US 68 Diamond Interchange
					B (RAMP "D")		Parallel	18	no dwg available		Yes	
						C (Ramp "C")	Taper	18	no dwg available		No	
					D (RAMP "A")		Parallel	18	Yes		Yes	
Marshall	I-24	52	51.398	1966		A1 (Ramp "C")	Taper	18	No	Yes	No	I-24 Interchange Full Clover Leaf Interhcnage
						A2 (Ramp "H")	Loop	18			N/A	
					B1 (Ramp "G")		Parallel	18	Yes	Yes	Yes	
					B2 (Ramp "F")		Loop	18		Yes	N/A	
						C1 (Ramp "E")	Taper	18	Yes	Yes	No	
						C2 (Ramp "B")	Loop	18			N/A	
					D1 (Ramp "A")		Parallel	18	Yes	Yes	Yes	
					D2 (Ramp "D")		Loop	18			N/A	

<sup>1</sup> Based on design speed and superelevation provided. Design speed calculated from current AASHTO 10% superelevation table. Reference Appendix F for design speed values.

**Table 6-1 Interchange Geometrics for I-69 (continued)**

## C. Alignment Geometry

### 1. Horizontal Alignment

The minimum horizontal radius for a directional ramp in rural and urban areas is 444 feet. The minimum horizontal radius for rural and urban loop ramps is 134 feet (25 mph design speed). For rural areas, the minimum horizontal radius for a ramp is 314 feet (35 mph design speed) and 134 feet (25 mph design speed) in urban areas. For the interchanges on the Purchase Parkway, minimum ramp and loop radius are met for all interchanges except for Exit 14 (MP 13.653) in Graves County. Exit 14 is previous toll booth interchange. Refer to **Appendix F** for interchange data.

### 2. Superelevation Rate

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

### 3. Vertical Alignment

#### a. Vertical Grade

AASHTO guidelines designate a maximum vertical grade from 5% to 7% for all ramp types in both rural and urban areas. Of the legible information provided on the as-built plans, this minimum recommendation is met for all ramps on the Purchase Parkway. The US 641 interchange (Exit 41) in Marshall County is the only interchange that has a vertical grade greater than 5%. The loop ramp at this interchange has a vertical grade of 6% and -6%. The information provided on the as-built plans is located in **Appendix F**.

#### b. Vertical Length of Curve

For this study, the minimum length of curve was calculated on the vertical grades of the approaching ramp alignment and the recommended rate of vertical curvature for the minimum design speed. All of the analyses were completed for the entire length of the ramp. The following list provides the locations, actual vertical length of curve, and calculated minimum vertical length of curve of those that do not meet the criteria. The following vertical curves are located at the end of the interchange ramps and would be approaching stopping condition. This data is provided in **Appendix F**.

- Fulton County – Exit 1 Ramp NE– Actual 150 feet, calculated minimum 151 feet;
- Fulton County – Exit 1 Ramp SE – Actual 250 feet, calculated minimum 257 feet;
- Graves County – Exit 22 Ramp 1 – Actual 150 feet, calculated minimum 183 feet.

#### c. Stopping Sight Distance

Stopping sight distance was evaluated on the vertical curvature for the ramps. The minimum stopping sight distance with the corresponding ramp type minimum design speed was compared to the calculated stopping sight distance. There are two vertical curves that do not provide the minimum stopping sight distance calculated based on the minimum ramp design speed. The following list provides the locations, actual stopping sight distance, and calculated stopping sight distance. These vertical curves are located at the end of the interchange ramps and travel would be approaching stopping condition. This data is provided in **Appendix F**.

- Fulton County – Exit 1 Ramp SE – Actual 245 feet, calculated minimum 250 feet;
- Graves County – Exit 22 Ramp 1 – Actual 246 feet, calculated minimum 250 feet.

### 4. Divergence Angle

The recommended divergence angle of the alignment break for a taper exit per AASHTO is two to five degrees. The divergence angle was not provided or was illegible on the as-built plans. Aerial mapping was used to estimate the existing divergence angle for the Purchase Parkway



interchange exit ramps. The following exit ramps had divergence angle estimates exceeding 5 degrees:

- Exit 2 (MP 2.478) KY 307, Northbound and Southbound
- Exit 14 (MP 13.653), KY 339, Northbound and Southbound
- Exit 21 (MP21.285) US 45 Southbound;
- Exit 27 (MP27.461) KY 131, Southbound;
- Exit 41 (MP 40.809) US 641, Southbound.

#### D. Speed-Change Lanes and Weaving Characteristics

Speed-change lanes and traffic weaving situations may be the two most important factors affecting safety at interchanges. The following is 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.

##### 1. Speed-Change Lanes

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

An exit ramp can have a parallel or taper type configuration. The taper type ramp alignment is generally designed with an alignment break at the outer edge of the pavement. The minimum divergence angle of the taper type alignment break is two to five degrees. The exit parallel type begins with a taper rate of 20:1 and the deceleration length of the parallel lane is dependent on the design speed of the mainline roadway and ramp design speeds. Exiting traffic can be assumed to be traveling 70% of the mainline design speed.

The design speed for entrance and exit ramp curves was calculated based on the superelevation provided in the as-built plans. Most of the interchange ramps have a superelevation greater than 8% but less than 10%, therefore the current AASHTO 10% maximum superelevation tables were referenced for calculating the design speed. In addition to the KY 339 (Exit 14) and KY 348 (Exit 43) interchanges, the KY 131 (Exit 27) interchange does not meet the recommended ramp design speed. Data is provided in **Appendix F**.

Since the original construction, some of the interchange ramps on the Purchase Parkway have been improved. However, a majority of the existing ramps on the parkway do not meet the minimum guideline of 50:1 entrance tapers, and existing ramps have exit tapers less than the minimum 20:1 taper. According to guidelines from AASHTO, the minimum deceleration length for exit ramps to a stop condition is 615 feet. Exit 0 along with all diamond interchange exit ramps on the Purchase Parkway meet the minimum deceleration length.

For this study, a minimum of 413 feet of taper length for an exit taper ramp was used for comparison. This length comes from using the maximum divergence



**Exit 14 – One of two previous toll booth plazas on the Purchase Parkway.**

angle of 5 degrees and 36 feet of ramp separation from the mainline.

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

## 2. Weaving Characteristics

There are 2 interchanges that do not meet the 1,000 foot minimum weaving length distance recommended for a service-to-service interchange. These interchanges are located at Exit 14 – Wingo / Clinton (MP 13.653) in Graves County and Exit 43 Benton / Symsonia (MP 42.555) in Marshall County. These two interchanges were initially designed for toll collection stations. The full cloverleaf configurations included short weaving sections of approximately 300 feet. The toll plazas have since been suspended and the interchange at Exit 43 currently is being red-designed.

Currently, the Purchase Parkway interchange with I-24 is a full cloverleaf interchange that has a weaving distance of approximately 480 feet on the Purchase Parkway and approximately 430 feet on I-24. A weaving analysis was not conducted on this interchange because it does not meet the recommended systems interchange configuration.

In addition to the interchanges mentioned, there is another weaving segment on the Purchase Parkway, which is located between the Mayfield Bypass (US 45) trumpet interchange at Exit 21 and KY 80 interchange at Exit 22. An auxiliary lane is provided for the northbound Purchase Parkway to Exit 22. Traffic counts were provided by KYTC and measurements were taken in the field for the weaving analysis. Highway Capacity Software (HCS) was used for the analysis. A 2.5% annual growth rate was applied to the 2010 DHV traffic counts, which is the annual growth rate used to calculate the 2040 traffic with I-69 designation. These traffic volumes and existing weave distance resulted in a LOS of B (15.02 passenger cars per mile per lane). See **Appendix F** for HCS output.

## E. Interchange Crash Data

To further analyze the interchange operations, crashes at interchanges were collected and analyzed. **Table 6-2** shows the types of crashes occurring within a 0.1 mile section on either side of the intersecting route at each interchange.

					Total Crashes by Type <sup>1</sup>							
Exit	MP	County	Intersecting Route	Ramp	Rear End	Fixed Object	Animal	Side Swipe	Ran Off Road	Other	Total	Fatalities
Purchase Parkway												
0	0.30	Fulton	Frontage Roads	0	1	1	2	0	1	0	5	0
1	1.42	Fulton	US 51	4	0	0	0	0	0	0	4	0
2	2.48	Fulton	KY 307	1	0	0	3	0	0	0	4	0
14	13.65	Graves	KY 339	2	1	0	0	1	2	0	6	0
21	21.29	Graves	US 45	4	2	14	1	2	1	2	26	1
22	22.27	Graves	KY 80	3	2	4	0	0	2	0	11	0
24	23.70	Graves	KY 121	3	2	1	0	0	2	1	9	0
25	24.73	Graves	US 45	4	0	5	2	3	4	0	18	0
27	27.46	Graves	KY 131	3	0	1	1	0	4	0	9	0
41	40.81	Marshall	US 641	13	0	0	2	1	2	0	18	0
43	42.56	Marshall	KY 348	31	3	7	0	5	1	1	48	0
47	46.94	Marshall	US 68	23	0	6	4	3	3	1	40	0
52	51.40	Marshall	I-24	55	1	3	2	4	5	4	74	0
Interstate 24												
25	24.94	Marshall	Purchase Pkwy	55	8	9	3	9	4	9	97	1
27	26.57	Marshall	US 62	14	6	7	1	5	2	4	39	1
31	30.73	Livingston	KY 453	1	3	1	3	3	3	9	23	2
40	39.52	Lyon	US 62	4	3	3	5	1	1	3	20	0
42	41.65	Lyon	Western KY Pkwy	23	3	1	2	5	4	3	41	1

<sup>1</sup> Number of crashes in period studied (2005-2009), within 0.1 mile on either side of intersection route.

**Table 6-2 Interchange Crash Data**

Along the Purchase Parkway, there are three interchanges that fall within a high crash segment, previously mentioned in **Sections 4 and 5 of Chapter III.**

- Exit 27, KY 131, in Graves County had nine crashes, of which four were ramp related;
- Exit 47, US 641, in Marshall County had 18 crashes. A majority of these crashes (13) were ramp related;
- Exit 43, KY 348 (previous toll plaza), in Marshall County had 48 crashes. 65% (31 of 48) were ramp related collisions.

Along I-24, there is one interchange that falls within a high crash segment.

- Exit 25, Purchase Parkway, in Marshall County had 97 crashes, of which 55 were ramp related.

The 171 crashes that occurred at the I-24 and Purchase Parkway Interchange accounted for 19% of all crashes during the study period.

## F. Interchange Spacing

The current minimum spacing between interchanges on an interstate for rural areas is three miles and one mile for urban areas. This spacing is measured between the centerline of intersecting routes. The three interchanges at Fulton are spaced closer than the rural interstate minimum. These three interchange exits are spaced within three miles of each other. The interchange at Exit 0 is an unconventional interchange that is too close to Exit 1 (MP 1.424). The interchanges at Exit 1 (MP 1.424) and Exit 2 (MP 2.442) are spaced closer than the minimum for rural areas. The two interchanges at Benton are within the rural three-mile spacing limit. There is less than two miles between Exit 41 (MP 40.809) and Exit 43 (MP 42.555).

## G. Interchange Control of Access

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

EXIT	RURAL/ URBAN	INTERSECTION ROUTE	QUADRANT	DISTANCE (FT)
14	RURAL	KY 339	Northwest	115
			Southwest	105
22	URBAN	KY 80	Northeast	65
			Northwest	85
			Southwest	60
27	RURAL	KY 131	Southeast	270
			Northwest	275
			Southwest	60
47	RURAL	US 68	Southeast	260
			Northeast	0
			Northwest	108
			Southwest	40

Table 6-3 Interchange Control of Access

## H. Interchange Configuration

Currently the Purchase Parkway has several interchanges that are not inconsistent with common practice for interstate interchange configuration.

### 1. Systems Interchanges

Currently, the Purchase Parkway and I-24 interchange is a full clover leaf (graphic below), which meets the recommendation for the two fully controlled access facilities interchange. However, with the implementation of converting the Purchase Parkway to I-69, the clover leaf is inconsistent with AASHTO recommendations for a systems interchange. Currently, the ramps and loop ramps within the interchange are also one lane.



**Exit 52 – I-24 / Purchase Parkway Interchange**

### 2. Service Interchanges

Two service interchanges are inconsistent with AASHTO recommendations are the previous toll plazas located Exit 14 and Exit 43 (graphics below). As previously mentioned, both of these interchanges have less than the minimum weaving distance. At the date of this report, Exit 43 is in the design phase to be improved and meet interstate standards.





**Exit 14 – Purchase Parkway / KY 339 Previous Toll Plaza**



**Exit 43 – Purchase Parkway / KY 348 Previous Toll Plaza**

Another service interchange that is inconsistent with AASHTO recommended interchange configuration is Exit 0 in Fulton County at the Tennessee state line (graphic below). This interchange includes a weigh station for the northbound Purchase Parkway. The weigh station



provides access to Eastwood Drive. Southbound Purchase Parkway exit and entrance ramps connect to KY 166. The KYTC has made overture to the TDOT regarding this interchange, the existing weigh station, and overall connectivity for I-69 between Kentucky and Tennessee. Thus far there has been no coordination with TDOT.



**Exit 0 – Purchase Parkway / Weigh Station / Eastwood Dr / KY 166**

The interchange at Exit 21 in Mayfield does not provide continuity for the Purchase Parkway (graphic below). The modified trumpet interchange is configured for the Mayfield Bypass (US 45) as the major route and the Purchase Parkway as the minor route. The northbound Purchase Parkway merges from two lanes to one lane, which then travels over US 45 and ultimately merges into the Mayfield Bypass. The southbound Purchase Parkway exits to the right via a one-lane ramp, while southbound US 45 continues straight.



**Exit 21 – Purchase Parkway / Mayfield Bypass Interchange**