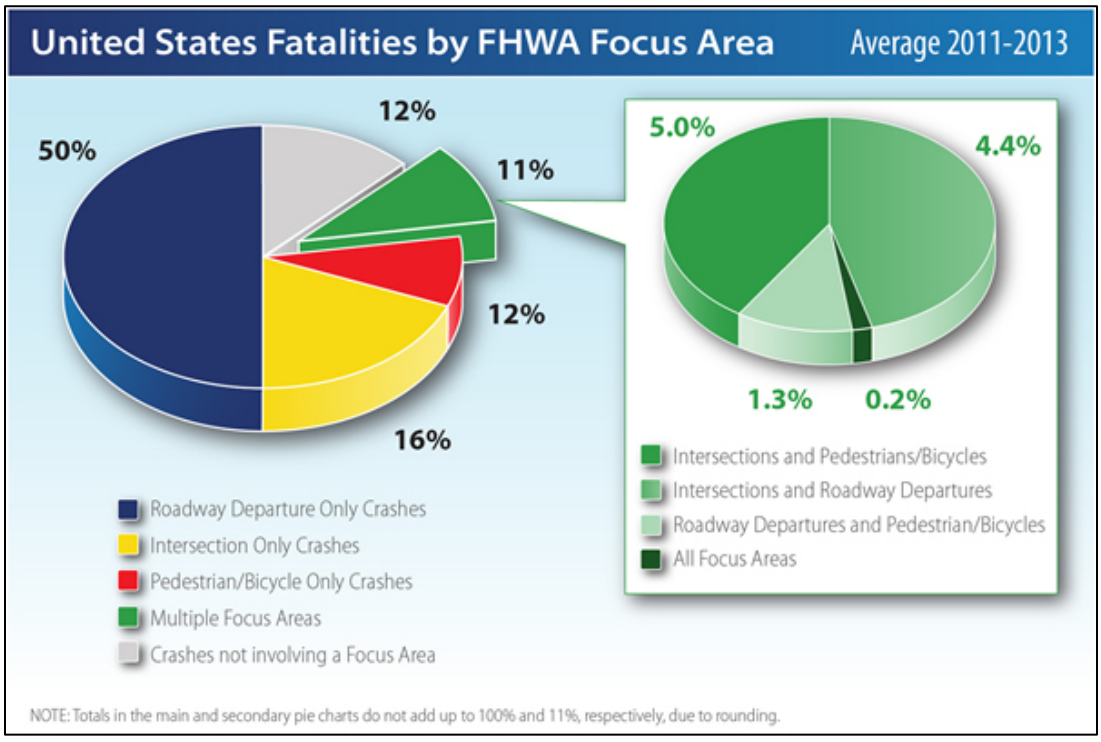
Kentucky Roadway Departure Best Practices

The Kentucky Roadway Departure Safety Implementation Plan's goal was to reduce roadway departure fatalities by approximately 65 fatalities per year, or by an approximate 15 percent reduction per year

Background

Focused Approach to Safety

The *Focused Approach to Safety* provides additional resources to eligible, high priority, states to address the Nation's most critical safety challenges through program benefits such as people, time, tools, and training. This approach increases awareness to critical and severe crash types and leads to the identification of appropriate safety infrastructure improvements, assists in the prioritization of limited resources, and creates positive organizational changes in safety culture, policies and procedures. Each eligible state participating in the *Focused Approach to Safety* is assisted in reducing fatalities in any one, or all, of three critical crash focus areas: roadway departure, intersection, and pedestrian/bicycle. These three focus areas encompass almost 90% of total highway-fatalities in the U.S.



The Kentucky Strategic Highway Safety Plan (SHSP) had a safety goal of reducing the number of annual roadway fatalities within the State to no more than 700 by the end of 2008 and an additional 15 percent reduction per year in the following years. In 2010, FHWA completed the *Kentucky Roadway Departure Safety Implementation Plan* (RwDSIP) for the Kentucky Transportation Cabinet (KYTC). The study aimed to assist in addressing roadway departure-related crash patterns throughout the state. The RwDSIP included traditional treatments at isolated high-crash locations, systemic treatments on corridors with moderate levels of crashes, and comprehensive safety solutions incorporating law enforcement and education. With a customized data analysis package, the RwDSIP identified a set of cost-effective countermeasures, potential deployment levels, and approximate funding needed to achieve the 15-percent reduction in roadway departure fatalities per year in the next 10 years, translated to 65 lives saved per year.

Kentucky has approximately 80,000 miles of public roadway, with approximately 27,000 miles being maintained by KYTC. Based on crash data obtained between 2004 and 2008, nearly 85-percent of total statewide fatalities occurred on state-maintained roadways. Additionally, there were a total of 2,846 roadway departure fatalities on state-maintained roadways between 2004 and 2008. With over a dozen potential countermeasures provided in the RwDSIP, the KYTC placed their focus on systemic implementation, and based countermeasure considerations on several factors including the availability of right-of-way, the need for public meetings, and environmental impacts. The KYTC developed deployment programs for four major countermeasures from the RwDSIP—rumble stripes/strips (i.e., center line, edge line, shoulder); high friction surface treatments (HFST) at horizontal curves; horizontal curve alignment sign improvements; and median cable barrier installations. Each program was generally funded by HSIP and through other state maintenance programs. The following document summarizes noteworthy practices from each of the four major countermeasure deployment programs.

Rumble Strips/Stripes

The RwDSIP indicates that up to approximately 32 annual fatalities could be reduced on state rural roadways with rumble strip/stripe improvements.

Kentucky's RwDSIP identifies 290 state-maintained candidate roadway sections, based on crash data, that could benefit from center line rumble stripe improvements (CLRS), with an additional 1,086 candidate sections for edge line rumble stripe improvements (ELRS), and another 397 candidate sections for shoulder rumble strip improvements. The KYTC has developed a statewide rumble strip/stripe program inclusive of each of the potential rumble treatments. As of 2016, approximately 1,537 miles of center line rumble stripes, 1,540 miles of edge line rumble stripes, and 295 miles of shoulder rumble strips have been installed across the state. In addition to a very successful deployment, KYTC has provided guidance in their standard details on how various rumble strips/stripes should be programmed into proposed projects based on several factors, including the number of lanes, pavement width, striping type, and location (i.e., rail crossings, driveways, mailbox turnouts, etc.). Although the state of Kentucky has provided guidance regarding rumble strips/stripes, they do not currently have any standard policies requiring the installation of rumble strips/stripes but highly encourage their project managers to have them included in their projects.

Figure 1 includes standard details for edge line rumble strip consideration along two-lane roadways in Kentucky. Additionally, **Figure 2** illustrates an example of a recent center line rumble stripe and shoulder rumble strip application along a rural undivided two-lane roadway.

The 2016 Kentucky Highway Safety Improvement Program (HSIP) annual report indicated that the benefit-cost ratio for rumble stripe projects throughout the state was approximately 65.7, which shows that the countermeasure has been very efficient in reducing crashes based on the costs invested.

***Figure 1**: KYTC Standard Detail Excerpt for Edge Line Rumble Strip Consideration along Two-Lane Roadways*

PAVEMENT WIDTH (W) ②	RUMBLE LENGTH (X) ⑥	ELRS ONLY		CLRS & ELRS	
		LANE WIDTH (Y) ③	SHOULDER WIDTH (Z) ④	LANE WIDTH (Y) ③	SHOULDER WIDTH (Z) ④
20'	8"	9'	1'	N/A	N/A
21'	8"	9.5'	1'	N/A	N/A
22'	8"	10'	1'	N/A	N/A
23'	8"	10'	1.5'	N/A	N/A
24'	8"	10.5'	1.5'	N/A	N/A
25'	8"	N/A	N/A	11'	1.5'
26'	8"	N/A	N/A	11'	2'
27'	8"	N/A	N/A	11.5'	2'
28'	8"	N/A	N/A	12'	2'
29'	8"	N/A	N/A	12'	2.5'
30'	8"	N/A	N/A	12'	3'
31'	8"	N/A	N/A	12'	3.5'
32'	8"	N/A	N/A	12'	4'
33'	8"	N/A	N/A	12'	4.5'

② PAVEMENT WIDTH (W) IS THE TOTAL WIDTH OF TRAVERSABLE PAVEMENT. DO NOT INCLUDE THE WIDTH OF ANY NON-TRAVERSABLE PAVEMENT, SUCH AS PAVEMENT WEDGES, WHEN MEASURING THE PAVEMENT WIDTH

③ LANE WIDTH (Y) TO BE MEASURED FROM THE CENTER OF THE ROAD TO LANE SIDE EDGE OF RUMBLE STRIP.

④ PAVED SHOULDER WIDTH (Z) TO BE MEASURED FROM LANE SIDE EDGE OF RUMBLE STRIP TO OUTSIDE EDGE OF TRAVERSABLE PAVEMENT

⑥ RUMBLE STRIP LENGTH (X) MAY BE MODIFIED AS THE ENGINEER DIRECTS. IF THE SHOULDER WIDTH (Z) IS EQUAL TO OR LESS THAN THE PROPOSED RUMBLE LENGTH (X)

Source: Kentucky Department of Highways.

***Figure 2:** Rumble Strip and Stripe Applications along a Rural Undivided Two-Lane Road*

Source: Kentucky Department of Highways.

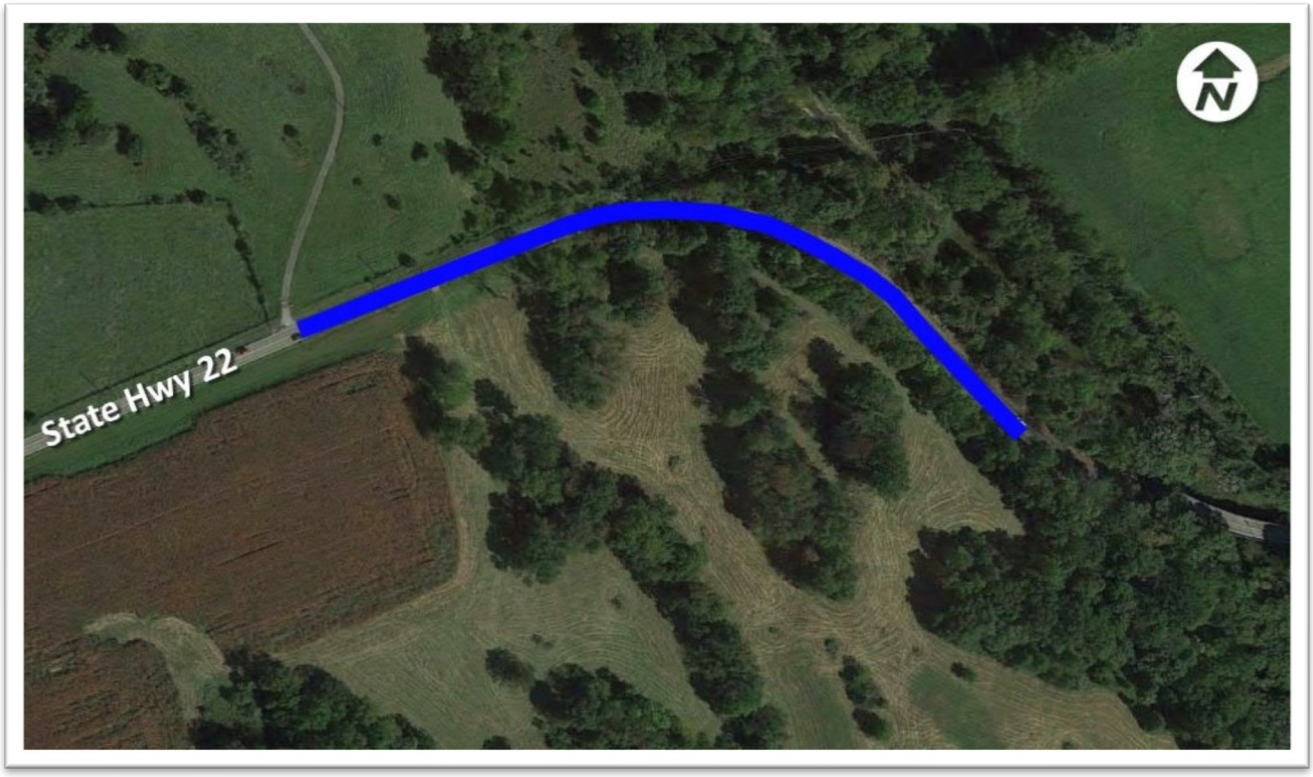
High Friction Surface Treatment (HFST)

The RwDSIP indicates that up to approximately two annual fatalities could be reduced on state rural roadways with HFST.

Kentucky's RwDSIP identifies 159 state-maintained candidate roadway sections that could benefit from HFST improvements. The KYTC studied crash data and conducted pavement condition assessments at candidate RwDSIP locations to determine if crashes were being attributed to poor superelevation or low pavement friction (i.e., wet crashes). From their evaluation, locations with low pavement friction were prioritized for HFST application. The KYTC has deployed HFST applications along more than 100 roadway segments over a two-year period, with each segment consisting of at least one horizontal curve, and along some segments, two horizontal curves along a winding section of road.

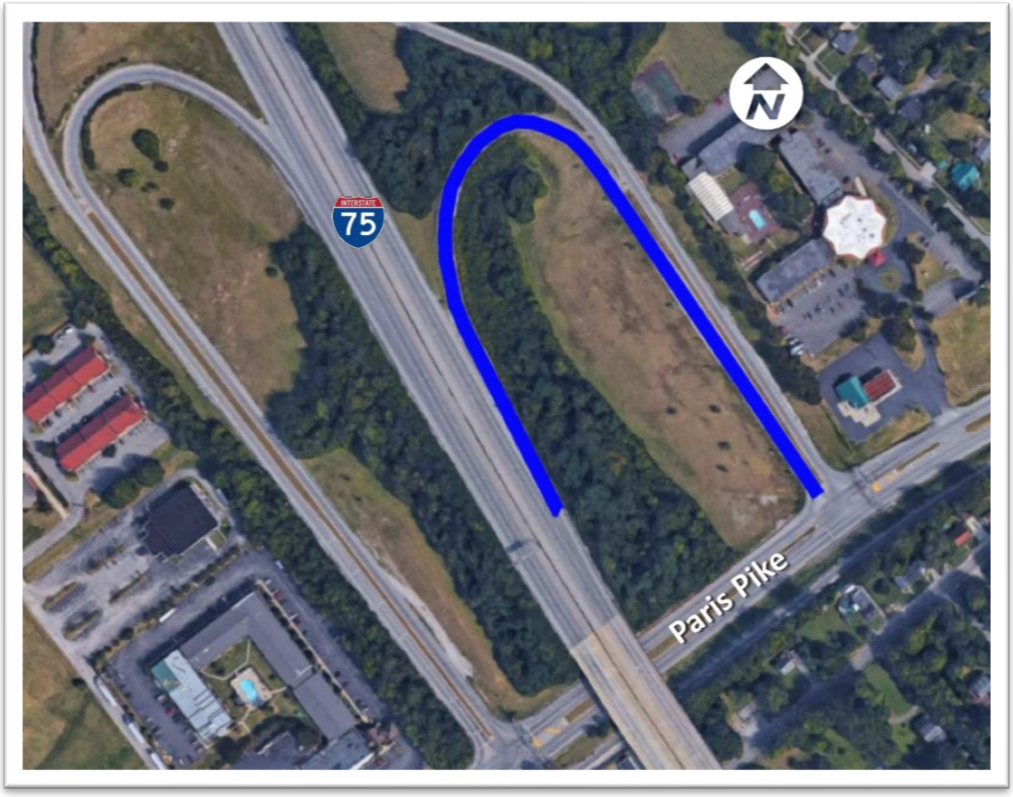
Below are two noteworthy HFST projects that Kentucky completed after the RwDSIP was developed in 2010. The first project included a HFST application along State Highway 22 in Oldham County (**Figure 3**). A significant reduction in total roadway departure crashes was observed during the first three years following the application (see **Table 1**). The second noteworthy project includes an HFST application along an interchange off-ramp at the I-75/Paris Pike interchange. At this interchange, the northbound I-75 off-ramp to Paris Pike (**Figure 4**) was experiencing both wet and dry condition roadway departure crash patterns prior to treatment. After the HFST application was completed, only one roadway departure crash was reported during the three years following the application (see **Table 1**).

Figure 3: *State Highway 22 HFST Application in Oldham County*



Source: Kentucky Transportation Cabinet.

Figure 4: *I-75/Paris Pike Interchange Off-Ramp HFST Application*



Source: Kentucky Transportation Cabinet.

Table 1: *Oldham County and Paris Pike Interchange Ramp Before and After Roadway Departure Crash Data*

Location	**3 Years Before HFST Application**	**3 Years Before HFST Application**	**3 Years After HFST Application**	**3 Years After HFST Application**
Road Condition	**Wet Crashes**	**Dry Crashes**	**Wet Crashes**	**Dry Crashes**
Oldham County	53	3	5	0
I-75 Off-Ramp to Paris Pike	17	8	0	1

Source: Kentucky Transportation Cabinet.

From the HFST projects performed throughout the state, KYTC has found that typical project applications extend approximately 50 to 100 linear feet beyond horizontal curve tangents and require approximately 700 to 1,000 square yards of HFST application materials. Kentucky's ongoing HFST program consists of an annual case-by-case screening process for new candidate HFST locations throughout the state where low pavement friction may be attributing to roadway departure crash patterns.

Horizontal Curve Alignment Signing Improvements

Kentucky's RwDSIP identifies 976 candidate horizontal curves that can benefit from potential horizontal curve alignment signing improvements. The KYTC performed field reviews and collected ball bank indicator data at candidate horizontal curves to determine appropriate advisory speeds and to inventory existing signs. Once this data was collected, the KYTC prioritized horizontal curve alignment signing projects based on associated crash types and frequencies. Additionally, KYTC determined that if at least two horizontal curves were prioritized along the same corridor, then signing improvements would be systemically developed for the entire corridor within the limits of the county. Due to the number of potential projects identified, KYTC developed a horizontal curve signing program that consists of five implementation phases. As of May 2017, Phase 1 has been completed with Phase 2 being underway.d

The RWDSIP indicates that up to approximately 6 annual fatalities could be reduced with enhanced signing and marking improvements.

Figure 5 consists of a sample quantity list for a proposed construction package as part of KYTC's horizontal curve signing program.

***Figure 5**: Example Horizontal Curve Alignment Sign Quantity Sheet*

MUTCD Ref. No.	Sample Picture	Description	Size IN	Quantity	Sheeting Type Background	Legend	0.125 SF	0.08 SF	# Posts	Post L FT	Total L FT
W1-2aL		Curve/Adv (Left)	36x36	9	Fluorescent Yellow (Type IX, XI)	Black		81	1	14	126
W1-2aR		Curve/Adv (Right)	36x36	8	Fluorescent Yellow (Type IX, XI)	Black		72	1	14	112
W1-2L		Curve (Left)	30x30	4	Fluorescent Yellow (Type IX, XI)	Black		25	1	14	56
W1-2L		Curve (Left)	36x36	4	Fluorescent Yellow (Type IX, XI)	Black		36	1	14	56
W1-2R		Curve (Right)	30x30	5	Fluorescent Yellow (Type IX, XI)	Black		31.25	1	14	70
W1-2R		Curve (Right)	36x36	2	Fluorescent Yellow (Type IX, XI)	Black		18	1	14	28
W13-1P		Advisory (XX MPH)	18x18	20	Fluorescent Yellow (Type IX, XI)	Black		45	0	0	0
W1-4L		Reverse Curve (Left)	36x36	5	Fluorescent Yellow (Type IX, XI)	Black		45	1	14	70
W1-8		Chevron	18x24	81	Fluorescent Yellow (Type IX, XI)	Black		243	0.75	14	850.5
DEL-W		Delineator-W	N/A	50	White (Type IX, XI)	N/A		0	0	0	0
REF-POST		Reflective Post	2x60	91	Fluorescent Yellow (Type IX, XI)	N/A		77.35	0	10	0

*Quantities of signs are summarized here. Information related to the specific signs required (i.e. size, advisory speed designation, destination names) are outlined in the corresponding detail sheets.

	0.125 SF	0.08 SF	Remove EA	Barcodes EA	Total L FT
Totals:	0.00	596.25	24	138	1368.50

Source: Kentucky Transportation Cabinet.

For each new horizontal curve alignment sign installed, a tracking number and barcode is assigned so KYTC can monitor each horizontal curve alignment sign in their asset management database. The effectiveness of this countermeasure will be evaluated once sufficient data is available for the locations implemented in Phase 1.

Median Barrier Installations

Kentucky's RwDSIP identifies 49 candidate segments that could benefit from median barrier installation. The KYTC considers two types of median barriers—W-Beam (guardrail) barrier and cable barrier.

The RwDSIP indicates that up to approximately three annual fatalities could be reduced with median barrier improvements.

The KYTC prioritizes W-Beam barrier installation based on a numeric score derived from a crash analysis and a risk analysis. For the crash analysis, KYTC uses the frequency and severity of crashes to calculate a crash rate, and a corresponding crash analysis score. For the risk analysis, KYTC considers terrain, lane/shoulder widths, and other roadside characteristics (i.e., recovery area, location of fixed objects, slopes, subjective hazard ratings, etc.) to develop a risk analysis score. Summing the individual crash analysis and risk analysis scores, an overall W-Beam barrier score is calculated and used to prioritize W-Beam installation projects.

Cable median barrier is considered based on crash analysis results and when locations can meet minimum median width and slope criteria. Although KYTC does not currently have a cable barrier specific policy, they do prioritize project locations based on their location (i.e., interstate facilities), crash history, median width, median slope profile, traffic volume, traffic composition, and operating speed. As of July 2017, KYTC has installed approximately 262 miles of cable median barrier throughout the state and continues to annually monitor existing systems to identify necessary improvements.

Results/Effectiveness of Implementation of the Roadway Departure Safety Implementation Plan (delivered by FHWA 2010)

Between 2004 and 2008, there were approximately 2,850 reported roadway departure fatalities on state-maintained facilities. In 2010, FHWA completed the Kentucky RwDSIP to assist in addressing roadway departure-related crash patterns throughout the state. The RwDSIP goal was to reduce roadway departure fatalities by approximately 65 fatalities annually, or by an approximate 15 percent reduction per year. Since 2010, the KYTC has taken a focused and systemic approach in addressing this statistic. Based on available crash data between 2013 and 2017, approximately 2,100 roadway departure fatalities were reported. This indicates that approximately 750 lives have been saved over the recent 5-year period, or an approximate average of 150 lives saved per year. This actual reduction is far greater than the expected 325 lives saved as targeted in the RwDSIP.

For Additional Information

For additional information about the FHWA Roadway Departure Focus State Initiative, contact Joseph Cheung, FHWA Office of Safety, at **joseph.cheung@dot.gov**.

For additional information about the Kentucky Transportation Cabinet, contact Tracy Lovell, Kentucky Transportation Cabinet – District 7, at **Tracy.Lovell@ky.gov.**

Publication Number FHWA-SA-19-006