



KY 151 Safety Study

Anderson and Franklin Counties

From US 127 to I-64
Alton Road/Graefenburg Road



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Kentucky Transportation Cabinet
Division of Planning
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Executive Summary

The Kentucky Transportation Cabinet (KYTC) conducted a safety study for KY 151 from US 127 in Anderson County to Interstate 64 (I-64) in Franklin County as a special case study to address the safety concerns of the local residents and analyze the Commercial Motor Vehicle (CMV) crashes between January 1, 2010, and December 31, 2015. See **Figure ES-1, p. ES-5**.

The purpose of the KY 151 Safety Study is to:

- Review the existing roadway characteristics, traffic volumes, geometries, speeds, and crashes
- Determine which size of vehicles can be safely accommodated within the existing roadway geometry
- Identify and examine the CMV-specific issues

Background

In 2015, five CMV crashes were reported by the Kentucky State Police (KSP) along KY 151 between milepoint (MP) 0.0 in Anderson County and MP 2.3 in Franklin County. This segment of KY 151 serves as a shorter route between locations south of the KY 151 and US 127 intersection, and locations west of the KY 151 and I-64 interchange.

In March 2016, in response to local residents' concerns about the recent number of CMV crashes, KYTC and the Federal Highway Administration (FHWA) took immediate action to place an emergency ban on certain classes of large and oversized commercial motor vehicles, referred to as STAA vehicles, while the causes of the CMV crashes and safety aspects of the roadway were analyzed by KYTC. Banning of STAA vehicles permanently and removing KY 151 from the National Truck Network is contingent on FHWA's approval after providing formal notice to the public and offering opportunity for citizen comments in the Federal Register.

In May 2016, Civil Action No. 16-CI-440 was filed in the Franklin Circuit Court against the Commonwealth of Kentucky, KYTC, KYTC Secretary Greg Thomas, and the Department of Public Highways. The plaintiffs in the civil action are Mr. Thomas D. Isaac and Mr. Don McCormick, who are local residents representing "Group 151." In addition to the ban of the STAA vehicles, the plaintiffs have requested that KYTC ban all non-local trucks from the KY 151 study corridor. The plaintiffs define "trucks" as any vehicle having more than three axles. Exceptions would be made for single unit garbage trucks, emergency vehicles, and other similar vehicles.

KYTC evaluated the existing roadway characteristics, traffic volumes, roadway geometrics, speeds, crashes, and pavement conditions. The key transportation issues identified from this analysis are summarized on the next page.

KY 151 Safety Study – Executive Summary

Roadway Geometrics

There are 31 horizontal curves along KY 151, between US 127 and I-64. All of the curves meet current design guidelines for the posted speed limits. Fourteen horizontal curves were further analyzed to determine which CMV sizes might have difficulty maneuvering without the rear wheels tracking off of the pavement. Two curves at MP 2.6 and MP 3.0 in Anderson County may not fully accommodate the offtracking of STAA vehicles, confirming that removing KY 151 from the National Truck Network and prohibiting STAA vehicles was an appropriate action to balance the concerns of the local residents, government officials, and commercial vehicle traffic, with the possibility of the geometric conditions of the roadway contributing to the CMV crashes.

A review of the crash report narratives did not appear to indicate any of the CMV crashes were related to sight distance issues.

Speed Analysis

Speed data was collected at five locations on KY 151 in May 2016. The analysis indicates the 85th percentile speeds recorded, both for trucks and non-trucks, are within 5 mph of the posted speed limits which indicates the posted speed limit is appropriate for the roadway conditions.

Crash Analysis

Between January 1, 2010, and December 31, 2015, there were 19 CMV crashes out of 177 all-vehicle type crashes on KY 151 between US 127 and I-64. Five of the 19 CMV-related crashes were recorded by the KSP as not being caused by the CMVs. The heaviest concentration of CMV crashes occurred between the community of Alton and the Anderson/Franklin County line. The crash analysis indicated low shoulders along the roadway may be a contributing factor in three locations. To mitigate the initial findings of this study, KYTC Maintenance crews widened the three low-shoulder locations in fall of 2015 and spring of 2016. The CMV crashes between Alton and the county line not related to low shoulders appear to be random events related to conditions such as icy weather and driver fatigue.

Overall statistical analysis of the all-vehicle-type crashes shows that KY 151 is experiencing lower crash rates and lower severity of crashes than Kentucky roadways of similar functional classification.

Pavement Condition Evaluation

In April 2016, the KYTC Division of Maintenance, Pavement Management Branch, conducted a review of KY 151 in order to assess potential impacts of heavy trucks on pavement conditions in accordance with KYTC *Pavement Management in Kentucky* procedures. The review involved investigation of:

- current pavement conditions
- historical construction data
- prior condition assessments

Analysis of pavement ride quality and visual distresses indicated no evidence of abnormal distress patterns. The pavement structure for KY 151 is considered sufficient to accommodate the existing 'AAA' truck weight classification.

KY 151 Safety Study – Executive Summary

Road Safety Audit

The Road Safety Audit conducted on May 10, 2016, recommended improvements to the KY 151 corridor to improve the safety of the roadway.

Conclusions

Safety is a high priority with KYTC, as documented in KYTC's Mission statement:

"To provide a safe, efficient, environmentally sound and fiscally responsible transportation system that delivers economic opportunity and enhances the quality of life in Kentucky."

As part of the Strategic Plan, KYTC's goals and objectives are to make well-informed, data-driven decisions to reduce the number and severity of motor vehicle crashes. This must be accomplished while also considering the local citizens' concerns, promoting economic development through improving freight movement, and managing limited transportation funds responsibly.

The KY 151 Safety Study evaluated the existing roadway characteristics, traffic volumes, roadway geometrics, speeds, crashes, and pavement conditions. The analysis shows the following:

- roadway capacity is not currently an issue, and will not likely be an issue in the next 20 years
- roadway geometrics, although not up to current industry guidelines, are not contributing to crash rates higher than what would be expected due to random occurrence
- existing traffic control devices are within industry guidelines
- posted speed limits are appropriate
- there are no apparent crash patterns indicating the roadway geometry is insufficient
- pavement conditions are fair
- the KY 151 study corridor has a better safety record than Kentucky roadways of similar functional classification in both rural and urban areas

The CMV-specific data and physical evidence were examined along the KY 151 corridor. The analysis and physical evidence indicate some of the CMV crashes may be related to offtracking and shoulder drop-offs at two curves located at MP 2.6 and MP 3.0, and the abrupt change in pavement width at MP 4.1 in Anderson County.

Although the analysis indicates STAA vehicles may have difficulty tracking within their 11-foot travel lanes at two of the curves in Anderson County, it does not necessarily indicate that the STAA vehicles must be removed from the KY 151 corridor. However, because of the proximity of US 127 as a viable alternate route and with the possibility of the roadway geometric conditions contributing to the CMV crashes, the Official Order prohibiting STAA vehicles was an appropriate action to balance the concerns of the local residents, government officials, and commercial vehicle traffic. A further ban on all CMVs, or trucks over three axles as requested by the civil action lawsuit is not supported by the analysis and would unjustifiably restrict freight movement.

KY 151 Safety Study – Executive Summary

While the crash analysis indicates the crashes along the corridor are likely occurring in a statistically random manner and are generally of lower severity than statewide averages, the overall evaluations indicate the CMV-related issues at MPs 2.6, 3.0, and 4.1 in Anderson County have the potential to be mitigated by a combination of improving the shoulders in the section of roadway between the community of Alton and the Anderson and Franklin County line, along with continuing to restrict the STAA vehicles. The STAA restriction reduced the overall percentage of CMVs on the study corridor by nearly half, thereby reducing the potential for CMV crashes along KY 151. Additional improvements to enhance safety along the corridor are listed in the Road Safety Audit section of this study. To address the initial findings of this study and improve safety along the corridor, the shoulders have been widened on the section of KY 151 between the community of Alton and the change in pavement width at MP 4.1.

KY 151 Safety Study – Executive Summary

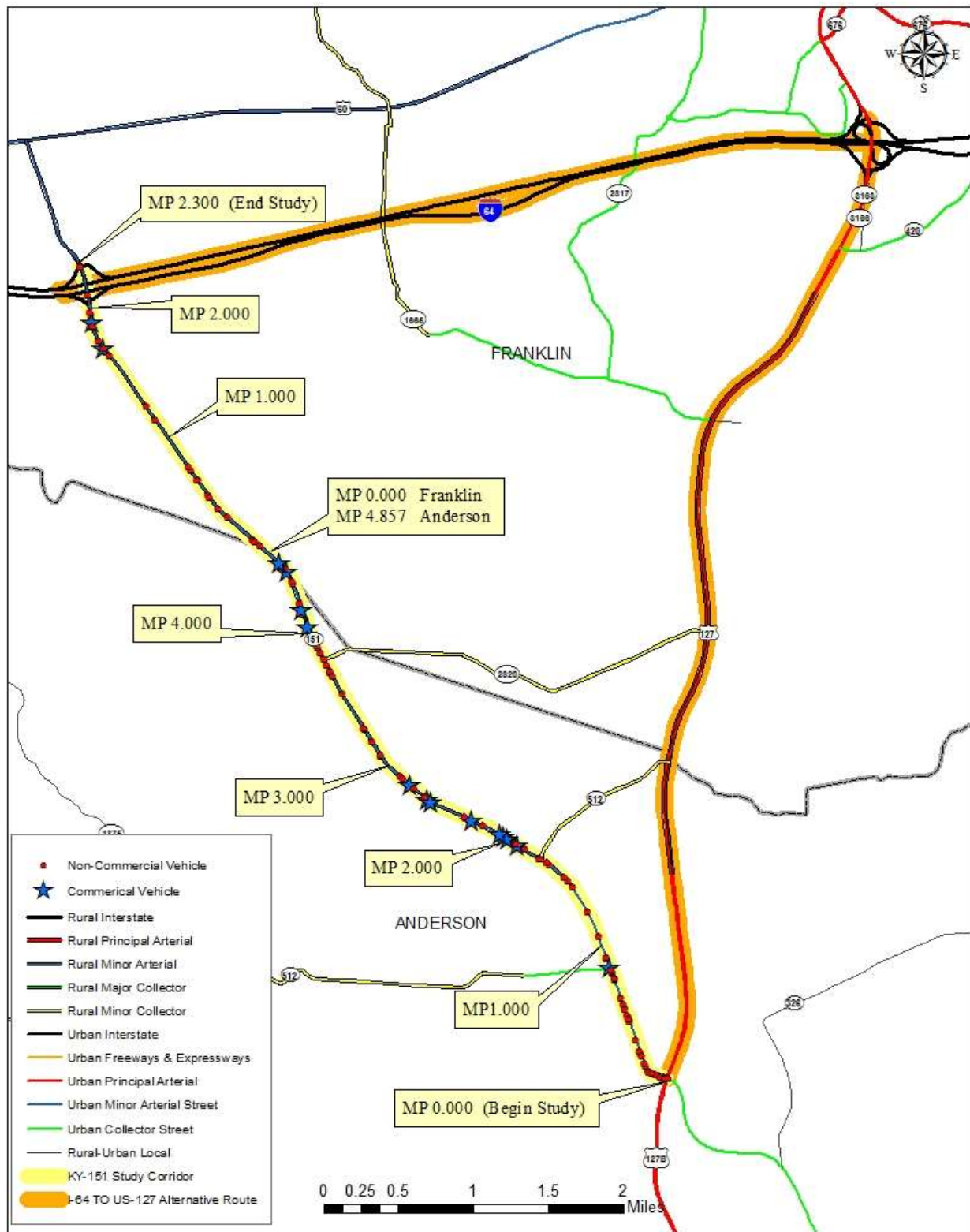


Figure ES-1 - KY 151 Safety Study Corridor

1. Study Overview

A. Study Purpose

The Kentucky Transportation Cabinet (KYTC) conducted a safety study for KY 151 from US 127 in Anderson County to Interstate 64 (I-64) in Franklin County as a special case study to address the safety concerns of the local residents and analyze the Commercial Motor Vehicle (CMV) crashes between January 1, 2010, and December 31, 2015.

The purpose of the KY 151 Safety Study is to:

- Review the existing roadway characteristics, traffic volumes, geometries, speeds, and crashes
- Determine which size of vehicles can be safely accommodated within the existing roadway geometry
- Identify and examine the CMV-specific issues



Fence and mailbox damaged by CMV crash in 2016

B. Study Setting

The KY 151 study corridor is a two-lane roadway which connects US 127 in Anderson County north of Lawrenceburg to I-64 in Franklin County west of Frankfort as shown in **Figure 1 (p.2)**. The study corridor is approximately 6.9 miles in length and runs approximately south to north. The southern section of the roadway is locally known as Alton Road, while the northern part is known as Graefenburg Road. KY 151 in Anderson County begins at milepoint (MP) 0.0 at the US 127 intersection, and ends at the Anderson/Franklin County line, MP 4.587. The KY 151 study area in Franklin County begins at MP 0.0 at the Anderson/Franklin County line, and continues to MP 2.3 at I-64. KY 151 continues north of the I-64 interchange and ends at US 60 (MP 3.22).



The corridor is characterized by level and rolling terrain with farms, small residential communities, and generally locally-owned small businesses.

KY 151 Safety Study

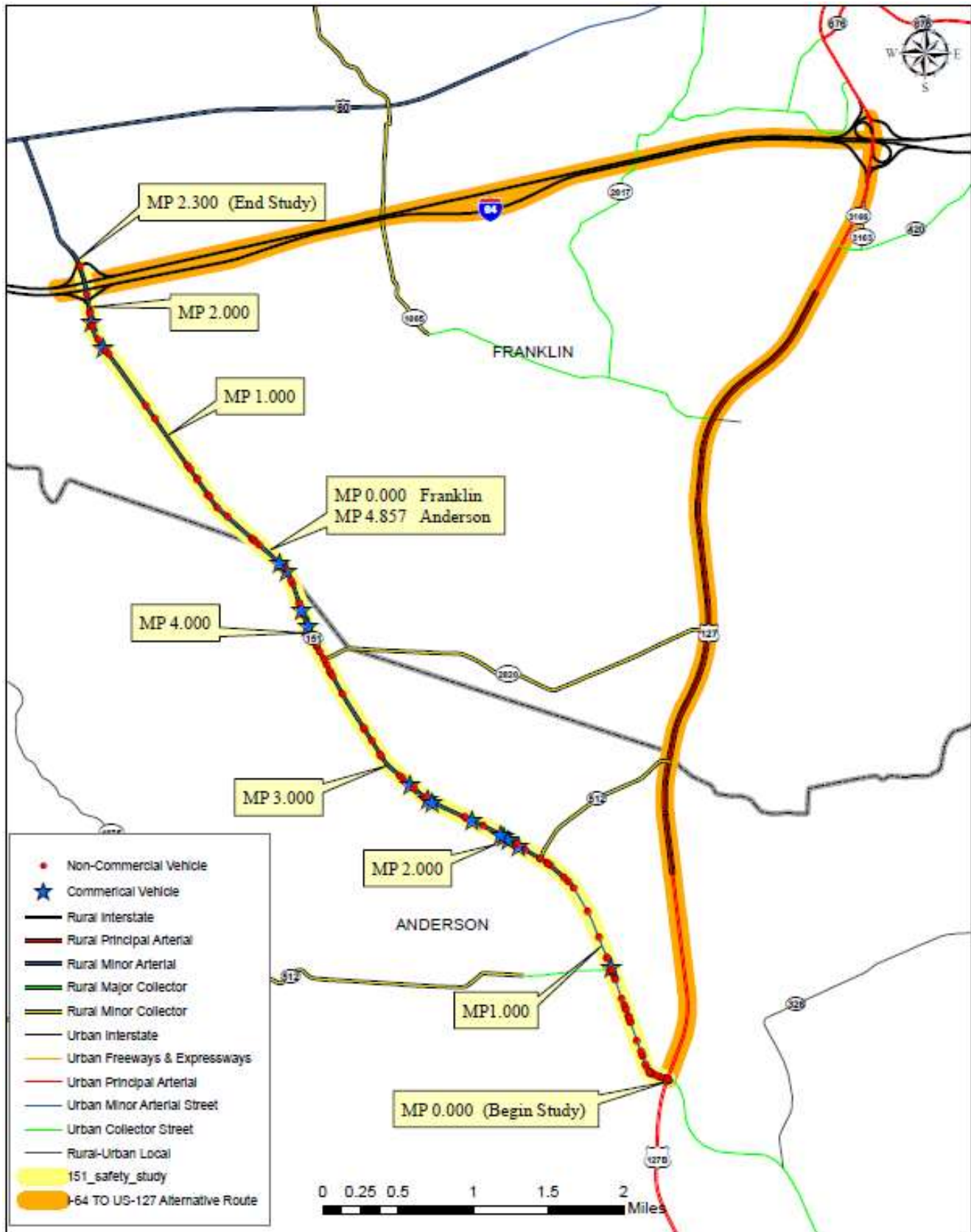


Figure 1 – KY 151 Safety Study Corridor

On the southern end of the corridor, the businesses include the Eagle Lake commercial development, the Florida Tile National Distribution Center, Inc., and Bluegrass Solutions (a truck-related business). Numerous businesses are located along the northern part of the corridor including Republic Services (locally known as the Benson Valley Landfill), two gas stations, and a large/heavy equipment supply business.

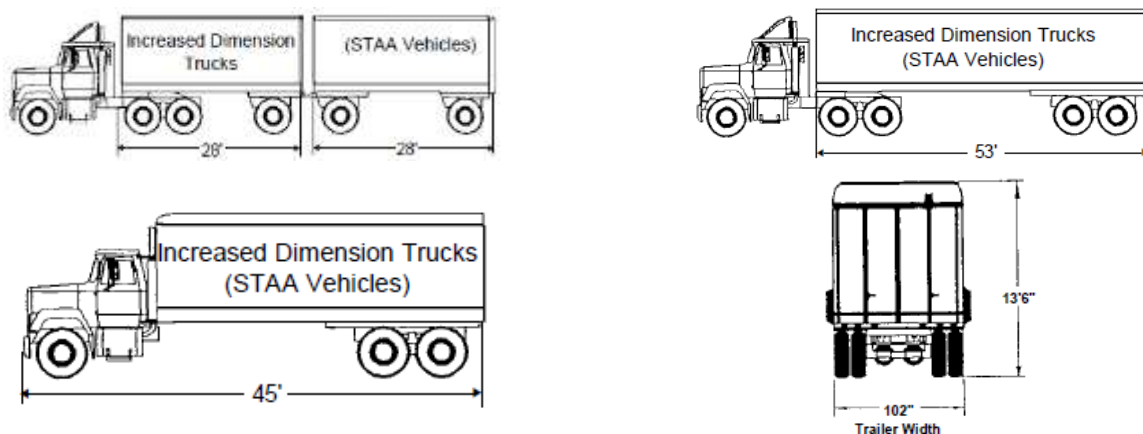
The KY 151 study corridor, highlighted in yellow in **Figure 1 (p.2)**, serves as a shorter route between locations south of the KY 151 and US 127 intersection, and locations west of the KY 151 and I-64 interchange. The alternative route, highlighted in orange in **Figure 1 (p.2)**, using US 127 to travel north to the US 127 and I-64 interchange, then traveling west on I-64 to the I-64 and KY 151 interchange, adds approximately 5 miles length, and 7½ minutes of travel time, versus using the KY 151 corridor. US 127 is a four-lane divided principal arterial roadway with a median and 4- to 10-foot paved shoulders.

C. Background

In 2015, five CMV crashes were reported by the Kentucky State Police (KSP) along KY 151 between MP 0.0 in Anderson County and MP 2.3 in Franklin County.

In March 2016, in response to local residents' concerns about the recent number of CMV crashes, KYTC and the Federal Highway Administration (FHWA) took immediate action to place an emergency ban on certain classes of large and oversized trucks, referred to as STAA vehicles (see the National Truck Network discussion in the paragraph below and the Kentucky National Designated Truck Network map in **Appendix A**), while the causes of the CMV crashes and safety aspects of the roadway were analyzed by KYTC. Banning of STAA vehicles permanently and removing KY 151 from the National Truck Network is contingent on FHWA's approval after providing formal notice to the public and offering opportunity for citizen comments in the Federal Register.

The National Truck Network was authorized by the Surface Transportation Assistance Act (STAA) of 1982 as specified in the U.S. Code of Federal Regulations (23 CFR 658). The CFR requires states to allow certain sizes of large and oversized trucks (STAA vehicles) on the National Truck Network to support interstate commerce. The network includes almost all of the Interstate Highway System and other, specified non-interstate highways. **Appendix A** details, and further defines, STAA vehicles and Kentucky's National Truck Network. KY 151 was placed on the National Truck Network at the inception of the network in 1982, prior to the completion of the US 127 bypass around the community of Alton.



Increased Dimension Trucks – STAA Vehicles

In May 2016, Civil Action No. 16-CI-440 was filed in the Franklin Circuit Court against the Commonwealth of Kentucky, KYTC, KYTC Secretary Greg Thomas, and the Department of Public Highways. The plaintiffs in the civil action are Mr. Thomas D. Isaac and Mr. Don McCormick, who are local residents representing Group 151. Group 151 is a group of local residents that are concerned with the CMV crashes along KY 151. In addition to the ban of the STAA vehicles, the plaintiffs have requested that KYTC ban all non-local trucks from the KY 151 study corridor. The plaintiffs define “trucks” as any vehicle having more than three axles. Exceptions would be made for single unit garbage trucks, emergency vehicles, utility vehicles, local construction vehicles, and for trucks accessing terminals, facilities, for food fuel, repairs, or rest. The plaintiffs assert that the trucks pose a danger to the personal safety of the traveling public.

D. Methodology

While most KYTC planning-type studies take, at a minimum, one year to complete, the KY 151 Safety Study was expedited due to the emergency safety aspects of the situation. This study focuses on the initial causes of the CMV crashes and does not include some aspects of typical planning-level studies including:

- Development of a Purpose and Need statement that explains to the public and decision-makers that expenditure of funds is necessary and worthwhile and that the priority of the work is warranted when compared to other needed highway projects
- A study of the environmental resources, including human resources (archeological, cultural, socioeconomic, etc.) and natural resources (threatened/endangered species, aquatic, geological, etc.)
- The involvement of the public and local officials, other than direct contact with local residents and Governor Bevin’s office
- An analysis of roadside and clear zone features (the possible presence of utility poles, for example) that may impact the severity of crashes. A clear zone is considered an unobstructed, traversable roadside area designated to enable a driver to stop safely or regain control of an errant vehicle.
- A Level of Service analysis that measures the quality of traffic service based on motorists’ expectations of traveling speed and density

Additional study and analysis may be required as any KY 151 improvement plans progress and as the purpose and needs of future projects are developed.

Although this study focuses on the CMV crashes, there are a relatively limited number of CMV crashes. The crash data, and corresponding KSP officers’ crash reports for all vehicle types, along with the CMV crash reports, were obtained from the KSP’s Kentucky Open Portal Solutions (KYOPS) Database and reviewed to identify any potential patterns and contributing causes, and to guide and focus the scope of this study.

This study uses the KYOPS database CMV Indicator to define crashes that are CMV-related.

KYTC and the Kentucky State Police (KSP) use the term CMV as defined by the Federal Motor Carrier Safety Administration and can generally be considered any motor vehicle used to transport passengers or property that:

- Has a gross vehicle weight of 10,001 pounds or more
- Transports more than 8 passengers for compensation
- Transports more than 15 passengers, not for compensation

E. Review and Summarization of Previous Corridor Documentation

A review of KYTC records shows the KY 151 corridor has been considered for improvements which are summarized in **Table 1**, below.

Table 1 – Summary of Previous Corridor Documentation

Study/PIF #	Year	Route	From	To	Description	Cost Est. (Millions)
¹ KY 151 Alton Bypass	1969	KY 151	Lawrenceburg Bypass	I-64	Determine the most feasible corridor for the reconstruction of US 127 and KY 151	\$2 M
² Environmental Impact Statement (EIS)	1977	KY 151	340' NW of county line	I-64	2 lane initial, 4 lane ultimate	\$0.45 M
Highway Plan Item No. 7-333	1995	KY 151	US 127	County line	Reconstruct KY 151 from US 127 in Anderson County to I-64 in Franklin County	\$0.3 M
PIF 07 003 D0151 1.00	2010	KY 151	MP 0.000 Anderson Co.	MP 4.587 Anderson Co.	Reconstruct KY 151 from US 127 in Anderson County to I-64 in Franklin Co.	\$32 M

¹ KYTC website. "Route Study - KY 151 Alton Bypass." [Transportation.ky.gov](http://transportation.ky.gov).

[http://transportation.ky.gov/Planning/Pages/Project-Details.aspx?Project=Route Study - KY 151 Alton Bypass](http://transportation.ky.gov/Planning/Pages/Project-Details.aspx?Project=Route%20Study%20-%20KY%20151%20Alton%20Bypass), (posted June 2016).

² KYTC website. "Environmental Impact Statement US 127 and KY 151." [Transportation.ky.gov](http://transportation.ky.gov).

[http://transportation.ky.gov/Planning/Pages/Project-Details.aspx?Project=Environmental Impact Statement \(EIS\) US 127 and KY 151](http://transportation.ky.gov/Planning/Pages/Project-Details.aspx?Project=Environmental%20Impact%20Statement%20(EIS)%20US%20127%20and%20KY%20151), (posted June 2016).

The previous study, titled *Route Study, KY 151 Alton Bypass from North End of Lawrenceburg Bypass to the Anderson-Franklin County Line and US 127 Alton Bypass*, was completed in 1969 prior to the construction of US 127 in its current location. Old Frankfort Road, US 512, was the original alignment of US 127, see **Figure 1 (p.2)**. The study looked at alternative alignments for US 127 to bypass the community of Alton.

The 1977 Environmental Impact Statement (EIS) was also approved prior to the realignment of US 127 in its current location. The EIS analyzed the environmental conditions prior to the plan of constructing KY 151 as an initial two lane roadway and eventual four lane roadway with an interchange at US 127. KY 151 would have served as the primary movement of north-south traffic from Frankfort to and from locations south of Lawrenceburg instead of US 127 at the time of the 1977 EIS.

Project Identification Form (PIF) number 07 003 D0151 1.00 proposes a major widening along KY 151 from US 127 in Anderson County to I-64 in Franklin County to promote the safe and efficient movement of people, goods, and services for the benefit of all in the region. PIFs are used by KYTC to initially identify and document possible projects for KYTC to consider including in the statewide Highway Plan and include preliminary information such as general estimates and environmental concerns.

F. KY 151 in the 2016 Enacted Highway Plan

Currently, the KY 151 corridor is in the 2016 Enacted Highway Plan as follows:

Table 2 – ³KY 151 in the 2016 Enacted Highway Plan

County	Item No.	Route	Description	Phase	Year	Amount
Anderson/ Franklin	05-806.00	KY 151	Reconstruct KY 151 from US 127 at Lawrenceburg to I-64 in Franklin County	Planning	2017	\$250,000
				Design	2017	\$1,750,000
				Right of Way	2018	\$5,000,000
				Utilities	2020	\$5,000,000
				Construction	2022	<u>\$20,000,000</u>
			Funding Source: SPP	Total		\$32,000,000

³KYTC website. "2016 Recommended Highway Plan." Transportation.ky.gov. <http://transportation.ky.gov/Program-Management/Pages/2016-Recommended-Highway-plan.aspx> (accessed June, 2016).

G. Removing KY 151 from the National Truck Network

KYTC Petitions FHWA to remove KY 151 from National Truck Network

The KYTC submitted a request in March 2016, to the FHWA to remove KY 151 from the National Truck Network. On April 26, 2016, on an emergency basis, the FHWA granted contingent authorization to remove KY 151 from the National Truck Network. A formal notice was posted in the Federal Register allowing for a public comment period prior to permanent removal (see **Appendix A**).

KYTC Official Order Removing KY 151 from National Truck Network

On April 29, 2016, KYTC Secretary Greg Thomas signed Official Order 110134, removing KY 151 from the National Truck Network to ensure wider vehicles use a more appropriate route while promoting safety to the traveling public. The Official Order and the specific restricted vehicles dimensions can be seen in **Appendix A**.

In addition, the Official Order states motor vehicles with increased dimensions are allowed one driving mile from the designated National Truck Network for the purpose of attaining reasonable access to terminals, and facilities for food, fuel, repairs and rest.



2. KY 151 Roadway Characteristics

A. Functional Classification

Functional classification is the process which streets and highways are grouped into classes or systems, according to the type of traffic service they are intended to provide. In accordance with the FHWA and American Association of State Highway Officials (AASHTO) guidelines, the functional classification of KY 151 is urban minor arterial from US 127 to County Road (CR) 1022 (McCormick Road, MP 1.473 in Anderson County), and rural minor arterial from CR 1022 to I-64. Both urban and rural minor arterials provide service for trips of moderate length, serve geographic areas smaller than their higher arterial counterparts and offer connectivity to the higher arterial system. See **Figure 2**, right.

B. Traffic Volumes

The KYTC Traffic Count Reporting System has three traffic counting stations along KY 151 between US 127 and I-64. The Average Annual Daily Traffic (AADT) varies from 8,917 vehicles per day (vpd) at the southern end of the corridor towards US 127, to 5,215 vpd at the northern section by I-64. These counts, along with the corresponding truck percentages, can be seen in **Figure 2**, right, in **Table 3**, below, and are detailed in **Appendix B**.

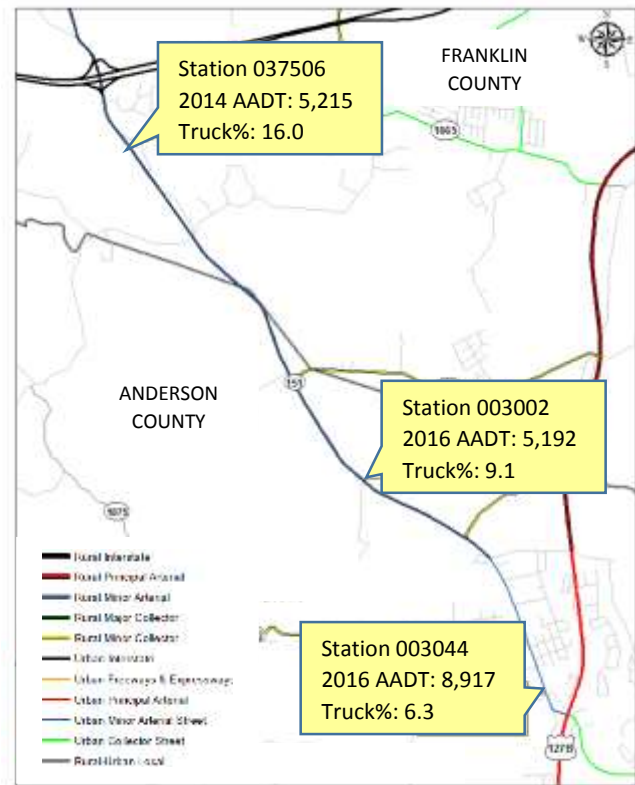


Figure 2 – Map of KY 151 Functional Classification and Traffic Counts

Table 3 – Traffic Volumes

Station ID	Begin – End Milepoints	Count Year	AADT (vpd)	% Single Trucks	% Combo Trucks	% *Illegal Combo Trucks	Total % Trucks	Truck AADT (vpd)
003044	0.000-1.761 Anderson Co.	2016	8,917	3.7	2.6	0.7	6.3	565
		2014	7,153	5.6	6.6		12.1	867
003002	1.761-4.587 Anderson Co.	2016	5,192	6.1	3.0	1.8	9.1	474
		2013	4,588	5.6	6.6		12.1	556
037506	0.000- 2.141 Franklin Co.	2014	5,215	9.4	6.7		16.0	837
For historic perspective		1969	**3,460				18.0	623

Numbers show the reduction in semi-trucks ((Combo, or Combination Trucks), see Effect of the STAA Ban discussion on p.8

*percentage of semi-trucks exceeding the STAA length ban in May 2016, 1 month after STAA ban was implemented

**Count taken prior to US 127 realignment to present day alignment

C. Effect of the STAA Vehicle Ban

The traffic count numbers highlighted in **Table 3 (p.7)** demonstrate the significant reduction in the percentage of combination trucks (% Combo Trucks) from 2013 and 2014 traffic volumes to 2016 volumes. The traffic volumes in 2016 were collected after the 2016 KYTC Official Order restricting STAA vehicles was implemented. The overall truck percentage (Total % Trucks) and percentage combination trucks (% Combo Trucks) both show significant reductions from pre-restriction measures. This indicates that the STAA restriction has resulted in a 50 percent reduction in semi-truck traffic on KY 151. Standard volume counting methods cannot distinguish vehicle widths and therefore it cannot be determined if any of the existing traffic exceeds the 96 inch width restrictions.

D. Capacity Analysis

The Transportation Research Board's Highway Capacity Manual 2010 (HCM 2010) defines roadway capacity as follows:

"The maximum sustainable hourly flow rate at which persons or vehicles reasonably can be expected to traverse a point or a uniform section of a lane or roadway during a given time period under prevailing roadway, environmental, traffic, and control conditions."

Volume to Capacity Analysis

Per the HCM 2010, the hourly directional capacity of a two-lane roadway is 1,700 passenger cars per hour per lane. Using the highest recorded AADT of 8,917 vpd, **Table 3 (p.7)**, and a one-direction traffic volume of 848 passenger cars per hour, the current volume to capacity (v/c) ratio is 0.50. The annual growth estimate from KYTC's statewide travel demand model for the study location is 1.1%. Therefore the one-direction traffic volume on KY 151 is projected to be approximately 1,055 passenger cars per hour per lane in 20 years. The v/c ratio in 20 years would then be 0.62. A roadway typically begins to experience capacity symptoms as it approaches a v/c ratio of approximately 0.70. Therefore, the v/c ratio of KY 151 is not an issue currently, and will not likely be an issue for the next 20 years. Capacity analysis details can be found in **Appendix B**.

Possible Crashes Related to Capacity

The crash reports for all vehicle types were reviewed to identify any capacity-related crash patterns, including crashes involving passing vehicles. Typically, as the v/c ratio increases, the demand for passing increases, and the crashes related to passing increase. In the six years of crash data reviewed, six of the 177 all-vehicle-type crashes appeared to be related to passing. Of the six passing-related crashes, four were caused by vehicles attempting to pass stopped or turning vehicles. The remaining two passing-related crashes appeared to be caused by vehicles illegally passing in no-passing zones. No capacity-related crash patterns were apparent.

Summary of the Capacity Analysis

Because the capacity calculations indicate there are no capacity issues currently or forecasted in the future and there was no apparent pattern of capacity-related crashes, the roadway capacity of KY 151 was not investigated further.

E. Roadway Geometric Analysis

A geometric analysis was conducted on KY 151 from the intersection with US 127 in Anderson County to the I-64 interchange in Franklin County. The analysis involved an overview of the horizontal geometry, vehicle offtracking, and vertical geometry. This planning-level geometric analysis is further explained in **Appendix C**.

Horizontal Geometry

According to KYTC's Highway Information System (HIS) database, there are 31 horizontal curves within the study limits (detailed in **Appendix C**). Seventeen of the curves listed in the HIS were not analyzed as they were not significant enough to show up on aerial photography or identified on existing roadway plans. Fourteen curves and their corresponding radii were identified through existing roadway plans or estimated from aerial photography.

Table 4 below shows the existing horizontal curve radii of each curve analyzed along with minimum radius for each curve based upon its design speed and an assumed maximum superelevation on the 8% e_{max} as detailed in the AASHTO's "A Policy on Geometric Design of Highways and Streets" 6th Edition (2011) (the Green Book).

Table 4 – Summary of Horizontal Curves

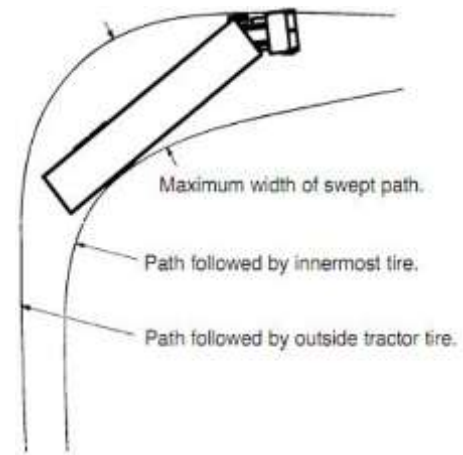
INAL	Milepoint	*Posted and Design Speed (mph)	Existing Curve Radius (feet)	Minimum Radius (feet) Per Current Design Guidelines
Anderson	0.1	45	**424	587
	1.2		2,000	587
	1.5		1,500	587
	1.7	35	1,433	314
	2.1	55	2,865	960
	2.6		1,146	960
	3.0		1,146	960
	3.5		5,730	960
	3.7		2,865	960
	4.0		2,865	960
	4.4		1,432	960
Franklin	0.4		1,432	960
	1.5		11,459	960
	1.8		1,432	960

*See Appendix C – Roadway Geometry Analysis Details

**While the posted speed limit on the curve at MP 0.1, Anderson County, is 45 mph, it is reasonable to assume that vehicles are either slowing as they approach the intersection with US 127 or are accelerating from slower speeds after they travel through the intersection. In either case it is unlikely that the 45 mph speed limit is achieved in this location.

Vehicle Offtracking

Vehicle offtracking was investigated following procedures outlined in AASHTO's Green Book to determine if CMVs might have difficulty maneuvering the curves without the rear wheels tracking off of the pavement. Fourteen horizontal curves were analyzed to determine how well they accommodate a full range of design vehicles from passenger cars to the currently prohibited STAA vehicles. The available pavement width was determined by field measured pavement widths for all 14 analyzed curves. The approximate curve radius of each curve on this corridor was taken from archived construction plans or estimated from aerial photography. Additional details showing many of the design vehicles that were analyzed as part of this study can be found on the Offtracking Analysis calculation sheets in **Appendix C**. The vehicle offtracking analysis determined that vehicles up to a wheel base of 50 feet, as



Vehicle Offtracking

measured from the center of the front axle to the center of the rear-most axle (WB-50: Wheel Base= 50 feet), would not encounter the problem of offtracking in the 14 curves analyzed. However, two curves at MP 2.6 and MP 3.0 in Anderson County may not fully accommodate the offtracking of STAA vehicles within the travel lane.

Table 5 shows a summary of the calculated pavement widening by design vehicle. The cells highlighted in red indicate curves that may require additional widening to be able to accommodate the currently prohibited STAA vehicle types.

Table 5 – Summary of Curve Widening Analysis

		Pavement widening (feet)									
		Allowed Vehicles						Banned STAA Vehicles			
		84" Wide	96" Wide					96" Wide		102" Wide	
County	Milepoint	P	S-BUS-36	SU-30	SU-40	WB-40	WB-50	WB-62	WB-67	WB-62	WB-67
Anderson	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.70	1.04
	3.0	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.74	1.40	1.74
	3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Franklin	0.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

P=passenger car, BUS= bus, SU=single unit, WB=wheel base

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Although the offtracking calculations show that some widening may be necessary for the STAA vehicles, guidance from chapter 3.3.10 of the AASHTO Green Book states:

“Widening is costly and very little is actually gained from a small amount of widening. It is suggested that a minimum of 0.6 m [2.0 ft] be used and that lower values...be disregarded.”

The KY 151 was also reviewed for physical evidence of offtracking. As shown in **Figure 3**, below, the curve located at MP 2.6 in Anderson County shows some evidence of scrubbing and tire rutting. This evidence, along with the calculated pavement widening for offtracking, supports the decision to remove KY 151 from the National Truck Network and prohibiting STAA vehicles.

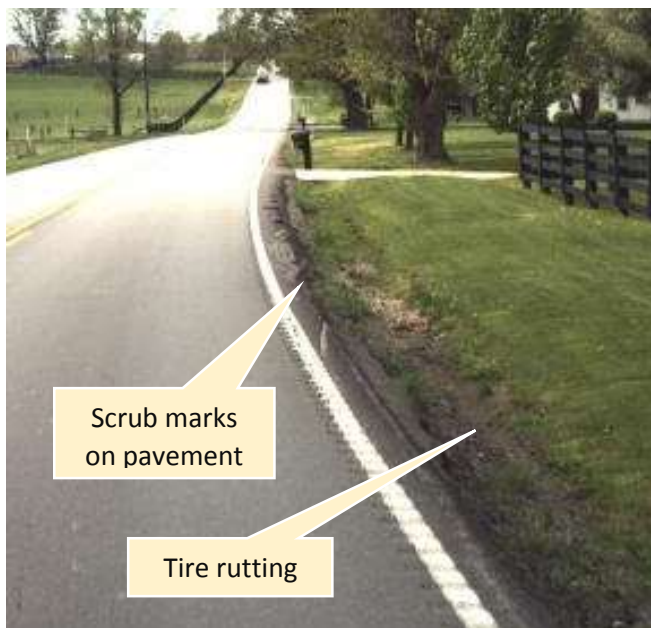


Figure 3: Scrub marks at MP 2.6, Anderson County

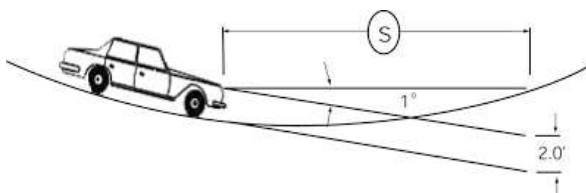


Figure 4: Curve at MP 3.0, Anderson County

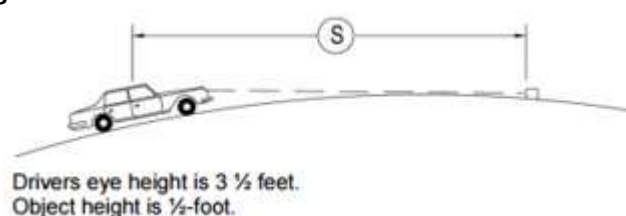
Vertical Geometry

The vertical geometry was investigated to determine if there are vertical curves not meeting current design guidelines for headlight sight distance and stopping sight distance. Forty-six vertical curves were analyzed for sight distance along the corridor. A table with the detailed analysis of the 46 vertical curves can be found in **Appendix C**. Eleven sag curves and nine crest curves do not meet current design guidelines for sight distance. These are summarized in **Table 6 (p.12)**. Of these 20 curves, 19 are located between Alton and I-64. Typical sight distance issues result in a pattern of rear-end type crashes. A review of the crash report narratives did not appear to indicate any of the CMV crashes were related to sight distance issues.

Vertical Curve Sight Distance



Sag Curve Headlight Stopping Distance



Crest Curve Stopping Sight Distance

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Table 6 – Summary of Substandard Vertical Curves

	County	Curve Location	Posted Speed (mph)	Crest or Sag	Approximate Sight Distance (feet)	Current Design Guideline Sight Distance (feet)
1	Anderson	MP 0.16 - 0.19	45	Sag	292	360
2		MP 1.97 – 2.03	55	Sag	293	495
3		MP 2.04 – 2.09		Crest	415	495
4		MP 2.13 – 2.19		Crest	363	495
5		MP 2.21 – 2.29		Sag	215	495
6		MP 2.31 – 2.37		Crest	309	495
7		MP 2.39 – 2.42		Sag	331	495
8		MP 2.51 – 2.57		Crest	362	495
9		MP 2.73 – 2.81		Sag	387	495
10		MP 2.99 – 3.04		Crest	285	495
11		MP 3.15 – 3.28		Sag	432	495
12		MP 3.35 – 3.38		Sag	440	495
13		MP 3.47 – 3.54		Crest	309	495
14		MP 3.61 – 3.67		Sag	227	495
15		MP 3.68 – 3.72		Crest	427	495
16		MP 3.72 – 3.80		Sag	418	495
17		MP 3.96 – 4.01		Crest	350	495
18	Franklin	MP 0.46 – 0.55	55	Sag	475	495
19		MP 1.73 – 1.83		Sag	435	495
20		MP 1.86 – 1.99		Crest	458	495

F. Ball-Bank Indicator Analysis of Curves and Curve Warning Signs

Ball-Bank Indicator Study Methodology

Ball-bank studies are conducted to determine if the horizontal curves along a roadway warrant curve warning signs to alert the traveling public to a curve ahead. The collected data is evaluated to determine the appropriate advisory speed for a horizontal curve. The standards by which a ball-bank study is conducted and by which advisory speeds are set are based on guidance from FHWA's *Procedures for Setting Advisory Speeds on Curves* and the *Manual on Uniform Traffic Control Devices (MUTCD)*.

In a ball-bank study, a curve is driven multiple times at a uniform speeds while readings from the speedometer and the ball-bank indicator are recorded. Additional runs are taken increasing the speed in 5 mph increments for each set of readings. The curve speeds that do not cause "driver discomfort" correspond to ball bank readings 16 degrees for 20 mph or less, 14 degrees for speeds of 25 to 30 mph, and 12 degrees for speeds of 35 mph and higher. The highest speed of travel at which the ball-bank indicator reading falls below the maximum allowed degree is the advisory speed.

Ball-Bank Analysis

Ball-bank data was collected in August 2016. Ball-bank readings were recorded at eight locations in both directions on KY 151 at the milepoints shown in **Table 7**, below, to determine the highest speed of travel at which the ball bank indicator reading falls below the maximum allowed degree. The corresponding advisory and posted speeds were recorded. If the advisory speed is less than the posted speed limit, an advisory speed plaque and curve warning sign is recommended. The ball-bank indicator analysis on KY 151 in Anderson County is shown in the **Appendix C**, along with an inventory of the curve warning signs in the study corridor.

The data in **Table 7** shows the resulting advisory speeds for each of the curve locations. Except for the one curve at MP 0.1 in Anderson County, all of the recorded ball-bank readings for the curves along the corridor were below the maximum allowed degree for the posted speeds. A 35 mph advisory speed is indicated at the curve located at MP 0.1 in Anderson County. While the posted speed limit on the curve is 45 mph, it is reasonable to assume vehicles are either slowing as they approach the US 127 intersection or are accelerating from slower speeds after they travel through the intersection. In either case, it is unlikely that the 45 mph speed limit is achieved in this location. The ball-bank analysis results show the advisory speed signage throughout the corridor is appropriate.

Table 7 – Summary of Ball Bank Indicator Advisory Speeds

County	Milepoint	Posted Speed (mph)	Advisory Speed (mph)	
			Northbound	Southbound
Anderson	0.1	45	-	35
	1.5	45	55	45
	1.7	35	55	50
	2.6	55	55	55
	3.0	55	55	55
	4.4	55	55	55
Franklin	0.4	55	55	55
	1.8	55	55	55

G. Speed Analysis

Spot Speed Study Methodology

Spot speed studies (speed studies) are conducted to determine the speed distribution of traffic currently using the roadway. The collected data is evaluated to determine the appropriate speed limit. The standards by which a speed study is conducted and by which speed limits are set are based on guidance from the MUTCD.

In the speed studies, the free-flow speed data from 50 to 100 vehicles is obtained through use of a radar device at a single location. Free flow speed is, in general, the speed at which a driver feels comfortable traveling without constraints from other drivers or traffic control devices. The collected data is then evaluated to find the speed 85% of the observed drivers are traveling at or below. This is commonly referred to as the 85th percentile speed and is used to determine the appropriate posted speed limit for the roadway. Speed limits establish an upper bound on speed and help lessen the differential in speed among drivers. This helps maintain an orderly flow of traffic and reduces the overall number of conflicts.

Speed Study on KY 151

Speed data was collected in 2016 at five locations on KY 151 at the milepoints shown in **Table 8** (also **Figure 5, p.15**) to determine vehicle speeds relative to the posted speed limit. Additionally, the speed studies conducted at MPs 1.761 and 2.900 in Anderson County separated the speed data into truck (box trucks and larger) speeds and non-truck speeds. The collected data was analyzed and 85th percentile speeds were recorded.

Speed Study Analysis

The data in **Table 8** shows the resulting 85th percentile speed from each of the locations. Generally, posted speed limits are set within 5 mph of the 85th percentile speed. The observed vehicle speeds in four of the study locations are within approximately 5 mph of the posted speed limit, which would indicate the posted speed limit is appropriate for the roadway conditions. One area differs from the posted speed limit by more than 5 mph is at MP 1.761 in Anderson County where a 35 mph speed zone is in effect (shown in red in **Table 8**).

Table 8 – Summary of Speed Data

County	Milepoint	Posted Speed Limit (mph)	*85 th Percentile Speed (mph)			
			Northbound Traffic		Southbound Traffic	
Anderson	0.740	45	46		45	
	1.761	35	45 (non-trucks)	42 (trucks)	45 (non-trucks)	42 (trucks)
	2.900	55	60 (non-trucks)	56 (trucks)	57 (non-trucks)	55 (trucks)
	4.560	55	57		57	
Franklin	1.900	55	54		48	

**85th Percentile Speeds have been rounded to the nearest whole number*

Numbers in red indicate locations where the recorded speeds exceed the posted speeds by more than 5 mph

KY 151 Safety Study

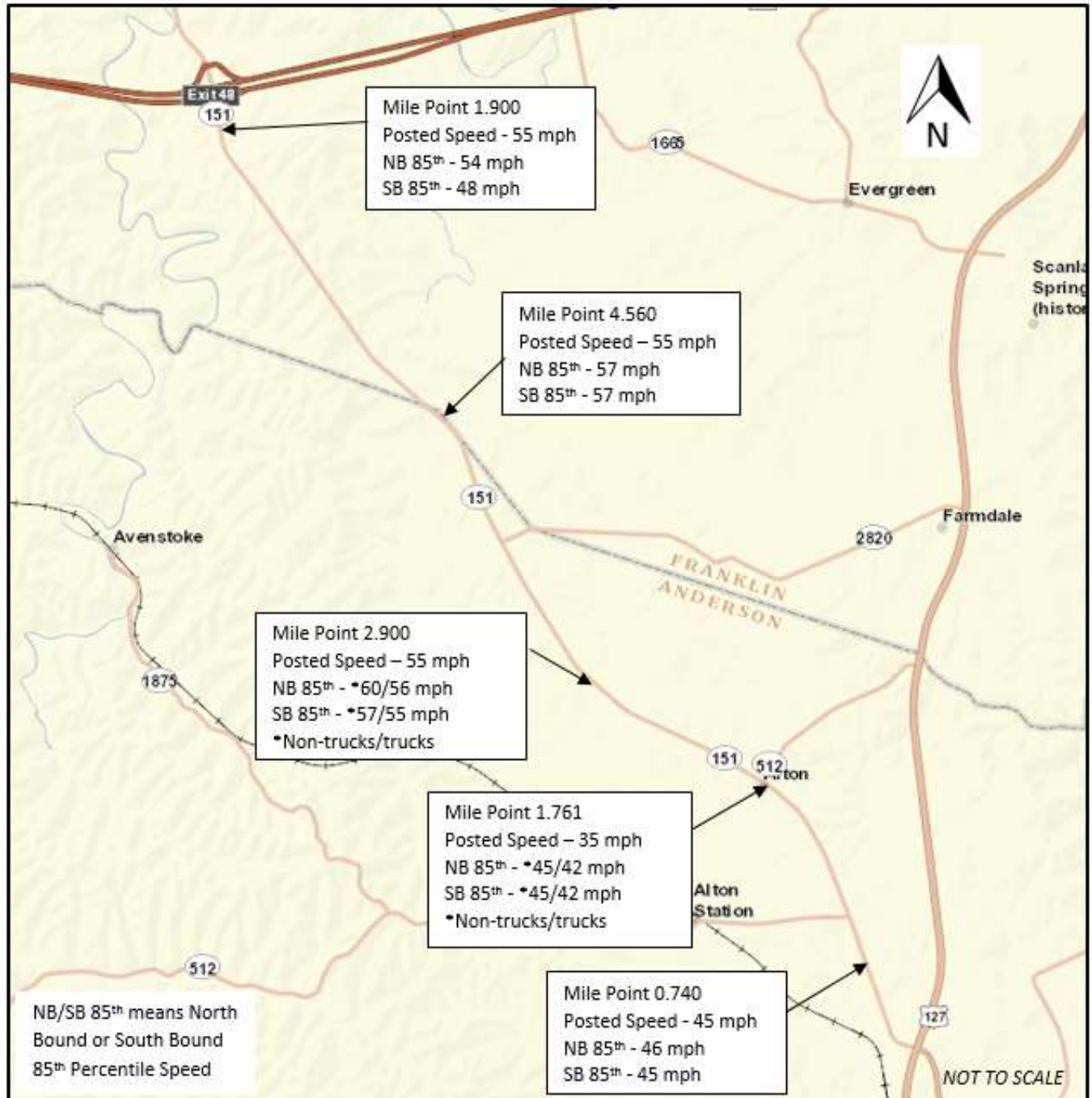


Figure 5 - Speed Studies on KY 151

H. Crash Analysis

Section Descriptions

For the purpose of crash analysis, the KY 151 corridor was considered in five logical sections based on similar characteristics in terrain, pavement typical sections, and posted speed limits as described in **Table 9** below. The CMV crashes that have occurred in Section 4, highlighted in **Table 9**, is the primary concern of the local residents.

Table 9 – Section Descriptions

Section	Begin MP	End MP	Length (miles)	Speed Limit (mph)	Location	Description
1	0.000	0.477	0.477	45	From US 127 to the Florida Tile entrance	Level and straight terrain, 12' lanes, 10' shoulders, 45 mph
2	0.477	1.473	0.996	45	Florida Tile entrance to 35 mph at Alton	Level and straight terrain, 11' to 12' lanes, 1' to 2' shoulders, 45 mph
3	1.473	1.990	0.517	35-45	Alton (35 mph and 45 mph through Alton)	Rolling terrain, 11' lanes, 1' to 2' shoulders, 35 mph, rumble strips on centerline and roadway edges
4	1.990	4.150	2.160	55	From 55 mph north of Alton to the change in pavement typical section	Rolling terrain, 11' lanes, 0' to 2' shoulders, 55 mph, rumble strips on centerline and roadway edges
5	4.150 Anderson Co.	2.300 Franklin Co.	2.737	55	From change in pavement typical section to I-64	Rolling terrain, 12' lanes, 4' to 10' shoulders, 55 mph, rumble strips on centerline and roadway edges

Crash records and reports for the KY 151 corridor were obtained from the KSP's Kentucky Open Portal Solutions (KYOPS) Database through the KYTC Highway Information System database extract. Crashes occurring in parking lots and on the I-64 ramps were not included in the scope of this study.

Between January 1, 2010, and December 31, 2015, there were a total of 177 all-vehicle-type crashes along the study corridor. These are detailed in the Crash Records charts in **Appendix D**. Nineteen of the 177 crashes involved CMVs, either as the vehicle causing the crash or as the vehicle being struck by another vehicle. The crash report narratives were also reviewed for all 177 crashes to identify any potential patterns and contributing causes. Crash report narratives contain the responding officer's written narrative of the crash events. A summary of the crashes for each section is detailed in **Table 10 (p.18)**.

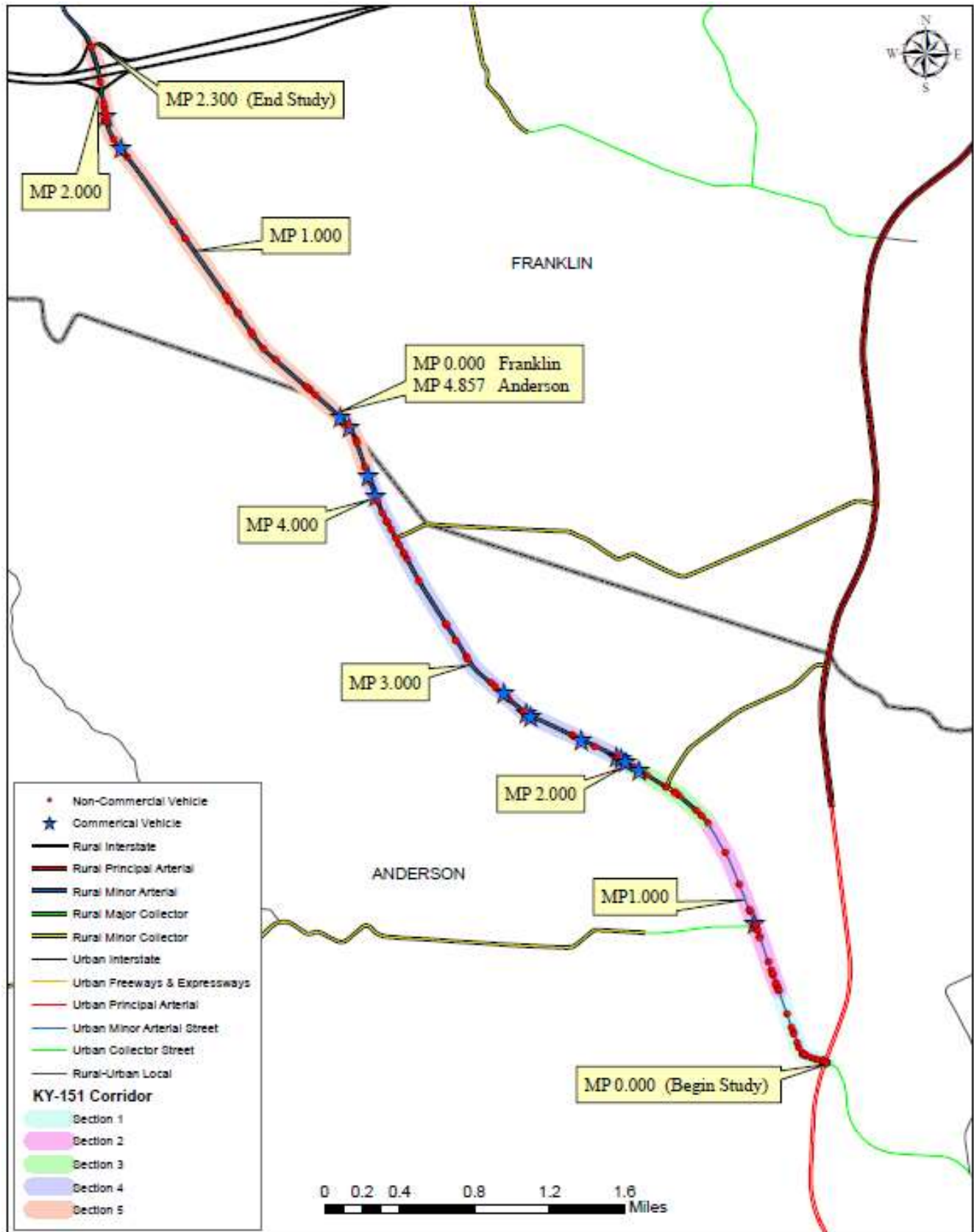


Figure 6 – Map of 2010 to 2015 Crashes

Table 10 – Summary of Crashes by Section

Section	Beginning MP	Ending MP	Length (miles)	% of Corridor Length	All Vehicle Types		CMVs Only	
					Crashes in Section	% of all crashes	Crashes in Section	% of CMV Crashes
1	0.000	0.477	0.477	6.9	48	27	0	0
2	0.477	1.473	0.996	14.5	23	13	1	5
3	1.473	1.990	0.517	7.5	10	6	1	5
*4	1.990	4.150	2.160	31.3	39	22	11	58
5	4.15 Anderson Co.	2.300 Franklin Co.	2.737	39.7	57	32	6	32
Totals			6.894	100	177	100%	19	100%

*section of concern to local residents

Critical Crash Rate Factor

KYTC uses a systematic procedure to identify locations having high crash rates. The actual number of crashes, as obtained from the KYOPS database, occurring within a roadway segment is used to calculate the Actual Crash Rate using the number of crashes, roadway length, AADT, and the number of years for which crash data is being examined. Using an analysis procedure from the Kentucky Transportation Center and referenced in *The Analysis of Traffic Crash Data in Kentucky (2010-2014)*, Actual Crash Rates are compared to the Critical Crash Rate for similar types of Kentucky roadways. The Critical Crash Rate is the rate which is greater statistically, than the average crash rate for similar roadways and represents a rate above which crashes may be occurring in a non-random fashion. This ratio of Actual Crash Rate to the Critical Crash Rate is the Critical Crash Rate Factor (CRF). Thus, a CRF greater than 1.0 indicates crashes may be occurring more often than can be attributed to random occurrence. This procedure is used as a screening technique indicating locations where further analysis may be needed. It is not a definitive statement of a crash problem, nor a measurement of a crash problem.

Using six years of crash data between January 1, 2010, and December 31, 2015, the KY 151 corridor was analyzed using a 0.1 mile spot analysis; a 0.3 mile spot analysis; and a segment analysis of each section as defined in **Table 9 (p.16)**. **Appendix D** provides the detailed spot crash analyses.

0.1 Mile Spot Crash Analysis

The individual 0.1 mile spot analysis highlighted five 0.1 mile spots where the CRF approached or was greater than one:

- the intersection of KY 151 with US 127
- the county line
- Three spots at the area of KY 151 close to the I-64 interchange and commercial businesses

Higher crash rates near intersections and interchanges are to be expected. Crashes at intersections and interchanges are analyzed using different AADTs than the corridor. Traffic counts along the corridor do not typically account for the increased traffic due to the proximity of the intersection or interchange, the nearby businesses, and the higher turning movement frequencies. The US 127 intersection and I-64 interchange are not within the scope of this corridor study. The CRF at the Anderson/Franklin county line is 0.89 and can be attributed to crash reporting errors. In many instances, if the exact milepoint location of a crash is unknown, the reporting official may record the location at the nearest known point, which in this case would be the county line. The other CRFs for the 0.1 mile spot analysis ranged from 0 to 0.57, suggesting the crash rates at any 0.1 mile spot is within what would be expected for other similarly classified roadways in Kentucky.

0.3 Mile Spot Crash Analysis

The individual 0.3 mile spot analysis highlighted four 0.3 mile spots where the CRF approached or was greater than one:

- One spot at the intersection of KY 151 with US 127
- Three spots at the area of KY 151 close to the I-64 interchange and commercial businesses

Again, higher crash rates near intersections and interchanges are expected, and are analyzed using different AADTs, and are not within the scope of this study. The other CRFs for the 0.3 mile spot analysis ranged from 0 to 0.53, suggesting the crash rates at any 0.3 mile spot is within what would be expected for other similarly classified roadways in Kentucky.

Section Crash Analysis

The roadway section crash analysis highlighted only one section where the CRF approached or was greater than one. Section 1 had a CRF of 1.04, but as can be seen from the 0.1 and 0.3 spot analyses, the majority of the crashes in Section 1 occurred at the intersection of US 127 and KY 151 (see **Appendix D, Crash Records, Section 1**), which would be analyzed using different traffic counts. The other CRFs for the section/segment analysis ranged from 0.27 to 0.59, suggesting the crash rates in the sections are within what would be expected for other similarly classified roadways in Kentucky.

Some of the geometric features, crash details, and CRFs for each of the sections are summarized as follows.

Section 1 – KY 151: from US 127 (MP 0) to the Florida Tile entrance (MP 0.477)

Between January 1, 2010, and December 31, 2015, there were a total of 48 crashes, with no CMV crashes, in Section 1. This number represents 27% of the total crashes along 7% of the 6.894 mile corridor (see **Table 10, p.18**). This is one of two sections of the KY 151 corridor where the CRF exceeds 1.0, the other section being in proximity to I-64. Again, the majority of the crashes in Section 1 occurred at the intersection of US 127 and KY 151 and would be analyzed using different data. The other CRFs for this section range from 0.06 to 0.57, suggesting the crash rates in this section are within what would be expected for other similar roadways in Kentucky. The predominant crash types are summarized in **Table 11a** on the following page.

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Table 11a – Section 1 Predominant Crash Types

Predominant Crash Type	Total Number of Crashes	Number of Crashes	
		Occurring at Night	Involving CMVs
Angle Collision	2	5	
Backing	1		
Head On	2		
Rear End	37		
Side Swipe – same direction	1		
Side Swipe – opposite direction	1	4	
Single Vehicle	4		
Total Crashes	48		

Section 1 recorded 37 rear end type crashes. Twenty-eight of the rear end crashes occurred at the intersection of US 127 and KY 151 and five occurred at the Eagle Lake entrances, mostly due to inattention to stopped or turning vehicles. The crashes resulted in either minor injuries or property damage only.

The **Table 11b** details the predominant contributing factor to the crashes in this section.

The crashes resulted in the following:

- 2 non-incapacitating injuries
- 6 possible injuries
- 40 property damage only

Table 11b – Section 1 Crash Contributing Factors

Factors	Number of Crashes
Inattention	40
Lost control/weather	4
Deer	3
Alcohol	1
Total	48

Section 2 – KY 151: from the Florida Tile entrance (MP 0.477) to Alton (MP 1.473)

Between January 1, 2010, and December 31, 2015, there were a total of 23 crashes, with one CMV crash, in Section 2. This number represents 13% of the total crashes along 14% of the 6.894 mile corridor (see **Table 10, p.18**). The CRFs in Section 2 range from 0.0 to 0.51, suggesting the crash rates in this section are within what would be expected for other similar roadways in Kentucky. The predominant crash types are summarized as follows:

Table 12a – Section 2 Predominant Crash Types

Predominant Crash Type	Total Number of Crashes	Number of Crashes	
		Occurring at Night	Involving CMVs
Angle Collision	3	1	
Opposing Left Turn	3		
Rear End	7		
Side Swipe – same direction	3	2	1
Side Swipe – opposite direction	1		
Single Vehicle	6		
Total Crashes	23		

The **Table 12b** details the predominant contributing factor to the crashes in this section.

The crashes resulted in the following:

- 1 incapacitating injury
- 2 non-incapacitating injuries
- 5 possible injuries
- 15 property damage only

Table 12b – Section 2 Crash Contributing Factors

Factors	Number of Crashes
Inattention	13
Lost control (wet/snow)	3
Shoulder Drop-Off	1
Backing up	1
Mechanical Failure/Debris	3
Alcohol	1
Work zone-related	1 (CMV)
Total	23

Section 3 – KY 151: Alton (MP 1.473 to MP 1.990)

Between January 1, 2010, and December 31, 2015, there were a total of 10 crashes, with one CMV crash, in Section 3. This number represents 6% of the total crashes along 8% of the 6.894 mile corridor (see **Table 10, p.18**). The CRFs in Section 3 range from 0.10 to 0.51, suggesting the crash rates in this section are within what would be expected for other similar roadways in Kentucky. The predominant crash types are summarized as follows:

Table 13a – Section 3 Predominant Crash Types

Predominant Crash Type	Total Number of Crashes	Number of Crashes	
		Occurring at Night	Involving CMVs
Angle Collision	3	1	
Opposing Left Turn	1		
Rear End	3	1	
Single Vehicle	3		1
Total Crashes	10		

The **Table 13b** details the predominant contributing factor to the crashes in this section.

The crashes resulted in the following:

- 4 non-incapacitating injuries
- 6 property damage only

Table 13b – Section 3 Crash Contributing Factors

Factors	Number of Crashes
Turkey	1
Inattention	4
Shoulder Drop-Off	1 (CMV)
Medical	2
Mechanical Failure	1
Night/no lights on vehicle struck	1
Total	10

Section 4 – KY 151: from the 55 mph north of Alton (MP 1.990) to the change in pavement section (MP 4.150)

Between January 1, 2010, and December 31, 2015, there were a total of 39 crashes, with 11 of those involving CMVs, in Section 4. After reviewing written narrative portions of the KSP crash reports, the crash numbers in this section have been adjusted to include two additional CMV crashes as the milepoints appeared to be incorrectly reported. The 39 crashes represent 22% of the total crashes along 31% of the 6.894 mile corridor, and the

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11 CMV crashes represent 58% of the total CMV crashes along the corridor (see **Table 10, p.18**). The CRFs in Section 4 range from 0.00 to 0.58, suggesting the crash rates in this section are within what would be expected for other similar roadways in Kentucky. The predominant crash types are summarized as follows:

Table 14a – Section 4 Predominant Crash Types

Predominant Crash Type	Total Number of Crashes	Number of Crashes	
		Occurring at Night	Involving CMVs
Angle Collision	1		
Backing	1		
Head On	1		
Rear End	5		
Side Swipe – opposite direction	2	1 (1 w/ CMV)	1
Single Vehicle	29	13 (2 w/ CMVs)	10
Total Crashes	39		

The **Table 14b** details the predominant contributing factor to the crashes in this section.

The crashes resulted in the following:

- 2 incapacitating injuries
- 2 non-incapacitating injuries
- 3 possible injuries
- 32 property damage only

Table 14b – Section 4 Crash Contributing Factors

Factors	Number of Crashes
Deer	10
Inattention	8
Shoulder Drop-Offs	6 (6 CMVs)
Snow/Ice	6 (3 CMVs)
Mechanical Failure	2
Fell Asleep	2 (1 CMV)
Cell Phone	1
Other (lost control/alcohol/unknown)	4 (1 CMV)
Total	39

Section 5 – KY 151: from the change in pavement section (MP 4.150, Anderson Co.) to I-64 (MP 2.3, Franklin Co.)

Between January 1, 2010, and December 31, 2015, there were a total of 57 crashes, with six of those involving CMVs, in Section 5. The 57 crashes represent 32% of the total crashes along 40% of the 6.894 mile corridor, while the six CMV crashes represent 32% of the total number of CMV crashes (see **Table 10, p.18**). Of the six CMV crashes in this section, five of the CMV crashes were caused by non-CMV vehicles striking CMVs. This is the second of two sections of the KY 151 corridor where the CRFs approach and exceed 1.0. The higher spot CRF values ranged between 0.96 and 1.79. The majority of the crashes in Section 5 occurred at the I-64 interchange and would typically be analyzed using different data. The crash rate at the Anderson/Franklin county line is 0.89 and can be attributed to crash reporting errors. The other CRFs for Section 5 range from 0.00 to 0.56 with an overall section/segment CRF of 0.51, suggesting the crash rates in this section are within what would be expected for other similar roadways in Kentucky. The predominant crash types are summarized in **Table 15a** on the following page.

Table 15a – Section 5 Predominant Crash Types

Predominant Crash Type	Total Number of Crashes	Number of Crashes	
		Occurring at Night	Involving CMVs
Angle Collision	11		2
Backing	1		1
Head On	1		
Opposing Left Turn	4	1	
Rear End	5		1
Side Swipe – opposite direction	3	1	2
Side Swipe – same direction	4		
Single Vehicle	28	15	
Total Crashes	57		

The **Table 15b** details the predominant contributing factor to the crashes in this section.

The crashes resulted in the following:

- 4 non-incapacitating injuries
- 8 possible injuries
- 45 property damage only

Table 15b – Section 5 Crash Contributing Factors

Factors	Number of Crashes
Inattention	27 (*3 CMVs)
Deer	21 (*1 CMV)
Lost Control/Weather	3
Fell Asleep	2
Mechanical Failure	2 (*2 CMVs)
Alcohol/Drugs	2
Total	57

**5 of the 6 crashes were caused by non-CMV vehicles*

CMV Crashes

Because of the relatively low volume of CMVs and CMV-related crashes, there are limitations in performing a robust statistical analysis of the CMV crashes or clearly establishing CMV-specific crash patterns. Therefore, any findings presented in this CMV Crashes portion of the KY 151 study should be qualified by the limited sample size of available CMV-related data.

Prior to the STAA restriction, the total percentage of trucks varied from about 12% to 16% (**Table 3, p. 7**). CMV crashes represented 19 of the 177 crashes, or 11% of the total number of crashes. This indicates CMVs did not represent a disproportionate number of the total number of crashes along the KY 151 study corridor. As seen in **Table 16 (p.24)**, when Section 4 between the community of Alton and the change in pavement width at MP 4.1 was analyzed, there were 11 CMV crashes as compared to 39 all-vehicle-type crashes, or 28% of the total number of crashes in Section 4. This indicates the number of CMV crashes may have been disproportionate in comparison to the total number of crashes in Section 4. When the STAA restriction went into effect in April 2016, the volume of CMVs was reduced by approximately half (**Table 3, p.7**). The effect of this change is not yet known.

Table 16 – Comparison of CMV Crashes to the Total Number of Crashes by Section

	Beginning MP	Ending MP	Total Number of Crashes	Number of Crashes Involving CMVs	% of CMV Crashes
Section 1	0.000	0.477	48	0	0%
Section 2	0.477	1.473	23	1	4%
Section 3	1.473	1.990	10	1	10%
Section *4	1.990	4.150	39	11	28%
Section 5	4.15	2.300	57	6	11%
	Anderson Co.	Franklin Co.			
Full corridor	0.000	2.300	177	19	11%
	Anderson Co.	Franklin Co.			

*section of concern to local residents

The CMV crash report narratives were reviewed to identify any potential patterns and contributing causes and are summarized in **Table 17 (p.25)**.

As can be seen in **Table 17 (p.25)**, seven of the 19 CMV crashes appear to be related to shoulder drop-offs. The remaining 12 crashes appear to be more random occurrences related to weather, driver fatigue, inattention, and mechanical failure. It should be noted that five of the 19 CMV crashes were reported by the KSP as not being caused by the CMVs.

When the CMV crashes are mapped by milepoint, as seen in **Figure 7**, the CMV crashes appear to be clustered in three locations in Anderson County: at approximately MP 2.0, MP 2.6, and MP 4.1. When the contributing cause from **Table 17 (p.25)** is reviewed at each of these three locations, along with the geometric analysis and the physical evidence, it appears that the low and/or narrow shoulders may be contributing to the CMV crashes.

Due to the relatively low number of CMV crashes, it is difficult to clearly establish a statistical cause. The CMV crashes located close to MP 4.1 in Anderson County are unusual because the roadway is generally straight, the terrain is open, and the horizontal curves in proximity to this area have relatively large radii. All three of the CMV crashes attributed to shoulder drop-offs in this location were southbound on KY 151 in the vicinity of an abrupt change in pavement width where the travel lane changes from 12-foot lanes to 11-foot lanes, and the shoulders change from approximately 10-foot paved shoulders to 0- to 2-foot combination shoulders. This suggests that CMVs exiting from I-64 and traveling southbound on KY 151 may be surprised by the abrupt change in pavement width.

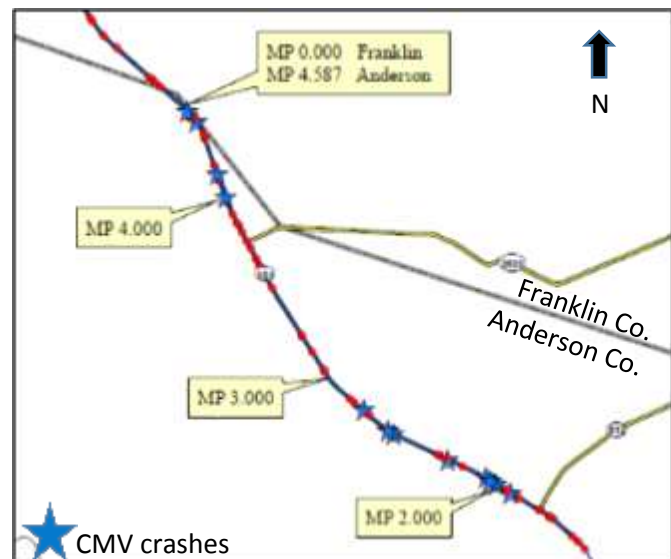


Figure 7 – CMV Crash Clusters

Table 17 – Summary of CMV Crashes

	County	Section	MP	Date of Crash	Summary of the Crash Report Narratives	¹ Unit 1 Vehicle Type	² Unit 2 Vehicle Type	Crash Contributing Causes
1	Anderson	2	0.873	06/02/14	Construction work zone incident.	Truck Tractor, Semi-Trailer	Other	Work Zone
2		3	1.931	05/22/13	Dropped off the shoulder.	Truck Tractor, Semi-Trailer	³ N/A	Shoulder dropoff
3		4	2.013	06/24/14	A NB vehicle drifted into the southbound lane causing the CMV driver to swerve off the roadway to miss the errant vehicle.	Truck Tractor, Semi-Trailer	N/A	Inattention Not caused by the CMV
4			2.043	08/18/15	The CMV struck a tree after the front passenger-side wheel dropped off the pavement.	Truck Tractor, Semi-Trailer	N/A	Shoulder dropoff
5			2.069	05/14/15	The CMV veered off the roadway because of inattention or fatigue and struck a tree.	Truck Tractor, Semi-Trailer	N/A	Fatigue
6			2.277	02/07/11	The SB CMV drifted off the roadway then overcorrected, crossed KY 151 and crashed on the opposite side.	Truck Tractor, Semi-Trailer	N/A	Shoulder dropoff
7			2.567	12/30/11	The CMV driver reported he didn't know what had happened to cause the crash.	Truck Tractor, Semi-Trailer	N/A	Possible shoulder dropoff
8			2.596	03/04/15	Lost control due to heavy snow and ice conditions.	Truck, Trailer	N/A	Weather
9			2.751	02/15/10	Lost control due to heavy snow and ice conditions.	Truck, Trailer	N/A	Weather
10			3.983	01/03/14	SB, the CMV dropped off the shoulder and was unable to correct the back onto the travel lanes, and overturned.	Truck Tractor, Semi-Trailer	N/A	Shoulder dropoff
11			4.101	10/12/15	A SB CMV crossed over into the northbound lane and side-swiped a passenger car to avoid hitting a previous crash.	Truck, Trailer	Passenger Car	Avoiding a previous crash
12			4.370	10/12/15	SB, a vehicle in front of the CMV driver was making a U turn, the CMV dropped a wheel off of the pavement while trying to avoid the other vehicle and was unable to redirect the vehicle back onto the travel lanes, then overturned.	Truck Tractor, Semi-Trailer	N/A	Shoulder dropoff
13			4.440	04/29/13	SB, the CMV dropped off the shoulder and couldn't redirect back onto the travel lanes.	Truck Tractor, Semi-Trailer	N/A	Shoulder dropoff
14	Franklin	5	0.092	11/27/12	A garbage truck had stopped to pick up trash and was struck by a passenger car with brake problems.	Passenger Car	Truck, Single Unit	Inattention Not caused by the CMV
15			0.178	01/15/10	The NB CMV was struck by a SB pickup truck that swerved into the northbound lane due to mechanical failure.	Light truck (Van/Sports Utility/Pickup)	Truck Tractor, Semi-Trailer	Mechanical failure Not caused by the CMV
16			0.608	12/09/10	A SB pickup truck had pulled into a right turn lane then made a left turn across the roadway. The CMV struck the pickup truck as the pickup turned in front of it.	Light truck (Van/Sports Utility/Pickup)	Truck Tractor, Semi-Trailer	Inattention Not caused by the CMV
17			1.705	08/06/14	The CMV was backing out of a parking lot and was struck by another vehicle.	Truck-other Combination	Light truck (Van/Sports Utility/Pickup)	Inattention
18			1.761	09/28/12	The CMV swerved and overcorrected when an animal ran across the roadway and struck another vehicle.	Light truck (Van/Sports Utility/Pickup)	Truck, Trailer	Animal strike
19			1.897	06/22/12	The CMV was traveling SB and a northbound pickup truck misjudged the distance and clipped the rear of the CMV while turning left into a gas station	Light truck (Van/Sports Utility/Pickup)	Truck, Trailer	Inattention Not caused by the CMV

NB: northbound; SB: southbound

1: Unit 1 is the vehicle attributed to causing the crash as reported by the KSP

2: Unit 2 is the vehicle that was struck by Unit 1 as reported by the KSP

3: N/A = no other vehicle was struck

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Change in paved width at MP 4.1, Anderson County, looking southbound

To mitigate the possibly low or narrow shoulders contributing to the CMV crashes at the three locations, the shoulders between Alton and MP 4.1 have been widened to address the initial findings of this study.



Shoulder widening in Alton area



Shoulder widening

KY 151 Safety Study

Comparison of Crash Rates: KY 151 vs Statewide Averages

KYTC uses a systematic procedure to identify locations having high rates of crashes. The actual number of crashes occurring within a roadway location is used to calculate the Actual Crash Rate, using the roadway length, AADT, and the number of years for which crash data is being examined. **Table 18** compares the Crash Rates on KY 151 to other Minor Arterial roadways in Kentucky. KY 151 has a better safety record compared to similar roadways in Kentucky.

Table 18 – Comparison of Crash Rates: KY 151 vs Statewide

	Crash Rate: Number of Crashes per 100 Million Vehicle Miles					
	Urban Sections			Rural Sections		
	All Crashes	Fatality Crashes	Injury Crashes	All Crashes	Fatality Crashes	Injury Crashes
KY 151	308	0	70	196	0	43
*Statewide Average	460	1.0	80	200	2.1	200

*From the Kentucky Transportation Center, *The Analysis of Traffic Crash Data in Kentucky (2010-2014), Statewide Crash Rates by Functional Classification (2010-2014) – Minor Arterials*

KY 151 Urban section: from MP 0.000 to MP 1.473, Anderson County

KY 151 Rural section: from MP 1.473 in Anderson County to MP 2.3 in Franklin County

I. Pavement Condition Evaluation

KYTC Division of Maintenance's Pavement and Operations Management Branch conducted a Pavement Condition Evaluation on KY 151 in July 2014 in accordance with KYTC procedures. The KY 151 pavement was evaluated from US 127 to the Anderson/Franklin County line and continued to Crab Orchard Road (MP 2.534) in Franklin County (**Appendix E**). The review involved investigation of current pavement conditions as well as historical construction data and prior pavement condition assessments. The Pavement Condition Evaluation included an assessment of fatigue cracking, raveling, and other physical conditions as shown below in **Table 19** (procedures are explained in **Appendix E**).

Table 19 - Summary of Pavement Condition Evaluation (2014)

COUNTY	Anderson	Franklin	Basis for Points ^a
MILEPOINTS	0-4.587	0-2.411	
CONDITION ^a	Points ^b		
Fatigue Cracking	0	0	Extent : Few 0-3 Points <i>Less than 20% of potential cracking areas show distress, Use a maximum of four potential cracking areas per section</i> Severity: Slight 0-3 Points <i>Cracks are less than ¼” in width, No adjacent hairline cracking</i>
Raveling	0	0	Extent: Few 0-1 Points <i>½ or more of the section shows slight raveling –or- 1/3 or more of the section has a combination of slight and moderate raveling</i> <i>No severe raveling is present</i> Severity: Slight 0-1 Points <i>Slight loss of aggregate or binder, Small amounts of pitting</i> <i>Pavement appears slightly aged or rough</i>
Other Cracking	0	0	Extent: Few 0-1 <i>Points Transverse cracks are spaced at 150’ Less than 20% of the section length shows longitudinal cracking</i> Severity: Slight 0-1 Points <i>Cracks are less than ¼” in width</i>
Out of Section	0	3.5	Anderson County pavement scored "0" points for extent and severity, Franklin County pavement scored 2.5 for extent and 1.0 point for severity. For point explanation, see page 12 of Appendix E.
Joint Separation	0	0	Extent: Few 0 Points <i>Less than 20% of the section length shows longitudinal cracking.</i> Severity: Slight 0-1 Points <i>Cracks are less than ¼” in width.</i>
Rideability (IRI)	12	10	Adjusted IRI (92 in Anderson County, 86 in Franklin County)
Rutting	0	0	Rutting less than 1/4" will not be assigned any points. See Appendix E for explanation of points assigned.

- Points for the first five conditions are a combination of extent and severity
- ^a Pavement Surface Conditions are explained in more detail in **Appendix E** (Pavement Management in Kentucky, An Overview in Year 2014, KYTC Division of Maintenance)
- ^b see **Appendix E**

Pavement Assessment Summary

The Pavement Condition Evaluations show that the Rideability or IRI (92 in Anderson County, 86 in Franklin County shown in **Table 19, p.29**) is in the range that would be considered “fair.” In general, the IRI classification used by KYTC is: Good 0-80, Fair 81-150, and Poor 151+.

Since the 2014 inspection, minor localized spots of asphalt pavement mat tearing and shoulder failure caused by the turning movements of garbage trucks were noted in the southbound right turn lane in close proximity to the landfill in Franklin County. This type of distress is considered a materials application related failure.



Asphalt mat tearing



Shoulder failure

KY 151 is classified as an “AAA” roadway. The “AAA” designation indicates the pavement on KY 151 is structurally able to accommodate 80,000 pounds gross weight. Analysis of the overall pavement ride quality (IRI) and visual inspection of the pavement condition showed only minor localized spots of abnormal distress patterns due to materials failure combined with truck traffic as noted above. As such, the pavement structure for KY 151 is considered sufficient to accommodate the existing “AAA” truck weight classification. The physical condition of the roadway falls within normal performance for a pavement within the normal resurfacing cycle.

The construction history for KY 151 within the project limits is:

- (2001) 1.25” CL2 0.38B PG76-22 thin asphalt overlay
- (2013) 1.25” CL3 0.38B PG 64-22 thin asphalt overlay

A typical resurfacing cycle is between 10 and 12 years. KY 151 is anticipated to need an overlay in 2025 to 2026.

J. Road Safety Audit

A Road Safety Audit (RSA) is a formal safety performance examination of an existing roadway by a multidisciplinary team. The RSA team performs a field review, reports on potential road safety issues, and identifies opportunities for improvements in safety for all roadway users.

An RSA was conducted on the KY 151 study corridor on May 10, 2016, with members from the KYTC District 7 Office and the KYTC Central Office, representing the Divisions of Highway Design, Traffic Operations, Permits,

and the Highway Safety Improvement Program. The purpose of the audit was to answer the following questions:

- What elements of the road present a potential safety concern
- What opportunities exist to eliminate or mitigate the identified safety concerns

The RSA Team noted the existing conditions along the corridor including:

- Typical roadway sections, driving lanes, shoulders, superelevation, and cross slopes
- Centerline and edgeline rumble strips
- Speed limits and speed limit changes
- Roadway signage and striping

The RSA report, included in **Appendix F**, details improvement recommendations as follows:

- Mow slopes and cut tree canopies along the roadway in needed areas
- Remove dead trees inside the corridor right-of-way
- In Anderson County, fill in the low shoulder areas
- In Franklin County, repair the localized distressed pavement and shoulder areas, and fill in any low shoulders in the southbound right turn only lane in proximity to the landfill
- Contact the landfill to consider
 - combining the two landfill entrances into one single entrance
 - installing or improving the truck wash system to prevent dust from tracking onto the roadway
- Update corridor signing to 2009 MUTCD standards
- Re-evaluate passing zones and speed limit zones
- Improve the roadway typical section within the 55 mph and 45 mph zones to match the typical section in Franklin County (12-foot driving lanes, 2-foot paved shoulders, and 8-foot earth shoulders)
- Correct the superelevation and curve transitions throughout the corridor
- Landfill entrance: adjust the lane taper to a lane-drop with additional pavement resurfacing and striping

3. Conclusions

Safety is a high priority with KYTC, as documented in KYTC's Mission statement:

"To provide a safe, efficient, environmentally sound and fiscally responsible transportation system that delivers economic opportunity and enhances the quality of life in Kentucky."

As part of the Strategic Plan, KYTC's goals and objectives are to make well-informed, data-driven decisions to reduce the number and severity of motor vehicle crashes. This must be accomplished while also considering the local citizens' concerns, promoting economic development through improving freight movement, and managing limited transportation funds responsibly.

The KY 151 Safety Study evaluated the existing roadway characteristics, traffic volumes, roadway geometrics, speeds, crashes, and pavement conditions. The analysis shows the KY 151 corridor between US 127 and I-64 has a better safety record than Kentucky roadways of similar functional classification in both rural and urban areas. The analysis also suggests roadway capacity is not an issue, the existing traffic control devices are within industry guidelines, the posted speed limits are appropriate, the pavement conditions are fair, the roadway geometrics, although not up to current industry guidelines, are not contributing to crash rates higher than would

be expected due to random occurrence, and there are no apparent all-vehicle type crash patterns indicating the roadway geometry is insufficient along the corridor.

The CMV-specific data and physical evidence were examined along the KY 151 corridor. The analysis and physical evidence indicate some of the CMV crashes may be related to offtracking and shoulder drop-offs at two curves located at MP 2.6 and MP 3.0, and the abrupt change in pavement width at MP 4.1 in Anderson County.

Although the analysis indicates STAA vehicles may have difficulty tracking within their 11-foot travel lanes at two of the curves in Anderson County, it does not necessarily indicate that the STAA vehicles must be removed from the KY 151 corridor. However, because of the proximity of US 127 as a viable alternate route and with the possibility of the roadway geometric conditions contributing to the CMV crashes, the Official Order prohibiting STAA vehicles was an appropriate action to balance the concerns of the local residents, government officials, and commercial vehicle traffic. A further ban on all CMVs, or trucks over three axles as requested by the civil action lawsuit is not supported by the analysis and would unjustifiably restrict freight movement.

While the crash analysis indicates the crashes along the corridor are likely occurring in a statistically random manner and are generally of lower severity than statewide averages, the overall evaluations indicate the CMV-related issues at MPs 2.6, 3.0, and 4.1 in Anderson County have the potential to be mitigated by a combination of improving the shoulders in the section of roadway between the community of Alton and the Anderson and Franklin County line, along with continuing to restrict the STAA vehicles. The STAA restriction reduced the overall percentage of CMVs on the study corridor by nearly half, thereby reducing the potential for CMV crashes along KY 151. Additional improvements to enhance safety along the corridor are listed in the Road Safety Audit section of this study. To address the initial findings of this study and improve safety along the corridor, the shoulders have been widened on the section of KY 151 between the community of Alton and the change in pavement width at MP 4.1.



Kentucky Transportation Cabinet
Division of Planning