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COUNTERMEASURES FOR FATAL CRASHES ON TWO-LANE RURAL ROADS

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16. Abstract

A detailed analysis was conducted for a random sample of 150 fatal crashes which occurred on a two-lane rural road. A site visit was made to each crash location with data obtained and analyzed. Recommendations were made for countermeaures to reduce the number and severity of crashes on this type of roadway. The countermeasures were divided into the general categories of roadway and non-roadway with the non-roadway divided into the areas of legislation, enforcement, and education/training. The roadway countermeasures did not include those involving roadway reconstruction. A recommendation was made that several of the countermeasures could be combined as part of a typical resurfacing project. The potential effectiveness of these countermeasures in preventing the crashes or reducing their severity was evaluated.

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EXECUTIVE SUMMARY

In the first phase of this study, characteristics of crashes on two-lane rural roads were summarized and compared to all crashes. Also, one-mile sections having high crash rates were identified. In this phase of the study, a detailed analysis was conducted for a random sample of 150 fatal crashes which occurred on a two-lane rural road. Recommendations were made for countermeasures to reduce the number and severity of crashes on this type of roadway. The potential effectiveness of these countermeasures in preventing the crashes or reducing their severity was evaluated.

Crashes were selected from the years of 1996 through 1998. The random sample represented slightly over 10 percent of all fatal crashes on two-lane rural roads. The crash report was obtained with information from the report summarized. A site visit was made to each crash location with data obtained and analyzed.

Data from each crash were reviewed with countermeasures noted which could have potentially affected the occurrence or severity of the specific crash. Using information from the review of these crashes and from the review of the literature, a summary of countermeasures for reducing the number and severity of crashes on two-lane rural roads was developed. The countermeasures were divided into the general categories of roadway and non-roadway with the non-roadway countermeasures further divided into the areas of legislation, enforcement, and education/training.

The countermeasures identified in the recommendations did not include those involving reconstruction of the road since this is an expensive measure usually taken only for sections of roads having a history of identified crash problems. These recommended countermeasures could be applied on a general basis across the state. A recommendation was made that several of the countermeasures could be combined as part of a typical resurfacing project.

A countermeasure effectiveness assessment was conducted which showed that enactment of a mandatory safety belt law had the highest potential to reduce fatalities on two-lane rural roads . The highest reduction estimates for roadway related countermeasures, which did not involve reconstruction, were adding shoulder or centerline rumble strips and installing chevron signs.

1.0 INTRODUCTION

The relatively high fatal crash rate in Kentucky is the result of the high rate of fatal crashes on two-lane rural roads. Data in Kentucky for 1995 through 1999 showed a rate of 3.1 fatal crashes per 100 million vehicles miles (100 MVM) for state maintained two-lane rural roads (1). The next highest rate for any highway type was 1.7 fatal crashes per 100 MVM for four-lane divided (non-interstate and parkway) roadways. The fatal crash rate on two-lane rural roads is approximately twice the overall fatal crash rate on all state maintained roads which is about 1.6 crashes per 100 MVM (1).

Two-lane rural roads account for about 85 percent of the state maintained mileage but only about 34 percent of vehicle miles traveled. These roads account for 40 percent of all crashes on state maintained roads, 47 percent of injury crashes, and 66 percent of fatal crashes.

In the first phase of this study, the characteristics of crashes on two-lane rural roads were summarized and compared to all crashes (2). Also, one-mile sections having high crash rates were identified. In this second phase of the study, a detailed analysis was conducted for a random sample of 150 fatal crashes which occurred on a two-lane rural road. Recommendations were made for countermeasures to reduce the number and severity of crashes on this type of roadway. They did not include reconstruction of the road since this is an expensive measure usually taken only for sections of roads having a history of identified crash problems. The countermeasures could be applied on a general basis across the state.

2.0 PROCEDURE

A major portion of this phase of the study involved collecting detailed information for 150 fatal crashes which occurred on a two-lane rural roadway. Since the previous analysis had been conducted using data for 1996 through 1999, the sample was taken from those years. There were almost 400 fatal crashes per year during these three years on this type of road so the sample represented slightly over 10 percent of all fatal crashes on two-lane rural roadways.

The case numbers for all fatal crashes on two-lane rural roads were obtained and randomly sorted. Copies of the police reports were obtained for the first 170 fatal crashes on this list. Since a site visit was made as part of the analysis, an extra number of reports was obtained to account for problems with either locating the site or for locations which had been reconstructed since the crash. Almost all of these crash reports had to be used to obtain 150 sites which could be identified with the available information.

The data collected in this phase of the study were part of a larger fatal crash study for the southeastern United States conducted by Georgia Tech. The site data collection forms used by the other states were also used for data collection at the 150 fatal crash sites in Kentucky. Information concerning the following general areas of interest were obtained during the site visit:

a) horizontal alignment,
b) grade,
c) cross-section,
d) presence of roadside barrier,
e) number of lanes and lane width,
f) nature of adjacent influences,
g) roadside illumination,
h) roadway shoulder description,
i) bridge/railroad involvement,
j) surface type,
k) roadway delineation, and
l) traffic control devices.

The site visit data were coded into a format used by all the participating states. Data from the crash report were also coded into various formats related to general crash elements, environmental elements, vehicle data elements, and person information. An attempt was made to relate emergency medical service (EMS) data to the person information on the crash report but insufficient data were available to make a usable number of accurate matches. Data from the Fatal Accident Reporting System (FARS) were also accessed to obtain information such as blood alcohol content (BAC).

The highway information system (HIS) file was used initially to determine if a crash occurred on a two-lane rural road. Other data from the HIS file were used to obtain some of the information necessary to complete the site data collection form. This included such data as: functional classification, national highway system designation, and traffic volume. Other information, such as lane width and shoulder type and width, were obtained from the HIS file, and then verified during the site visit.

Each fatal crash was reviewed with the objective of determining any countermeasures which could have either reduced the probability of the crash or reduced the severity of the injuries. Consideration was given to the countermeasures identified as part of a review of the literature. The countermeasures were divided into the general categories of roadway and non-roadway (related to the driver, other vehicle occupants, other road users such as pedestrians, and vehicle) with the non-roadway countermeasures further divided into the areas of legislation, enforcement, and education/training.

3.0 RESULTS

The 150 fatal crashes randomly selected were distributed across the state. The crash sites were located in 69 of Kentucky's 120 counties. The highest number in any county was seven in Pike County. Data have shown that Pike County has the highest number of fatal crashes on this type of road so it was logical that the random sample should have the largest number of crashes in that county. The data necessary to locate a crash were the county, route, and milepoint. In

some instances, a milepoint was not provided or it was inaccurate, and the site could not be located. The next crash in the random list was used if a crash site could not be located.

3.1 Site Data Elements

Data from the site visits are summarized in Table 1. A large percentage of the crashes occurred on a curve (58 percent) with most of the curves described as sharp. More of the curves were a lefthand as opposed to a righthand curve. If more than one vehicle was involved, the direction of the curve applied to the at-fault driver. More than twice as many crashes occurred on the outside of the curve compared to the inside of the curve. Most of the sharp curves had curve warning signs (81 percent), and slightly over one-half of the curves had a warning sign with an advisory speed. Only about 17 percent of these sharp curves had delineators or chevron signs. All but a very few curves had typical superelevation provided.

There was a fairly equal distribution between the type of slope (up, down, or flat) at the crash locations. There were only a few crashes (about 15 percent) where the slope was described as steep. There were a few crashes at a hill crest (about 13 percent) but only three were at a sag vertical curve.

Almost 70 percent of the roads had a functional classification of a collector compared to about 28 percent classified as an arterial. Only about 15 percent were on roads which are part of the National Highway System. The crashes occurred on roads having a wide range of traffic volumes. The average daily traffic (ADT) ranged from 25 to 15,300 with an average of 3,316. About 27 percent had an ADT under 1,000 with about 25 percent over 5,000. Almost 20 percent had an ADT between 1,000 and 2,000.

Very few sites had any types of lanes in addition to the two through lanes. There were four sites with a turning lane and seven with a passing lane. At 18 sites the shoulder was wide enough to be classified as an emergency lane.

Lane widths varied from seven to 12 feet. The most common lane width was ten feet. There were 10 sites with a lane width under nine feet. About 65 percent had a lane width of ten feet or more.

There was either a paved or graded shoulder provided at most of the sites with only 14 percent having no shoulder. Almost all the shoulders were paved with the width of the paved shoulder typically two feet or less. Only 15 percent of the sites had a paved shoulder with a width over two feet. Rumble strips had been placed in about 60 percent of the paved shoulders.

The adjacent feature, as described in the data collection form, which was present in most instances was a residential driveway. There was a driveway in the vicinity of the crash site at about 75 percent of the locations.

The regulatory speed limit was 55 mph at over 90 percent of the locations. There was an advisory speed at 39 sites with the advisory speed typically 10 or 20 mph under the regulatory speed limit.

Only eight sites had no pavement markings. The most common pavement marking was a solid, double yellow centerline. Edgelines were provided at 92 sites with the lane width under 10 feet at nine of these locations. Edgelines were placed at 40 of 53 sites where the lane width was 10 feet and 43 of 44 locations where the lane width was over 10 feet.

Roadway illumination was only provided at four of the locations. Approximately one-third of the sites had raised pavement markers. Less than 10 percent had delineation provided by either a chevron sign or post delineator.

The terrain at the site was determined using information from the HIS file. About 75 percent were classified as rolling with 22 percent mountainous. Only five sites were classified as flat.

Only 15 crashes directly involved an intersection. There were intersection warning signs at eight of these intersections with five of those signs having an advisory speed. Four intersections had a flashing beacon. Separate data were collected for the intersecting road. A stop sign controlled right of way at all the intersections. Eight of the intersections had a stop ahead warning sign.

The most common warning sign was either a curve, reverse curve, or winding road sign. Most of those signs had an advisory speed.

A subjective roadside hazard rating, from one to seven with one having the best conditions, was assigned to each site. The description for a rating of one was; wide clear zones of 30 feet or more with a sideslope flatter than 1:4 and recoverable. This compares to a description of a rating of seven with a clear zone of no more than five feet, a sideslope of 1:2 or steeper, cliff or vertical rock cut, no guardrail, and non-recoverable. The most common rating assigned, with 39 percent, was three which has a description of a clear zone of about 10 feet, a sideslope of 1:3 or 1:4, and marginally recoverable. The next most common ratings were four or five. There were no ratings of one or seven.

The pavement was asphalt at all but one location which had a concrete pavement. None of the locations had roadside parking. A bridge was involved in five crashes with no crashes directly involving a railroad. There was guardrail at about one-fourth of the sites.

3.2 Crash Data Elements

A summary of crash data elements is given in Table 2. A comparison of the characteristics given in Table 2 with previous data for all fatal crashes on two-lane rural roads

shows that the random sample provided a good representation of all fatal crashes. For example, 56 percent of the crashes in the sample were single vehicle compared to 54 percent of all fatal crashes on this type of road. Most single vehicle crashes involved an impact with a fixed object.

There was no pattern by month with the highest number occurring in April, May, and October. Considering day of the week, the highest numbers occurred the weekend days of Saturday and Sunday. The most common time period was noon to 6 pm followed by 6 pm to midnight. Only 12 percent occurred between midnight and 6 am.

Twenty of the 150 crashes involved more than one fatality. Almost one-half of the crashes also involved an injury. In about one-third of the crashes there was only one occupant involved. In about one-fourth there were more than three occupants involved when all vehicles were considered.

Alcohol can be listed on the crash report as a contributing factor by the investigating officer based on his opinion of the evidence observed at the crash scene. Using the code noting alcohol as a contributing factor given on the crash report, about one-third of the crashes involved alcohol. Drugs were listed as a factor in only two crashes.

Kentucky is divided into 12 highway districts. This geographical classification was used to summarize crash locations into area of the state. There was no definite trend in location across the state. The fewest number of crashes occurred in District 6 which contains the urban area in northern Kentucky. The highest number occurred in Districts 7 (which contains Lexington) and District 8 which is more rural.

Times are given on the police report noting the time EMS was notified, when they arrived at the scene, and their time of arrival at a hospital. The time from EMS being notified to arriving at the scene was 10 minutes or less for about 53 percent of the crashes. This time was over 15 minutes in only eight crashes. These times were related to highway district to determine if higher times occurred more often in certain sections of the state. Of 12 crashes where this time was 20 minutes or more, seven were in the southeastern part of the state. Four, or 25 percent, of the crashes in District 11 were in this category. The time from arriving at the scene to the hospital was 30 minutes or less in 42 percent of the crashes where data was available. This time was over 60 minutes in 14 crashes. Of 20 crashes where this time was 60 minutes or more, the highest numbers were five in District 9 and four in District 12. As would be expected, the crashes with the highest times for EMS to arrive at the scene and transport a patient to a hospital occurred more often in rural districts.

3.3 Environmental Data Elements

A summary of environmental data elements is given in Table 3. Slightly under one-half (44 percent) involved a collision with another motor vehicle. The most common fixed object hit was a tree. The distance from the road to the tree is shown in Table 1. It should be noted that the

tree was not necessarily the first harmful event so the number of trees included in Table 1 is higher than in Table 3. The site visit data showed that the tree was over 10 feet from the road in about one-half of the crashes and within five feet in only about 17 percent.

The crashes were divided almost equally between occurring on and off the road. The most common type of two vehicle collision was a head-on impact followed by an angle collision.

Only about 15 percent of the crashes involved some type of inclement weather condition with about 20 percent involving a roadway surface condition other than dry. About 30 percent occurred during darkness with roadway lighting rarely provided. An environmental contributing factor was listed on the police report in only about 11 percent of the cases with weather conditions noted as a factor most often.

A roadway contributing factor was only listed on the police report in 14 percent of the crashes. The most common factor noted was roadway surface condition.

There were 15 crashes at an intersection with another three at a driveway. The most common type of intersection was a T-intersection. The percentage of these crashes which occurred at an intersection compares closely to data for all fatal crashes on two-lane rural roads which confirms that this sample was representative of all fatal crashes.

3.4 Vehicle Data Elements

Data for the vehicles involved in these crashes are summarized in Table 4. Almost one-half of the vehicles were passenger cars. Another 39 percent were classified as a light truck such as a pickup. None of the vehicles were code as an emergency vehicle. Twelve percent were either a single unit or combination truck. The most common truck cargo body type was dump followed by van or box. Only one truck was hauling a hazardous material which was gasoline.

About 60 percent of the vehicles had only one occupant. Approximately nine percent of the vehicles had more than three occupants. About 90 percent of the vehicles were traveling straight when the crash occurred. A few vehicles were turning left or passing. There was a wide range in the age of the vehicle. About 15 percent were less than three years old with 10 percent more than 15 years old.

An estimated travel speed was given on the police report for less than one-half of the vehicles. This estimate was typically based on the statement of the driver. The estimate was over 65 mph in nine percent of the cases and less than 35 mph in 12 percent. In most instances, the information did not allow a determination of a crash avoidance maneuver. Using available information, the most common crash avoidance maneuver was steering followed by braking with skidmarks evident. About seven percent of the vehicles experienced an underride and override situation. A fire was involved for about five percent of the vehicles.

3.5 Occupant Data Elements

Data for the vehicle occupants are presented in Table 5. The distribution of drivers by age is similar to that for all drivers involved in crashes on all roads in Kentucky (3). There was a higher percentage of males involved in crashes on two-lane rural roads compared to all crashes.

The driver was using safety equipment (typically a combination shoulder harness/lap belt) in about 40 percent of the crashes. This percentage is similar for passengers when the "not available" and "not applicable" categories are not considered. However, for drivers sustaining fatal injuries, only about 25 percent were using safety equipment. There was a large number of non-drivers in the "not available" category resulting from one crash which involved a large number of persons riding on a hay wagon. Of the seven motorcycle drivers, five were wearing a helmet. None of the four ATV drivers were wearing a helmet. There were only eight crashes in which it was determined that the driver air bag deployed.

The increase in severity resulting from ejection was shown. Slightly over one-third of all the fatal injuries occurred to an occupant who was ejected. Also, about one-third of the occupants were trapped in their vehicle as a result of the collision.

A contributing factor was assigned to each driver. By a large margin, the most common factor was failure to keep in the proper lane or running off road. This confirms the previous data which showed that the most common two-vehicle crash involved a head on impact with the most common overall type of crash involving a single vehicle traveling off the road. The most common contributing driver condition was alcohol followed by falling asleep. The driver was cited in less than 10 percent of the crashes. The most common license restriction was corrective lenses. The driver did not have a valid license in only about two percent of the cases.

Blood alcohol test (BAC) results were obtained from FARS data. There was some level of alcohol present for 50 percent of drivers where there was information available with 40 percent having a BAC of 0.10 or more. There was 18 percent with a BAC over 0.20. Almost all of the available BAC information was for the driver with a very few tests available for a passenger.

4.0 RECOMMENDED COUNTERMEASURES

Data from each crash were reviewed with countermeasures noted which could have potentially affected the occurrence or severity of that crash. The summary for each crash is given in Appendix A. A brief description of the crash is given along with relevant information about the site, and related countermeasures are listed. These included both roadway and non-roadway countermeasures. The potential roadway countermeasures in Appendix A include those which would involve reconstruction such as realignment or widening lanes. However, as previously noted, those involving reconstruction were not part of the following list since the objective was to determine countermeasures which could be applied on a general basis across the state.

Using information from the review of these crashes and from the review of the literature, a summary of countermeasures which have the potential to reduce the number and severity of crashes on two-lane rural roads was developed. The following lists of countermeasures are divided into general categories of roadway and non-roadway with the non-roadway countermeasures further divided into the areas of legislation, enforcement, and education/training. These roadway countermeasures did not involve reconstruction.

4.1 Roadway Related Countermeasures

1. Install centerline rumble strips on high volume roads with sufficient lane width which have a potential for head on collisions.
2. Install rumble strips on all paved shoulders.
3. Improve clear zone.
4. Review permits for entrances to ensure there is adequate sight distance.
5. Provide additional delineation through sharp horizontal curves.
6. Provide advance warning signs with a proper advisory speed for sharp horizontal curves.
7. Provide intersection warning signs with advisory speed where the sight distance is limited.
8. Conduct regular inspection of the condition of the pavement and shoulder.
9. Install object marker/delineation at all headwalls and bridge ends.
10. Provide centerline and edge line marking where pavement width allows.
11. Install raised pavement markers.
12. Add a narrow paved shoulder (with grooves) where cross section allows.
13. Lower the speed limit where roadway geometrics over a substantial length of road dictate.
14. Provide adequate sight distance at intersections.
15. Provide adequate warning on stop approaches.
16. Verify superelevation and cross slope during resurfacing.
17. Install guardrail where warranted and past history indicates need.

Several of these issues could be addressed as part of a resurfacing project. While a typical resurfacing project on a two-lane rural road cannot be expected to bring the roadway up to the level of a reconstructed roadway, consideration should be given to including the following items in the contract in addition to the placement of the pavement overlay. These relatively low cost items address some of the major roadway related factors found in fatal crashes on this type of road.

a. install shoulder rumble strips on all paved shoulders,
b. provide centerline and edge line markings where pavement width allows,
c. install object marker/delineation at all headwalls and bridge ends within the clear zone,
d. provide additional delineation through sharp horizontal curves,

e. provide advance warning signs with advisory speeds for sharp horizontal curves,
f. provide raised pavement markers where traffic volume warrants,
g. install centerline rumble strips on high volume and high speed roads which have sufficient lane width,
h. ensure that a shoulder dropoff problem has not been created,
i. install intersection warning signs with advisory speed where sight distance is limited,
j. ensure that the proper superelevation is provided on horizontal curves,
k. check to determine that the proper crown is provided,
l. extend pipes to eliminate culvert headwalls, and
m. remove fixed objects.

4.2 Non-Roadway Related Countermeasures

Legislative	1.	Enact primary safety belt law.
	2.	Reenact requirement for mandatory use of motorcycle helmets.
	3.	Strengthen existing graduated licence law.
	4.	Require driver retesting (specifically, vision testing).
	5.	Enact bicycle helmet law.
	6.	Prohibit use of an ATV on public highways.
	7.	Require limited vehicle inspection.
	8.	Prohibit use of unlighted farm equipment on public highway during darkness.
Enforcement	1.	Increased alcohol enforcement.
	2.	Increased speed enforcement.
	3.	Increased safety belt enforcement.
Education/ Training	1.	Increased alcohol education.
	2.	Education concerning proper use of safety seats.
	3.	Public information and education on the benefits of utilizing safety belts.
	4.	Increase exposure of Medical Review Board (driver licensing).
	5.	Additional motorcycle training prior to licensing.
	6.	Training for proper use of ATV.
	7.	Continuing education for CDL license.
	8.	Public information related to accident avoidance and defensive driving.
	9.	Public information related to proper vehicle maintenance.
	10.	Public information related to hazard of riding in bed of pickup.
	11.	Public information related to causes of pedestrian/bicycle crashes.
	12.	Information provided for proper method of towing.

5.0 COUNTERMEASURE EFFECTIVENESS ASSESSMENT

As part of the fatal crash study for the southeastern United States, a countermeasure handbook was developed which listed possible engineering-based improvements and a subjective analyses of effectiveness (4). The improvements listed in this handbook could be related to the preceding list of roadway-related countermeasures. For each crash, an effectiveness rating, related to the effect on severity or preventing the crash, was given for each countermeasure. A Bayesian Safety Assessment Framework was developed to prioritize the countermeasures (5). A description of this procedure and the results are given in Appendix B. The reduction estimate represents the potential benefit the given countermeasure may have in reducing all fatalities on two-lane rural roads by either preventing the crash or reducing the severity of the crash. The effect would be small if the countermeasure applied to only a small number of crashes.

Both roadway and non-roadway countermeasures were considered. At least one potential roadway countermearure was identified in 120 of the 150 crashes with at least one non-roadway countermeasure identified in 137 of the 150 crashes. The roadway-related countermeasures with the highest reduction estimates (which could involve preventing the crash or reducing the severity of the crash) were modifying the geometric alignment (32 percent), widening the pavement (30 percent), adding shoulder rumble strips (26 percent), installing chevron signs (25 percent), and adding centerline rumble strips (21 percent). The reduction estimate was influenced greatly by the existing traffic control or roadway geometrics. For example, almost all the crash sites had a centerline so the potential reduction would be very small.

The non-roadway related countermeasures with the highest reduction estimates were enactment of a primary safety belt law (45 percent), increased alcohol education and enforcement (28-30 percent), and increased speed enforcement (8 percent). Enactment of a primary safety belt law had the highest reduction estimate of either category.

6.0 REFERENCES

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TABLE 1 SUMMARY OF SITE DATA ELEMENTS

VARIABLE	CATEGORY	TOTAL	PERCENTAGE
General Alignment	Straight	63	42.0
	Curved	87	58.0
Direction of Curve	Not Applicable	63	42.0
	Right	38	25.3
	Left	49	32.7
Estimated Curve Radius	Not Applicable	63	42.0
	Sharp Curve	54	36.0
	Mild/Gentle Curve	33	22.0
Crash Location	Not Applicable	63	42.0
	Inside of Curve	26	17.3
	Outside of Curve	61	40.7
Direction of Slope	Up	47	31.3
	Down	48	32.0
	Flat	55	36.7
Estimate of the Percentage of Slope	Not Applicable	55	36.7
	Level	14	9.3
	Mild Slope	59	39.3
	Steep Slope	22	14.7
Crest Vertical Curve	Not Applicable	55	36.7
	Yes	19	12.7
	No	76	50.7
Sag Vertical Curve	Not Applicable	55	36.7
	Yes	3	2.0
	No	92	61.3
Cross-Section	Typical Rooftop	67	44.7
	Super Elevated	82	54.7
	Flat	1	0.7
National Highway System	Yes	22	14.7
	No	128	85.3
Functional Classification of Roadway	Principle Arterial	21	14.0
	Minor Arterial	21	14.0
	Major Collector	68	45.3
	Minor Collector	35	23.3
	Local	5	3.3

TABLE 1 SUMMARY OF SITE DATA ELEMENTS (continued)

VARIABLE	CATEGORY	TOTAL	PERCENTAGE
Roadside Barrier	None	115	76.7
	W-Beam Not Blocked-Out	4	2.7
	Blocked-Out W-Beam	31	20.7
Number of Turning Lanes	None	146	97.3
	One	2	1.3
	Two	2	1.3
Number of Passing Lanes	None	143	95.3
	One	7	4.7
Number of Emergency Lanes	None	132	88.0
	Two	18	12.0
Lane Width (feet)	Seven	2	1.3
	Eight	8	5.3
	Nine	43	28.7
	Ten	53	35.3
	Eleven	15	10.0
	Twelve	29	19.3
Number of Driveways (within 250 feet)	None	36	24.0
	One	65	43.3
	More than One	49	32.7
Number of Intersections (within 250 feet)	None	103	68.7
	One	40	26.7
	More than One	7	4.7
Adjacent Features	Residential Driveways	103	68.7
	Commercial Driveways	11	7.3
	None	36	24.0
Roadway Illumination	None	146	97.3
	Spot Illumination	2	1.3
	Continuous Illumination	2	1.3
Shoulder Type	Paved	108	72.0
	Graded	18	12.0
	Combination Paved and Graded	3	2.0
	No Shoulder	21	14.0
Paved Shoulder Grooves	Yes	66	59.5
	No	45	40.5

TABLE 1 SUMMARY OF SITE DATA ELEMENTS (continued)

VARIABLE	CATEGORY	TOTAL	PERCENTAGE
Paved Shoulder Width (feet)	Not Applicable	39	26.0
	One	39	26.0
	Two	49	32.7
	Over Two	23	15.3
Graded Shoulder Width (feet)	Not Applicable	129	86.0
	One	12	8.0
	Two	3	2.0
	Over Two	6	4.0
Bridge/Railroad Involvement	Not Applicable	145	96.7
	Bridge	5	3.3
	Railroad	0	0.0
Speed Limit Type	Regulatory	150	79.4
	Warning Advisory Speed	39	20.6
Posted Speed Limit	35 MPH	5	3.3
	45 MPH	6	4.0
	55 MPH	139	92.7
Amount Advisory Speed Limit Under Regulatory Speed Limit	0 mph	1	2.6
	5 mph	1	2.6
	10 mph	13	33.3
	15 mph	3	7.7
	20 mph	15	38.5
	25 mph	2	5.1
	30 mph	4	10.3
Surface Type	Concrete	1	0.7
	Blacktop	149	99.3
Pavement Markings	Centerline, Skip-dash, Yellow	28	18.7
	Centerline, Solid, Yellow	16	10.7
	Centerline, Solid double, Yellow	110	73.3
	Lane Line, Skip-dash, White	6	4.0
	Edge Line, Right, White	92	61.3
	None	8	5.3
Lane Width with Edgeline	Under 9 feet	0	0.0
	9 feet	9	20.9
	10 feet	40	75.5
	over 10 feet	43	97.7

TABLE 1 SUMMARY OF SITE DATA ELEMENTS (continued)

VARIABLE	CATEGORY	TOTAL	PERCENTAGE
Raised Pavement Reflectors	Yes	51	34.0
	No	99	66.0
Delineator Presence	None	139	92.7
	Right	8	5.3
	Left	2	1.3
	Both	1	0.7
Type of Delineator	Not Applicable	139	92.7
	Directional Chevron Signs	7	4.7
	Mounted Reflectors	4	2.7
Roadside Parking	None	150	100.0
Roadside Hazard Rating	One	0	0.0
	Two	11	7.3
	Three	59	39.3
	Four	42	28.0
	Five	32	21.3
	Six	6	4.0
	Seven	0	0.0
Terrain	Flat	5	3.3
	Rolling	112	74.7
	Mountainous	33	22.0
Highway Traffic Signals	Not Applicable	146	97.3
	Flashing Beacon	4	2.7
Regulatory Signs	Not Applicable	143	96.0
	Stop Sign	1	0.7
	Yield Sign	1	0.7
	Miscellaneous	4	2.7
School Zone Signs	Not Applicable	149	99.3
	School Bus Stop Ahead	1	0.7

TABLE 1 SUMMARY OF SITE DATA ELEMENTS (continued)

VARIABLE	CATEGORY	TOTAL	PERCENTAGE
Traffic Counts	ADT less than 250	7	4.7
	ADT between 250-500	10	6.7
	ADT between 500-750	11	7.3
	ADT between 750-1000	12	8.0
	ADT between 1000-2000	28	18.7
	ADT between 2000-3000	19	12.7
	ADT between 3000-4000	21	14.0
	ADT between 4000-5000	5	3.3
	ADT between 5000-7500	22	14.7
	ADT between 7500-10000	9	6.0
	ADT greater than 10000	6	4.0
Intersection	Yes	15	9.8
	No	138	90.2
Warning Sign	Yes	64	42.7
	No	86	57.3
Type of Warning Sign	Curve (with advisory speed)	22	31.9
	Curve (without advisory speed)	11	15.9
	Reverse Curve (with advisory speed)	8	11.6
	Reverse Curve (without advisory speed)	6	8.7
	Winding Road (with advisory speed)	4	5.8
	Winding Road (without advisory speed)	3	4.3
	intersection (with advisory speed)	5	7.2
	Intersection (without advisory speed)	3	4.3
	Congested Area	2	2.9
	Object Marker	2	2.9
	Hill	1	1.4
	Slippery When Wet	1	1.4
	Divided Highway Ahead	1	1.4
Warning Signs at Sharp Curve	Curve Sign (with advisory speed)	30	55.6
	Curve Sign (without advisory speed)	14	25.9
	No Sign	10	18.5
Sharp Curve with Delineator/Chevrons	Yes	9	16.7
	No	45	83.3
Impact with Tree (Distance from Road to Tree)	Less than 5 feet	6	17.1
	6-10 feet	12	34.3
	11-15 feet	9	25.7
	16-20 feet	4	11.4
	More than 20 feet	4	11.4

TABLE 2 SUMMARY OF CRASH DATA ELEMENTS

VARIABLE	CATEGORY	TOTAL	PERCENTAGE
Month Accident Occurred	January	13	8.7
	February	8	5.3
	March	12	8.0
	April	18	12.0
	May	18	12.0
	June	14	9.3
	July	9	6.0
	August	12	8.0
	September	12	8.0
	October	18	12.0
	November	8	5.3
	December	8	5.3
Time Accident Occurred	Midnight to 5:59am	18	12.0
	6:00am to 11:59am	34	22.7
	Noon to 5:59pm	55	36.7
	6:00pm to 11:59pm	43	28.7
Highway District	District 1	16	10.7
	District 2	8	5.3
	District 3	11	7.3
	District 4	9	6.0
	District 5	6	4.0
	District 6	5	3.3
	District 7	19	12.7
	District 8	19	12.7
	District 9	14	9.3
	District 10	11	7.3
	District 11	16	10.7
	District 12	16	10.7
Number of Vehicles Involved in Crash	One	84	56.0
	Two	58	38.7
	More than Two	8	5.3
Number of Driver/Occupants (All Vehicles)	One	52	34.7
	Two	34	22.7
	Three	23	15.3
	More Than Three	41	27.3
Total Fatal Injuries in Crash	One	130	86.7
	Two	15	10.0
	Three	5	3.3

TABLE 2 SUMMARY OF CRASH DATA ELEMENTS (continued)

VARIABLE	CATEGORY	TOTAL	PERCENTAGE
Total Non-fatal Injuries in Crash	None	71	47.3
	One	35	23.3
	Two	20	13.3
	Three	13	8.7
	More than three	11	7.3
Alcohol/Drug Involvement (Based on Police Report Contributing Factor)	None	99	66.0
	Alcohol Only	48	32.0
	Alcohol and Drugs	3	2.0
Day of Week	Monday	22	14.7
	Tuesday	19	12.7
	Wednesday	13	8.7
	Thursday	21	14.0
	Friday	22	14.7
	Saturday	28	18.7
	Sunday	25	16.7
Time EMS Notified to Time Arrived at Scene (Excluding 11 unknown)	Less than 5 minutes	16	11.5
	5 to 10	58	41.7
	11 to 15	57	41.0
	16 to 20	7	5.0
	over 20 minutes	1	0.7
Time EMS Arrived at Scene to Arrive at Hospital (Excluding 47 unknown)	Less than 10 minutes	4	3.9
	10 to 20	15	14.6
	21 to 30	24	23.3
	31 to 40	19	18.4
	41 to 50	14	13.6
	51 to 60	13	12.6
	over 60	14	13.6

TABLE 3 SUMMARY OF ENVIRONMENTAL DATA ELEMENTS

VARIABLE	CATEGORY	TOTAL	PERCENTAGE
First Harmful Event	Overturn	8	5.3
	Other Non-collision	10	6.7
	Collision with Pedestrian	2	1.3
	Collision with Pedacycle	1	0.7
	Collision with Animal	1	0.7
	Collision with Motor Vehicle in Transport	66	44.0
	Collision with Other Non-fixed object	1	0.7
	Collision with Bridge/Culvert	8	5.3
	Collision with Guardrail/Median/Barrier	3	2.0
	Collision with Utility Pole/Light Support	2	1.3
	Collision with Embankment/Ditch/Curb	17	11.3
	Collision with Tree	22	14.7
	Collision with Other Fixed Object	9	6.0
Relation to Roadway	Roadway	76	50.7
	Roadside	74	49.3
Manner of Impact	Not collision Between Two Vehicles in Transport	84	56.0
	Rear-end	2	1.3
	Head-on	32	21.3
	Rear to Rear	0	0.0
	Angle	17	11.3
	Sideswipe, Same Direction	1	0.7
	Sideswipe, Opposite Direction	14	9.3
Weather Condition	Clear	101	67.3
	Cloudy	26	17.3
	Fog, Smog, Smoke	6	4.0
	Rain	13	8.7
	Sleet, Hail	2	1.3
	Snow	2	1.3
Ambient Light	Daylight	99	66.0
	Dawn	2	1.3
	Dusk	3	2.0
	Dark, Lighted Roadway	4	2.7
	Dark, Roadway not Lighted	42	28.0
Roadway Surface Condition	Dry	120	80.0
	Wet	27	18.0
	Snow	1	0.7
	Ice	2	1.3
Contributing Circumstances, Environment	None	133	88.7
	Weather Conditions	11	7.3
	Physical Obstruction	3	2.0
	Glare	2	1.3
	Animal in Roadway	1	0.7

TABLE 3 SUMMARY OF ENVIRONMENTAL DATA ELEMENTS (continued)

VARIABLE	CATEGORY	TOTAL	PERCENTAGE
Contributing Circumstances, Road	None	129	86.0
	Roadway Surface Condition	14	9.3
	Debris	0	0.0
	Rut, Holes, Bumps	1	0.7
	Obstruction in Roadway	3	2.0
	Shoulders (none, low, soft, high)	2	1.3
	View Limited	1	0.7
Type of Roadway Junction	Not a Junction	132	88.0
	Four-way Intersection	5	3.3
	T-intersection	8	5.3
	Y-intersection	2	1.3
	Driveway	3	2.0

TABLE 4 SUMMARY OF VEHICLE DATA ELEMENTS

VARIABLE	CATEGORY	TOTAL	PERCENTAGE
Vehicle Configuration	Passenger Car	109	47.8
	Light Truck	89	39.0
	Single-unit Truck (2 axles)	5	2.2
	Single-unit Truck (3 or more axles)	3	1.3
	Truck/trailer	10	4.4
	Farm Equipment	1	0.4
	Motorcycle	7	3.1
	All-terrain Vehicle	4	1.8
Cargo Body Type	Van/enclosed Box	5	27.8
	Dump	6	33.3
	Garbage	1	5.6
	Flatbed	1	5.6
	Cargo Tank	2	11.1
	Tow Truck	1	5.6
	Unknown	2	11.1
Occupants in Vehicle	1	137	60.1
	2	42	18.4
	3	28	12.3
	More than 3	21	9.2
Hazardous Material	Yes	1	0.4
Emergency Use	Yes	0	0.0
Vehicle Maneuver	Moving Essentially Straight	205	89.9
	Overtaking/passing	7	3.1
	Turning Right	3	1.3
	Turning Left	8	3.5
	Making U-turn	1	0.4
	Entering Traffic Lane	1	0.4
	Parked	2	0.9
	Slowing or Stopped in Traffic	1	0.4
Override/Underride	Underride	4	1.8
	Override	11	4.8
	None	212	93.4
Vehicle Age	Less than 3 years old	35	15.4
	4-7	59	25.9
	8-10	52	22.8
	11-15	56	24.6
	More than 15 years old	22	9.6
	Unknown Age	4	1.8
Travel Speed (Excluding 130 unknown)	Stopped	2	2.0
	Less than 35 mph	12	12.0
	36 to 50 mph	47	47.0
	51 to 65 mph	30	30.0
	More than 65 mph	9	9.0

TABLE 4 SUMMARY OF VEHICLE DATA ELEMENTS (continued)

VARIABLE	CATEGORY	TOTAL	PERCENTAGE
Fire Occurrence	Yes	11	4.8
Crash Avoidance Maneuver	None Reported	147	64.5
	Braking (skidmarks evident)	18	7.9
	Braking (no skidmarks evident)	2	0.9
	Steering (evidence or stated)	47	20.6
	Steering and Braking (evidence or stated)	14	6.1

TABLE 5 SUMMARY OF PERSON DATA ELEMENTS

VARIABLE	CATEGORY	TOTAL	PERCENTAGE
Driver Age	16-19	25	11.2
	20-24	32	14.3
	25-29	52	23.2
	30-39	52	23.2
	40-49	26	11.6
	50-59	17	7.6
	60-69	12	5.4
	Over 70	8	3.6
Driver Sex	Male	157	70.1
	Female	67	29.9
Driver Injury	Fatal	118	52.7
	Incapacitating	34	15.2
	Nonincapacitating	30	13.4
	Possible	13	5.8
	None	29	12.9
Non-Driver Injury	Fatal	57	29.1
	Incapacitating	36	18.4
	Nonincapacitating	34	17.3
	Possible	29	14.8
	None	40	20.4
Driver Protection Used	None	132	58.9
	Shoulder Belt Only	2	0.9
	Lap Belt Only	2	0.9
	Both Shoulder Belt and Lap Belt	74	33.0
	Helmet	5	2.2
	Unknown (not coded)	7	3.1
	Not Available in Vehicle	2	0.9
Non-Driver Protection Used	None	100	51.0
	Shoulder Belt Only	1	0.5
	Lap Belt Only	18	9.2
	Both Shoulder Belt and Lap Belt	36	18.4
	Child Safety Seat	6	3.1
	Helmet	1	0.5
	Not Available in Vehicle	31	15.8
	Not Applicable (pedestrian/bicyclist)	3	1.5
Driver Protection Used (Fatal)	None	87	73.7
	Shoulder Belt Only	1	0.8
	Both Shoulder Belt and Lap Belt	19	16.1
	Helmet	5	4.2
	Unknown (not coded)	5	4.2
	Not Available in Vehicle	1	0.8

TABLE 5 SUMMARY OF PERSON DATA ELEMENTS (continued)

VARIABLE	CATEGORY	TOTAL	PERCENTAGE
Non-Driver Protection Used (Fatal)	None	33	57.9
	Shoulder Belt Only	1	1.8
	Lap Belt Only	2	3.5
	Both Shoulder Belt and Lap Belt	12	21.1
	Helmet	1	1.8
	Not Available in Vehicle	1	1.8
	Not Available in Position	4	7.0
	Not Applicable (pedestrian/bicyclist)	3	5.3
Driver Air Bag Deployed	Yes	8	3.6
Ejection (All Occupants)	Not Ejected	327	77.9
	Totally Ejected	70	16.7
	Partially Ejected	20	4.8
	Does Not Apply (pedestrian/bicyclist)	3	0.7
Ejection (Fatal Injuries)	Not Ejected	109	62.3
	Totally Ejected	45	25.7
	Partially Ejected	18	10.3
	Does Not Apply (pedestrian/bicyclist)	3	1.7
Trapped	Yes	143	34.0
	No	274	65.2
	Does Not Apply (pedestrian/bicyclist)	3	0.7
Driver Contributing Factor	No Improper Driving	74	33.0
	Failed to Yield Right of Way	8	3.6
	Disregarded Traffic Signs, Signals, Road Markings	3	1.3
	Exceeded Authorized Speed Limit	12	5.4
	Driving Too Fast For Conditions	16	7.1
	Made an Improper Turn	5	2.2
	Wrong Way	1	0.4
	Failure to Keep in Proper Lane or Running off Road	62	27.7
	Operating Vehicle in Erratic, Reckless, Careless, Negligent, or Aggressive Manner	2	0.9
	Swerving or Avoiding Due to Wind, Slippery Surface, Vehicle, Object, Non-motorist in Roadway	9	4.0
	Overcorrecting/Oversteering	12	5.4
	Visibility Obstructed	1	0.4
	Inattention	10	4.5
	Distracted	3	1.3
	Fatigued/Asleep	2	0.9
	Operating Defective Equipment	4	1.8
Driver Condition	Apparently Normal	157	70.1
	Physical Impairment	4	1.8
	Illness	1	0.4
	Fell Asleep, Fainted, Fatigued, etc.	8	3.6
	Under the Influence of Medication/Drugs/Alcohol	54	24.1

TABLE 5 SUMMARY OF PERSON DATA ELEMENTS (continued)

VARIABLE	CATEGORY	TOTAL	PERCENTAGE
Driver Cited	Yes	19	8.5
	No	205	91.5
License Restrictions	None	187	83.5
	Corrective Lenses	36	16.1
	Automatic Transmission	1	0.4
License Compliance	No License Required for this Class Vehicle (4-ATV; 1-farm vehicle)	5	2.2
	No Valid License for this Class Vehicle (2-no license; 1-no MC license; 1-suspended)	4	1.8
	Valid License for this Class Vehicle	215	96.0
Alcohol/Drug Involvement (Drivers Only)	Neither Drugs nor Alcohol	170	75.9
	Yes- Alcohol Suspected	40	17.9
	Yes- Alcohol and Drugs Suspected	14	6.3
Blood-Alcohol-Content (All, sample of 420) (313 unknown)	Zero	53	49.5
	.01 to .04	4	3.7
	.05 to .07	1	0.9
	.08 to .09	6	5.6
	.10 to .14	11	10.3
	.15 to .20	13	12.1
	.21 to .25	12	11.2
	.26 to .30	4	3.7
	Over .30	3	2.8
Blood-Alcohol-Content (Drivers, sample of 224) (124 unknown)	Zero	50	50.0
	.01 to .04	3	3.0
	.05 to .07	1	1.0
	.08 to .09	6	6.0
	.10 to .14	10	10.0
	.15 to .20	12	12.0
	.21 to .25	11	11.0
	.26 to .30	4	4.0
	Over .30	3	3.0
Non-Motorist Type	Pedestrian	2	66.7
	Bicyclist	1	33.3

APPENDIX A

Description of 150 Randomly Selected Fatal Crashes on Two-Lane Rural Roads and Related Countermeasures

KY001

Description: Pickup attempted to turn left into driveway and turned in front of opposing motorcycle which was speeding.

Related Countermeasures: Additional training to obtain motorcycle license; enforce speed limits.

KY002

Description: Car turned left into business into path of opposing car; view limited due to hill crest; fatality to passenger wearing only automatic shoulder harness and no lap belt.

Related Countermeasures: Review of permits for entrances related to available sight distance; safety belt education; primary safety belt law.

KY 003

Description: All Terrain Vehicle (ATV) driver (age 38) lost control in curve; alcohol involved; no helmet in use.

Related Countermeasures: Prohibit use of ATVs on public highways; training and public information concerning hazard of operating ATV on paved public road; alcohol education and enforcement.

KY 004

Description: Head on collision; car crossed centerline (in righthand curve) into path of tractor trailer; 12-foot lanes with 5-foot shoulders; just past end of 3-lane section where car had passed another vehicle.

Related Countermeasures: Centerline rumble strips.

KY 005

Description: Head on collision; pickup crossed centerline (in righthand curve) into path of single unit truck; heavy fog; 12-foot lanes with 10-foot shoulders.

Related Countermeasures: Centerline rumble strips; raised pavement markers; education related to driving in inclement weather conditions.

KY 007

Description: Swerved to miss stopped vehicle and hit pole which was located about 20 feet from edge of pavement; fatality involved four year old in safety belt (not safety seat).

Related Countermeasures: Expand safety seat legislation to younger than six.

KY 009

Description: Driver and passenger arguing when passenger pulled driver's arm causing car to travel off road and overturn; passenger fatally injured when ejected and hit by car; possible alcohol involvement.

Related Countermeasures: Primary safety belt law.

KY 010

Description: Hit bridge abutment located at edge of road; in lefthand curve; nighttime.

Related Countermeasures: Add narrow paved shoulder with rumble strips; additional delineation (Note: object markers installed after crash); install guardrail; relocate fixed object.

KY 011

Description: Pulled into path of single unit truck from side road; no sight distance restriction; flashing beacon; fatality to ejected passenger.

Related Countermeasures: Add intersection warning signs with speed advisory on mainline; primary safety belt law.

KY 012

Description: Head on collision; ran onto shoulder and overcorrected into opposing lane; nine-foot lane and one-foot paved shoulder; no shoulder dropoff; alcohol and drug involvement; darkness.

Related Countermeasures: Widen lanes and shoulder and add rumble strips to shoulder; install raised pavement markers; alcohol education and enforcement.

KY 013

Description: Ran off road in tangent and overturned with driver ejected; excessive speed and alcohol involved.

Related Countermeasures: Add rumble strips to two-foot paved shoulder; primary safety belt law; alcohol education and enforcement; enforce speed limit.

KY 014

Description: Head on impact when car crossed centerline into path of truck; on three lane section (passing lane) with 12-foot lanes and 9-foot shoulders; fatal injury to unrestrained driver who was thrown forward with head hitting windshield.

Related Countermeasures: Centerline rumble strips; primary safety belt law.

KY 015

Description: Head on impact when driver lost control on snow and ice and slid across centerline into truck; driver had just passed another vehicle in three lane section; steep grade.

Related Countermeasures: Public education related to driving during inclement weather.

KY 016

Description: Lost control while driving through curve at excessive speed and hit tree (about 15 feet from pavement); not sharp curve; daytime; dry; seat belts not used.

Related Countermeasures: Primary safety belt law; enforce speed limit.

KY 017

Description: Motorcycle ran off road in curve and hit tree (5 feet off road); driver not experienced with no motorcycle license; curve warning sign; dry; dusk.

Related Countermeasures: Additional training for motorcycle owners; add advisory speed to warning sign and chevrons; modify alignment and add narrow paved shoulder (with grooves).

KY 018

Description: Driver lost control when swerved to miss vehicle turning left into his path; unrestrained driver partially ejected when Jeep CJ7 overturned; darkness.

Related Countermeasures: Primary safety belt law.

KY 019

Description: Ran off road in sharp curve into tree (5 feet off road); alcohol and speed involved; darkness.

Related Countermeasures: Additional warning signs and delineation; modify alignment; widen clear zone (remove fixed object); alcohol education and enforcement (Note: curve warning signs added after crash).

KY 020

Description: Head on impact when driver crossed centerline in mild curve; fatally injured driver unrestrained.

Related Countermeasures: Primary safety belt law; centerline rumble strips.

KY 022

Description: Ran off road in sharp curve on steep downgrade over cliff into tree (over 30 feet off road); curve warning sign with no advisory speed; unrestrained; alcohol involved.

Related Countermeasures: Add speed advisory and chevrons; modify alignment; add guardrail; primary safety belt law; alcohol education and enforcement.

KY 023

Description: Ran off road when had tire failure; overcorrected and crossed road and hit trees on opposite side (7 feet off road); all tires were in very poor condition (pickup seven years old); unrestrained.

Related Countermeasures: Vehicle inspection requirement; public education concerning proper vehicle maintenance; education of drivers relating to driving during emergency; primary safety belt law; increase clear zone (remove fixed object).

KY 024

Description: Vehicle dropped off road (straight and level section of road) and driver overcorrected and hit tree on opposite side of road (35 feet off road); police report noted shoulder problem; unrestrained driver thrown into vehicle interior.

Related Countermeasures: Regular inspection of shoulder condition; add edgeline when pavement width permits; widen paved shoulder; primary safety belt law.

KY 025

Description: Head on collision; driver crossed centerline in straight and level section; 12-foot lanes with two-foot paved shoulder; fatal injury to unrestrained driver.

Related Countermeasures: Centerline rumble strips; primary safety belt law.

KY 026

Description: Fatal injuries to pedestrian walking on pavement at night after mechanical problem with vehicle.

Related Countermeasures: Widen paved shoulder and increase lane width; public education about lack of visibility when walking on road during darkness.

KY 028

Description: Driver of a single unit truck ran onto the shoulder, lost control, and the rear of the truck rotated into the opposing lane; police report noted a shoulder problem at a gravel driveway where the truck lost control; in a curve on a steep downgrade; fatal injuries to unrestrained driver.

Related Countermeasures: Widen shoulder with regular inspection; modify alignment; primary safety belt law; commercial driver training

KY 029

Description: Fatal head injuries to bicyclist (12 years of age) who pulled from side road into path of car; bicyclist not wearing helmet.

Related Countermeasures: Education/legislation concerning benefits of bicycle helmet use.

KY 031

Description: Vehicle ran off outside of mild lefthand curve and traveled over culvert headwall (18 inches off edge of road) before hitting tree (8 feet off edge of road); alcohol involved; unrestrained.

Related Countermeasures: Delineation at culvert headwall; widen lanes and add narrow paved shoulder (with grooves); install guardrail; widen clear zone (remove fixed object and transverable drainage structure); primary safety belt law; alcohol education and enforcement.

KY 032

Description: Trailer being hauled by pickup broke loose from tow hitch (safety chain failed), crossed centerline, and hit opposing vehicle; fatal injuries to unrestrained driver.

Related Countermeasures: Provide information for proper towing procedure when purchase or rent trailers; primary safety belt law.

KY 033

Description: Head on collision on narrow (7-foot lane width) road; limited sight distance; fatal injuries to unrestrained driver.

Related Countermeasures: Modify alignment; widen lane width; pave shoulder; lower speed limit; primary safety belt law.

KY 034

Description: Driver ran off outside of sharp curve into tree which was over 10 feet off pavement; 10-foot lanes; alcohol and drugs involved; unrestrained.

Related Countermeasures: Add edgeline where pavement width permits; additional delineation of curve; modify alignment; add narrow paved shoulder (with grooves); primary safety belt law; alcohol education and enforcement.

KY 035

Description: Driver (age 17) overcorrected when passenger side tires of vehicle ran onto shoulder and crossed centerline into path of opposing vehicle; 10-foot lanes with paved shoulder.

Related Countermeasures: Add grooves to paved shoulder; include education for proper steering when passenger side tires drop onto shoulder in graduated drivers license (GDL) class and other driver training classes.

KY 036

Description: Driver (age 19) overcorrected when passenger side tires dropped onto shoulder and crossed road hitting tree on opposite side; straight and downgrade; tree about 7 feet off edge of pavement; unrestrained passenger sustained fatal injuries.

Related Countermeasures: Widen lanes and add narrow paved shoulder (with grooves); widen clear zone (remove fixed object); include education for proper steering when passenger side tires drop onto shoulder in GDL class and other driver training classes; primary safety belt law.

KY 037

Description: Driver lost control when vehicle hit a break in the pavement; driver ejected.

Related Countermeasures: Widen lanes and shoulder; inspection of pavement surface; primary safety belt law.

KY 038

Description: Driver lost control of vehicle as he was entering road, crossed centerline, and hit opposing truck head on; alcohol involved; unrestrained.

Related Countermeasures: Primary safety belt law; alcohol education and enforcement.

KY 039

Description: Driver lost control when crossed centerline and steered hard back toward proper lane, ran off road, and car overturned; tangent approaching sharp curve; daylight; pavement wet.

Related Countermeasures: Widen clear zone (flatten side slope); provide education to drivers relating to proper driving in response to an emergency situation.

KY 040

Description: Driver attempting to turn left into side road turned into path of opposing vehicle; view limited.

Related Countermeasures: Place warning signs with lower advisory speeds; modify alignment.

KY 041

Description: Head on collision when driver attempted to pass line of vehicles traveling at 70 mph; passing zone; 20-year old driver with two teenage passengers; 12-foot lanes and 10-foot shoulders.

Related Countermeasures: Education in GDL process.

KY 042

Description: Head on collision when driver lost control on wet pavement in curve, overcorrected and hit vehicle in opposing lane; curve warning sign with reduced advisory speed; unrestrained driver of compact car.

Related Countermeasures: Add chevrons signs; modify alignment; primary safety belt law; education relating to proper driving during inclement weather.

KY 043

Description: Driver ran off outside of sharp lefthand curve and hit fence and trees; curve warning sign with lower advisory speed; daylight; dry; driver unrestrained; alcohol involved.

Related Countermeasures: Modify alignment and add narrow paved shoulder (with grooves); additional curve delineation; widen clear zone (flatten side slope and remove fixed object); primary safety belt law; increased alcohol education and enforcement.

KY 044

Description: Head on collision at hillcrest; lane width 9 feet; fatality to motorcyclist who was not wearing helmet.

Related Countermeasures: Provide centerline when pavement width allows; modify alignment; widen lanes; motorcycle helmet law/education.

KY 045

Description: Driver attempting to turn left from side road turned into path of tractor trailer; sight distance not limited; unrestrained.

Related Countermeasures: Primary safety belt law.

KY 046

Description: Pedestrian fatality involving operator of disabled vehicle; darkness with no lighting; 12-foot lanes and 10-foot shoulders.

Related Countermeasures: Education to public about lack of visibility during darkness.

KY 047

Description: Impact with bridge headwall (two feet from edge of paved shoulder) on inside of curve; daylight; dry; driver unrestrained; driver age 77.

Related Countermeasures: Widen lanes and shoulders; install guardrail; widen clear zone (relocate fixed object); primary safety belt law; retesting for older drivers.

KY 049

Description: Driver (age 17) overcorrected when passenger tires dropped onto shoulder, crossed road, and hit tree which was located about 30 feet off road; 10-foot lanes with two-foot paved shoulder (with grooves); excessive speed; unrestrained driver ejected.

Related Countermeasures: Widen lanes; include education for proper steering when passenger side tires drop onto shoulder in GDL class and other driver training classes; primary safety belt law.

KY 051

Description: Driver (age 18) ran onto shoulder on outside of lefthand curve, overcorrected, and collided with opposing single unit truck; 10-foot lanes with two-foot paved shoulder (no grooves); excessive speed; unrestrained driver.

Related countermeasures: Widen lanes and add grooves to wider shoulder; lower speed limit; enforce speed limit; include education for proper steering when tires drop onto shoulder in GDL class and other driver training classes; primary safety belt law.

KY 053

Description: Hit culvert headwall ejecting unrestrained passenger; dry; daylight; 11-foot lanes with two-foot paved shoulder (no grooves); alcohol involved.

Related Countermeasures: Additional delineation of headwall; add grooves to paved shoulder; install guardrail; widen clear zone; construct transverable drainage structure; primary safety belt law; alcohol education and enforcement.

KY 054

Description: Driver fell asleep and drifted across road and into a tree located about 9 feet from the pavement; alcohol involved; unrestrained.

Related Countermeasures: Add narrow paved shoulder (with grooves); widen clear zone (remove fixed object); primary safety belt law; alcohol education and enforcement.

KY 055

Description: Driver lost control when attempted to pass another vehicle at an excessive speed in a curve; ran off road into tree (about 15 feet from pavement); daylight; dry; 9-foot lanes with no passing zone markings; unrestrained.

Related Countermeasures: Provide curve warning sign with advisory speed and chevrons; modify alignment; add narrow paved shoulder (with grooves); enforce speed limit; primary safety belt law.

KY 056

Description: Driver lost control when attempted to pass another vehicle at an excessive speed in a curve; ran off road and overturned; alcohol involved; unrestrained driver ejected; 12-foot lanes.

Related Countermeasures: Primary safety belt law; alcohol education and enforcement; speed enforcement.

KY 057

Description: Driver did not stop at stop sign and pulled into path of vehicle on major road; stop ahead sign; unrestrained.

Related Countermeasures: Dual mount stop and stop ahead signs; intersection warning sign; primary safety belt law.

KY 059

Description: Driver ran off outside of curve and hit tree (15 feet off edge of road); 9-foot lanes and two-foot paved shoulder (with grooves); winding road warning sign; darkness.

Related Countermeasures: Additional curve delineation and speed advisory; modify alignment; install guardrail; widen clear zone (flatten side slope, remove fixed object); speed enforcement.

KY 060

Description: Head on collision when driver crossed centerline in righthand curve; curve warning sign with speed advisory and chevrons; wet pavement; alcohol involved; driver unrestrained.

Related Countermeasures: Centerline rumble strips; modify alignment; primary safety belt law; alcohol education and enforcement.

KY 061

Description: Ran off outside of sharp curve and overturned; warning sign with advisory speed; alcohol involved; unrestrained.

Related Countermeasures: Additional curve delineation; modify alignment; centerline rumble strips; speed enforcement; primary safety belt law; alcohol education and enforcement.

KY 062

Description: Ran off outside of curve, hit driveway culvert and overturned; curve sign with advisory speed; unrestrained.

Related Countermeasures: Additional curve delineation; widen lanes; construct traversable drainage structure; primary safety belt law.

KY 063

Description: Head on collision; straight and hillcrest; car crossed centerline into path of truck; sun glare noted as factor; 10 foot lanes with no edgeline; unrestrained.

Related Countermeasures: Widen lanes; centerline rumble strips; primary safety belt law.

KY 064

Description: Head on collision; straight with 10-foot lanes and two-foot paved shoulder; pavement wet; alcohol involved.

Related Countermeasures: Widen lanes; centerline rumble strips; alcohol education and enforcement.

KY 065

Description: Driver attempting to pass another vehicle (in no passing zone) when it turned left into intersection; vehicle overturned and unrestrained driver ejected.

Related Countermeasures: Add turn lane; primary safety belt law.

KY 066

Description: Ran off road into rock wall ejecting unrestrained passengers; alcohol involved; straight and grade; dark; dry; 11-foot lanes; two-foot paved shoulders with grooves; painted centerline and edgelines.

Related Countermeasures: Install raised pavement markers; centerline rumble strips; primary safety belt law; alcohol education and enforcement.

KY 067

Description: Lost control due to excessive speed in mild curve; dry; daylight; painted centerline and edgelines; overturned after hitting drain for driveway; unrestrained driver ejected; alcohol involved.

Related Countermeasures: Centerline rumble strips; traversable drainage structure; primary safety belt law; alcohol education and enforcement; speed enforcement.

KY 068

Description: Driving ATV when ran into bridge railing and overturned; helmet not used; dry; dark; alcohol involvement.

Related Countermeasures: Widen lanes and add narrow paved shoulder (with grooves); upgrade guardrail end treatment; widen clear zone (relocate fixed object); prohibit use of ATVs on public highways; alcohol education and enforcement; additional delineation of bridge railing.

KY 069

Description: Ran off road into culvert headwall four feet off pavement; unrestrained passenger fatally injured; alcohol involved; straight; dry; day; nine-foot lanes with two-foot paved shoulder with grooves.

Related Countermeasures: Delineation of culvert headwall; install guardrail; remove sixed object; traversable drainage structure; primary safety belt law; alcohol education and enforcement.

KY 070

Description: Ran off road in sharp curve and hit large rock 7 feet off edge of road; curve with advisory speed; 9-foot lanes with no shoulder; dry; dawn; painted centerline; unrestrained 17 year old driver partially ejected (three teenage passengers).

Related Countermeasures: Additional delineation for curve; modify alignment; add narrow paved shoulder (with grooves); widen clear zone (remove fixed object); primary safety belt law; emphasize proper speed for curves in GDL training.

KY 072

Description: Head on collision when driver fell asleep and crossed centerline; straight and level; 12-foot lanes; 10-foot paved shoulders with grooves; dry; daylight.

Related Countermeasures: Centerline rumble strips.

KY 073

Description: Lost control due to excessive speed and ran off road into ditch; unrestrained driver ejected as vehicle overturned; dry; day; 10-foot lanes with centerline.

Related Countermeasures: Place edgelines where pavement width permits; add narrow paved shoulder (with grooves); install guardrail; widen clear zone (flatten side slope); primary safety belt law; speed enforcement.

KY 074

Description: Ran off road after lost control in curve; 10-foot lanes with one-foot paved shoulder with grooves; painted centerline and edgelines; dry; darkness; curve warning sign with no advisory speed.

Related Countermeasures: Additional delineation for curve; add advisory speed to warning sign; modify alignment; centerline rumble strips.

KY 076

Description: Ran off road hitting pole and small trees and overturning; unrestrained driver partially ejected; dry; daylight; 9-foot lanes with two-foot paved shoulders; straight and upgrade.

Related Countermeasures: Widen lanes; install shoulder rumble strips; primary safety belt law.

KY 077

Description: Ran off road in sharp curve and overturned; darkness; 10-foot lanes with no shoulder; painted centerline; no warning sign; unrestrained driver partially ejected.

Related Countermeasures: Place edgelines when pavement width allows; place curve warning signs and advisory speed; add narrow paved shoulder (with grooves); install raised pavement markers; modify alignment; widen lanes; primary safety belt law.

KY 078

Description: Head on collision when 18-year old driver attempted to pass in no-passing zone; unrestrained passenger sustained fatal injuries.

Related Countermeasures: Primary safety belt law; GDL education.

KY 079

Description: Ran off road in straight and level section and hit tree located about 10 feet from the edge of the pavement; dry; daylight; 9-foot lanes with no shoulder; 18-year old driver unrestrained.

Related Countermeasures: Widen lanes; add narrow paved shoulder (with grooves); widen clear zone (flatten side slope and remove fixed object); primary safety belt law; emphasize use of safety belts in GDL training.

KY 080

Description: Ran off road in sharp curve into creek; wet; darkness; 10-foot lanes with two-foot paved shoulders with grooves; painted centerline and edgelines; curve warning sign with no advisory speed; chevrons; 18-year old driver with 16-year old passenger; (Note: guardrail added).

Related Countermeasures: Place advisory speed; install raised pavement markers; modify alignment; widen lanes; install guardrail; primary safety belt law; GDL education.

KY 081

Description: Head on collision when vehicle crossed centerline; 12-foot lanes with 10-foot paved shoulders; unrestrained driver.

Related Countermeasures: Centerline rumble strips; primary safety belt law.

KY 082

Description: Head on collision when vehicle crossed centerline and hit motorcycle; curve and grade; curve warning sign with advisory speed; 11-foot lanes with two-foot paved shoulder; dry; daylight; painted centerline and edgelines.

Related Countermeasures: Additional curve delineation; centerline rumble strips.

KY 083

Description: Lost control when dropped onto shoulder and hit tree located about 11 feet from edgeline; straight; 10-foot lanes with one-foot paved shoulder; painted centerline and edgelines; dry; daylight; 17-year old driver.

Related Countermeasures: Widen lanes and shoulder (place grooves in shoulder); widen clear zone (remove fixed object); GDL training.

KY 084

Description: Lost control in curve; hit guardrail and crossed road and hit embankment and overturned; unrestrained driver partially ejected; 10-foot lanes with two-foot paved shoulder; painted centerline and edgelines; curve warning sign with advisory speed; alcohol involvement; dry; daylight.

Related Countermeasures: Modify alignment; place grooves in paved shoulder; primary safety belt law; alcohol education and enforcement.

KY 085

Description: Lost control in curve, hit driveway, and overturned; 9-foot lane with one-foot paved shoulder with grooves; dry; daylight; painted centerline; curve warning sign with advisory speed; unrestrained driver.

Related Countermeasures: Additional curve delineation; modify alignment; widen lanes and shoulder; traversable drainage structure; primary safety belt law.

KY 086

Description: Lost control in sharp curve due to excessive speed, overcorrected and hit tree located about 9 feet off pavement; 9-foot lanes with one-foot paved shoulder; painted centerline; dry; daylight.

Related Countermeasures: Curve warning signs with advisory speed and curve delineation; modify alignment; wider lanes and shoulder (with grooves); install guardrail; speed enforcement.

KY 087

Description: Head on collision in mild curve; 11-foot lanes with two-foot paved shoulder with grooves; painted centerline and edgelines; curve warning sign; unrestrained.

Related Countermeasures: Centerline rumble strips; primary safety belt law; accident avoidance education.

KY 088

Description: Head on impact in straight section; 12-foot lanes with 12-foot paved shoulders; passing lane.

Related Countermeasures: Centerline rumble strips.

KY 089

Description: Driver traveled the wrong direction on a turn lane into path of vehicle on mainline; alcohol involved; unrestrained.

Related Countermeasures: Add intersection lighting; alcohol education and enforcement; primary safety belt law.

KY 090

Description: Opposite direction collision in sharp curve; 11-foot lanes with one-foot shoulder with grooves; painted centerline and edgelines; curve warning sign; unrestrained driver ejected; dry; dusk; alcohol involved.

Related Countermeasures: Additional curve delineation and advisory speed; modify alignment; centerline rumble strips; primary safety belt law; alcohol education and enforcement.

KY 091

Description: Ran off road on steep downgrade in curve due to ice on road; hit tree located about 15 feet from edge of road; 10-foot lanes with two-foot paved shoulder; unrestrained.

Related Countermeasures: Primary safety belt law; education for proper driving during inclement weather conditions.

KY 092

Description: Ran off road in sharp curve and hit tree located about 6 feet off pavement; 9-foot lane with no shoulder; painted centerline; curve warning sign with advisory speed; dry; darkness; unrestrained.

Related Countermeasures: Additional curve delineation; add narrow paved shoulder (with grooves); install raised pavement markers; modify alignment; widen lanes; widen clear zone (remove fixed object); primary safety belt law.

KY 093

Description: Ran off shoulder, overcorrected across road and hit tree about 10 feet off edge of road; 10-foot lanes with one-foot paved shoulder with grooves; painted centerline and edgelines; straight and level after curve with warning sign and advisory speed; alcohol and drugs involved; unrestrained; dry; darkness.

Related Countermeasures: Additional curve delineation; modify alignment; widen lanes and shoulder; widen clear zone (flatten side slope and remove fixed object); primary safety belt law; alcohol education and enforcement.

KY 094

Description: Opposite direction collision; passing lane; 12-foot lanes with 10-foot paved and gravel shoulder; dry; darkness.

Related Countermeasures: Centerline rumble strips.

KY 095

Description: Two vehicles ran off road in curve due to excessive speed while racing, hit trees located about 20 feet from edge of road and overturned; unrestrained drivers ejected; dry; darkness; 10-foot lanes with one-foot paved shoulder; curve sign with advisory speed.

Related Countermeasures: Additional curve delineation; install raised pavement markers; modify alignment; widen lanes and shoulder; primary safety belt law; speed enforcement.

KY 096

Description: Ran off road and hit driveway pipe (located 10 feet from edge of road) and overturned; unrestrained driver ejected; straight; darkness; alcohol involved; painted centerline and edgelines.

Related Countermeasures: Install raised pavement markers; widen lanes; add narrow paved shoulder (with grooves); traversable drainage structure; primary safety belt law; alcohol education and enforcement.

KY 097

Description: Head on collision when vehicle crossed centerline; straight and level; dry; daylight; 12-foot lanes; 11-foot paved/gravel shoulders; one fatality unrestrained.

Related Countermeasures: Centerline rumble strips; primary safety belt law.

KY 098

Description: Head on collision when vehicle crossed centerline; straight and level; dry; darkness; 12-foot lanes with 10-gravel shoulders; unrestrained.

Related Countermeasures: Centerline rumble strips; primary safety belt law.

KY 099

Description: Driver lost control when attempted to avoid left turning vehicle and hit opposing vehicle; straight and level; 12-foot lanes with 10-foot paved shoulders; unrestrained.

Related Countermeasures: Primary safety belt law.

KY 100

Description: Ran onto shoulder in sharp curve, overcorrected and crossed road where it hit a tree and overturned; 9-foot lanes with no shoulder; no pavement markings or warning signs; ADT of 165; darkness; unrestrained; alcohol involved.

Related Countermeasures: Place centerline where pavement width permits; place curve warning signs and delineation; modify alignment; widen lanes; add narrow paved shoulder (with grooves); lower speed limit; speed enforcement; primary safety belt law; alcohol education and enforcement.

KY 101

Description: Ran off road in sharp curve and hit tree located about four feet off road; 10-foot lanes with two-foot gravel shoulder; painted centerline; no curve warning signs; unrestrained.

Related Countermeasures: Place edgeline where pavement width permits; place curve warning signs with advisory speed and chevrons; modify alignment; widen lanes and shoulder (with grooves); widen clear zone (remove fixed object); primary safety belt law.

KY 102

Description: Ran off road in sharp curve and hit tree (11 feet off edgeline); 10-foot lanes with two-foot paved shoulder with grooves; painted centerline and edgelines; warning sign with advisory speed; darkness; unrestrained..

Related Countermeasures: Additional curve delineation; modify alignment; widen lanes; widen clear zone (remove fixed object); primary safety belt law.

KY 103

Description: Ran off road in sharp curve, down embankment, and hit trees over 30 feet from edge of road; dry; daylight; 10-foot lanes with one-foot gravel shoulder; painted centerline; curve warning sign with advisory speed.

Related Countermeasures: Place edgeline where pavement width permits; add paved shoulder with grooves; additional curve delineation; modify alignment.

KY 104

Description: Driver failed to stop at intersection; stop and stop ahead signs; unrestrained passenger ejected.

Related Countermeasures: Dual mount stop and stop ahead signs; add intersection lighting; primary safety belt law.

KY 105

Description: Ran off road in sharp curve and overturned; speed and alcohol involved; fatality to passenger riding in bed of pickup who was ejected when it overturned; 9-foot lanes with two-foot paved shoulders with grooves; painted centerline; curve warning sign with advisory speed; darkness; dry.

Related Countermeasures: Additional curve delineation; install raised pavement markers; modify alignment; widen clear zone (flatten side slope); speed enforcement; alcohol education and enforcement; public education concerning danger of riding in the bed of a pickup.

KY 107

Description: Ran onto shoulder, overcorrected, and crossed road and overturned; unrestrained driver partially ejected; straight and steep downgrade; darkness; 8-foot lanes with one-foot paved shoulders with grooves; 19 year old driver; alcohol.

Related Countermeasures: Install raised pavement markers; widen lanes and shoulder; primary safety belt law; alcohol education and enforcement; accident avoidance education.

KY 108

Description: Head on collision in sharp curve; 10-foot lanes with two-foot paved shoulders; painted centerline and edgelines with snowplowable markers; curve warning sign with advisory speed; darkness; alcohol; unrestrained.

Related Countermeasures: Primary safety belt law; alcohol education and enforcement.

KY 109

Description: Motorcycle ran off road in curve and hit culvert headwall (less than 5 feet from pavement); curve warning sign with advisory speed; 11-foot lane with paved shoulder; painted centerline and edgelines; dry; daylight.

Recommended Countermeasures: Delineation of headwall; modify alignment; grooves on paved shoulder; relocate fixed object; traversable drainage structure.

KY 110

Description: Brakes failed on 1969 single unit truck with vehicle traveling through intersection and overturning.

Recommended Countermeasures: Vehicle enforcement inspections of older trucks.

KY 111

Description: Head on collision; straight and level; dry; daylight; 10-foot lanes with one-foot paved shoulder; painted centerline and edgelines; alcohol involved; unrestrained.

Recommended Countermeasures: Centerline rumble strips; alcohol education and enforcement; primary safety belt law.

KY 112

Description: Lost control in sharp curve, hit guardrail, and rebounded across road and overturned; dry; darkness; 9-foot lane with two-foot paved shoulders with grooves; painted centerline and edgelines; curve warning sign with advisory speed; alcohol involved; unrestrained.

Recommended Countermeasures: Additional curve delineation; install raised pavement markers; modify alignment; widen lanes; alcohol education and enforcement; primary safety belt law.

KY 113

Description: Lost control after dropped tires onto shoulder and overturned on pavement; unrestrained and partially ejected; alcohol involved; straight and level; 10 foot lane with one-foot paved shoulder.

Recommended Countermeasures: Widen lanes and shoulder (grooves in shoulder); primary safety belt law; alcohol education and enforcement.

KY 114

Description: Ran off road into fence (about 10 feet from pavement) and tree (about 15 feet from pavement); straight and level; 10-foot lanes; one-foot paved shoulder with grooves; dry; darkness; painted centerline; alcohol involvement; unrestrained.

Recommended Countermeasures: Place edgeline where pavement width permits; install raised pavement markers; widen clear zone (relocate and remove fixed objects); add segment lighting; primary safety belt law; alcohol education and enforcement.

KY 115

Description: Head on collision when crossed centerline in sharp righthand curve; wet; daylight; 10-foot lanes with one-foot paved shoulder; painted centerline and edgelines; curve warning sign with advisory speed; alcohol involved; unrestrained.

Recommended Countermeasures: Additional curve delineation; modify alignment; primary safety belt law; alcohol education and enforcement; education concerning driving during inclement weather.

KY 116
Description: ATV hit dog and overturned; not wearing helmet.

Related Countermeasures: Prohibit use of ATVs on public highways; training and public information concerning hazard of operating ATV on paved public road and need to wear helmet.

KY 117
Description: Ran off road in sharp curve and hit large rock about 4 feet from edgeline; 10-foot lane with two-foot paved shoulder; painted centerline and edgelines; curve warning signs with advisory speed; dry; darkness; alcohol involved; unrestrained.

Related Countermeasures: Modify alignment; install grooves in paved shoulder; additional curve delineation; install raised pavement markers; widen clear zone (remove fixed object); primary safety belt law; alcohol education and enforcement.

KY 118
Description: Opposite direction collision when driver lost control in righthand curve due to water on road; driver has physical disability; curve warning sign; fatal injuries to two children in rear seat (ages 7 and 9) who were buckled together in one lap belt.

Related Countermeasures: Education concerning the proper method to use safety belts for children; emphasis on medical review board.

KY 119
Description: Head on collision when driver overcorrected after running off pavement; dry; darkness; straight; 10-foot lanes with one-foot paved shoulder; painted centerline; unrestrained.

Related Countermeasures: Place edgeline where pavement width permits; widen lanes and shoulders (install grooves in shoulder); install raised pavement markers; primary safety belt law.

KY 120
Description: Driver talking on cell phone and hit rock bridge wall located 6 inches from edgeline; hit tree (located about 4 feet from road); 10-foot lanes with one-foot paved shoulder with grooves; straight; dry; daylight; unrestrained.

Recommended Countermeasures: Widen lanes and shoulder;install guardrail; widen clear zone (remove fixed object); primary safety belt law.

KY 122

Description: Head on collision when driver crossed centerline into opposing lane in mild righthand curve; 10-foot lanes with two-foot paved shoulder; painted centerline and edgelines; curve warning sign; unrestrained.

Recommended Countermeasures: Centerline rumble strips; primary safety belt law.

KY 123

Description: Lost control in sharp curve, hit guardrail, and rebounded into tree (20 feet from pavement); dry; darkness; 10-foot lanes with two-foot paved shoulder with grooves; curve warning sign; unrestrained.

Recommended Countermeasures: Additional curve delineation; add advisory speed; install raised pavement markers; modify alignment; widen lanes; primary safety belt law; speed enforcement.

KY 124

Description: Ran off road at bridge; straight and level; 8-foot lanes with no pavement markings; dry; darkness; unrestrained. (Note: guardrail installed after accident.)

Recommended Countermeasures: Provide centerline when pavement width permits; additional delineation of bridge; add paved shoulder (with grooves); install guardrail; primary safety belt law.

KY 125

Description: Ran off outside of righthand curve and hit parked vehicle; dry; daylight; 9-foot lanes with one-foot paved shoulder; mild curve with unsafe speed; unrestrained.

Recommended Countermeasures: Add grooves to paved shoulder; primary safety belt law; speed enforcement.

KY 126

Description: Driver pulled from side road into path of mainline vehicle; straight and level; 12-foot lanes with 10-foot paved shoulders.

Recommended Countermeasures: Add intersection warning sign with advisory speed.

KY 127

Description: Passing line of vehicles on straight and level roadway when lost control and ran off road into creek; 10-foot lanes with two-foot paved shoulders; unrestrained.

Recommended Countermeasures: Install guardrail; primary safety belt law; increased alcohol education and enforcement; speed enforcement.

KY 128

Description: Ran off road in mild curve and hit rock located about 7 feet from edge of pavement; 9-foot lanes with two-foot gravel shoulder; dry; daylight; painted centerline; unrestrained driver ejected.

Recommended Countermeasures: Replace gravel with paved shoulder with grooves; widen clear zone (remove fixed object); primary safety belt law.

KY 129

Description: Lost control after dropping passenger tires onto shoulder; overturned; 9-foot lanes with one-foot paved shoulder; painted centerline; straight and level; dry; daylight; unrestrained; alcohol involvement.

Recommended Countermeasures: Widen lanes and shoulder (install grooves on shoulder); primary safety belt law; alcohol education and enforcement.

KY 130

Description: Lost control in mild curve and hit tree (about 10 feet off road); 9-foot lanes with no shoulder; painted centerline; dry; daylight; alcohol involvement; unrestrained.

Recommended Countermeasures: Add narrow paved shoulder (with grooves); widen clear zone (remove fixed object); primary safety belt law; alcohol education and enforcement.

KY 132

Description: Lost control exiting mild curve, ran off road, and overturned; reported steering problem with 1985 car; 9-foot lanes with two-foot paved shoulders; painted centerline and edgelines; dry; daylight; unrestrained occupant ejected.

Recommended Countermeasures: Vehicle inspection law and public information concerning proper vehicle maintenance; primary safety belt law.

KY 133

Description: Head on collision when car crossed centerline in sharp curve; 9-foot lanes with one-foot gravel shoulder; painted centerline and edgelines; curve warning sign; dry; daylight; unrestrained.

Recommended Countermeasures: Add advisory speed to warning sign and chevrons; widen lanes and change gravel to paved shoulder (with grooves); primary safety belt law.

KY 134

Description: Truck pulled from side road into path of car; 12-foot lanes with 9-foot paved shoulders; dry; daylight; stop and stop ahead signs; unrestrained.

Recommended Countermeasures: Add intersection warning sign with advisory speed; primary safety belt law.

KY 135

Description: Opposite direction collision when driver failed to negotiate righthand curve; 11-foot lanes; four-foot graded shoulder; painted centerline and edgelines; curve warning sign with no advisory speed; dry; daylight; unrestrained driver ejected.

Recommended Countermeasures: Add advisory speed to warning sign and chevrons; modify alignment; pave gravel shoulder and add grooves; primary safety belt law.

KY 136

Description: Lost control on slight downgrade on ice and slid into tree located about 20 feet off road; straight; 11-foot lanes with two-foot paved shoulders; unrestrained.

Recommended Countermeasures: Primary safety belt law; education concerning driving during inclement weather.

KY137

Description: Head on collision when driver fell asleep and crossed centerline into path of truck; 12-foot lanes and 10-foot paved shoulders; darkness; mild curve; unrestrained.

Recommended Countermeasures: Centerline rumble strips; primary safety belt law.

KY 138

Description: Driver ran off straight and level road into tree (about 20 feet off road); 10-foot lanes with one-foot paved shoulder; driver diabetic; alcohol involvement.

Recommended Countermeasures: Alcohol education and enforcement; speed enforcement.

KY 139

Description: Head on collision in tangent when vehicle drifted across centerline; 10-foot lanes with two-foot paved shoulder; unrestrained.

Recommended Countermeasures: Centerline rumble strips; primary safety belt law.

KY 140

Description: Lost control in sharp curve and overturned off road; 10-foot lanes with no shoulder; curve sign with no advisory speed; wet; dusk; unrestrained.

Recommended Countermeasures: Add edgeline; add advisory speed to warning sign; additional curve delineation; modify alignment; widen lanes; add narrow paved shoulder (with grooves); widen clear zone (flaten side slope); primary safety belt law.

KY 141

Description: Driver (18years old) ran onto shoulder on straight and level section and overcorrected into opposing lane into path of truck; 11-foot lanes with 3-foot paved shoulders (with grooves); wet; daylight; unrestrained.

Recommended Countermeasures: Training in the GDL program and driver's training related to accident avoidance maneuvers; primary safety belt law.

KY 142

Description: Opposite direction collision; driver ran off outside of curve and overcorrected into opposing lane; 11-foot lanes with no shoulder; painted centerline; curve warning sign with advisory speed and chevrons; dry; daylight; unrestrained.

Recommended Countermeasures: Place edgelines when pavement width allows; add narrow paved shoulder (with grooves); primary safety belt law.

KY 143

Description: Vehicle crossed centerline in righthand curve resulting in head on collision; 10-foot lanes with two-foot paved shoulder; painted centerline and edgelines; curve warning sign; dry; daylight; alcohol involvement.

Recommended Countermeasures: Add curve delineation; add advisory speed; modify alignment; widen lanes; centerline rumble strips; speed enforcement; alcohol education/enforcement.

KY 145

Description: Passenger fell off ATV while traveling through curve; no helmet.

Recommended Countermeasures: Prohibit use of ATVs on public highways; training and public information concerning hazard of operating ATV on paved public road and need to wear helmet.

KY 146

Description: Driver failed to stop at stop sign (on county road) and pulled into mainline; sight distance to stop sign limited (Note: stop ahead signs added.).

Recommended Countermeasures: Warning signs; modify alignment.

KY 147

Description: Ran off road in straight and level section into tree located about 9 feet from road; wet; daylight; 10-foot lanes with two-foot paved shoulders; painted centerline and edgelines; 70 year old driver had health problems; unrestrained.

Recommended Countermeasures: Widen lanes; grooves on paved shoulder; widen clear zone (remove fixed object); increase exposure of driver medical review board; primary safety belt law.

KY 148

Description: Rear end collision into rear of tractor pulling hay wagon with 28 people on wagon; 9-foot lanes with two-foot paved shoulders; painted centerline and edgelines; hillcrest limited view; dry; darkness; alcohol involved.

Recommended Countermeasures: Alcohol education and enforcement; limitation on operation of farm equipment on public highway during darkness.

KY149

Description: Trailer portion of tractor trailer swung across centerline into opposing vehicle; sharp curve and steep downgrade; 12-foot lanes with three-foot paved shoulders; passing lane; curve warning sign with advisory speed; painted centerline and edgelines; unrestrained.

Recommended Countermeasures: Training of commercial truck drivers about operating characteristics of their vehicle; primary safety belt law.

KY 150

Description: Ran off road in sharp curve into several trees (about 5 feet from road); 8-foot lanes with no shoulder; no pavement markings or signs; unrestrained.

Recommended Countermeasures: Place curve warning signs and centerline; modify alignment; widen lanes; add shoulder with grooves; widen clear zone (remove fixed object); primary safety belt law.

KY 153

Description: Head on collision when driver lost control on wet road when distracted by child and crossed centerline into opposing lane; straight and level; 9-foot lanes with no shoulder; daylight; painted centerline; unrestrained 9-year old child fatally injured.

Recommended Countermeasures: Primary safety belt law.

KY 154

Description: Ran off outside of sharp righthand curve down embankment; 9-foot lanes with one-foot paved shoulders; painted centerline; curve warning sign; dry; darkness; three unrestrained occupants ejected.

Recommended Countermeasures: Add advisory speed to warning sign; additional curve delineation; install raised pavement markers; modify alignment; install guardrail; flatten side slope; primary safety belt law.

KY 155

Description: Lost control in mild curve and hit embankment and overturned; excessive speed and alcohol involved; 9-foot lanes with one-foot paved shoulder; centerline; curve sign with advisory speed and chevrons; dry; daylight; unrestrained driver ejected.

Recommended Countermeasures: Modify alignment; widen lanes and shoulder (add grooves to paved shoulder); alcohol education and enforcement; primary safety belt law; speed enforcement.

KY 156

Description: Lost control on wet pavement on straight and level road and hit tree (about 15 feet off pavement); alcohol and speed involved for 16 year old driver; fatal injuries to all three unrestrained teenage occupants; 10-foot lanes with one-foot paved shoulders; tire tread marginal.

Recommended Countermeasures: Install raised pavement markers; emphasize safety belt use, alcohol education, and proper vehicle maintenance in graduated license training; primary safety belt law; vehicle inspection law.

KY 157

Description: Lost control while avoiding a turning vehicle; overturned down embankment with all unrestrained occupants ejected.

Recommended Countermeasures: Warning sign with advisory speed; primary safety belt law.

KY 158

Description: Lost control while avoiding a turning vehicle and hit vehicle in opposing lane; straight and grade; wet; daytime; unrestrained driver ejected.

Recommended Countermeasures: Primary safety belt law.

KY 159

Description: Opposite direction impact when driver crossed centerline in mild righthand curve; 10-foot lanes with one-foot paved shoulder; painted centerline and edgelines; alcohol involved; unrestrained.

Recommended Countermeasures: Centerline rumble strips; primary safety belt law; alcohol education and enforcement.

KY 160

Description: Driver made U-turn in front of other vehicle; passing lane; 12-foot lanes with 12-foot paved shoulders.

Recommended Countermeasures: None.

KY 161

Description: Ran off road on outside of sharp lefthand curve into tree located about 12 feet from edge of road; 10-foot lanes with one-foot paved shoulder with grooves; painted centerline and edgelines; curve warning sign with advisory speed; dry; darkness; unrestrained driver ejected; alcohol involvement.

Recommended Countermeasures: Additional curve delineation; modify alignment; widen lanes and shoulder; install guardrail; widen clear zone (flatten side slope and remove fixed object); primary safety belt law; alcohol education and enforcement.

KY 162

Description: Ran off road on outside of sharp lefthand curve into tree located about 7 feet from edge of road; 8-foot lanes with no shoulder; no pavement markings or warning signs; dry; daylight; ADT about 350; unrestrained 87 year old driver.

Recommended Countermeasures: Place appropriate centerline markings and warning signs; modify alignment; widen lanes and shoulder (with grooves); lower speed limit; widen clear zone (remove fixed object); primary safety belt law; increase exposure of driver medical review board.

KY 163

Description: Ran off road in series of curves, down embankment and overturned; unrestrained occupant ejected; 8-foot lanes with two-foot paved shoulders; no pavement markings or warning signs; dry; darkness; ADT about 600.

Recommended Countermeasures: Place appropriate centerline markings and warning signs; modify alignment; widen lanes; install guardrail; widen cleare zone (flatten side slope); lower speed limit; primary safety belt law.

KY 164

Description: Opposite direction collision when lost control on wet pavement (tires inadequate); straight and grade; 11-foot lanes with two-foot paved shoulders; daylight; painted centerline and edgelines; unrestrained.

Recommended Countermeasures: Primary safety belt law; vehicle inspection/law.

KY 165

Description: Head on impact; impaired driver on wrong side of 3-lane section; no headlights during darkness; 12-foot lanes with 10-foot paved shoulders; painted centerline ad edgelines and snowplowable markers; mild curve and grade; unrestrained.

Recommended Countermeasures: Centerline rumble strips; alcohol education and enforcement; primary safety belt law.

KY 167

Description: Pulled from private driveway into path of truck; straight and hillcrest; sight distance limited; wet; daylight; unrestrained.

Recommended Countermeasures: Review permits relative to sight distance; primary safety belt law.

KY 168

Description: Motorcycle ran off road on outside of mild lefthand curve and overturned when hit driveway pipe located about 7 feet from road; excessive speed; no helmet; 10-foot lanes with no shoulder; painted centerline; no warning sign; dry; daylight.

Recommended Countermeasures: Place edgeline where pavement width permits; modify alignment; widen lanes; add narrow shoulder with grooves; transverable drainage structure; mandatory helmet use..

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APPENDIX B

Countermeasure Effectiveness Assessment

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Countermeasure Effectiveness Assessment

The data relating to each of the 150 fatal crashes (crash report, site visit data, photographs) were reviewed and used to estimate the effect of the various countermeasures on the specific crash. Using a countermeasure effectiveness form, the potential effect of each countermeasure was rated. The following categories were used:

Survey Response	Description	Corresponding Theta
N/A	Can not determine effect of countermeasure	N/A
-1	Would worsen severity of crash	1.33
0	Would have no effect whatsoever on crash	1.0
+1	Would not prevent crash, but may reduce severity	0.67
+2	Would not prevent crash, but would reduce severity	0.33
+3	Would prevent the crash	0.0

The "does not apply" category represented a large majority of crashes for several of the countermeasures. If the countermeasure was already at the crash site, it would not apply. For example, centerline markings existed at 144 of the crash sites so the N/A category was used for all but six of the crashes.

The estimate of the potential reduction in the 150 sample crashes would be:

Number of crashes (excluding N/A) x (1 - theta)

The percent reduction in fatal crashes for the total sample would be obtained by dividing the number of fatal crashes which may be prevented, as determined in the preceding formula, by the total sample of 150. For the centerline example, there was a theta of 0.00 for the six crashes so adding a centerline could have possibly reduced six fatal crashes which represents a four percent reduction of the 150 crashes included in the analysis.

The reduction estimate for the various countermeasures at the 150 crash sites was greatly influenced by the existing traffic control or roadway geometrics. For example, as previously noted, almost all the sites had a centerline. Therefore, although the addition of a centerline would have a significant effect at locations with no existing centerline, the estimated reduction when all of the study sites were considered would be very small.

The methodology used to estimate the potential reduction factor that a specific countermeasure could have on the total sample of 150 fatal crashes first involved determining the number of crashes where it would apply and the theta for those crashes. If the opinion was that the countermeasure would apply at the crash site, possible categories used were: a) no effect on

the crash, b) possibly reducing the severity, c) reducing the severity, and d) preventing the crash. An example would be adding an edgeline where in 136 of the crashes an edgeline was in place so the countermeasure would not apply. In the remaining 14 crashes the opinion was adding an edgeline could prevent the crash in 10, have no effect in 3, and reduce severity in one. The theta for this analysis was 0.24 giving a reduction estimate to use for the 14 crashes for which this countermeasure applied of 0.76. Multiplying the 14 applicable crashes by this percentage results in a potential reduction of 10.7 crashes or 7 percent of the total sample.

The reduction estimate considers the effect the countermeasure would have on all fatal crashes by either preventing the crash or reducing the severity of the crash. The effect would be small if the countermeasure applied to only a small number of crashes. For example, one countermeasure considered was legislation prohibiting all terrrain vehicles from public highways. There were 4 crashes to which this applied with a reduction estimate of 100 percent. However, since this countermeasure only applied to 4 crashes, the reduction estimate for all fatal crashes was 3 percent which represents the potential reduction of all fatal crashes on two-lane rural roads if this countermeasure was in place.

The following reduction estimates were determined. They were developed using the preceding methodology and consider the effect on all crashes rather than only those to which the given countermeasure may apply. A reduction estimate of 0 percent does not imply that the countermeasure could not be beneficial in some circumstances; however, it does mean that in the sample of crashes used in this study the specific countermeasure was not considered to be an effective alternative.

Countermeasure (Roadway Related)	Reduction Estimate (Percent)*
Add Edgeline	7
Add Centerline	4
Add No-Passing Zone	1
Add Raised Pavement Markers	13
Install Warning Sign	14
Add Advisory Speed Sign	15
Install Chevron Sign	25
Install Post Delineators	12
Modify Geometric Alignment	32
Modify Superelevation/Cross Slope	0
Improve Sight Distance without Geometric Realignment	0
Widen Lanes/Pavement Width	30
Add Turn Lane	1

- The reduction estimate represents the potential benefit the given countermeasure may have in reducing all fatalities on two-lane rural roads by either preventing the crash or reducing the severity of the crash.

Countermeasure (Roadway Related)	Reduction Estimate (Percent)*
Widen Existing Graded/Stabilized Shoulder	10
Pave Existing Graded/Stabilized Shoulder	17
Widen Existing Paved Shoulder	13
Add Shoulder Rumble Strips	26
Add Centerline Rumble Strips	21
Improve Roadway Access Management	1
Install/Upgrade Guardrail	7
Upgrade Guardrail End Treatment	1
Widen Clear Zone	15
Flatten Side Slope	4
Relocate Fixed Object	2
Remove Fixed Object	12
Convert Object to Breakaway	0
Construct Traversable Drainage Structure	4
Add Segment Lighting	1
Add Intersection Lighting	1
Upgrade Segment/Intersection Lighting	0

Countermeasure (Non-Roadway Related)	Reduction Estimate (Percent)*
Enforce Speed Limits	8
Lower Speed Limit	3
Increased Alcohol Enforcement	30
Enact Primary Safety Belt Law	45
Reenact Requirement for Mandatory Use of Motorcycle Helmets	1
Strengthen Existing Graduation License Law	8
Require Driver Retesting (vision)	1
Enact Bicycle Helmet Law	1
Prohibit Use of ATV on Public Highways	3
Require Limited Vehicle Inspection	3
Prohibit Use of Unlighted Farm Equipment on Public Highway during Darkness	1
Increased Alcohol Education	28
Education Concerning Proper Use of Safety Seats	1
Increased Exposure of Medical Review Board	3
Additional Motorcycle Training Prior to Licensing	2
Training for Proper Use of ATV	3

Countermeasure (Non-Roadway Related)	Reduction Estimate (Percent)*
Continuing Education for CDL License	1
Public Information Related to Accident Avoidance and Defensive Driving	4
Public Information Related to Proper Vehicle Maintenance	3
Public Information Related to Hazard of Riding in Bed of Pickup	1
Public Information Related to Causes of Pedestrian/Bicycle Crashes	1
Information Provided for Proper Method of Towing	1

- The reduction estimate represents the potential benefit the given countermeasure may have in reducing all fatalities on two-lane rural roads by either preventing the crash or reducing the severity of the crash.