



Research Report
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SAFETY IMPLICATIONS FROM DESIGN EXCEPTIONS

by

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16. Abstract The objectives of this study were to: a) summarize past design exceptions to document their frequency and reason for their use and b) determine if any adverse safety implications can be related to adopting design policies and practices related to design exceptions. The design exception file was obtained with data obtained relating to the types of project, exceptions requested, and the reasons for the various exceptions. A site visit was made to a large number of the locations where the project was built with the requested design exception with crash data obtained at most of these locations. The majority of the projects involved a bridge replacement followed by a roadway widening reconstruction project and construction of a turning lane. The most common design exception was for a design speed lower than the posted speed limit followed by a reduction in either the sight distance, curve radius, or shoulder width. The most common reason referred to the existing conditions on the road followed by the right-of-way issue and project cost. The crash analysis showed that, with a very few exceptions, use of the design exception process did not result in either construction of projects with high crash rates when compared to statewide average rates or an increase in crashes after compared to before construction.			
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EXECUTIVE SUMMARY

The objectives of this study were to: a) summarize past design exceptions to document their frequency and reason for their use and b) determine if any adverse safety implications can be related to adopting design policies and practices related to design exceptions.

The design exception file maintained by the Kentucky Transportation Cabinet was obtained with data obtained relating to the types of project, exceptions requested, and the reasons for the various exceptions. A site visit was made to a large number of the locations where the project was built with the requested design exception. Available crash data were obtained at these locations.

There was an average of 39 design exceptions per year from 1993 through 1998. The majority of the projects involved a bridge replacement with the next most frequent being roadway widening reconstruction projects and construction of turning lanes. The most common design exception was for a design speed lower than the posted speed limit followed by a reduction in either the sight distance, curve radius, or shoulder width. The most common reason for the request referred to the existing conditions on the road followed by the right-of-way issue and project cost. The crash analysis showed that, with a very few exceptions, use of the design exception process did not result in either construction of projects with high crash rates when compared to average statewide rates or an increase in crashes after construction compared to before construction.

The analysis showed that the design exception projects resulted in an improvement over the prior condition although some aspect of the design may not be typical. The reasons for the design exceptions have been well documented, and there is no evidence that construction of projects with a design exception had an adverse effect on highway safety.

1.0 INTRODUCTION

The AASHTO publication titled "A Policy on Geometric Design of Highways and Streets" (commonly referred to as the Green Book) provides guidance to the designer by referencing a recommended range of values for critical dimensions for the design of new alignments and those undergoing major reconstruction. These guidelines permit sufficient flexibility to encourage independent designs for specific situations and should not be considered as standards. The Green Book indicates that the referenced guidelines provide a safe, comfortable, and aesthetically pleasing roadway. However, the current emphasis in Context Sensitive Design (CSD) has created concern regarding the potential decrease of safety which may result from designing various features along roadways to accommodate such concerns as the roadway appearance.

The CSD approach encourages the designer to use flexibility to introduce "lower than typical" design values for a specific element to address an impacted area. This process allows for adjusting almost every aspect of the geometric design and may require both state and federal approval. Use of design flexibility may include use of a design exception. Kentucky has a formal procedure to document the request and approval of a design exception. The documentation materials include: a description of the project, the design criteria, a description of the exception requested, and the reason for requesting the exception.

The objectives of this study were to: a) summarize past design exceptions to document their frequency and reason for their use and b) determine if any adverse safety implications can be related to adopting design policies and practices related to design exceptions.

2.0 PROCEDURE

The Kentucky Transportation Cabinet maintains a file for each design exception. The amount of information related to any specific exception varies from only the Design Executive Summary form to detailed background information. The design exception file was obtained and reviewed for the years of 1993 through 2000. The data contained in the file were summarized to obtain such information as the types of project, exceptions requested, and the reasons for the various exceptions.

A site visit was made to a large number of the locations where the project was built with the requested design exception. Available crash data were obtained at these locations. Where possible, the dates of construction were obtained. Crash data were analyzed to determine the effect the design exception had on the crash history at the construction location. Different procedures were used in the crash analysis. They included either: a) before and after comparisons when the construction time period allowed or b) comparison of the crash history at a location with the statewide average for that type of road. Selected sites were also inspected where the project had not been built to review the reason for the exception request.

3.0 RESULTS

3.1 Number of Design Exceptions

The annual numbers of design exceptions from 1993 through 2000 are summarized in Table 1. The summary is divided into the general type of project as provided by the project description on the Design Executive Summary form. Information was obtained for 312 design exceptions. This represents an average of 39 per year over this eight-year period with a range of from 24 in 1993 to 55 in 1998. The majority of the projects (57 percent) involved a bridge replacement. Second most common were roadway widening reconstruction projects (13 percent) followed by construction of a turning lane (9 percent).

The location of the design exception (county and route) along with the exceptions requested and the reasons for the exception are summarized in Appendix A. A summary by type of highway found that 53 percent occurred on a KY route, followed by 28 percent on a non-state maintained route, 16 percent on a US route, and 4 percent on an interstate. The projects which were not on a state maintained route were typically a bridge replacement. Design exceptions were used in 96 counties which represents 80 percent of Kentucky's 120 counties. The counties with the largest number of design exceptions were Jefferson (24), Pike (12), and Scott (9).

3.2 Type of Design Exception Requested

The types of design exception requested are summarized in Table 2. There was an average of 1.8 exceptions for each project. The most common design exception was for a design speed lower than the posted speed limit (34 percent) with this exception commonly requested on bridge replacement projects. This type of exception was followed by a reduction in either the minimum sight distance (12 percent), minimum curve radius (12 percent), or shoulder width (11 percent).

The type of design exception was related to the most common types of project. For bridge replacement projects, the most frequent design exceptions were: design speed (39 percent), minimum sight distance (12 percent), minimum curve radius (11 percent), bridge width (8.9 percent) and pavement width (8.1 percent). For widening/reconstruction projects, the most frequent were: design speed (36 percent), minimum sight distance (16 percent), shoulder width (12 percent), minimum curve radius (10 percent) and ditch width (9 percent). The most common types of design exception were different turning lanes additions with shoulder width (35 percent) and ditch width (23 percent) given most often.

3.3 Reason for Design Exception

The documentation provided with the request included reasons for the exception. A listing and summary of the types of reasons listed are given in Table 3. There was an average of 1.7 reasons provided to justify each exception. The most common reason referred to the existing

conditions on the road which was given in 66 percent of the cases. A comment made in many of the cases was that a design speed lower than the posted speed limit was requested to match existing roadway conditions. A reference was typically made to the existing horizontal and vertical alignment noting that it would not allow speeds higher than the requested design speed. This reason was followed by the right-of-way issue (33 percent) and project cost (25 percent). The usual comment made concerning right of way was that the exception would limit the amount of right of way needed for the project. The reason related to cost was that the cost to meet typical criteria would be excessive.

A direct reference was made to the crash history for 21 projects. The actual crash history was specified in only a very few instances. The reference was usually a comment that there had been several crashes at the project site in the past several years with no specific data provided. There was a general reference to safety concerns noted for 12 other projects. However, a review of the crash history at these locations did not typically find any problem prior to construction of the project.

A reference to a historic or environmental feature was made in the commentary for 17 projects. A variety of features were noted. The most common reference noted impacts to a stream or wetland with other features including a historic register property and a stone masonry wall.

3.4 CRASH ANALYSIS

Site visits were made at 86 design exception locations. The locations were selected to give a range of types of projects and various exceptions. When possible, the crash history at the locations was summarized using the available data. The objective was to determine any effect the design exception may have had on crashes. In order to conduct a before and after type of analysis, the start and end dates of the construction must be known and the construction must have occurred during a time period for which before and after crash data were available. Since crash data could typically be obtained for the years of 1995 through 2000, the construction period had to be within these years to allow a before and after comparison. An alternative to the before and after analysis for the older projects where before data is not readily available or where the exact date of construction is not known would be to calculate the crash rate at the location after the project and compare that rate with statewide crash rates for similar types of roads.

Summaries of the crash analysis which could be conducted at 65 of the 86 case study sites are presented in Appendix B. Locations off the state maintained system are not included since crash data are not available at those locations. In many instances, the time frame would not allow any detailed type of analysis. The crash history was obtained at some locations where the construction has not been completed and compared to statewide averages to determine if there had been a crash problem. A tabulation of the before and after crash data for the 65 case study sites is also included in Appendix B.

The analysis showed that, with a very few exceptions (6 of the case study sites), use of the design exception process did not result in the construction of projects with crash rates higher than either average rates for the type of location where the project occurred or the crash rate at the site before the construction occurred. Considering all locations, a direct reference to a prior crash problem was only noted in the background information for 21 projects (6.7 percent) with a general reference to safety concerns at 12 locations (3.8 percent). Therefore, it would not be expected that improvements, which only had some aspects of the design criteria not meeting optimum criteria, would result in the occurrence of crashes. When comparing the existing geometric conditions before construction, the improvement projects resulted in improved roadway geometrics at all sites.

4.0 CONCLUSIONS

The objectives of this study were to: a) summarize past design exceptions to document their frequency and reason for their use and b) determine if any adverse safety implications could be related to adopting design policies and practices related to design exceptions.

The most common design exception has involved a reduced design speed at a bridge replacement project. The typical reason for the exception was that the design conformed to the existing conditions on the roadway adjacent to the project.

The analysis shows that use of the design exception process has not resulted in construction of projects with high crash rates. The projects constructed with the design exceptions resulted in an improvement over the prior condition although some aspect of the design may not be typical. The reasons for the design exceptions have been well documented, and there is no evidence that construction of projects with a design exception had an adverse effect on highway safety.

TABLE 1. GENERAL TYPE OF PROJECT

NUMBER REQUESTING DESIGN EXCEPTION IN GIVEN YEAR									
DESCRIPTION	1993	1994	1995	1996	1997	1998	1999	2000	TOTAL
Bridge Replacement	14	26	27	40	27	29	9	14	179
Widening/Reconstruction	1	7	2	8	4	6	6	8	42
Turning Lanes	5	3	3	0	6	8	2	2	29
Alignment	1	0	1	1	1	2	5	0	11
Relocation/New Construction	0	0	1	0	1	3	5	1	11
Intersection (general)	1	2	1	1	0	1	2	2	10
Pavement Rehabilitation	0	3	3	1	0	2	0	1	10
Raise Roadway Elevation	1	0	0	0	0	3	1	0	5
Sight Distance	1	0	0	1	1	1	1	0	5
Slide/Rock Fall	0	1	1	0	0	0	1	2	5
Spot Reconstruction	0	1	0	0	1	0	0	1	3
Ramp	0	1	0	0	0	0	0	0	1
Rest Area	0	0	0	1	0	0	0	0	1
All	24	38	38	53	41	55	32	31	312

TABLE 2. TYPE OF DESIGN EXCEPTION REQUESTED

EXCEPTION	YEAR								TOTAL
	1993	1994	1995	1996	1997	1998	1999	2000	
Design speed	9	30	31	33	30	29	14	15	191
Minimum sight distance	3	6	9	12	13	10	5	10	68
Minimum radius (Curvature)	11	2	7	16	6	13	6	6	67
Shoulder width	7	12	3	5	5	16	9	6	63
Ditch width	4	4	5	6	5	8	5	6	43
Pavement/lane width	4	2	1	15	7	8	1	4	42
Bridge width	1	3	0	14	7	6	1	3	35
Number of lanes	0	0	0	5	3	3	0	5	16
Maximum grade	1	2	2	2	0	4	3	1	15
Superelevation	0	1	0	1	0	9	1	0	12
Acceleration lane	0	1	2	1	0	0	0	0	4
Clear zone/Border	0	0	0	0	0	2	1	0	3
Earth cut/fill slope	1	0	0	0	1	0	0	0	2
Bridge railing	0	1	0	0	0	0	0	0	1
Tie down	0	0	0	0	0	1	0	0	1
Access spacing	0	0	0	0	0	0	0	1	1
Guardrail end treatment	0	0	0	0	0	0	0	1	1
Total	41	64	60	110	77	109	46	58	565

TABLE 3. REASON FOR DESIGN EXCEPTION

REASON	NUMBER
Existing conditions	207
Right-of-way issue	103
Cost	78
Length (scope)	35
Environmental	27
Adjacent property issue	25
Stop condition	18
Utility	17
Defer construction	4
Railroad issue	2
Lighting	1
Congestion	1
Total	518

**APPENDIX A. SUMMARY OF DESIGN EXCEPTION LOCATIONS
(INCLUDING EXCEPTION REQUESTED AND REASON)**

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
93-1	Madison	KY 595	Design speed	Available funds; existing alignment
93-2	Ohio	Non-SM	Design speed	Existing alignment (non-posted speed limit)
93-3	Warren	KY 880	Design speed	Crest vertical curve at railroad because railroad and adjacent intersection close together.
93-4	Powell	KY 1028	Design speed	Construction costs; right-of-way
93-5	Johnson	KY 40	Design speed	Existing alignment (non-posted speed limit)
93-6	Harlan	Non-SM	Design speed	Existing alignment (non-posted speed limit)
93-7	Meade	US 31W	Shoulder width; Ditch width	Cost; right-of-way acquisition; utility relocations
93-8	Scott	Non-SM	Design speed	Length of project; cost
93-9	Muhlenberg	US 62	Pavement width Shoulder width	Right-of-way acquisition; utility relocations
93-10	Breathitt	KY 476	Design speed	Most economical alignment
93-11	Clark	Non-SM	Design speed	Existing alignment
93-12	Bourbon	Non-SM	Design speed Pavement width	Existing conditions; right-of-way acquisition
93-13	Ohio	Non-SM	Design speed Max. curvature	Existing alignment (non-posted speed limit); meet grade requirement for bridge
93-14	Union	KY 2091	Pavement width Shoulder width	Adversely impact business district
93-15	Allen	Non-SM	Maximum grade Min. sight dist.	Avoid a cemetery; length; cost; existing operating speed
93-16	Madison	US 421	Shoulder width Ditch width Bridge width	Utility and construction costs
93-17	Madison	US 25	Shoulder width Ditch width	Right-of-way acquisition; utility relocation
93-18	Boyle	KY 1915	Design speed	Existing conditions; right-of-way
93-19	Mason	US 62	Max. curvature	Length; costs; right-of-way acquisition
93-20	Breathitt	Non-SM	Pavement width Earth cut slope	Existing conditions; right-of-way
93-21	Wolfe	KY 15	Shoulder width Ditch width	Discourage large trucks from parking on shoulder; costs from large cuts
93-22	Montgomery	US 460	Min. Sight Dist.	Existing conditions (no safety problem)
93-23	Kenton	KY 17	Shoulder width	Match existing conditions
93-24	Washington	KY 438	Design speed Min. sight dist.	Maintain existing condition (sight dist.); (no crash history); effect to state park

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
94-1	Anderson	US 62	Shoulder width Bridge width	Existing conditions; short length of project; cost
94-2	Taylor	KY 3183	Design speed Shoulder width Min. sight dist.	Existing conditions; cost
94-3	Kenton	Non-SM	Design speed	Reconstruction beyond scope of project
94-4	Perry	Non-SM	Design speed Max. curvature	Cost; existing conditions
94-5	Marion	Non-SM	Design speed	Existing conditions
94-6	Whitley	Non-SM	Design speed	Existing conditions; right-of-way acquisition; limit length
94-7	Christian	KY 380	Shoulder width	Right-of-way acquisition; cost
94-8	Caldwell	Non-SM	Design speed Shoulder width Min. sight dist.	Right-of-way acquisition; cost
94-9	Estill	KY 89	Design speed Shoulder width	Cost
94-10	Jessamine	KY 29	Design speed	Right-of-way acquisition
94-11	Perry	KY 15	Shoulder width Ditch width	Avoid impact to river; cost of new bridge
94-12	Hopkins	US 41	Design speed	Existing conditions; right-of-way acquisition
94-13	Oldham	Non-SM	Design speed	Existing conditions less than design speed
94-14	Scott	KY 922	Design speed Ditch width Min. sight dist.	Existing conditions; right-of-way funding
94-15	Bell	US 119	Design speed Bridge width	Existing conditions
94-16	Harrison	US 27	Design speed Pavement width Shoulder width Max. grade Min. sight dist.	Right-of-way acquisitions
94-17	Butler	KY 1153	Design speed	Existing conditions; right-of-way acquisitions
94-18	Warren	KY 743	Design speed	Existing conditions; right-of-way acquisitions; length
94-19	Mercer	KY 33	Design speed	Extend design speed to lower speed limit
94-20	Marion	KY 52	Design speed	

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
94-21	Anderson	KY 512	Design speed Pavement width Max. grade Min. sight dist.	Existing conditions
94-22	Hardin	KY 251	Design speed	Existing conditions; cost, minimize lateral encroachment
94-23	Perry	KY 3194	Design speed	Existing conditions; cost
94-24	Scott	US 25	Design speed Superelevation Shoulder width	Existing conditions; length
94-25	McCreary	KY 92	Design speed	Less encroachment on wetlands
94-26	Bourbon	Non-SM	Design speed Shoulder width Bridge width Max. curve Min sight dist.	Existing conditions; length
94-27	Pike	KY 2061	Design speed	Existing conditions; costs
94-28	Kenton/ Campbell	I 275	Bridge railing	
94-29	Woodford/ Scott/Fayette	I 64	Bridge width Acceleration lane	Defer work
94-30	Barren	I 65	Shoulder width	Existing conditions
94-31	Fayette	KY 1974	Design speed	Right-of-way acquisition
94-32	Clark	Non-SM	Shoulder width Ditch width	Right-of-way acquisition
94-33	Lawrence	KY 707	Design speed	Existing conditions (non-posted speed limit)
94-34	Carroll	I 71	Shoulder width	Impact on wetlands
94-35	Jefferson	I 64	Design speed	
94-36	Campbell	KY 10	Design speed	Cost; right-of-way acquisition
94-37	Mercer	KY 1915	Design speed	Existing conditions; length; right-of-way acquisition
94-38	Boone	KY 338	Design speed	Existing conditions

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
95-1	Bell	Non-SR	Design speed	Limits length of project requiring no construction across railroad tracks.
95-2	Greenup	Non-SR	Design speed Max. curvature Min. sight dist.	Cost; existing conditions; minimize effect to side road
95-3	Harlan	KY 215	Design speed	Existing conditions; right-of-way acquisition
95-4	Magoffin	KY 1437	Design speed	Existing conditions (non-posted speed limit)
95-5	Jefferson	KY 146	Shoulder width Acceleration lane	Defer construction
95-6	Jessamine	Non-SR	Design speed Max. curvature Min. sight dist.	Existing conditions; cost
95-7	Bourbon	Non-SR	Design speed	Existing conditions; cost
95-8	Garrard	Non-SR	Design speed	Existing conditions
95-9	Madison	Non-SR	Design speed	Existing conditions
95-10	Whitley	Non-SR	Design speed	Existing conditions
95-11	Morgan	KY 711	Design speed Max. curvature Max. grade Min. sight dist.	Existing conditions; cost; length; right-of-way acquisition
95-12	Shelby	KY 53	Ditch width	Existing conditions adequate
95-13	Martin	Non-SR	Design speed	Meets geometric criteria for local traffic in mountainous terrain
95-14	Menifee	Non-SR	Design speed	
95-15	Powell	KY 1057	Design speed Ditch width	Existing conditions; right-of-way acquisition
95-16	Washington	KY 1586	Design speed Max. curvature Min. sight dist.	Existing conditions; right-of-way acquisition; cost
95-17	Jessamine	US 68	Design speed Ditch width	Right-of-way acquisition; impact on historic property; stop condition
95-18	Larue	US 31E	Ditch width	Right-of-way acquisition
95-19	Laurel	Non-SM	Design speed Max. curvature	Existing conditions
95-20	Boyle	KY 1108	Design speed Pavement width Max. grade	Existing conditions; length

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
95-21	Breathitt	KY 2469	Design speed	Existing conditions; cost
95-22	Menifee	US 460	Design speed	Existing conditions; right-of-way acquisition; congestion
95-23	Jefferson	Non-SM	Headlight SD	Existing conditions; lighted; stop condition
95-24	Knox	Non-SM	Design speed (Passing SD)	Existing conditions; cost
95-25	Johnson	KY 40	Design speed	Existing conditions
95-26	Madison	KY 876	Design speed Ditch width Max. curvature Min. sight dist.	Right-of-way acquisitions; effect on historic area
95-27	Montgomery	KY 1331	Design speed Max. curvature	Existing conditions
95-28	Butler	KY 2267	Design speed	Existing conditions; right-of-way acquisition
95-29	Whitley	KY 1064	Design speed (SSD)	Existing conditions; effect on river
95-30	Harlan	KY 72	Design speed	Cost
95-31	Butler	KY 70	Design speed	
95-32	Madison	KY 52	Design speed	Right-of-way acquisition
95-33	Henry	US 421	Design speed	Existing conditions; length
95-34	Mercer	Non-SM	Design speed	Existing conditions
95-35	Jefferson	KY 1531	Design speed Vertical SD	Existing conditions; cost
95-36	Christian	US 41A	Storage length Taper length	Interfere with existing entrance
95-37	Mason	KY 9	Shoulder width	Consistent with 4R guidelines.
95-38	Greenup	KY 9	Shoulder width	Consistent with 4R guidelines

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
96-1	Jefferson	KY 1747	Shoulder width Ditch width	Right-of-way acquisition; cost
96-2	Madison	I 75	Design speed	
96-3	McLean	KY 85	Design speed SSD	Right-of-way acquisition
96-4	Breathitt	Non-SM	Design speed Ditch width	
96-5	Hardin	KY 1357	Sight distance	Impact on adjacent properties and streets
96-6	Hart	Non-SM	Design speed Max. curvature Min. sight dist.	Existing conditions; cost
96-7	McCracken	KY 2411	Design speed	Existing conditions; right-of-way acquisition; shorten length; cost
96-8	Jefferson	Non-SM	Max. curvature	Existing conditions
96-9	Hickman	Non-SM	Design speed	Existing alignment; length; right-of-way acquisition; cost
96-10	Oldham	Non-Sm	Pavement width Shoulder width	Proximity of residences; right-of-way; acquisition; cost
96-11	Warren	US 31W	Design speed	Existing conditions
96-12	Nelson	US 31E	Max. grade	Project length; cost
96-13	Meade	Non-SM	Number lanes Pavement width Bridge width Max. curvature	Existing conditions; right-of-way acquisition
96-14	Breckinridge	Non-SM	Number lanes Pavement width Bridge width	Existing conditions; right-of-way acquisition
96-15	Jefferson	Non-SM	Pavement width Shoulder width Bridge width	Existing conditions
96-16	Whitley	KY 904	Design speed	Existing conditions; limit length; not encroach on railroad crossing
96-17	Jefferson	Non-SM	Min. sight dist. (headlight)	Existing conditions; limit length; right-of-way acquisition; cost
96-18	Clark	Non-SM	Design speed Max. curvature Min. sight dist.	Existing conditions; cost
96-19	Harlan	Non-SM	Design speed	Existing conditions; stop condition
96-20	Harrison	Non-SM	Design speed Pavement width Bridge width	Existing conditions; right-of-way acquisition

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
96-21	Pendleton	Non-SM	Design speed Pavement width	Existing conditions; right-of-way acquisition
96-22	Madison	KY 595	Design speed	Existing conditions; right-of-way
96-23	Jessamine	Non-SM	Design speed	Existing conditions
96-24	Gallatin	KY 3002	Design speed Pavement width Bridge width Super. runoff ln.	Existing conditions; right-of-way; cost
96-25	Butler	KY 949	Design speed	Existing conditions
96-26	Kenton	KY 1120	Design speed Min. SSD	Existing conditions
96-27	Campbell	KY 10	Design speed	Existing alignment
96-28	Meade	KY 448	Design speed	Right-of-way acquisition
96-29	Pendleton	Non-SM	Design speed Number lanes Pavement width Bridge width Min. radius	Existing conditions; right-of-way acquisition
96-30	Harrison	Non-SM	Design speed Number lanes Pavement width Bridge width	Existing conditions; right-of-way acquisition
96-31	Rowan	I 64	Bridge width	Defer widening
96-32	Owen	Non-SM	Design speed Number lanes Pavement width Bridge width	Existing conditions; right-of-way acquisition
96-33	Fayette	I 64	Ln. accel. Lns.	Defer reconstruction
96-34	Jefferson	Non-SM	Vertical curve	Existing conditions; cost
96-35	Jefferson	Non-SM	Pavement width Shoulder width Ditch width Min. radius Min. sight dist.	Existing conditions
96-36	Shelby	Non-SM	Pavement width Ditch width Bridge width Min. Radius Min. sight dist.	Existing conditions
96-37	Jefferson	Non-SM	Pavement width Ditch width	Existing conditions

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
96-38	Shelby	Non-SM	Pavement width Ditch width Bridge width Min. radius Max. grade Min. sight dist.	Existing conditions
96-39	Hickman	KY 924	Design speed Sight dist. (HLSD)	Existing conditions, length, cost
96-40	Breathitt	KY 1278	Design speed Bridge width Min. radius	Existing conditions
96-41	Wolfe	KY 3356	Design speed Min. radius	Existing conditions
96-42	Owsley	KY 1503	Bridge width Min. radius	Existing conditions
96-43	Powell	Non-SM	Design speed Min. radius	Existing conditions
96-44	Pulaski	US 27	Design speed	
96-45	Boyle	KY 34	Design speed Ditch width Max. curvature	Existing conditions
96-46	Morgan	KY 711	Bridge width Min. radius	Existing conditions
96-47	Allen	Non -SM	Design speed	Existing conditions, stop condition
96-48	Butler	KY 2267	Design speed	Existing conditions
96-49	Butler	KY 2713	Design speed	Existing conditions
96-50	Bullitt	KY 2673	Design speed Pavement width Shoulder width Min. radius Min. sight dist.	Existing conditions
96-51	Trimble	KY 3175	Design speed Min. radius	Existing conditions, right-of-way acquisition; cost
96-52	Hardin	KY 1600	Design speed	Right-of-way acquisition; effect on entrances
96-53	Mercer	KY 342	Design speed	Minimum impact to surrounding property

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
97-1	Bullitt	KY 1442	Design speed Min. radius	Existing geometrics
97-2	Bourbon	KY 353	Design speed	Existing conditions; right-of-way damage
97-3	Bullitt	KY 1417	Design speed Pavement width Shoulder width Minimum radius Min. sight dist.	Existing conditions
97-4	Washington	Pulliam Rd.	Design speed Number of lanes	Existing conditions; avoid historical district
97-5	Calloway	KY 893	Pavement width Bridge width Min. radius Min. sight dist.	Existing conditions
97-6	Barren	KY 63	Design speed Min. sight dist.	Existing conditions
97-7	Metcalfe	Jack Sparks Road	Design speed	Existing conditions; stop condition
97-8	Estill	KY 52	Min. sight dist.	Stop condition
97-9	Clark	Mina Station Road	Pavement width Ditch width Minimum radius	Existing conditions
97-10	Jefferson	US 42	Lane width	Existing conditions; right-of-way cost; utility relocations
97-11	Larue	US 31E	Design speed	Right-of-way cost
97-12	Laurel	Quaker Rd.	Design speed Ditch width Bridge width	Minimal cost and disruption to adjacent properties
97-13	Shelby	KY 53	Ditch width	Width sufficient for left-turn lane
97-14	Hopkins	Church St.	Min. sight dist.	Damage to residences; cost
97-15	Kenton	KY 371	Design speed Pavement width	Existing conditions; avoid historic resources
97-16	Floyd	Rough and Tough Rd.	Design speed Number of lanes Pavement width Bridge width Min. sight dist.	Existing conditions
97-17	Fayette	Huffman Mill Road	Design speed Shoulder width Shoulder width	Existing conditions; avoid "wet stone masonry wall"; reduce right-of-way impacts

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
97-18	Floyd	KY 2030	Design speed Min. sight dist.	Existing conditions
97-19	Floyd	Hamilton Br. Road	Design speed Bridge width Min. sight dist.	Existing conditions
97-20	Johnson	Swamp Br.. Road	Design speed Bridge width	Existing conditions
97-21	Knott	Hemp Patch . Br. Road	Design speed Minimum radius Min. sight dist.	Existing conditions
97-22	Martin	Setser Br. Rd.	Design speed Bridge width	Existing conditions (consistent with adjacent road)
97-23	Pike	Blue Head Br.	Design speed Bridge width	Right -of-way and utility relocations; stop condition
97-24	Pike	KY 612	Design speed Min. sight dist.	Length and grade of project; affect on creek
97-25	Henderson	US 41	Shoulder width Ditch width Fill slope	Existing conditions
97-26	Clark	KY 1927	Design speed	Existing conditions; cost; length
97-27	Harlan	KY 38	Design speed	Cost
97-28	Butler	Gilstrap Rd.	Design speed	Existing conditions (operating speed); cost; length
97-29	Anderson	Anderson City	Design speed	Existing conditions
97-30	Hart	US 31W	Berm width	Right-of-way requirements and utility relocations
97-31	Jefferson	Lyndon Lane	Minimum radius	Existing conditions; minimize right-of-way and utility relocation costs; avoid loss of parking spaces and steep entrances for property owners
97-32	Pike	Terry Br. Rd.	Design speed Number lanes Pavement width Pavement width Min. sight dist.	Existing conditions; right-of-way acquisitions and utility relocations; channel change; cost
97-33	Scott	KY 620	Design speed	Existing conditions; minimizes right-of-way and utility involvement

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
97-34	Scott	KY 227	Design speed	Existing conditions; minimize property damage
97-35	Washington	Cardwell Rd.	Design speed	Existing conditions; length
97-36	Clay	KY 3473	Design speed	Existing conditions; minimize impact to stream; cost
97-37	Harlan	KY 1601	Design speed	Existing conditions; minimize impact to stream; minimize cost and disruption to adjacent properties
97-38	Laurel	KY 830	Design speed	Existing conditions; minimize impact to stream; minimize cost and disruption to adjacent properties
97-39	Jefferson	KY 865	Min. sight dist.	Restricted by at grade RR crossing and connection with previous project
97-40	Shelby	KY 53	Ditch width Min. sight dist.	Existing conditions; cost
97-41	Boyle	KY 33	Design speed Shoulder width	Minimizes right-of-way impact; reduces amount of pipe extension

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
98-1	Johnson	KY 40	Design speed	Fewer relocations
98-2	Pike	Swings Camp	Design speed Number lanes Bridge Width Min. sight dist.	Existing conditions
98-3	Jefferson	KY 155	Pavement width Berm width Min. sight dist.	Existing conditions; cost; length
98-4	Menifee	KY 715	Design speed Max. curvature Max. super.	Existing conditions; adjacent natural and cultural resources
98-5	Henry	Sulphur Rd.	Design speed Minimum radius Max. super.	Existing conditions; right-of-way costs; relocations
98-6	Kenton	KY 536	Design speed Shoulder width Bridge width	Existing conditions; damage to adjacent properties
98-7	Fayette	US 25	Border width Shoulder width	Existing conditions
98-8	Jefferson	KY 1020	Shoulder width Ditch width Minimum radius	Existing conditions; right-of-way impacts and cost; utility relocation
98-9	Muhlenberg	Vincent Rd.	Minimum radius Maximum grade Min. sight dist.	Right-of-way effects
98-10	Boone	KY 338	Pavement width Shoulder width Ditch width Bridge width Min. sight dist.	Right-of-way acquisition; existing conditions
98-11	Campbell	KY 547	Design speed Pavement width Shoulder width Ditch width Bridge width	Right-of-way acquisition; existing conditions
98-12	Robertson	Old Corinth	Design speed Number lanes Pavement width Bridge width	Right-of-way acquisition; existing conditions
98-13	Jefferson	Dawson Hill	Shoulder width	Space restrictions

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
98-14	Floyd	KY 114	Design speed	Right-of-way cost; traffic volume; safety; historic properties
98-15	Pike	US 23	Design speed Minimum radius	Existing conditions; length; cost
98-16	Jefferson	KY 155	Shoulder width Maximum grade Min. sight dist.	Existing conditions; cost
98-17	Marshall	US 68	Shoulder width Bridge width	Existing conditions; preserve aesthetics
98-18	Carter	KY 7	Design speed	Existing geometrics
98-19	Mason	US 62	Design speed Minimum radius	Construction and right-of-way costs
98-20	Greenup	KY 7	Tie-down loc.	Existing conditions
98-21	Fleming	Mt. Vernon. Road	Design speed	Existing conditions
98-22	Lee	KY 708	Design speed Minimum radius	Existing conditions; stop condition; right-of-way acquisition cost
98-23	Rowan	KY 32	Shoulder width Ditch width	Existing conditions
98-24	Warren	US 31W	Superelevation	Slow speeds; stop condition; existing condition
98-25	Grayson	US 62	Design speed	Available stopping distance
98-26	McLean	KY 81	Max. curvature	Minimize right-of-way damage
98-27	Garrard	KY 52	Max. curvature	Existing conditions; cost; prevent channel realignment
98-28	Jefferson	US 42	Lane width Ditch width Min. sight dist.	Existing conditions; cost; right-of-way impacts
98-29	Jefferson	US 42	Pavement width Shoulder width Ditch width	Existing conditions; cost; right-of-way impacts minimize location of utility poles
98-30	Lawrence	KY 644	Minimum radius	Existing conditions
98-31	Perry	KY 476	Minimum radius	Right-of-way acquisition; cost
98-32	Pike	US 460	Maximum grade	Cost
98-33	Pike	KY 1499	Design speed	Existing conditions
98-34	Bell	KY 2013	Design speed	Existing conditions
98-35	Livingston	KY 952	Design speed	Existing roadway alignment
98-36	Hardin	US 31W	Min. sight dist.	Right-of-way acquisition
98-37	Jefferson	I 265	Shoulder width	Construction cost

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
98-38	Franklin	I 64	Shoulder width Bridge shld. width Clear zone width	Cost; existing conditions
98-39	Harlan	KY 215	Design speed	Existing conditions
98-40	Mason	KY 9	Ditch width	Existing conditions
98-41	Fulton	KY 1129	Design speed	Existing conditions; cost
98-42	Oldham	US 42	Lane width Shoulder width Ditch width	Existing conditions; right-of-way impact
98-43	Martin	KY 292	Design speed Min. sight dist.	Existing conditions; stop condition; minimize length
98-44	Pike	US 119	Maximum grade	Cost
98-45	Scott	Galloway Rd.	Design speed	Existing conditions
98-46	Rowan	KY 799	Design speed Superelevation	Existing conditions; right-of-way acquisition
98-47	Boyd	Meade Spr.. Road	Design speed Min. sight dist. Superelevation	Existing conditions
98-48	Fleming	KY 3303	Design speed Superelevation	Existing conditions; right-of-way acquisition
98-49	Lewis	Trinity Stat. Road	Design speed Number lanes Pavement width Superelevation	Existing conditions; right-of-way acquisition
98-50	Lewis	KY 1306	Design speed Max. curvature Superelevation	Existing conditions
98-51	Nicholas	KY 1244	Design speed Superelevation	Existing conditions; right-of-way acquisition
98-52	Rowan	KY 32	Max. curvature	Length; cost
98-53	Nelson	KY 55	Design speed Min. sight dist.	Existing conditions; avoid encroachment onto cemetery
98-54	Elliott	KY 32	Design speed	Existing conditions; length
98-55	Powell	KY 11	Shoulder width	Existing conditions; impact to adjacent properties

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
99-1	Gallatin	KY 35	Min. sight dist.	Will be eliminated with future construction
99-2	Nelson	US 62	Design speed	Minimize right-of-way acquisition and construction costs
99-3	Pike	KY 3419	Design speed Shoulder width	Existing conditions; right-of-way acquisition and costs
99-4	Powell	KY 213	Shoulder width	
99-5	Pulaski	KY 90	Max. curvature	Stop condition
99-6	Boyd	KY 5	Min. radius Min. sight dist.	Stop condition
99-7	Greenup	KY 503	Design speed	Right-of-way acquisition
99-8	Jefferson	Gilmore Lane	Shoulder width Ditch width	Low speeds; right-of-way acquisition; effect on entrances
99-9	Pike	KY 199	Design speed Shoulder width	Existing conditions; length; construction costs; right-of-way acquisition
99-10	Harlan	US 421	Max. curvature Min. sight dist. Shoulder width	Right-of-way acquisition; geologic concerns
99-11	Fayette	Henry Clay Blvd.	Pavement width	Existing conditions
99-12	Breckinridge	KY 992	Design speed	Existing conditions
99-13	Boyd	US 23	Bridge width	Existing conditions
99-14	Floyd	KY 1428	Max. curvature	Right-of-way acquisition; stop condition; cost
99-15	Bath	KY 111	Design speed	Right-of-way acquisition; construction cost
99-16	Greenup	KY 1172	Max. grade	Effect on adjacent property (entrances)
99-17	Floyd	KY 122	Min. radius	Effect on adjacent property (high school); shoulder and slope restrictions
99-18	Pike	KY 194	Design speed Superelevation	Existing conditions; length; safer intersection
99-19	Warren	KY 880	Design speed	Existing conditions
99-20	Bullitt	Ramblin Rd.	Min. sight dist. Design speed	Existing conditions; stop condition
99-21	Floyd	KY 3384	Border area	Adverse effects to adjacent historic properties
99-22	Bell	US 119	Design speed	Existing conditions; construction cost (excavation)

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
99-23	Warren	KY 2158	Design speed	Right-of-way acquisition; utility relocation cost
99-24	Bracken	KY 19	Design speed Max. grade Shoulder width Ditch width	Minimize property damage
99-25	Larue	KY 470	Design speed	Existing conditions; cost
99-26	Oldham	KY 393	Max. grade Min. sight dist.	Stop condition
99-27	Lawrence	KY 3	Design speed	Stop condition; impact on commercial development; construction cost; environmental impacts
99-28	Pendleton	US 27	Shoulder width Ditch width	Right-of-way acquisition; utility avoidance
99-29	Whitley	US 25W	Shoulder width Ditch width	Right-of-way acquisition; impact on adjacent property
99-30	Fleming	KY 165	Design speed Max. curvature	Avoid sink hole; existing conditions
99-31	Henderson	US 60	Ditch width	Existing conditions; historic home; no accident history
99-32	Laurel	KY 229	Shoulder width	Existing conditions; right-of-way impact; maintenance of traffic

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
00-1	Carroll	US 42	Ditch width	Possible industrial and residential property damage
00-2	Rowan	KY 32	Shoulder width Ditch width	Right-of-way acquisition; minimizes environmental impacts; existing conditions
00-3	Clay	Sugar Cr. Rd.	Design speed	Existing conditions
00-4	Greenup	KY 503	Design speed	Existing conditions; impact on residences
00-5	Scott	US 62	Access spacing	Minimize impact on historic rock wall
00-6	Scott	KY 32	Design speed Shoulder width Min. radius Min. sight dist.	Existing conditions; minimize impact on rock wall
00-7	Elliott	KY 706	Design speed Min. radius Min. sight dist.	Cost; scope of project
00-8	Nelson	US 31E	Design speed Min. sight dist.	Existing conditions; right-of-way acquisition; utility relocation
00-9	Jefferson	Echo Trail	Design speed Min. sight dist.	Existing conditions; length (scope)
00-10	Jefferson	Indep. Sch. Road	Min. sight dist.	Existing conditions; cost; right-of-way acquisition
00-11	Grayson	US 62	Number lanes Min. sight dist.	Cost; right-of-way acquisition
00-12	McCreary	KY 1363	Number lanes Pavement width Bridge width Min. radius Min. sight dist.	Existing conditions; right-of-way issues; environmental issues
00-13	Carter	I 64	Bridge shld. wd.	Cost
00-14	Warren	KY 2158	Design speed	Utility relocation cost
00-15	Letcher	Dixon Sch. Road	Design speed	Existing conditions; stop condition; length
00-16	Meade	KY 1051	Number lanes Pavement width Shoulder width Guardrail end	Right-of-way acquisition; utility acquisition; cost
00-17	Whitley	KY 92	Design speed Max. grade	Cost; right-of-way acquisition
00-18	Carlisle	US 62	Ditch width	Existing conditions
00-19	Christian	KY 380	Shoulder width	Existing conditions

<u>NO.</u>	<u>COUNTY</u>	<u>ROUTE</u>	<u>EXCEPTION</u>	<u>REASON</u>
00-20	McCreary	Bell Farm Rd.	Design speed Number lanes Bridge width	Existing conditions; least environmental impact; right-of-way issue
00-21	Clark	KY 974	Design speed Number lanes Pavement width Bridge width Min. radius	Existing conditions
00-22	Grant	I 75	Design speed	Right-of-way acquisition
00-23	Mason	KY 10	Min. sight dist.	Existing conditions; length
00-24	Shelby	KY 53	Min. sight dist.	Existing conditions; right-of-way acquisition
00-25	Morgan	US 460	Ditch width Min. radius	Existing conditions; right-of-way acquisition
00-26	Robertson	KY 165	Design speed	Cost
00-27	Daviess	KY 405	Min. curvature	Impact on surrounding property
00-28	Estill	KY 594	Design speed	Existing conditions
00-29	Henry	KY 389	Pavement width Shoulder width Ditch width Min. sight dist.	Existing conditions; right-of-way acquisition
00-30	Kenton	KY 16	Design speed	Existing conditions
00-31	Shelby	US 60	Ditch width	Existing conditions

APPENDIX B. CRASH ANALYSIS

Number: 93-1
Location: Madison County, KY 595
ADT: 3,400
Description: curve widening project on two-lane rural road
Exception: design speed of 35 mph at curve compared to speed limit of 55 mph (note in commentary that numerous crashes had been reported at this location)
Reason: existing alignment adjacent to project and available funds
Analysis: 6 crashes at 0.5-mile site in 5 year period of 1996 through 2000 with rate of 194 crashes per 100 million vehicle miles (C/100MVM); rate much lower than critical rate of 499 C/100MVM and average rate of 250 C/100MVM for rural, two lane roadway

Number: 93-3
Location: Warren County, KY 880
ADT: 11,400
Description: widening of road including overpass of railroad
Exception: design speed of 40 mph for crest vertical curve at railroad overpass compared to 45 mph speed limit
Reason: existing conditions (close spacing of railroad and intersection)
Analysis: construction completed in 1996; average number of crashes for a 0.1-mile spot on an urban, four lane divided roadway (1998 through 2000) was 8 compared to only 2 crashes at the location of the bridge in 1998 through 2000

Number: 93-4
Location: Powell County, KY 1028
ADT: 300
Description: bridge replacement on two-lane rural road
Exception: design speed 30 mph compared to 55 mph speed limit
Reason: changing alignment would not be economical (high cost of construction and right-of-way acquisition)
Analysis: no crashes occurred at site from 1996 through 2000

Number: 93-5
Location: Johnson County, KY 40
ADT: 2,800
Description: replacement of bridge on two-lane rural road
Exception: design speed of 40 mph compared to 55 mph speed limit
Reason: existing horizontal and vertical curvature prevents travel at speed limit
Analysis: no crashes occurred at site from 1996 through 2000

Number: 93-7
Location: Meade County, US31W
ADT: 21,800
Description: construct two-way left turn lane on four lane highway (reference to prior crash history)
Exception: reduced shoulder and ditch widths
Reason: right-of-way acquisition; cost; utility relocations
Analysis: construction was in 1994; there were 131 crashes (43 rear end) in a 2-mile section from 1995 through 2000 resulting in a rate of 165 C/100MVM compared to an average of 226 C/100MVM for a four-lane, undivided rural highway; the documentation noted 248 crashes in 5 years prior to construction with the majority rear end collisions involving left turning vehicles

Number: 93-9
Location: Muhlenberg County; US 62
ADT: 10,000
Description: construct two-way left turn lane for about 0.5 mile section (urban, two lane)
Exception: lane and shoulder width less than desirable
Reason: reduced width did not require new right-of-way and minimized impact on utilities
Analysis: 10 crashes at 0.5 mile site in 3 year period of 1998 through 2000 with rate of 183 C/100MVM; rate much lower than average rate in 1998 through 2000 for two-lane urban road of 306 C/100MVM

Number: 93-10
Location: Breathitt County, KY 476
ADT: 800
Description: bridge replacement on two-lane rural road
Exception: design speed of 45 mph compared to 55 mph speed limit
Reason: economical alignment
Analysis: construction completed 1997; no crashes at site in 1998 through 2000

Number: 93-14
Location: Union County; US 60
ADT: 14,400
Description: provide two-way left turn lane between Morton Street and KY 2091
Exception: reduced pavement and shoulder width
Reason: reduce adverse impacts to business district
Analysis: construction in 1997; 42 crashes in three years prior to construction and 35 crashes in three years after; rates of 736 C/100MVM before and 613 C/100MVM after construction

Number: 93-17
Location: Madison County; US 25
ADT: 17,000
Description: construct left turn lanes at intersection on two-lane urban road
Exception: reduced shoulder and ditch widths
Reason: reduce right-of-way acquisition and utility costs
Analysis: 24 crashes in 0.3-mile spot in 1998 through 2000 with rate of 1.29 C/MV compared to average rate of 0.92 C/MV in this three-year period

Number: 93-18
Location: Boyle County; KY 1915
ADT: 300
Description: bridge replacement on two-lane rural road
Exception: design speed of 40 mph compared to speed limit of 55 mph
Reason: existing conditions and higher design speed would require more right-of-way
Analysis: no crashes at site from 1996 through 2000

Number: 93-20
Location: Breathitt County; KY 476
ADT: 1,600
Description: improve sight distance at intersection at two-lane rural road
Exception: reduced pavement width and steeper cut slope used
Reason: minimize right-of-way acquisition
Analysis: no crashes at intersection from 1996 through 2000

Number: 93-21
Location: Wolfe County; KY 15
ADT: 9,800
Description: add two-way left turn lane in Campton (two lane road)
Exception: reduced shoulder and ditch widths
Reason: discourage large trucks from parking on shoulder; costs from large cuts
Analysis: construction was in 1994; 25 crashes in 0.9-mile section from 1996 through 2000 for a rate of 156 C/100MVM compared to an average of 250 C/100MVM for two-lane rural road

Number: 93-22
Location: Montgomery County; US 460
ADT: 4,400
Description: bridge replacement on two-lane urban street
Exception: less than minimum sight distance at intersection at one end of bridge
Reason: no safety problem since intersection is signalized and lighted
Analysis: 4 crashes at intersection from 1998 through 2000; crash rate of 0.82 C/MV compares to average of 0.92C/MV for a 0.3-mile spot

Number: 93-24
Location: Washington County; KY 438
ADT: 400
Description: bridge replacement on two-lane rural road
Exception: design speed of 30 mph compared to speed limit of 55 mph; reduced sight distance
Reason: maintain existing condition (sight distance); no past crash problem; avoid alteration of state park
Analysis: no crashes at bridge from 1996 through 2000

Number: 94-1
Location: Anderson County; US 62
ADT: 2,200
Description: bridge replacement on two-lane rural road
Exception: reduced shoulder width and bridge width
Reason: reductions fit existing conditions
Analysis: no crashes on bridge from 1996 through 2000

Number: 94-10
Location: Jessamine County; KY 29
ADT: 7,200
Description: bridge replacement on two-lane urban street
Exception: design speed of 35 mph compared to a speed limit of 45 mph for a portion of the project
Reason: minimized right-of-way acquisition
Analysis: 10 crashes from 1998 through 2000 at 0.3-mile spot at bridge milepoint (critical number is 14); crash rate of 1.27 C/MV compared to average of 0.92 C/MV

Number: 94-12
Location: Hopkins County, US 41
ADT: 14,000
Description: widening from two lanes to five lanes, improving turn lanes, bridge replacement
Exception: design speed of 43.5 mph compared to 45 mph speed limit
Reason: terrain, number of entrances, retaining walls, and minimize right-of-way acquisition
Analysis: construction period from October 1998 through June 2000; 43 crashes in 1.4-mile section in 2000; crash rate of 200 C/100MVM compares to average of 313 C/100MVM on four-lane divided urban road; 40 crashes on section in 1997

Number: 94-14
Location: Scott County; KY 922
ADT: 250
Description: widening 0.3-mile spot
Exception: design speed of 35 mph compared to 55 mph speed limit; reduced ditch width and sight distance
Reason: existing conditions; minimize right-of-way acquisition
Analysis: one crash from 1998 through 2000 with rate of 3.6 C/MV compared to critical rate of about 6.2 C/MV

Number: 94-16
Location: Harrison County, US 27
ADT: 5,500
Description: construct truck climbing lane
Exception: design speed 50 mph compared to 55 mph speed limit; reduced pavement and shoulder widths and minimum sight distance; increased maximum grade
Reason: minimize right-of-way acquisition
Analysis: 13 crashes from 1998 through 2000 for 1.4-mile section; crash rate of 153 C/100MVM compares to average of 202 C/100MVM for three-lane rural roadway

Number: 94-19
Location: Mercer County; KY 33
ADT: 2,000
Description: bridge replacement on two-lane road at edge of a small town
Exception: design speed of 37 mph on bridge approaches compared to speed limit of 55 mph on one approach
Reason: existing conditions
Analysis: no crashes at bridge from 1996 through 2000

Number: 94-20
Location: Marion County; KY 49
ADT: 4,800
Description: reconstruction section of two-lane road through small town
Exception: design speed of 30 mph compared to speed limit of 35 mph
Reason: existing conditions
Analysis: 11 crashes from 1998 through 2000 on two-lane urban road for 0.6-mile section; crash rate of 349 C/100MVM compared to average of 306 C/100MVM

Number: 94-21
Location: Anderson County; KY 512
ADT: 250
Description: bridge replacement on two-lane rural road
Exception: design speed of 50 mph compared to speed limit of 55 mph; reduced pavement width; match existing grade and sight distance
Reason: existing conditions and low traffic volume
Analysis: one crash at bridge in 1996 and none in 1997 through 2000

Number: 94-22
Location: Hardin County; KY 251
ADT: 9,900
Description: widen urban road from two to four lanes
Exception: design speed of 37 mph compared to speed limit of 45 mph
Reason: existing conditions, reduce construction costs, minimize right-of-way acquisition
Analysis: under construction in 2001; crash rate for 1998 through 2000 of 620 C/100MVM compared to average of 501 C/100MVM for urban, four-lane undivided street

Number: 94-31
Location: Fayette County; KY 1974
ADT: 4,500
Description: reconstruction of 2.7-mile section of road (both two lane and four lane)
Exception: design speed of 45 mph compared to speed limit of 55 mph for portion of road
Reason: additional right-of-way acquisition is not economically feasible
Analysis: construction in 1999; crash rate of 278 C/100MVM in 1996 through 1998 compared to 158 C/100MVM in 2000 through 2001

Number: 94-37
Location: Mercer County; KY 1915
ADT: 200
Description: bridge replacement on two-lane rural road
Exception: design speed of 43 mph compared to speed limit of 55 mph
Reason: existing conditions and right-of-way acquisition
Analysis: no crashes at bridge from 1996 through 2000

Number: 94-36
Location: Campbell County; KY 536
ADT: 3,000
Description: widen and realign 2.3-mile section
Exception: design speed of 45 mph compared to speed limit of 55 mph
Reason: more balanced earthwork, budget constraints, and use of existing right-of-way
Analysis: crash rate of 140 C/100MVM in 1996 through 1998 which is below average rate of 248 and 202 C/100MVM for rural two lane and three lanes roads, respectively

Number: 94-38
Location: Boone County; KY 338
ADT: 1,800
Description: upgrade 3 mile section of two-lane rural road
Exception: design speed of 40 mph compared to speed limit of 55 mph
Reason: match existing vertical and horizontal alignment
Analysis: construction period was between 1995 and 1997; using two years of before and three years of after data shows 8 crashes before and 23 after with the rate increasing from 195 to 339 C/100MVM

Number: 95-11
Location: Morgan County; KY 711
ADT: 200
Description: reconstruct curve on steep grade; about 0.8-mile section on two-lane rural road
Exception: design speed of 45 mph compared to 55 mph speed limit; exceeded maximum curvature and grade with lower than minimum sight distance
Reason: existing conditions, cost, length, and right-of-way acquisition
Analysis: construction in 1997; no crashes reported in section from 1996 through 2000

Number: 95-12
Location: Shelby County; KY 53
ADT: 13,200
Description: intersection improvements (left turn lanes) at intersection with Seven Mile Pike
Exception: reduced ditch width
Reason: utilized ditch width sufficient (addition of left turn lanes does not fully upgrade roadway section)
Analysis: 11 crashes in 1998 through 2000 results in crash rate of 0.76 C/100MV compared to an average of 0.75 C/MV for a 0.3-mile spot for a two-lane, rural road

Number: 95-15
Location: Powell County; KY 1057
ADT: 600
Description: bridge replacement on two-lane rural road
Exception: design speed of 50 mph compared to speed limit of 55 mph; reduced ditch width
Reason: existing conditions; right-of-way acquisition
Analysis: no crashes at bridge from 1996 through 2000

Number: 95-16
Location: Washington County; KY 1586
ADT: 300
Description: bridge replacement on two-lane rural road
Exception: design speed of 31 mph compared to speed limit of 55 mph; reduced curve radius and sight distance
Reason: existing conditions; right-of-way acquisition and cost
Analysis: no crashes at bridge from 1996 through 2000

Number: 95-17
Location: Jessamine County; US 68
ADT: 6,800
Description: reconstruct intersection with KY 29
Exception: design speed of 45 mph on KY 29 compared to speed limit of 55 mph; reduced ditch width
Reason: right-of-way acquisition; impact on historic property; stop condition
Analysis: project not started; 14 crashes in 1998 through 2000 results in 1.88 C/MV compared to average of 0.75 C/MV for 0.3-mile spot on two-lane rural road

Number: 95-20
Location: Boyle County; KY 1108
ADT: 200
Description: slide repair
Exception: design speed of 20 mph compared to speed limit of 55 mph; reduced pavement width and increased grade
Reason: match existing conditions
Analysis: no crashes in 0.32 mile section in 2000

Number: 95-21
Location: Breathitt County; KY 2469
ADT: 200
Description: bridge replacement on two-lane rural road
Exception: design speed of 19 mph compared to 55 mph speed limit
Reason: existing conditions; cost
Analysis: no crashes at bridge from 1996 through 2000

Number: 95-22
Location: Menifee County; US 460
ADT: 4,200
Description: construct left turn lane at KY 713
Exception: design speed of 35 mph compared to speed limit of 55 mph
Reason: existing conditions; right-of-way acquisition; congestion
Analysis: one crash in 1998 through 2000 giving rate of 0.22 C/MV compared to average of 0.53 C/MV for 0.3-mile spot on two-lane rural road; only left turn crash was in 1995

Number: 95-26
Location: Madison County; KY 876
ADT: 600
Description: bridge replacement on two-lane rural road
Exception: design speed of 20 mph compared to speed limit of 55 mph; reduced ditch width and sight distance; increased curvature
Reason: right-of-way acquisition; effect on historic area
Analysis: under construction in 2001; two crashes at 0.3-mile spot in 1996 through 2000 giving a rate of 1.76 C/MV compared to a critical rate of about 3.4 C/MV

Number: 95-29
Location: Whitley County; KY 1064
ADT: 500
Description: bridge replacement on two-lane rural road
Exception: design speed of 37 mph compared to 55 mph speed limit
Reason: existing conditions; effect on river
Analysis: no crashes at bridge from 1996 through 2000

Number: 95-35
Location: Jefferson County; KY 1531
ADT: 900
Description: bridge replacement on two-lane rural road
Exception: design speed of 37 mph (due to reduced vertical sight distance) compared to speed limit of 55 mph
Reason: existing conditions; cost
Analysis: no crashes at bridge from 1996 through 2000

Number: 96-1
Location: Jefferson County; KY 1747
ADT: 64,000
Description: improvements to Hurstborne Parkway at intersections and I 64
Exception: reduced shoulder and ditch width
Reason: limit right-of-way acquisition and cost
Analysis: rate of 938 C/100MVM in 1995 and 1996 compares to 676 C/100MVM in 2000 and 2001

Number: 96-5
Location: Hardin County; KY 1357
ADT: 8,400
Description: widening and reconstruction of urban section
Exception: reduced sight distance at vertical curve
Reason: impact on adjacent properties and streets
Analysis: construction in 1997 and 1998; 11 crashes in 1994 through 1996 compared to 24 crashes in 1999 through 2001 results in rate increase from 199 to 435 C/100MVM; increase related to more angle crashes at Westport Road

Number: 96-7
Location: McCracken County; KY 2411
ADT: 400
Description: bridge replacement on two-lane rural road
Exception: design speed of 43 mph compared to speed limit of 55 mph
Reason: existing conditions; limit right-of-way acquisition and costs
Analysis: no crashes on bridge from 1996 through 2000

Number: 96-11
Location: Warren County; US 31W
ADT: 10,200
Description: widen at South Industrial Park intersection for turn lanes
Exception: design speed of 35 mph compared to speed limit of 55 mph
Reason: compatible with adjacent existing roadway
Analysis: rate of 0.55C/MV for 1995 through 1997 compared to 0.45 C/MV for 1999 through 2001

Number: 96-12
Location: Nelson County; US 31E
ADT: 10,000
Description: bridge replacement on two-lane rural road
Exception: increased grade
Reason: project length and cost
Analysis: construction in 2000; only one crash in 1996 through 1999 at bridge

Number: 96-22
Location: Madison County; KY 595
ADT: 600
Description: bridge replacement on two-lane rural road
Exception: design speed of 37 mph compared to 55 mph speed limit
Reason: existing conditions; reduce right-of-way acquisition
Analysis: no crashes at bridge from 1996 through 2000

Number: 96-40
Location: Breathitt County; KY 1278
ADT: 120
Description: bridge replacement on two-lane rural roadway
Exception: design speed of 19 mph compared to 55 mph speed limit; reduced bridge width and curve radius
Reason: existing conditions
Analysis: no crashes at bridge in 1999 and 2000

Number: 96-41
Location: Wolfe County; KY 3356
ADT: 100
Description: bridge replacement on two-lane rural road
Exception: design speed of 19 mph compared to 55 mph speed limit; reduced curve radius
Reason: existing conditions
Analysis: construction in 2000; no crashes in 1996 through 2000

Number: 96-45
Location: Boyle County; KY 34
ADT: 6,600
Description: widening and constructing turn lanes at intersection
Exception: design speed of 40 mph compared to 55 mph speed limit; reduced ditch width
Reason: existing conditions (curvature)
Analysis: no related crashed from 1998 through 2000

Number: 96-46
Location: Morgan County; KY 711
ADT: 200
Description: bridge replacement on two-lane rural road
Exception: reduced bridge width and curve radius
Reason: existing conditions
Analysis: construction in 1999; no crashes at bridge from 1996 through 2001

Number: 96-52
Location: Hardin County; KY 1600
ADT: 3,300
Description: vertical alignment improvement on urban two-lane road
Exception: design speed of 25 mph compared to 35 mph (relates to stopping sight distance at side road)
Reason: limit right-of-way acquisition and effect on entrances
Analysis: 8 crashes in 1995 and 1996 compared to 7 in 2000 and 2001

Number: 96-53
Location: Mercer County; KY 342
ADT: 400
Description: bridge replacement on two-lane rural road
Exception: design speed of 37 mph compared to speed limit of 55 mph
Reason: minimum impact to surrounding property
Analysis: no crashes at bridge from 1996 through 2000

Number: 97-6
Location: Barren County; KY 63
ADT: 1,400
Description: spot reconstruction related to shoulder and guardrail (noted prior accident history)
Exception: design speed of 37 mph compared to 55 mph speed limit; reduced sight distance
Reason: existing conditions (hills and curves on adjacent sections of road)
Analysis: construction in 1998; 6 crashes in two-year period before (1996-1997) compared to 1 in two-year period after (1999-2000)

Number: 97-13
Location: Shelby County; KY 53
ADT: 13,500
Description: add left turn lane at Old Mt. Eden Road (reference to rear-end collisions)
Exception: reduced ditch width
Reason: compatible with roadway
Analysis: construction in 2000; prior average of about 3 related crashes per year with no crashes at intersection in 2001

Number: 97-25
Location: Henderson County; US 41
ADT: 3,500
Description: widen for left turn lane at entrance
Exception: reduced shoulder and ditch width
Reason: existing conditions
Analysis: 2 related crashes in 1995 , 1 in 1996, 1 in 1999 with none in 1997, 1998, or 2000.

Number: 97-26
Location: Clark County; KY 1927
ADT: 1,800
Description: curve revision (relates prior crash history)
Exception: design speed of 47 mph compared to 55 mph speed limit
Reason: existing conditions for other spot improvements; cost
Analysis: not completed; only 2 crashes at curve for 1996 through 2000

Number: 98-4
Location: Menifee County; KY 715
ADT: 100
Description: bridge replacement on two-lane rural road (Gladie Creek bridge)
Exception: design speed of 20 mph compared to 35 mph speed limit; increased curvature and reduced superelevation
Reason: existing conditions; adjacent natural and cultural resources
Analysis: no crashes at bridge from 1996 through 2000

Number: 98-14
Location: Floyd County; KY 114
ADT: 9,700
Description: reconstruct two lane road to four lane road with flush median; length 2.3 miles
Exception: design speed of 43 mph compared to 45 and 55 mph speed limits
Reason: reduce right-of-way acquisition and effect on historic properties; safety
Analysis: crash rate of 262 C/100MVM for three-year period prior to construction compared to 258 C/100MVM in 2001

Number: 98-26
Location: McLean County; KY 81
ADT: 4,300
Description: replacement of bridge and approaches over Green River at Calhoun
Exception: maximum curvature
Reason: minimize right-of-way acquisition
Analysis: average of about 3 crashes per year prior to construction

Number: 98-28
Location: Jefferson County; US 42
ADT: 25,400
Description: construction of left turn lane and replace traffic signal at Seminary Drive intersection; reference to crash history
Exception: reduced lane and ditch widths and reduced sight distance
Reason: match existing lane width; reduce construction costs and right-of-way impacts
Analysis: related crashes were 5 in 1995, 6 in 1996, and 1 each year for 1997 through 2001

Number: 98-29
Location: Jefferson County; US 42
ADT: 19,200
Description: construction of left turn lane and replace traffic signal at Blankenbaker Lane intersection (reference to crash history)
Exception: reduced pavement, shoulder, and ditch widths
Reason: match existing lane width; reduce construction costs and right-of-way impacts
Analysis: average of 7 crashes per year in 1995 through 1997; none in 1998 and 1999, 3 in 2000, and 1 in 2001

Number: 98-53
Location: Nelson County; KY 53
ADT: 2,100
Description: reconstruct vertical and horizontal curves (under 0.1 mile in length); noted prior crash history
Exception: design speed of 31 mph compared to 55 mph speed limit; reduced sight distance
Reason: existing conditions; avoid encroachment into cemetery
Analysis: not constructed; 5 crashes at site in 2000

Number: 99-14
Location: Floyd County; KY 1428
ADT: 6,700
Description: relocation and widening including turn lane and sidewalks (noted prior history of rear end and angle crashes)
Exception: maximum curvature
Reason: right-of-way acquisition; cost; stop condition
Analysis: not constructed; rate of 450 C/100MVM for 1996 through 2000 compared to average of 323 C/100MVM for two-lane urban road

Number: 99-29
Location: Whitley County; US 25W
ADT: 10,200
Description: improve sight distance at intersection with KY 727 (noted crash history)
Exception: reduced shoulder and ditch widths
Reason: right-of-way considerations and impacts to adjacent properties
Analysis: not constructed; rate of 1.67 C/MV at 0.3-mile spot for 1996 through 2000 compared to average of 0.75 C/MV for two-lane rural road and critical rate of 1.30 C/MV

Number: 99-31
Location: Henderson County; US 60
ADT: 9,800
Description: widen about 0.9-mile section of two-lane road
Exception: reduced ditch width
Reason: existing conditions; minimize impact on historic home; no crash history
Analysis: crash rate for 1995 through 1999 was 253 C/100MVM compared to average of 252 C/100MVM for two-lane rural road

Number: 00-8
Location: Nelson County; US 31E
ADT: 4,500
Description: improve geometrics at intersection with KY247 (noted crash history)
Exception: design speed of 40 mph compared to 55 mph speed limit; reduced sight distance
Reason: existing conditions; right-of-way acquisition; utility relocation
Analysis: crash rate of 1.10 C/MV for 0.3-mile spot for 1995 through 1999 compared to average of 0.76 C/MV for two-lane rural road and critical rate of 1.63 C/MV

Number: 00-11
Location: Grayson County; US 62
ADT: 14,400
Description: widen from two to three lanes
Exception: number of lanes; minimum sight distance
Reason: cost and right-of-way acquisition
Analysis: not constructed; crash rate of 62 C/100MVM for 1995 through 1999 compared to average of 333 C/100MVM for two-lane urban road

Number: 00-17
Location: Whitley County; KY 92
ADT: 2,200
Description: reconstruct 6.45 miles
Exception: design speed of 45 mph for a portion of the project; increased grade
Reason: right-of-way acquisition; cost
Analysis: not constructed; crash rate of 326 C/100MVM for 1996 through 2000 compared to average of 250 C/100MVM for two-lane rural road

TABLE B-1. SUMMARY OF CRASH DATA FOR CRASH STUDY SITES

SITE NO.	LOCATION (COUNTY/ROUTE)	CRASH RATE OR NUMBER OF CRASHES		STATEWIDE AVERAGE RATE/NO.	CRITICAL RATE OR NUMBER
		BEFORE	AFTER		
93-1	Madison/KY 595		194	250	499
93-3	Warren/KY 880		2*	8*	16*
93-4	Powell/KY 1028		0*		
93-5	Johnson/KY 40		0*		
93-7	Meade/US 31W	300	165	226	293
93-9	Muhlenberg/US 62		183	306	707
93-10	Breathitt/ KY 476		0*		
93-14	Union/US 60	736	613	487	670
93-17	Madison/US 25		1.29	0.92	
93-18	Boyle/KY 1915		0*		
93-20	Breathitt/KY 476		0*		
93-21	Wolfe/KY 15		156	250	347
93-22	Montgomery/US 460		0.82	0.92	
93-24	Washington/KY 438		0*		
94-1	Anderson/US 62		0*		
94-10	Jessamine/KY 29		1.27	0.92	
94-12	Hopkins/US 41		200	313	405
94-14	Scott/KY 922		3.6		6.2
94-16	Harrison/US 27		153	202	376
94-19	Mercer/KY 33		0*		
94-20	Marion/KY 49		349	306	536
94-21	Anderson/KY 512		0*		
94-22	Hardin/KY 251	630		501	695
94-31	Fayette/KY 1974	278	158		
94-36	Campbell/KY 536		140	202	
94-37	Mercer/KY 1915		0*		
94-38	Boone/KY 338	195	339	248	396
95-11	Morgan/KY711		0*		
95-12	Shelby/KY 53		0.76	0.75	1.23
95-15	Powell/KY 1057		0*		
95-16	Washington/KY 1586		0*		
95-17	Jessamine/US 68	1.88		0.75	
95-20	Boyle/KY 1108		0*		
95-21	Breathitt/KY 2469		0*		

TABLE B-1. SUMMARY OF CRASH DATA FOR CRASH STUDY SITES

SITE NO.	LOCATION (COUNTY/ROUTE)	CRASH RATE OR NUMBER OF CRASHES		STATEWIDE AVERAGE RATE/NO.	CRITICAL RATE OR NUMBER
		BEFORE	AFTER		
95-22	Menifee/US 460		0.22	0.53	
95-29	Whitley/KY 1064		0*		
95-35	Jefferson/KY 1531		0*		
96-1	Jefferson/KY 1747	938	676	313	360
96-5	Hardin/KY1357	199	435	306	491
96-7	McCracken/KY 2411		0*		
96-11	Warren/US 31W	6*	2*		
96-12	Nelson/US 31E	0.45	0.55	0.75	1.30
96-22	Madison/KY 595		0*		
96-40	Breathitt/KY 1278		0*		
96-41	Wolfe/KY 3356		0*		
96-45	Boyle/KY 34		0*		
96-46	Morgan/KY 711	0*	0*		
96-52	Hardin/KY 1600	664	581	248	503
96-53	Mercer/KY 342		0*		
97-6	Barren/KY 63	6*	2*		
97-13	Shelby/KY 53	3*	0*		
97-25	Henderson/US 41	3*	1*		
97-26	Clark/KY 1927	2*			
98-4	Menifee/KY 715	0*	0*		
98-14	Floyd/KY 114	262	258		
98-26	McLean/KY 81	3*			
98-28	Jefferson/US 42	4*	1*		
98-29	Jefferson/US 42	7*	2*		
98-53	Nelson/KY 53	5*			
99-14	Floyd/KY 1428	450		323	
99-29	Whitley/US 25W	1.67		0.75	1.30
99-31	Henderson/US 60	253		252	
00-8	Nelson/US 31E	1.10		0.76	1.63
00-11	Grayson/US 62	62		333	
00-17	Whitley/KY 92	326		250	

- Refers to number of crashes; otherwise would be crash rate (C/100MV or C/100MVM).