1551

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16. Abstract

The effect of 8-in. wide edgelines on the incidence of run-off-the-road (ROR) and related accidents was evaluated. The treatment locations consisted of three two-lane rural road sections totaling 55.2 miles. A before-and-after design with a comparison group, and a check for comparability were used to analyze data. Five years of accident data, covering the three years before wide edgeline installation and the two years after installation, were used.

It was concluded that there is no evidence to indicate that wide edgelines significantly affected the incidence of ROR and related accidents for any individual treatment location or for the locations combined. The related accidents include ROR accidents involving driving under the influence of alcohol or drugs, ROR accidents on curves, ROR accidents during darkness, and opposite-direction accidents. Consequently, it was recommended that wide edgelines not be considered as a countermeasure for ROR accidents in Virginia.

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-1552

SI CONVERSION FACTORS

To Convert From	To	Multiply By
Length:		
in	cm	2.54
in	m	0.025 4
ft	m	0.304 8
yd	m	0.914 4
mi	km	1 . 609 344
Area:		
in^2	cm^2	6.451 600 E+00
ft^2	m^2	9.290 304 E-02
yd^2	m^2	8.361 274 E-01
mi^2	Hectares	2.589 988 E+02
acre (a)	Hectares	4.046 856 E-01
Volume:		
oz	m^3	2.957 353 E-05
pt	m^3	4.731 765 E-04
qt	m^3	9.463 529 E-04
gal	m^3	3.785 412 E-03
in^3	m^3	1.638 706 E-05
ft^3	m^3	2.831 685 E-02
yd^3	m^3	7.645 549 E-01
Volume per Unit Time:	NOTE: 1m^3 = 1,000 L	
ft^3/min	m^3/sec	4.719 474 E-04
ft^3/s	m^3/sec	2.831 685 E-02
in^3/min	m^3/sec	2.731 177 E-07
yd^3/min	m^3/sec	1.274 258 E-02
gal/min	m^3/sec	6.309 020 E-05
Mass:		
oz	kg	2.834 952 E-02
dwt	kg	1.555 174 E-03
lb	kg	4.535 924 E-01
ton (2000 lb)	kg	9.071 847 E+02
Mass per Unit Volume:		
lb/yd^2	kg/m^2	4.394 185 E+01
lb/in^3	kg/m^3	2.767 990 E+04
lb/ft^3	kg/m^3	1.601 846 E+01
lb/yd^3	kg/m^3	5.932 764 E-01
Velocity: (Includes Speed)		
ft/s	m/s	3.048 000 E-01
mi/h	m/s	4.470 400 E-01
knot	m/s	5.144 444 E-01
mi/h	km/h	1.609 344 E+00
Force Per Unit Area:		
lbf/in^2 or psi	Pa	6.894 757 E+03
lbf/ft^2	Pa	4.788 026 E+01
Viscosity:		
cS$_t$	m^2/s	1.000 000 E-06
P	Pa·s	1.000 000 E-01

Temperature: (°F-32)^5/9 = °C

FINAL REPORT

EVALUATION OF WIDE EDGELINES ON TWO-LANE RURAL ROADS

by

B. H. Cottrell, Jr.
Research Scientist

(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

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ABSTRACT

The effect of 8-in. wide edgelines on the incidence of run-off-the-road (ROR) and related accidents was evaluated. The treatment locations consisted of three two-lane rural road sections totaling 55.2 miles. A before-and-after design with a comparison group, and a check for comparability were used to analyze data. Five years of accident data, covering the three years before wide edgeline installation and the two years after installation, were used.

It was concluded that there is no evidence to indicate that wide edgelines significantly affected the incidence of ROR and related accidents for any individual treatment location or for the locations combined. The related accidents include ROR accidents involving driving under the influence of alcohol or drugs, ROR accidents on curves, ROR accidents during darkness, and opposite-direction accidents. Consequently, it was recommended that wide edgelines not be considered as a countermeasure for ROR accidents in Virginia.

1556

FINAL REPORT

EVALUATION OF WIDE EDGELINES ON TWO-LANE RURAL ROADS

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INTRODUCTION

Problem Statement

There are a high number of run-off-the-road (ROR), drunken driving, and night accidents in rural areas. In 1985, there were 19,385 ROR accidents in rural areas in Virginia (1). Of this total, 268 (1.4%) were fatal accidents, 9,434 (48.6%) were injury accidents, and 9,683 (50.0%) were property damage accidents. ROR accidents accounted for 29.1% of all rural accidents, 40.7% of the fatal accidents (the largest percentage for any type of accident), and 35.6% of the injury accidents in rural areas. Persons driving under the influence of alcohol or drugs (DUI) were involved in 9,878 (14.8%) of all rural accidents. Accidents involving DUI accounted for 34.4% of fatal accidents, 20.1% of injury accidents, and 11.0% of property damage accidents in rural areas. There were 22,570 accidents during darkness, which constituted 33.9% of all accidents in rural areas.

To provide guidance to motorists , edgelines are used to delineate the right edge of the roadway. The standard edgeline width is 4 inches. The edgeline is one element in a pavement marking system that provides warning and guidance information to the driver without diverting his attention from the roadway (2). Reflectorized pavement markings are the most common form of delineation at night when the reduced visibility creates a greater need for guidance information.

Edgelines 8 in. wide have the potential to reduce the probability of a driver running off the road and increase the probability of a driver positioning his vehicle close to the centerline. However, since wide edgelines have the potential to influence the lateral position of the vehicle in this manner, the probability of centerline encroachment may increase. The Virginia Department of Transportation currently uses wide edgelines and centerlines in special circumstances, viz. in gore areas on interstate routes, tunnel entrances, and approaches to narrow bridges.

Objectives and Scope

The objectives of this research, which was requested by the Traffic Engineering Division, were to evaluate the effect of wide edgelines on the incidence of ROR, DUI and other related accident types, and on the lateral placement and speed of vehicles.

The Governor's Task Force to Combat Drunk Driving addressed the issue of highway edgelines in its action plan, and recommended that the "Virginia Department of Highways and Transportation should investigate the use of wide (8-inch) edgelines on secondary roads as a measure for reducing accidents involving DUI" (3).

The scope was limited to two-lane rural roads. Primary routes were selected because accident data are more detailed and more readily available for them than for secondary routes.

This final report is concerned with the incidence of accidents. The interim report, which documented the evaluation of lateral placement and speed, is summarized below.

Interim Report Summary

This interim report presented the results of an evaluation of 4-in. and 8-in. wide edgelines on the lateral placement and speeds of vehicles on two-lane rural roads (4). Data were collected at twelve locations on sections of roadway covering 55.2 mi. Two methods of painting the 8 in. width were also analyzed. The following conclusions were drawn.

Analysis of Wide Edgeline Painting

1. The costs per mile for materials (paint and beads) were 100% greater and the labor and equipment costs per mile were 33% greater for the 8-in. wide edgeline than the costs for the 4-in. line. The total costs per mile were 90% greater for the 8-in. wide edgeline.

2. The total cost per mile for the raised-paint-gun method was 7% lower than that for the two-paint-gun method of painting wide edgelines.

Analysis of Lateral Placement and Speed

1. There were no statistically significant differences between the 4- and 8-in. wide edgelines in lateral placement, lateral placement variance, encroachments by cars and trucks, mean speed, and speed variance.

2. The mean lateral placement was significantly lower for the 8-in. wide edgeline. However, the difference was of a small magnitude and of no practical significance.

   Lateral placement and speed were not practically affected by a change from a 4-in. to an 8-in. wide edgeline.

STUDY DESIGN

The study design consisted of the experimental plan, the treatment locations, the comparison locations, and the measures of performance.

Experimental Plan

After the evaluation and testing of several procedures for evaluating highway safety improvements, a before-after design with a comparison group and a check for comparability was selected. A detailed description of this procedure is given in reference 5. The before-after design with a comparison group, and a check for comparability provides some relief from two fallacies. By using a comparison group, the influence of extraneous factors are at least partially controlled; therefore, there is some relief from the post hoc ergo propter hoc (after the fact, therefore, because of the fact) fallacy (5). By using multiple before and after readings (for example, each year represents a reading), there is some relief from the regression toward the mean fallacy (5). Consequently, this evaluation design is more rigorous and more valid than a simple before-after design and a before-after design with a comparison group.

The comparability is determined by the difference in the rate of change in the frequency of accidents at the treatment and comparison locations during the before and after periods (figure 1). The rates of change in accident frequencies are expressed as natural logarithms. When the rates of change in accident frequencies of the treatment and comparison groups are equivalent, the slopes of the natural log (ln) frequency over time are the same, and therefore they are parallel (figure 2). The procedure involves the two steps described below.

Step 1. Check for Comparability

If the slopes on the treatment and comparison functions of ln frequency versus time deviate by more than chance expectation during the before and after periods, then the comparison group is not comparable to the treatment group and further analysis is not appropriate. If the slopes do not deviate, there is no reason to doubt the comparability of the comparison group (5).

Figure 1. Frequency Graph

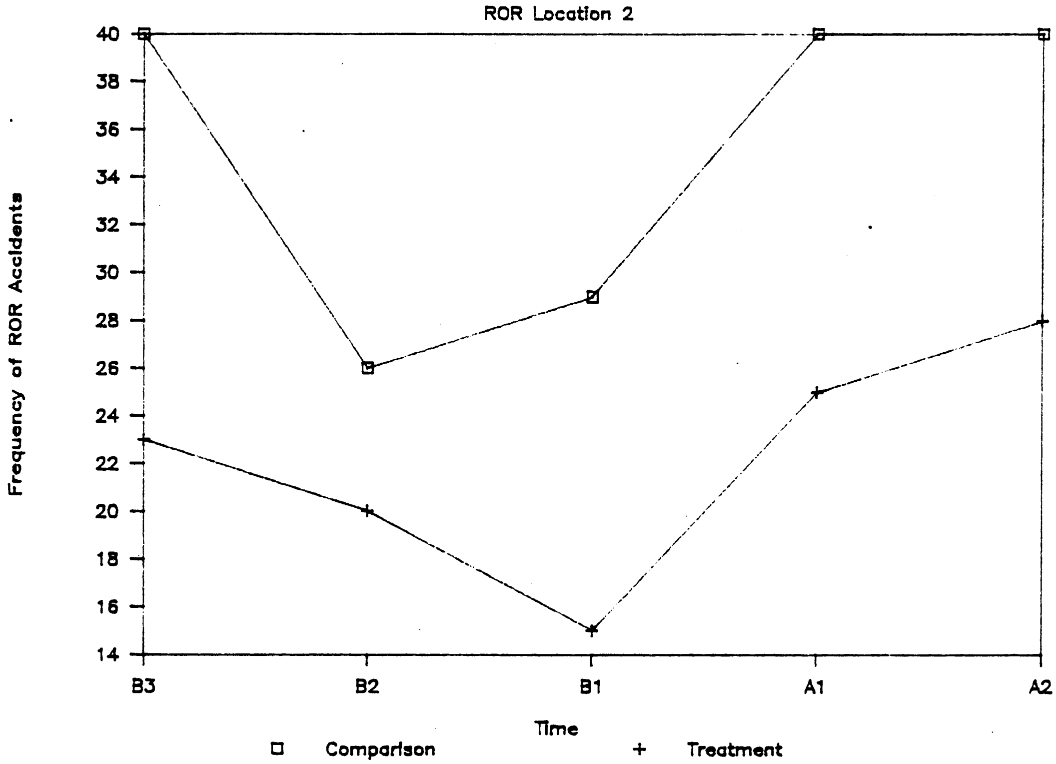
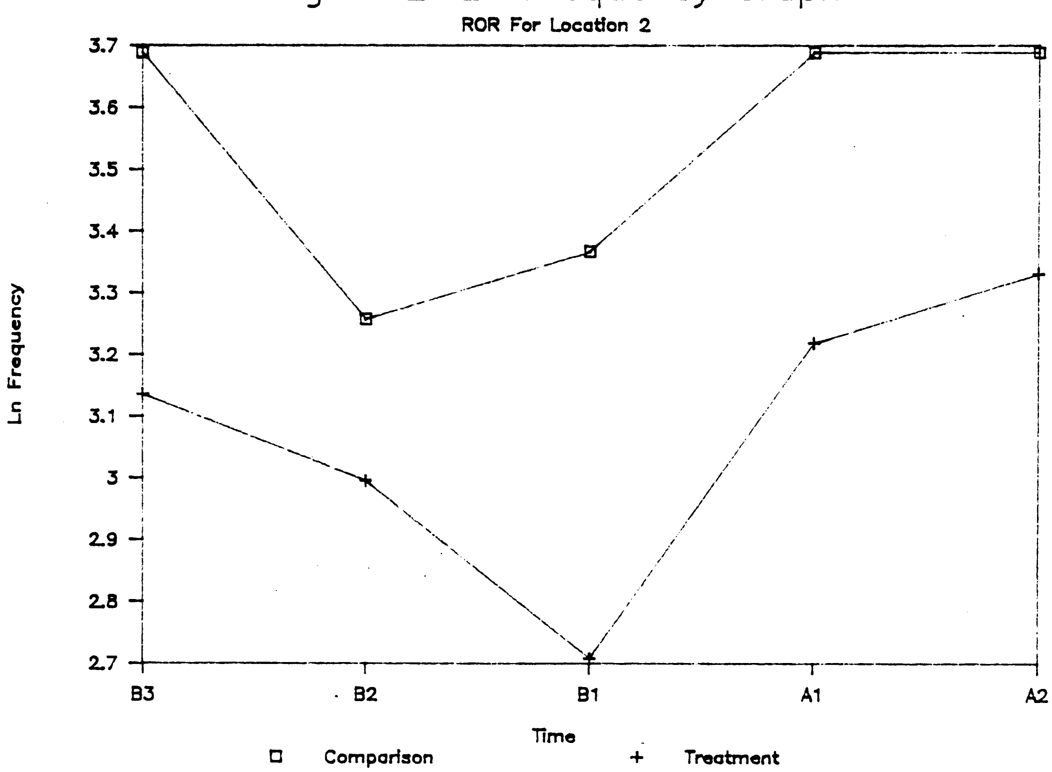


Figure 2. Ln Frequency Graph



Step 2. Effect of the Treatment

In the second step, the treatment and comparison groups are collapsed across the before and after periods. If the slopes on the treatment and comparison functions do not deviate by more than chance expectation from before to after, then there is no evidence that the treatment imposed affected the incidence of accidents. If the slopes do deviate, then the treatment is said to have produced an effect. If the slope on the treatment is more negative (or less positive) than the slope in the comparison function, the treatment is beneficial. If the slope on the treatment function is less negative (or more positive) than the slope on the comparison function, the treatment is harmful (5).

Statistical Equations

The calculations used to answer the questions are based on the likelihood ratio chi-square (G^2) test. A 2 X n contingency table, where n = total number of years of data, is developed. The overall goodness-of-fit test, G^2 total, is equal to the sum of G^2 Comparability and G^2 Treatment. In other words, the contingency table is partitioned into two parts: G^2 Comparability for the goodness of fit within the before and after periods for homogeneity of the treatment and comparison group (this is step 1), and G^2 Treatment, the goodness of fit from the before and after periods for the association of the treatment and comparison groups (step 2) (5, 6).

The critical G^2 values that are compared with G^2 Comparability and G^2 Treatment are based on a 0.05 level of significance and are 7.81 and 3.84, respectively.

The formula for the likelihood ratio chi-square (G^2) test is (5):

$$G^2 = -2 \sum_i \sum_j X_{ij} \ln \frac{\hat{m}_{ij}}{X_{ij}} \qquad (1)$$

where X_{ij} = observed accident frequency in cell i j row (i) and column (j)

$\hat{m}_{ij} = \frac{X_{i+}X_{+j}}{X_{++}}$ for G^2 Before $i = 1,2,3$, $j = 1,2$

for G^2 After and G^2 Treatment $i = 1,2$, $j = 1,2$

$X_{i+} = \sum_j X_{ij}$ (sum of row i)

$X_{+i} = \sum_i X_{ij}$ (sum of column j)

$X_{++} = \sum_i \sum_j X_{ij}$ (sum of the partitioned contingency table being tested)

An alternative exists for calculating G^2 Treatment when G^2 Comparability is not significant. Using the same 2 X 2 table as in step 2, where the treatment and comparison groups are collapsed across the before and after periods (as shown below), the following equations may be used.

	Comparison	Treatment
B3-B1	X_{11}	X_{12}
A1-A2	X_{21}	X_{22}

$$\tau = \frac{X_{11} \; X_{22}}{X_{12} \; X_{21}} \qquad (2)$$

τ-1 equals the apparent percentage change in accidents attributable to the treatment

$$Z = \frac{\ln \tau}{\sqrt{\frac{1}{X_{11}} + \frac{1}{X_{12}} + \frac{1}{X_{21}} \; \frac{1}{X_{22}}}} \qquad (3)$$

For $\alpha = 0.05$ and a two-tailed test the confidence interval lies between -1.96 and +1.96.

The advantage to using this alternative is that the apparent change in accidents attributable to the treatment is obtained. Both methods of calculating G^2 treatment were used in the analysis. A limitation is noted in using this study design: to avoid dividing by 0, which results in an undefined G^2 value, each cell in the 2 X 5 contingency table must be greater than 0.

It is noted the frequencies are used in contingency tables instead of rates. Moreover, with a good comparison group, exposure is omitted as a factor.

Combining Treatment Sections

In order to examine the effects of all three treatment sections together, the logarithms of the odds ratios are combined using a procedure commonly referred to as Gart's procedure (6, 7, 8). Gart's procedure combines 2 X 2 contingency tables using the natural logarithm of the odds (or the maximum likelihood) ratio as the measure of association. The ordinary weighted arithmetic mean of the treatment effect is obtained for each location. Figure 3 displays the worksheet used for the procedure and the equations used. The chi-square statistic for testing the homogenity of the odds ratio, X^2 homogeneity with 2 degrees of freedom, indicates the existence of significant differences among the three odd ratios. An acceptable X^2 homogeneity indicates no significant difference. The chi-square statistic for testing the significance of the mean log odds ratio, X^2 association with one degree of freedom, indicates the existence of significant differences between the comparison and treatment groups. The chi-square total is equal to the sum of X^2 homogeneity and X^2 association.

There are benefits to combining the three locations. By increasing the amount of data available for testing, the statistical power is increased. Furthermore, combining the locations improves the opportunity to identify a treatment effect if one is present.

Accident Type:

Study Number	Comparison Before a	Comparison After b	Treatment Before c	Treatment After d	Estimated Weights W_i	Relative Risk L_i	Product $W_i \cdot L_i$	$W_i\ (L_i)^2$
1								
2								
3								
Total					ΣW_i		$\Sigma W_i L_i$	$\Sigma W_i\ (L_i)^2$

$W_i = \frac{1}{a} + \frac{1}{b} + \frac{1}{c} + \frac{1}{d}\ ^{-1}$ - weighted arithmetic mean

$L_i = \ln \frac{a}{b} \cdot \frac{d}{c}$ - natural logarithm of the odds ratio

$X^2_{total} = \Sigma W_i\ (L_i)^2$

$X^2_{homogeneity} = \Sigma W_i\ (L_i)^2 - \frac{\Sigma W_i L_i)2}{\Sigma W_i}$

$X^2_{association} = X^2_{total} - X^2_{homogeneity}$

Critical X^2

df	α=0.05
2	5.99
1	3.84

Figure 3. Worksheet for combining the three locations.

-1568

Treatment Locations

The three sections of roadway that served as the treatment locations are (1) Route 20, Buckingham County (17.17 miles); (2) Route 20 from Route 53 near Charlottesville south to county line, Albemarle County (19.05 miles); and (3) Route 501, Bedford County from Route 761 north to county line, and Rockbridge County from county line 5.4 miles northward (24.4 miles). Wide edgelines, 8 in. in width, were painted at these sites during the spring and summer of 1984. The wide edgelines were repainted approximately one year later. The actual edgeline width varied from 7.0 to 10.0 in. The study sections were in four districts, therefore, four different paint crews were used. Based on 12 sample-site studies in the interim report for lateral placement and speed changes, the average edgeline width for each treatment section was: (1) Route 20, Buckingham County--7.6 in.; (2) Route 20, Albemarle County--7.4 in.; and (3) Route 501, Bedford County--10 in., Rockbridge County--7 in. (overall weighted average of 9.3 in.).

Comparison Locations

Several measures were used as a guide in selecting locations for comparison with the three treatment locations. The primary objective was to identify locations that were similar to the treatment locations for the following characteristics: 2-lane rural roads, overall roadway geometrics, total accident frequencies, run-off-the-road accident frequencies, and alcohol-drug related accident frequencies. Also, there were no changes planned for the road sections that would influence the frequency of accidents. The key to the appropriateness of a comparison location is the check for comparability. If the check results in the treatment location not being comparable with the comparison location, the alternative comparison location was the treatment location with all other accident types. The alternative comparison locations eliminate extraneous factors such as exposure, alignment, and weather, since the alternative comparison and treatment road sections are the same. The treatment and original comparison locations are listed below.

	Treatment	Comparison
1.	Route 20, Buckingham County Counties	Route 40, Halifax and Pittsylvania (Route 501 to Gretna)
2.	Route 20, Albemarle County	Route 8, Floyd and Montgomery Counties (Route 221 to Christianburg)
3.	Route 501, Bedford and Rock-bridge Counties	Route 20, Albemarle and Orange County (Route 33 to Route 250)

Data

Accident data were obtained from the Virginia Department of Transportation's computerized traffic accident reporting system. The years and time periods are shown below.

B3	1981
B2	1982
B1	1983
A1	7/1/84 to 6/30/85 or 9/1/84 to 8/31/85
A2	7/8/85 to 6/30/86 or 9/8/85 to 8/31/86

Measures of Effectiveness

This evaluation focuses on the effectiveness of the wide edgelines in reducing accidents, especially ROR, DUI, and other related accidents. ROR accidents are the primary accident type evaluated. Also, ROR accidents involving four other factors, besides DUI were selected for a detailed analysis. ROR accidents at curves were considered since horizontal alignment is a factor in ROR accidents. Since edgelines are important in delineating the roadway during darkness, ROR accidents during darkness were selected as a measure. Since inclement weather is an extraneous factor that may contribute to ROR accidents, ROR accidents in inclement weather were selected as a measure. Because of concern about drivers encroaching on the centerline with wide edgelines,

-1568

opposite-direction accidents were evaluated. A total of six measures of effectiveness were used.

ACCIDENT DATA ANALYSIS

The analysis results for each measure of performance are described below for each treatment section and for all sections combined.

Run-off-the-Road Accidents

The analysis data for ROR accidents are shown in Table 1.

In the check for comparability, treatment location 1, Route 20, Buckingham County, was not comparable to its original comparison location. Therefore, the alternative comparison location of all non-ROR accidents on the treatment location was used and found to be comparable for all treatment locations. Based on G^2 Treatment, there was no evidence that the wide edgelines significantly affected the incidence of ROR accidents for any of the three treatment locations individually or combined.

ROR Accidents Involving DUI

The analysis data are shown in Table 2.

Due to 0 values in the original comparison location for treatment location 1, the alternative comparison location of all other accidents on the treatment locations was used and found to be comparable for all treatment locations at $\alpha = 0.05$. There was no evidence that the wide edgelines significantly affected the incidence of accidents involving both ROR and DUI on all treatment locations. Based on X^2 homogeneity and X^2 association, the combined locations are acceptable and there is no indication of a significant effect.

TABLE 1
ROR Accidents

a. Analysis for Each Location

Year	Location 1		Location 2		Location 3	
	C	T	C	T	C	T
B1	1	4	40	23	20	21
B2	10	10	26	20	18	16
B3	5	10	29	15	23	16
A1	13	6	40	25	14	12
A2	12	11	40	28	25	20

Source	Location 1	Location 2	Location 3	df	Critical X^2 $\alpha=0.05$
Comparability					
Before	2.02	0.93	0.84	2	5.99
After	1.15	0.10	0.02	1	3.84
Treatment	3.14	0.11	0.04	1	3.84
Total	6.31	1.14	0.90	4	
Apparent Change (%)	-55	9	-6		

Conclusion for Each Location

Comparability--Acceptable for each
Treatment--No significant effect for each

b. Combining Locations Using Gart's Procedure

Source	X^2	df	Critical X^2 $\alpha=0.05$
Homogeneity	2.91	2	5.99
Association	0.31	1	3.84
Total	3.22	3	

Conclusion for Combined Locations

Homogeneity--Acceptable
Association--No significant effect

Legend
C--Comparison T--Treatment

Apparent change values are given only if locations are comparable.

1570

TABLE 2
ROR Involving DUI

a. Analysis for Each Location

Year	Location 1 C	Location 1 T	Location 2 C	Location 2 T	Location 3 C	Location 3 T
B1	2	3	60	3	34	7
B2	18	2	36	10	30	4
B3	11	4	43	1	38	1
A1	16	3	60	5	22	4
A2	19	4	64	4	42	3

Source	Location 1	Location 2	Location 3	df	Critical X^2 $\alpha=0.05$
Comparability					
Before	5.52	11.80	5.31	2	5.99
After	0.02	0.17	1.35	1	3.84
Treatment	0.44	0.55	0.02	1	3.84
Total	5.99	12.52	6.69	4	
Apparent Change (%)	-31	--	-7		

Conclusion for Each Location

Comparability--Location 2 not acceptable; locations 1 and 3 acceptable
Treatment--No significant effect for locations 1 and 3

b. Combining Locations Using Gart's Procedure

Source	X^2	df	Critical X^2 $\alpha=0.05$
Homogeneity	0.25	2	5.99
Association	0.20	1	3.84
Total	0.45	3	

Conclusion for Combined Locations 1 and 3

Homogeneity--Acceptable
Association--No significant effect

Legend
C--Comparison T--Treatment

Apparent change values are given only if locations are comparable.

ROR Accidents on Curves

Treatment location 3, was not comparable with the original or alternative comparison locations. The other two treatment locations were comparable with both the original and alternative comparison locations. There was no evidence that the wide edgelines significantly affected the incidence of ROR accidents on curves for these two treatment locations for both comparison locations. In Table 3, the analysis data are shown for the original comparison location. When locations 1 and 2 are combined, the X^2 homogeneity was acceptable and X^2 association indicated no significant effect.

ROR Accidents During Darkness

The analysis data are shown in Table 4.

All three pairs of treatment and original comparison locations were comparable. Furthermore, for all three locations, there was no evidence to suggest that the wide edgelines significantly affected the incidence of ROR accidents during darkness.

X^2 homogeneity is acceptable and X^2 association indicates that there is no significant effect for the combined locations.

ROR and Weather

Due to the presence of 0 values for each treatment and comparison location in the contingency table, it was not possible to analyze ROR and weather. The low frequency of ROR accidents in inclement weather demonstrates that weather is not a substantial influence in ROR accidents. Consequently, it was concluded that there was an insufficient number of ROR accidents in inclement weather to determine a statistical effect.

-1572

TABLE 3
ROR on Curves

a. Analysis for Each Location

Year	Location 1 C	Location 1 T	Location 2 C	Location 2 T	Location 3 C	Location 3 T
B1	4	1	46	17	25	16
B2	17	3	33	13	23	11
B3	11	4	36	8	29	10
A1	15	4	50	15	19	7
A2	19	4	49	19	29	16

Source	Location 1	Location 2	Location 3	df	Critical X^2 $\alpha=0.05$
Comparability					
Before	0.72	1.55	46.18	2	5.99
After	0.09	0.41	-64.19	1	3.84
Treatment	0.01	0.02	0.46	1	3.84
Total	0.82	1.99	-17.55	4	
Apparent Change (%)	-6	4	--		

Conclusion for Each Location

Comparability--Locations 1 and 2 are comparable; not location 3
Treatment--No significant effect for locations 1 and 2

b. Combining Locations Using Gart's Procedure

Source	X^2	df	Critical X^2 $\alpha=0.05$
Homogeneity	0.02	2	5.99
Association	0.01	1	3.84
Total	0.03	3	

Conclusion for Combined Locations 1 and 2

Homogeneity--Acceptable
Association--No significant effect

Legend
C--Comparison T--Treatment

Apparent change values are given only if locations are comparable.

TABLE 4
ROR During Darkness

a. Analysis for Each Location

Year	Location 1 C	Location 1 T	Location 2 C	Location 2 T	Location 3 C	Location 3 T
B1	2	2	6	8	5	15
B2	1	5	4	12	9	8
B3	1	5	5	8	9	5
A1	3	5	4	13	13	8
A2	2	7	3	16	10	13

Source	Location 1	Location 2	Location 3	df	Critical X^2 $\alpha=0.05$
Comparability					
Before	1.64	1.18	5.96	2	5.99
After	0.48	0.34	1.50	1	3.84
Treatment	0.08	2.37	0.49	1	3.84
Total	2.19	3.90	7.95	4	
Apparent Change (%)	-20	122	-25		

Conclusion for Each Location

Comparability--Acceptable for each
Treatment--No significant effect for each

b. Combining Locations Using Gart's Procedure

Source	X^2	df	Critical X^2 $\alpha=0.05$
Homogeneity	2.28	2	5.99
Association	0.58	1	3.84
Total	2.86	3	

Conclusion for Combined Locations

Homogeneity--Acceptable
Association--No significant effect

Legend
C--Comparison T--Treatment

Apparent change values are given only if locations are comparable.

Opposite Direction

The analysis data are shown in Table 5.

Since treatment location 1 had three 0 values in the contingency table, it was not possible to analyze this location. Since the original comparison location for treatment location 2 had a 0 in the table, the alternate comparison location of all non-opposite-direction accidents were used. Treatment locations 2 and 3, and their alternative comparison locations were comparable. There was no evidence that wide edgelines affected the incidence of opposite-direction accidents.

Similarly, the X^2 homogeneity and X^2 association were acceptable and showed no evidence of a significant effect.

Summary

Based on the analysis of the six measures of effectiveness, there is no evidence to indicate that wide edgelines significantly affected the incidence of ROR accidents and related accident types. This is also true when the level of significance was increased to 0.10 for a lower level of confidence.

Moreover, these findings concur with the results of an evaluation of wide edgelines in New Mexico (9) where, using a before-after design with a comparison group, 100 miles of wide 8-inch edgelines were compared with 353 miles of a comparison group with the standard 4-inch edgelines.

TABLE 5
Opposite Direction

a. Analysis for Each Location

Year	Location 1 C	Location 1 T	Location 2 C	Location 2 T	Location 3 C	Location 3 T
B1	5	0	56	7	36	5
B2	20	0	41	5	29	5
B3	15	0	37	7	34	5
A1	16	3	57	8	20	6
A2	22	1	65	3	41	4

Source	Location 1	Location 2	Location 3	df	Critical X^2 $\alpha=0.05$
Comparability					
Before	--	0.67	0.11	2	5.99
After	--	2.82	2.64	1	3.84
Treatment	__	1.32	0.03	1	3.84
Total	--	4.80	2.77	4	
Apparent Change (%)	--	-36	8		

Conclusion for Each Location

Comparability--Location 1 is omitted due to 0 values; locations 2 and 3 are acceptable
Treatment--No significant effect

b. Combining Locations Using Gart's Procedure

Source	X^2	df	Critical X^2 $\alpha=0.05$
Homogeneity	0.79	2	5.99
Association	0.51	1	3.84
Total	1.30	3	

Conclusion for Combined Locations 2 and 3

Homogeneity--Acceptable
Association--No significant effect

Legend
C--Comparison T--Treatment

Apparent change values are given only if locations are comparable.

-1578

CONCLUSION

The before-and-after design with a comparison group, a check for comparability, and Gart's procedure (for combining the accident data from the three study locations and the respective comparison groups) were used to analyze the data. It was concluded that the wide edgelines did not significantly affect the ROR accident frequency or related accident types for any individual location nor for the combined locations at 0.05 level of confidence. The accident types included: ROR accidents, ROR involving DUI, ROR on curves, ROR during darkness, ROR and weather, and opposite direction. The findings are based on five years of accident data, three years before wide edgeline installation and two years after installation.

RECOMMENDATIONS

Based on the findings of this research, it is not recommended that the Virginia Department of Transportation use wide edgelines on two-lane rural roads as a countermeasure for ROR accidents.

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1578

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-1589