

# Critique of :

## *An Evaluation of Red Shoulders as a Bicycle and Pedestrian Facility*

Wayne Pein    [wpein@nc.rr.com](mailto:wpein@nc.rr.com)



April 2008

## **Introduction**

*An Evaluation of Red Shoulders as a Bicycle and Pedestrian Facility* is a report produced by William W. Hunter of the University of North Carolina Highway Safety Research Center for the Florida Department of Transportation. It can be found online at:

[http://www.dot.state.fl.us/Safety/ped\\_bike/handbooks\\_and\\_research/research/redstudy.pdf](http://www.dot.state.fl.us/Safety/ped_bike/handbooks_and_research/research/redstudy.pdf)

In Florida, a 35 mph speed limit two-lane road with 9.5 foot lanes and 1,700 vehicles per day had 3-foot shoulders added to a 1.1 mile section as a bicycle and pedestrian facility. The shoulders were painted red in an effort to perceptually maintain a narrow road even though it was widened by 3 feet on each side. This in turn was intended to attenuate motorist speed.

The evaluation used videotaping to compare shoulder and non-shoulder sites, and had 8 components:

1. Shoulder use by bicyclists.
2. Amount and severity of motor vehicle encroachment into the opposing lane.
3. Conflicts between passing and oncoming motor vehicles.
4. Conflicts between motor vehicles and bicycles.
5. Distance from bicycle to edge of pavement.
6. Spacing between bicycles and passing motor vehicles.
7. Motor vehicle speed.
8. A mail-back questionnaire comprising three questions administered to bicyclists.

## **Critique**

Although the title of the report is *An Evaluation of Red Shoulders as a Bicycle and Pedestrian Facility*, and the intent of the shoulder project was to provide a separated space for bicyclists, and seemingly pedestrians, no pedestrian assessment was conducted. The only mention of pedestrians is in the report's Overview with the statement, "The location is popular with bicyclists and walkers." The designers and researcher did not consider the effects of placing 30 inch wide bicycle vehicle operators together with pedestrians on the 36 inch wide portion of the road not intended for vehicular travel (i.e. the shoulder).

The shoulders were not evaluated prior to painting them red. Thus, it is not possible to definitively ascribe evaluation findings to the red paint alone; the findings may be due to the shoulder space itself, the presence of the shoulder line, or the red paint.

Following are the report's findings and my analysis for each of the 8 evaluation elements, presented in the same order as in the report.

### **1. Shoulder use by bicyclists.**

Findings: Nearly 80 percent of bicyclists used the shoulders after installation.

The author wrote on page 19, "Riders who did not use the red shoulder tended to be part of a group, where the typical placement was to have one or more following cyclists riding to the left of lead cyclists for safety purposes...Children also had a tendency to be partial users of the red shoulders, with a tendency to cross back and forth across the road."

Analysis: The author noted that group bicyclists typically used the travel lane for safety purposes, but apparently doesn't understand the rationale for this, and does not make the connection that what is good for experienced group riders is also good for individuals. He also does not acknowledge the hazard of misleading incompetent children and their parents into believing that a road is safe for them with 3-foot shoulders.

The author seems to believe that shoulder riding is fully voluntary. There is no recognition that some bicyclists may be coerced into using the shoulder by motorist harassment, or feel intimidated from using the travel lane that may now be perceived as motorists' space.

## 2. Amount and severity of motor vehicle encroachment into the opposing lane.

Finding: There were more encroachments, and more were rated "severe" (defined as more than ½ of vehicle over centerline) at the normal road site (no shoulder) than at the red shoulder site. The author wrote, "Encroachment was defined as the motor vehicle moving across the center line and into the other lane of opposing traffic when passing the bicycle."

Analysis: Figures 7, 8, and 9 from the report depict what the author considered minor, moderate, and severe "encroachments" respectively. All of these "encroachments" occurred where the centerline was dashed, formally allowing motorists to fully change lanes, as when passing another motor vehicle. Would a pass of a slower motor vehicle under such conditions be called an "encroachment?"

As used by the author, the word "encroachment" implies a forced deviation caused by the inconvenient presence of interloper bicyclists. However, motorists choose when and how to pass bicycle drivers. A volitional and routine change in lateral position by motorists due to bicyclist presence should correctly be characterized as a purposeful maneuver to pass a slower vehicle, not "encroachment," especially when in a passing-permitted zone.

In a narrow lane, bicycle drivers' presence compels motorists to appropriately move left when passing. When bicyclists are on a narrow shoulder, motorists are deceived into thinking there is sufficient passing clearance without changing trajectory or with less of a change in position: if the bicyclist remains in his "lane," the motorist can remain in his.



**Figure 1.** Figure 7 from the report shows a "minor encroachment" over the dashed line.



**Figure 2.** Figure 9 from the report depicts a "severe encroachment" over the dashed line.

The bicyclist's narrow profile, along with typical right-side-of-lane position gives an advantage to the motorist. Thus, partial lane changes, called "straddle passes" are possible and routinely executed when passing bicycle drivers in both passing and no-passing zones. To characterize a partial lane change as an "encroachment" is misleading at best. However, the author rated the maneuver, implying that a "severe encroachment" is worse than a "minor encroachment." An alternative, completely opposite and more accurate view is that a motorist executing a "severe encroachment" is being more considerate by affording greater passing clearance.

The author believes a pass without "encroachment" is desirable for motor vehicle operation, and wrote, "There were also occasions at this site [red shoulder site 3] where the motor vehicle passed the bicycle without any encroachment into the adjacent traffic lane (Figure 10)." The number or percent of passes without "encroachment" is not given.

An undesirable consequence of not crossing the centerline from such a narrow 9.5-foot lane is very close passing of bicyclists. An 8.5-foot wide truck (not considering extended mirrors) fully left in the lane but not "encroaching" will pass a bicyclist *centered* on the shoulder by a scant 1 foot 3 inches.



**Figure 3.** Figure 10 from the report shows passing without "encroachment" of a bicyclist using the left half of the shoulder.

### **3. Conflicts between passing and oncoming motor vehicles.**

Finding: The author wrote, "An encroachment conflict between motor vehicles was defined as one of the motor vehicles having to suddenly change speed or direction as a result of a motor vehicle passing a bicycle and encroaching into the adjacent lane...There were no encroachment conflicts at the red shoulder site and eight conflicts at the non-red shoulder site (four minor and four serious)."

Analysis: There is no objective criteria for what constitutes "suddenly." Apparently "suddenly" was defined subjectively by the person reducing the video data. This is not proper research methodology. Since videotaping was used in the evaluation, it should have been relatively easy to define a sudden change in speed or direction quantitatively in terms of time and distance.

Given the author's improper definition of encroachment and inappropriate classification of crossing a dashed line as encroachment, a subjective assessment of encroachment conflict must be met with skepticism. That the author claims to be able to distinguish between minor and serious conflicts is cause for further suspicion, as no objective, measurable, and repeatable criteria for conflict were used.

### **4. Conflicts between motor vehicles and bicycles.**

Finding: The report says, "A bicycle-motor vehicle conflict was defined as the bicycle or motor vehicle having to suddenly change speed or direction as a result of a maneuver by the other. There were a few events that nearly met this definition of a conflict, but none that actually merited such a classification at either Site 3 or Site 4."

Analysis: The author again does not define what constitutes a “sudden” change in direction or speed. Figure 12 from the report is called a “potential” bicycle-motor vehicle conflict. From the picture it appears that a group of bicyclists were rightly using the travel lane and a motorist made a straddle pass in a passing permitted zone. Without clearly defined parameters, an alleged sudden change in speed or direction of the motorist may have simply been a figment of the person coding the video.



**Figure 4.** Figure 12 from the report is described as a “potential” bicycle-motor vehicle conflict. Is this classic “Fear From the Rear” mongering?

Moreover, the definition of bicycle-motor vehicle conflict and the stationary location of the camera indicates that only motorist overtaking type conflicts were considered, rather than the more likely conflicts with merging or turning motor vehicles at junctions. Such conflicts would be exacerbated by operating on the shoulder rather than in the travel lane. Similarly, conflicts with pedestrians were not considered.

Given the complete absence of conflicts between motor vehicles and bicycles at the non-shoulder site, the rationale for providing the red shoulders as bicycle facilities is suspect. Did the designers imagine bicyclists merely in the travel lane as being in “potential” conflict?

## **5. Distance from bicycle to edge of pavement.**

Finding: Bicyclists rode about the same distance from the edge of pavement at both the red shoulder (1.56 feet) and non-red shoulder (1.32 feet) sites. There was no statistical difference.

Analysis: In both cases, the average bicyclist tracked too close to pavement edge. Bicyclists on the 3-foot shoulder typically tracked along its midline, encouraged by the design of the narrow space. Those at non-shoulder sites on average operated as is usual for bicyclists who are not knowledgeable of the effects of lateral positioning. Neither behavior should be fostered or modeled. Narrow shoulders should not be constructed for the purpose of bicycle travel, and education on proper lateral positioning should be widespread.

## **6. Spacing between bicycles and passing motor vehicles.**

Finding: The spacing between bicycles and passing motor vehicles was a statistically significant 0.62 feet less at the site with red shoulders.

Analysis: An expected outcome of removing bicycle drivers from the traveled way and placing them behind a shoulder stripe is that motorists will pass closer on average, even though there is more total pavement. The obvious problem with this is that 36 inch shoulders (which may have pedestrians) next to 9.5 foot lanes is a substandard amount of space in which to induce passing without lane change. Bicyclists are 30 inches wide, have an essential operating space of 40 inches, and require 48 inches *minimum* of usable surface. Tricycles, present in this study, are considerably wider. Trucks are 8.5 feet wide; extended mirrors may bring this to 10 feet.

## 7. Motor vehicle speed.

Finding: “At the Main Site the mean speed increased by 2.1 percent from before to after, while at the Comparison Site the mean speed increased by 4.5 percent...Thus, there is no evidence that the mean speed increased at the Main Site any more than at the Comparison Site.”

Analysis: After red shoulders were added, motor vehicle speed increased by 2.1 percent at the “Main Site” and by 4.5 percent at another “Comparison Site.” Thus, two separate sites showed small increases in speed after adding red shoulders. Presumably, this was free flowing speed. Motorist *overtaking* speed was not measured. It is probable that motorists passed bicyclists at higher speed with the red shoulders than without shoulders. Such a result would be consistent with the reduced caution exhibited by closer passes on the red-shoulder section, and is an expected result of removing bicyclists from the normal traffic lane and placing them behind a stripe in their own space. In that case there is little need for motorists to move over or slow, much as they do not need to move over or slow when passing other motorists in adjacent lanes on a multi-lane road. In contrast, a bicyclist in the lane induces caution in motorists. The further left in the travel lane a bicycle driver operates, the more motorists are compelled to reduce speed.

## 8. A mail-back questionnaire comprising three questions administered to bicyclists.

The questionnaire was answered by more than 90 bicyclists.

“Question 1. Do you feel that widening Lakeshore Drive and adding the painted red shoulders has resulted in:

a. Slower speeds for cars and trucks	12 (13.2%)
b. Faster speeds for cars and trucks	6 (6.6%)
c. No change in the speeds of cars and trucks	73 (80.2%)
Total	91 (100.0%)”

Analysis: The results for this question show that a combined 19.8% of bicyclists perceived that speeds were either slower or faster. In fact, there was no change in the speed of motor vehicles due to adding the shoulders. Thus, nearly 1 in 5 bicyclists was wrong on speed estimation. As previously noted, however, motorist speed may not be the same as motorist overtaking speed.

“Question 2. As a result of adding the painted red shoulders, do you feel that there is:

a. More space between bicyclists and passing vehicles	79 (85.9%)
b. Less space between bicyclists and passing vehicles	0 (0%)
c. No change in the space between bicyclists and passing vehicles	13 (14.1%)
Total	92 (100.0%)”

Analysis: Eighty six percent of bicyclists perceived that there was more space between themselves and passing motorists with the added shoulder, and 14 percent felt there was no change. In fact, the actual spacing between bicycles and motor vehicles was 0.62 feet *less* with the red shoulders than before their placement.

Nearly eighty six percent of bicyclists’ perceptions were not only wrong, they were completely opposite of reality. The remaining 14 percent were merely wrong. Thus, 100 percent of bicyclists were wrong at judging overtaking spacing.

The author recognizes bicyclists' mis-perceptions, but dismisses them as being greater comfort, saying, "It is obvious that the red shoulders increased the comfort level of bicyclists on the section, because the actual spacing between bicycles and motor vehicles was greater on the section without red shoulders."

"Question 3. Compared to ordinary unpainted paved shoulders, do the painted red shoulders:

a. Make you feel more safe	75 (79.0%)
b. Make you feel less safe	3 (3.2%)
c. Make no difference in how safe you feel	17 (17.9%)
Total	95 (100.0%)

Analysis: Seventy nine percent of respondents felt more safe with the shoulders. Nearly 4 of 5 bicyclists say they felt more safe, yet the operational analysis shows that motorists passed closer, and likely faster.

The results of the mail-back questionnaire show that bicyclists have poor perceptions with regard to motor vehicle speed, and especially, motor vehicle overtaking distance. It's astounding that all respondents were wrong on distance estimation. As further evidence of the faulty perceptions of bicyclists, many responding to the survey with write-in comments considered the 3-foot red shoulders to be bike lanes, even though no bike lane markings or signs were placed.

The author did not expound on the findings of false perceptions, and has failed to recognize the concerns associated with bicyclists, including children, believing that a 3-foot red shoulder is a space to operate, and which causes them to feel safer and judge that motorists pass further, even though passes were actually closer.

The author failed to survey motorists to determine the perceptions of the motoring public, the vast majority of the users of the roadway at 1700 vehicles per day (so few bicyclists used the road weekdays that video data collection had to be restricted to busier weekends). It should be of great concern that motorists may have the same faulty perceptions as bicyclists, and that they may perceive they are giving more passing clearance when they actually give less.

Further, given that many bicyclists thought the shoulder space was a bike lane and used it as such, it is reasonable to think that some, perhaps most, motorists would deem it to be a bike lane, and thus bicyclists should use it and not the travel lane, which has then become in their minds the "motor vehicle" lane. Other motorists who didn't think it was a formal bike lane may still believe that bicyclists should be to the right of the line and operate on the shoulder. In either case, bicyclists using the travel lane as legitimate users would be considered as encroaching into what is considered motorists' space, and would be ripe for harassment and intimidation.

The author notes that most of the write-in comments were positive, but does not discuss that these perceptions may have been just as flawed as the responses to the questionnaire. The author also cites in the report the Bicycle Compatibility Index (BCI), an effort by his organization, but does not recognize the disconnect between his findings of faulty bicyclist perceptions and the use of bicyclists' perceptions to rate roadways in the BCI .

## Critique of Report Discussion (Conclusions)

In his last paragraph the author wrote,

“Perhaps the most important evaluation parameter was the speed of motor vehicle traffic before and after the placement of the red shoulders. The primary intent of the red shoulders was to create a visual sense of no widening of the road, which would lead to no increase in traffic speed. This appears to be the case.”

The speed of motor traffic is not the most important evaluation parameter; the safety and operational function of bicyclists is top priority. Further, the speed did increase, albeit a very small amount.

The road was widened with 3 foot shoulders, and the red paint was intended to avoid a motor vehicle speed increase, but that alleged effect was not appropriately evaluated. Motor vehicle speed with “plain” shoulders was not compared to the speed with red shoulders.

The author concluded in bold type, **“The overall conclusion is that the red shoulders have produced operational benefits for both bicyclists and motorists.”**

There are no operational benefits to bicyclists reported in the study, so it is unclear to which benefits the author is referring. The benefit to some bicyclists is psychological; they feel more “comfort” operating on the shoulder. The operational benefit to motorists of not having to move over as much or not at all when passing bicyclists on the shoulder comes at the expense of bicyclists.

## Critique Conclusions

*An Evaluation of Red Shoulders as a Bicycle and Pedestrian Facility* has numerous flaws. The author misrepresents or misinterprets many of the findings. It is not a credible research paper.

A useful piece of information from the questionnaire is that bicyclists do not reliably judge motor vehicle speed and, especially, passing distance, but this was mostly overlooked. In contrast, this result should be emphasized, as its implications have important broad application.

Motorists should not be tricked into moving over less and passing bicyclists closer. Bicycle drivers should not be deluded or compelled to use a shoulder barely wider than their vehicle that then leads to poor passing behavior; that pedestrians may also walk on the shoulder adds further emphasis.

Fear mongering about “potential” conflicts involving motorists passing bicyclists in the travel lane should not be tolerated. Instead, bicycle drivers should be encouraged to use more of the travel lane, where a further leftward position results in many positive operational outcomes.

*An Evaluation of Red Shoulders as a Bicycle and Pedestrian Facility* cites two papers that have been critiqued as fatally flawed. These critiques are located at:

[http://www.humantransport.org/bicycledriving/library/SharedUse\\_critique.pdf](http://www.humantransport.org/bicycledriving/library/SharedUse_critique.pdf)

[http://humantransport.org/bicycledriving/library/critique\\_BCI.pdf](http://humantransport.org/bicycledriving/library/critique_BCI.pdf)