The Conversion of Four-Lane Undivided Urban Roadways to Three-Lane Facilities

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ABSTRACT

In recent years, many traffic engineers have advocated converting four-lane undivided urban streets to three-lane two-way left-turn facilities. A number of these conversions have been successfully implemented. Accident rates have decreased while corridor and intersection levels of service remained acceptable. This conversion concept is yet another viable alternative "tool" to place in our urban safety/congestion toolbox.

BACKGROUND

Prior to the mid 1980s, it was common practice in Iowa to widen an existing two-lane urban roadway to a four-lane undivided facility if traffic volumes were in excess of 6,000 vehicles per day (vpd). Further, if a four-lane undivided roadway was experiencing an unacceptable accident rate, either a four-lane divided or five-lane two-way left-turn lane (TWLTL) facility was proposed to improve safety along the corridor. Each of these proposals was generally opposed by most property owners adjacent to the roadway because of the right-of-way impacts and/or the changes in access control.

At public hearings, project engineers would state that corridor safety would improve if the two-lane roadway were widened to a four lane undivided roadway. Graphics would be shown to illustrate that additional acceptable gaps in the traffic stream would result, and motorists could avoid rear-end collisions by changing lanes, etc. Those in opposition to the widening would argue that travel speeds would increase, pedestrians would have to cross a wider street, and noise would increase. In most cases, however, the four-lane undivided cross-section was selected as the preferred alternative because the only other alternative was generally to do nothing (i.e., the roadway remains a two-lane facility).

I conducted a 2-year before and after study on US-61 through Ft. Madison, Iowa (*1*) to assist in identifying the road-user benefits and noise impacts of widening an urban two-lane roadway to a four-lane undivided facility. US-61 was widened from two to four lanes in 1983 and had an average daily traffic volume between 10,000 and 14,000 vpd. Table 1 is a summary of the before and after data.

During this same time period, the Iowa Department of Transportation (DOT) authorized the re-stripping of several wide (40–42 feet) two-lane urban roadways to three-lane two-way left-turn lane facilities. The collision rates on the first seven conversions,

TABLE 1 Changes After Highway Widened from Two to Four Lanes (US-61 at Ft. Madison, Iowa)

Corridor Element	Change
• Traffic Volume	Increased 4 percent
• Corridor Travel Delay	Increased 4 percent
• Mid-block 85th% Speed	Increased 2.5 mph
• Traffic Traveling More Than 5 mph Over Speed Limit	Increased from 0.5 percent to 4.2 percent
• Accident Rate	Increased 14 percent
• Injury Rate	Increased 88 percent
• Total Value Loss	Increased 280 percent

which had Average Daily Traffic (ADT) volumes from 5,400 to 13,500 vpd, decreased an average of 40 percent (23 percent to 48 percent) (*2*). Because of the results in Ft. Madison and the success of our two-lane to three-lane conversions, I began a search to determine if anyone had converted a four-lane undivided urban roadway to a three-lane two-way left-turn facility. My search led me to Billings, Montana.

The City of Billings had restripped 17th Street West from a four-lane undivided roadway to a three-lane two-way left-turn lane facility in 1979. 17th Street West is 40 feet wide with an ADT range of 9,200–10,000 vpd and a posted speed limit of 35 mph. City Traffic Engineer Pierre Jomini, P.E., reported that the number of reported accidents decreased from 37 in the 20 months before to 14 in the 20 months after the conversion. He further stated that there was "no increase in traffic delay (*3*)."

I began to look for a candidate roadway to propose a four- to three-lane conversion. The Iowa DOT management staff had only recently accepted the concept of three-lane two-way left-turn lane facilities and was apprehensive about *decreasing* the number of traffic lanes on a state primary highway. However, I was able to convince the City of Storm Lake, Iowa, to convert a portion of existing US-71 after the DOT built a US-71 bypass and transferred jurisdiction of existing US-71 to the City of Storm Lake. Old US-71, Flindt Drive, is 40 feet wide and has an ADT of 8,500 vpd. The roadway was converted to a three-lane facility in 1996. Clyde Bartel, Iowa DOT Resident Engineer, reports that there has been a "very positive community reaction" to the conversion. The city is very pleased with the traffic operations and improvement in safety. At about the same time, a similar conversion was also made on Clay Street in Muscatine, Iowa. Ray Childs, City Engineer, reported "an immediate large reduction in accidents."

The Iowa DOT Office of Transportation Safety has recently begun to actively promote the conversion of other four-lane undivided urban roadways to three-lane two-way left-turn lane facilities when a concern about safety along the existing highway is expressed to the Iowa DOT. Several of these roadways under consideration are 48 feet wide and have traffic volumes in excess of 13,000 vpd. The recommendation to convert to a three-lane facility on these 48-foot-wide roadways is often met with apprehension by the

local community and other engineers. As a result, additional inquiries were made around the country about the experience others have had with this concept. I found a number of states discouraged the construction of new four-lane undivided roadways and that those who had experience with the conversion concept had a very positive experience with it.

One example provided was an urban primary highway (US-12) in Helena, Montana. It is a 48-foot-wide, 35-mph roadway with an ADT of 18,000. The roadway did not have a high collision rate but it did have a high percentage of rear-end and sideswipe accidents. It is located in a commercial area with numerous commercial access points. Montana State Traffic Engineer Don Dusek proposed restripping the roadway to a three-lane facility. Both the city staff and other state staff engineers were apprehensive at first, but after observing the improvement in traffic operations and reduction in accidents they support the conversion. They also have received numerous complimentary remarks from city residents about the conversion. Don Dusek stated that the "number of accidents decreased, good traffic flow was maintained, and community residents prefer the three-lane facility over the former four-lane roadway." The roadway cross section was marked with 5-12-14-12-5 foot lanes which meets AASHTO standards to accommodate bikes along a roadway. However, they do not designate the five-foot lanes as a bike path.

In a study conducted for the Minnesota DOT, Howard Preston, BRW Inc., found that the highest urban corridor accident rates were found on four-lane undivided roadways. In fact, the collision rate on four-lane undivided roadways was 35% higher than on urban three-lane roadways (*4*). The study found three-lane roadways in Minnesota with ADTs as high as 20,000 vpd. Mr. Preston stated he would convert most four-lane undivided urban roadways with ADTs less than 20,000 vpd to three lane facilities "in a heart beat."

A good example of a change in community attitude toward the four- to three-lane conversion is the conversion of 21st Ave. East in Duluth, Minnesota. (ADT is 17,000 vpd.) Prior to the conversion many in the community opposed decreasing the number of traffic lanes. A *Duluth News-Tribune* article pleaded "Don't limit 21st Ave. East" and "it's not too late to keep [it] a four-lane street." However, after the conversion, a *Duluth News-Tribune* staff editorial (*5*) stated the following:

> Admit it, 21st East Works
>
> When Duluth officials announced they would convert busy 21st Avenue East between London Road and Woodland Avenue from four lanes to two, with a turn lane in the middle, some armchair analysts predicted it wouldn't work. The News-Tribune Opinion page was among them. Well, it works. About everyone agrees—from city traffic officials to neighbors—that the change has eased congestion and reduced drivers' speed making it safer for pedestrians, and it hasn't caused problems in winter. Traffic moves steadily up and down the hill even though the volume is up. Cutting available traffic lanes by 50 percent on the already heavily used stretch carrying vehicles between the I-35 exit at 21st Avenue East at London Road and the Hunters Park and Woodland neighborhoods did not seem like a good prospect when it was done last May. Initiated at the end of the academic year, many believed that, when the University of Minnesota–Duluth and St. Scholastica resumed classes in the fall, the thoroughfare wouldn't be able to handle the traffic. And winter . . . well, it would be a disaster, we doomsayers predicted. None of it happened. Now the city is planning to repaint the lanes and keep the pattern on 21st indefinitely—as well it should.

ADVANTAGES

Improved Safety

At first glance, it is difficult for most, including many transportation engineers and planners, to accept that, in urban corridors with less than 20,000 vpd, reducing the number of traffic lanes will improve traffic safety and maintain an acceptable level of service. The substantial reduction in accident rates is primarily the result of the reduction in conflict points and improved sight distance for turning and crossing traffic along the corridor. See Figures 1 and 2 for examples of reductions in traffic conflict points along a three-lane corridor. Figure 3 illustrates the improved intersection sight distance.

The three-lane facility is also much more user friendly to elderly drivers. Fewer decisions and judgments have to be made to enter or cross a three-lane facility. Iowa has the third highest percentage of elderly drivers in the country and is making an effort to better accommodate this growing segment of the population on its roadways.

Table 2 shows the 3-year before and after midblock and nonsignalized intersection crash information for a four-to-three-lane conversion project on Minnesota Trunk Highway 49 (Rice Street) in Ramsey County, Minnesota (Figure 4) (*6*). The ADT on Rice Street during the after period was 16,400 vpd. Table 3 reflects data from several street conversions in Seattle, Washington (*7*). It appears a 20 to 30% reduction in crashes would be a reasonable estimate of the potential safety improvement of a four-to-three-lane conversion.

Improved Pedestrian Safety

For pedestrians, the three-lane facility can on occasion provide a pedestrian refuge allowing pedestrians to focus on one lane of traffic at a time. If necessary, elderly and

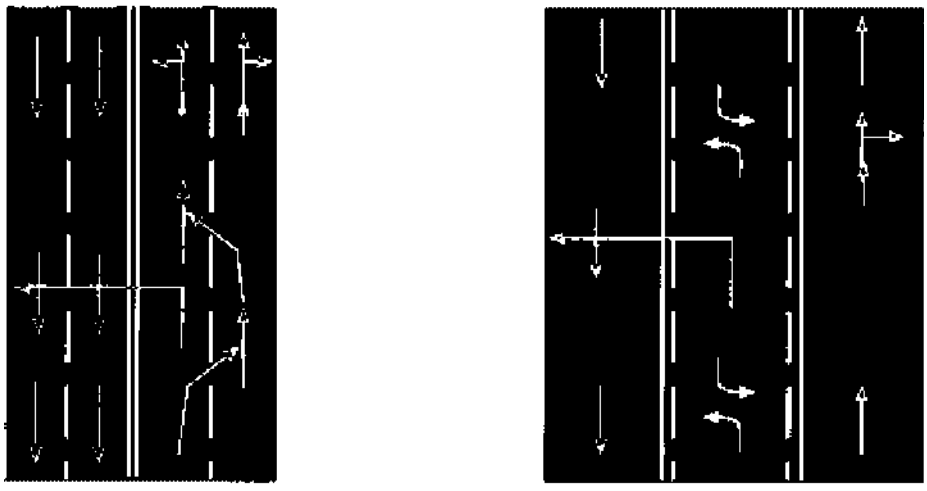
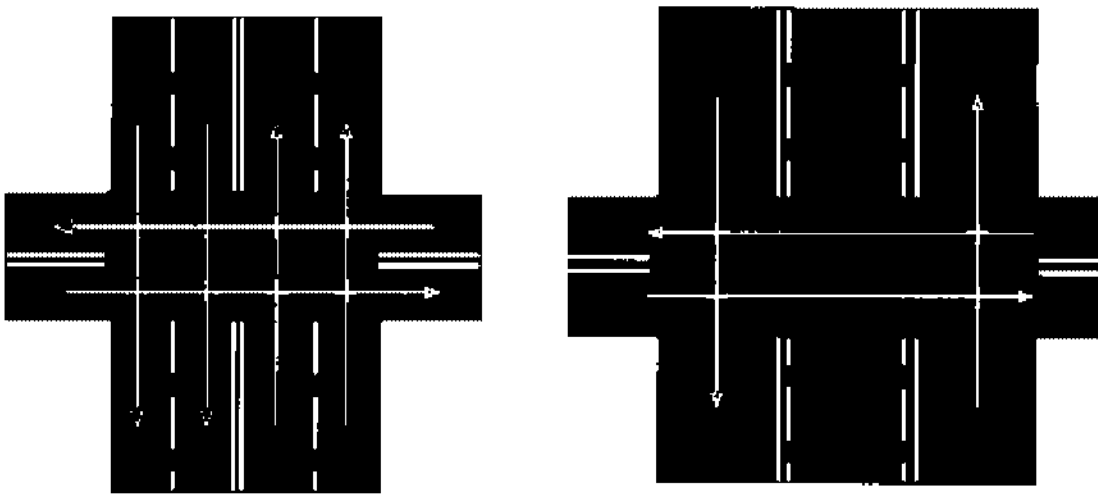
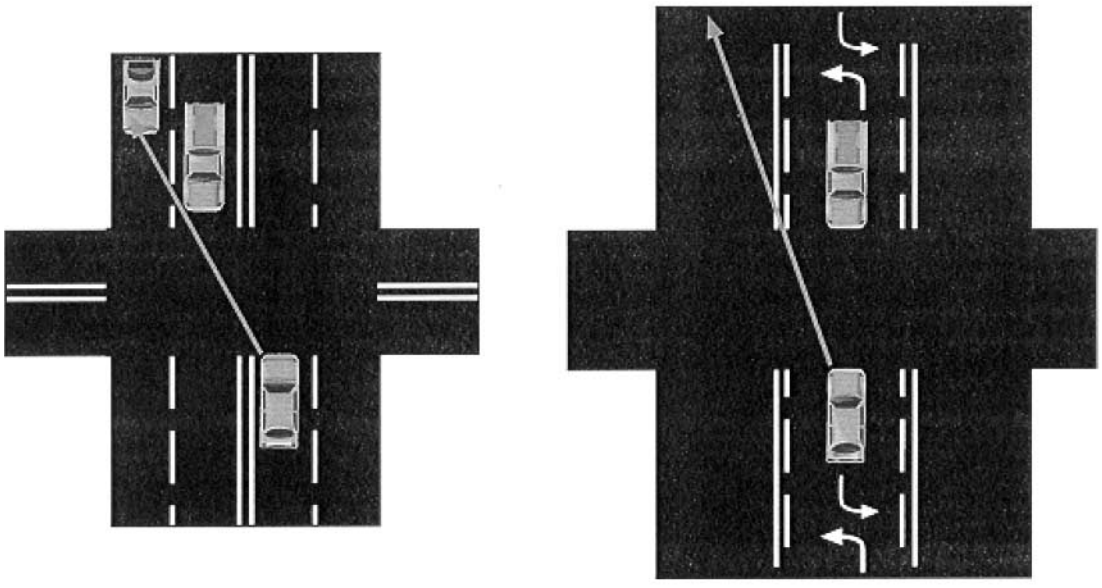


FIGURE 1 Midblock conflict points.



4 Lane 3 Lane

FIGURE 2 Cross-traffic conflict points.



4 Lane 3 Lane

FIGURE 3 Intersection sight distance.

TABLE 2 Collisions Before and After Three-to-Four-Lane Conversion

Corridor Element	Change
• Traffic Volume	Increased 4 percent
• Corridor Travel Delay	Increased 4 percent
• Mid-block 85th% Speed	Increased 2.5 mph
• Traffic Traveling More than 5 mph Over Speed Limit	Increased from 0.5 percent to 4.2 percent
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• Total Value Loss	Increased 280 percent

young pedestrians can stop in the two-way left turn lane, an option not available on four-lane undivided roadways. While the center lane is an active traffic lane, it would have a lower volume of traffic and slower vehicle speeds. Often this lane would be unoccupied by vehicles.

Traffic Calming

Another attribute of the three-lane facility is the traffic calming effect it has on the traffic flow. Aggressive motorists can not travel along three-lane corridors at excessive speeds making multiple lane changes. The three-lane concept also reduces the variability of travel speeds along the corridor, which helps reduce possible collisions. On a four-lane roadway crossing traffic must not only find a gap in four traffic lanes but must also make a judgment on the approach speed of four different vehicles. This is very difficult to do, particularly for elderly drivers and pedestrians.

Improved Emergency Response Time

Emergency vehicles often find it difficult to travel down four-lane urban roadways. Waiting for all the traffic to move over to the curb lane can cause delays to emergency vehicles. The center two-way left-turn lane can be used as a lower-conflict access route along the roadway corridor (Figure 5).

DISADVANTAGES

Increased Travel Delay

Increased travel delay along the corridor is the primary concern many have with converting a four-lane roadway to a three-lane facility. Many assume there will be a 50% reduction in corridor capacity because the number of “through lanes” is reduced by half.

Before

After

FIGURE 4 Four-to-three-lane conversion, Minnesota Trunk Highway 49 (Rice Street), Ramsey County, Minnesota.

TABLE 3 Changes in Traffic Volume and Collisions After Roadways Changed from Four Lanes to Two Lanes plus TWLTL (Seattle, Wash.)

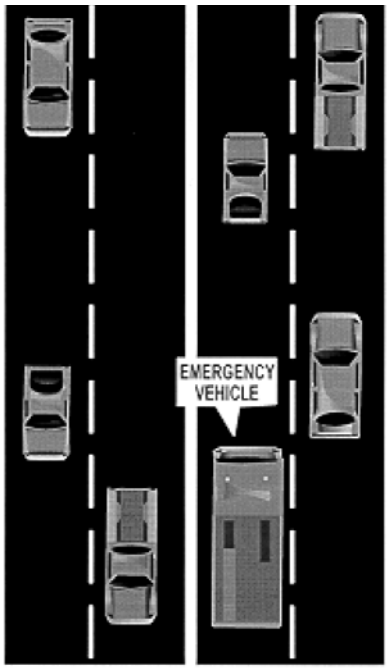
ROADWAY SECTION	DATE CHANGE	ADT (BEFORE)	ADT (AFTER)	CHANGE	COLLISION REDUCTION
Greenwood Ave. N, from N 80th St. to N 50th St.	April 1995	11872	12427	4 lanes to 2 lanes plus TWLTL plus bike lanes	24 to 10 58%
N 45th Street in Wallingford Area	December 1972	19421	20274	4 lanes to 2 lanes plus TWLTL	45 to 23 49%
8th Ave. NW in Ballard Area	January 1994	10549	11858	4 lanes to 2 lanes plus planted median with turn pockets as needed	18 to 7 61%
Martin Luther King Jr. Way, north of I-90	January 1994	12336	13161	4 lanes to 2 lanes plus TWLTL plus bike lanes	15 to 6 60%
Dexter Ave. N, East side of Queen Anne Area	June 1991	13606	14949	4 lanes to 2 lanes plus TWLTL plus bike lanes	19 to 16 59%
24th Ave. NW, from NW 85th St. to NW 65th St.	October 1995	9727	9754	4 lanes to 2 lanes plus TWLTL	14 to 10 28%
Madison St., from 7th Ave. to Broadway	July 1994	16969	18075	4 lanes to 2 lanes plus TWLTL	28 to 28 0%
W Government Way/Gilman Ave. W, from W Ruffner St. to 31st. Ave. W	June 1991	12916	14286	4 lanes to 2 lanes plus TWLTL plus bike lanes	6 to 6 0%
12th Ave., from Yesler Way to John St.	March 1995	11751	12557	4 lanes to 2 lanes plus TWLTL plus bike lanes	16 to 16 0%
				Total	185 to 122 34%

In reality the capacity of a three-lane facility is very near that of a four-lane undivided roadway. Envision a four-lane undivided roadway in a commercial area during the peak hour of the day. Drivers who want to travel through the corridor generally stay in the outside curb lane to avoid getting caught behind mid-block left-turning vehicles. During these peak hours the inside lanes are generally used by left-turning vehicles and very few through trips are made in those lanes. As such, only one lane in each direction is accommodating most of the through trips—which is similar to a three-lane facility.

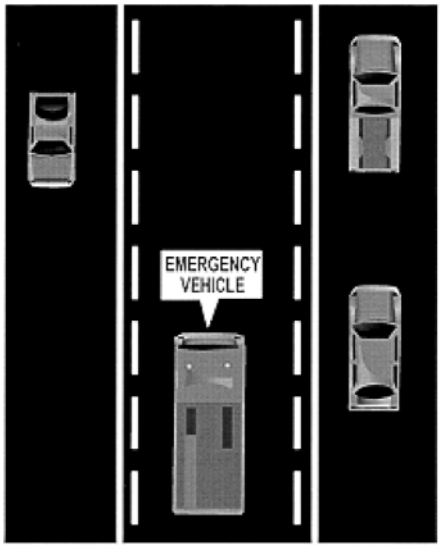
Further, the actual capacity of a corridor is controlled by the signalized intersections. These intersections generally have high volumes of left-turning traffic. As such, once again most of the through traffic is carried in one lane—the outside curb lane.

The following is an example corridor level of service analysis performed on a proposed high-volume roadway in Iowa. Table 4 is an arterial level of service analysis for a section of US-75 through the central business district of Sioux Center, Iowa (population 5,100) (*8*). The ADT on US-75 is 14,500 vpd with 9 percent trucks.

Table 5 is the intersection level of service analysis for the signalized intersection along a proposed conversion of US-65 in Iowa Falls, Iowa (population 5,500) (*9*). The 1996 ADT on US-65 was 8,700 vpd with 8 percent trucks and on Brooks Road the ADT was 1,600 vpd. This is an example of a typical intersection along a three-lane roadway corridor in Iowa.



(a)



(b)

FIGURE 5 Emergency vehicle access (a) on four-lane road; (b) on three-lane road.

As shown, while travel delay increases, an acceptable level of service would be maintained if these four-lane undivided roadways were converted to a three-lane two-way left-turn lane facility. Travel delay along these corridors could be further reduced if right-turn lanes were constructed at major intersections and high-volume commercial entrances. In addition larger turning radii at other driveways will help right-turn traffic exit the roadway quicker, reducing travel delay and the potential for rear-end accidents.

TABLE 4 Arterial Level of Service (LOS) Analysis for Proposed High Volume Roadway[1]

Cross Section	Total Corridor Travel Delay	Average Travel Speed	LOS
Four lane undivided	20.5 secs	16.0 mph	C
Three lane alternative	29.4 secs	14.3 mph	C
Five lane alternative	15.8 secs	17.1 mph	C

[1] U.S. Highway 75 corridor, 1st St. to N. 4th St., Sioux Center, Iowa.

TABLE 5 Intersection Level of Service (LOS) Analysis for Proposed Conversion of a Signalized Intersection[1]

Existing 4 lane undivided							
	Lane Mvmts	v/c Ratio	g/C Ratio	Mvmt: Delay	LOS	Approach: Delay	LOS
EB	LTR	0.356	0.314	12.2	B	12.2	B
WB	LTR	0.379	0.314	12.4	B	12.4	B
NB	LTR	0.342	0.600	4.6	A	4.6	A
SB	LTR	0.293	0.600	4.4	A	4.6	A
Intersection Delay = 6.2 sec/veh					Intersection LOS = B		

Proposed 3-lane with TWLT Lane							
	Lane Mvmts	v/c Ratio	g/C Ratio	Mvmt: Delay	LOS	Approach: Delay	LOS
EB	LTR	0.356	0.134	12.2	B	12.2	B
WB	LTR	0.379	0.314	12.4	B	12.4	B
NB	L	0.234	0.600	4.3	A	5.1	B
	TR	0.457	0.600	5.2	B		
SB	L	0.139	0.600	4.0	A	5.0	A
	TR	0.438	0.600	5.1	B		
Intersection Delay = 6.7 sec/veh					Intersection LOS = B		

L = Left, T = Through, R = Right.

[1] U.S. Highway 65 at Brooks Road, Iowa Falls, Iowa.

However, this is not recommended if large volumes of pedestrians are present on adjacent sidewalks.

Increased Delay at Driveways

Often when this concept is proposed through a residential area, residents will express concerns about increased difficulty in backing out of their driveways. Granted, conversion to a three-lane roadway will result in fewer gaps in the traffic stream and motorists will have to be more patient. However, backing onto a four-lane undivided highway and into a traffic lane is a high-risk traffic maneuver. The three-lane concept can enhance the safety of this traffic maneuver by allowing motorists to back across the traffic lane into the unoccupied center lane, and then proceed to enter the traffic lanes in either direction. The center lane also provides a low-risk escape lane for motorists who need to avoid a potential collision with a vehicle backing into the roadway.

Loss of Passing Opportunities

A concern often heard is from aggressive motorists who do not want to lose the opportunity to pass vehicles along the corridor. As previously discussed, that disadvantage provides a benefit to pedestrians and other motorists trying to enter or cross the roadway.

Some are of the opinion that aggressive drivers will use the center lane as a passing lane. While this does occur occasionally it has not been a problem in Iowa on three-lane facilities.

Also, in Iowa slow-moving agriculture vehicles commonly travel on these urban roadways to either grain elevators or implement dealers. There is concern that removing a through lane in each direction will result in motorists illegally passing these agriculture vehicles. This likely will happen just as it occurs on two-lane roadways through a community. While this potential conflict may occur several hundred times each year, this disadvantage must be put in the proper perspective. The safety advantages the three-lane facility provides are to the thousands of vehicles which try to cross and turn left onto or off of the highway each day.

ACCESS CONTROL

Opportunities for eliminating, consolidating and relocating driveways should be investigated during the study analysis. Particular attention should be made to ensure high-volume access points on opposite sides of the roadway are not offset in the wrong direction, which could result in “gridlock” in the center turn lane.

Turbulent traffic flow along the corridor can be reduced by constructing right-turn lanes at signalized intersections and constructing larger turning radii at high-volume commercial driveways.

FACTORS TO CONSIDER

A number of factors should be considered before this type of conversion is made. They include roadway function and access control; total traffic volume; turning volumes

and 85 percent speed; accident type and patterns; pedestrian and bike activity; and right-of-way availability and cost. A qualitative discussion of each factor and the changes it may experience due to a conversion are being documented in a follow-up report to be presented at the 1999 Institute of Transportation Engineers Annual Conference (*10*).

CONCLUSIONS

Most of Iowa's four-lane undivided urban roadways are providing both an acceptable level of service and safety to the local community because of the relatively low volume of traffic they carry. However, when safety concerns are expressed about one of these corridors, we have another "tool" in our traffic safety tool box we can consider to address these concerns. This "tool" can be implemented quickly, at a very low cost and with less right-of-way, environmental impact (i.e., tree removal), and other controversy associated with improvement alternatives.

Along four-lane undivided corridors, where it is not acceptable to add more lanes or a median, the key question to answer during an evaluation of alternatives is: What is the primary need in the corridor under study? Is it to move high volumes of traffic as quickly as possible? Or is it to improve corridor safety for motorists and pedestrians, while providing an acceptable level of service to corridor traffic? The answers to these questions will determine if converting to a three-lane facility is a viable alternative to include in your study. There is a need to perform a comprehensive before and after study on this concept. However, the positive community reactions to the past conversions and the fact that none of the previous conversions has been converted back to a four-lane undivided roadway support placing this tool in your traffic safety "tool box."

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