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A CASE FOR NARROWER ARTERIAL STREETS

BROWN COUNTY PLANNING COMMISSION
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A Case for Narrower Arterial Streets

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Introduction

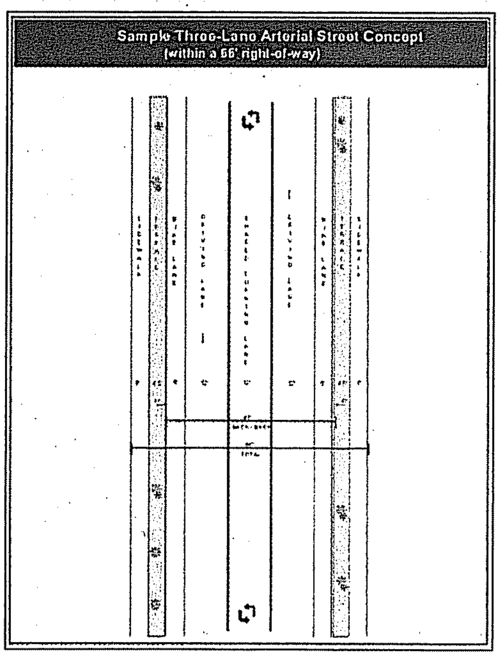
Over the last several decades, the term transportation has become synonymous with streets and highways. If you ask someone to come up with a brief definition of a community's transportation system, chances are the person will tell you it is the community's street network. Although streets and highways are components of a transportation system, they are just that – components. A truly comprehensive and balanced transportation system includes several modes and facilities that can be conveniently and safely used by people of all ages, physical abilities, and income levels.

If communities hope to succeed in their quests to increase the accessibility and appeal of their arterial street corridors, they must develop strategies to enable and encourage people to live, work, and shop in the corridors. In short, communities need to make their arterial street corridors places to travel *to* instead of merely places to travel *through*. One important element of these strategies should be the creation of a balanced transportation system that makes it easier and more pleasant for people to walk across the street to visit shops and restaurants, to ride a bicycle to and from work, and to talk to a friend or neighbor without having to shout to be heard above the roar of passing traffic. Some methods of accomplishing this while possibly improving traffic capacity and efficiency in arterial street corridors are addressed in this paper.

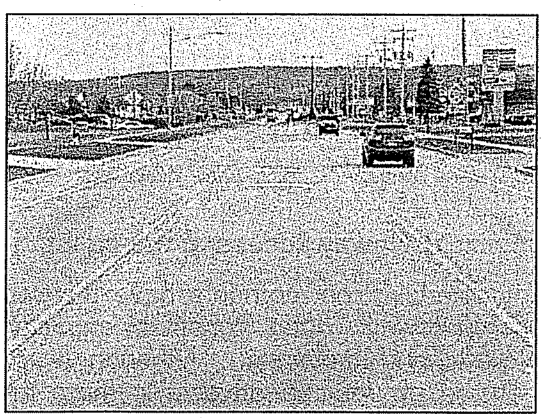
Suggested Treatments for Arterial Street Corridors

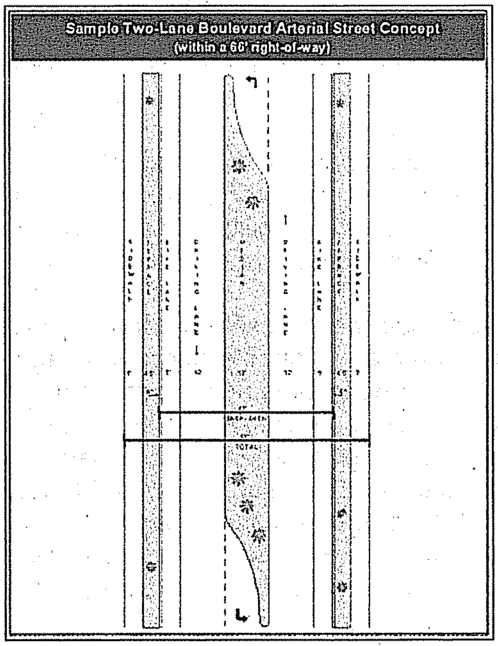
Build three-lane streets and/or two-lane boulevards instead of four-lane arterials

Instead of creating, retaining, or widening four-lane arterial streets, communities should consider narrowing their arterial streets to three-lane facilities that have a single overhead (through) lane in each direction, a continuous left turn lane in the center, and striped bicycle lanes along the curbs. In areas where driveways are uncommon or absent, the center turn lane can be replaced by a landscaped median, and negative-offset left turn bays can be added at intersections to allow left-turning motorists to exit the flow of traffic.

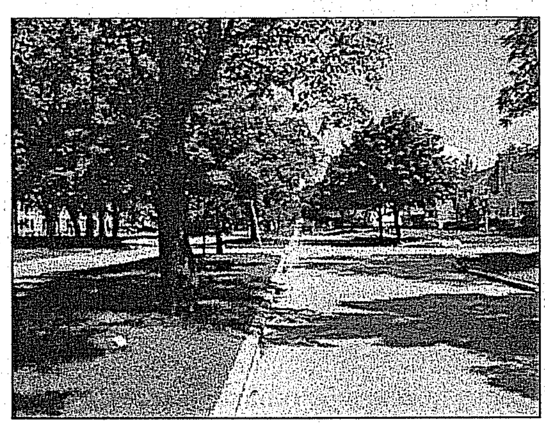


Three-lane streets work well when arterial corridors contain driveways...





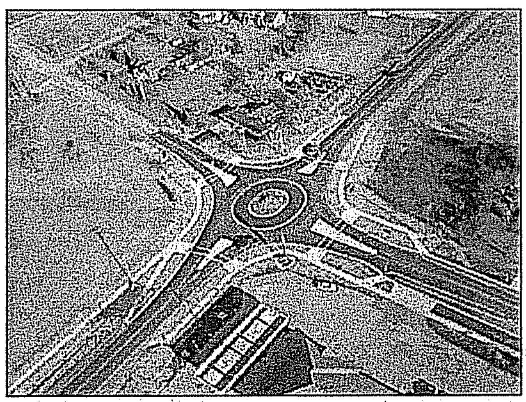
...but two-lane boulevards are ideal for streets that have little or no direct driveway access.



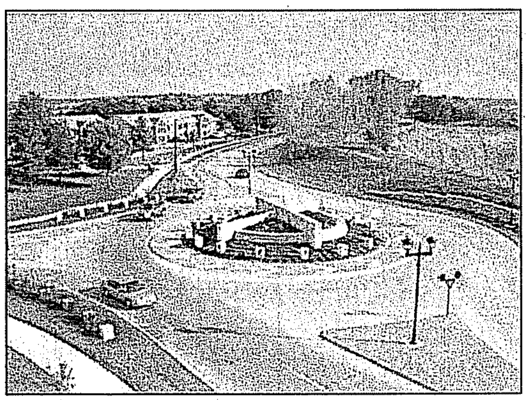
Source: Brown County Planning Commission

Substitute roundabouts for traffic signals at major intersections

Communities should substitute roundabouts for traffic signals at major intersections that have enough space to accommodate them. The roundabouts can be single-lane facilities at intersections with other three- or two-lane streets, and single/double-lane roundabouts can be placed where three- or two-lane streets intersect with four-lane streets. The single/double-lane roundabouts can also serve as safe and efficient transition points between three- or two-lane arterial street segments and four-lane segments that connect to them.



Single-lane roundabout in Howard, Wisconsin



Single/double-lane roundabout in Coralville, Iowa

Minimize driveway access to the street

Many arterial street corridors have driveways that serve businesses and homes, but these driveways often constrain capacity and can be hazardous to pedestrians, bicyclists, and motorists. Although it is almost always difficult (and occasionally expensive) to remove driveways, there are many potential opportunities to improve safety and capacity along arterial street corridors by reducing the number of driveways that connect directly to the streets. This does not mean that arterial streets should be flanked by frontage roads or surrounded by structures that do not face the street. Instead, communities should encourage the development of buildings that face the street and can be reached by driveways along intersecting streets, through alleys, and by local streets within neighborhoods.

Why Implement These Treatments?

Believe it or not, it's already happening in some communities

Lane reduction projects on arterial streets have occurred in the United States and Canada, and the results appear to be positive. Figure 1 shows six examples of arterial streets that have been converted from four lanes to three (or two) with bicycle lanes and other features, and each street has or had average daily traffic (ADT) volumes that exceed or exceeded 20,000 vehicles.

Figure 1: Examples of lane reduction projects on arterial streets with volumes exceeding 20,000 vehicles per day

Street Section	Change	ADT Before Change	ADT After Change
Lake Washington Blvd. (Kirkland, Washington)	4 lanes to 2 lanes + TWLTL* + bike lanes	23,000	25,913
Grand River Blvd. (East Lansing, Michigan)	4 lanes to 2 lanes + TWLTL* + bike lanes	23,000	23,000
Danforth Street (Toronto, Ontario)	4 to 2 lanes + bike lanes, 4 to 2 lanes + turning pockets + bike lanes	22,000	22,000
North 45th Street (Seattle, Washington)	4 lanes to 2 lanes + TWLTL*	19,421	20,274
Edgewater Drive (Orlando, Florida)	4 lanes to 2 lanes + TWLTL* + bike lanes	20,501	18,131
Main Street (Santa Monica, California)	4 to 2 lanes + TWLTL*, 4 to 2 lanes + median + bike lanes	20,000	18,000

*A TWLTL is a two-way left turn lane situated between the two driving lanes.

Sources: *Road Diets – Fixing the Big Roads* by Dan Burden and Peter Lagerwey (1999); *Edgewater Drive Before & After Re-Striping Results* by the City of Orlando Transportation Planning Bureau (November 1, 2002).

Orlando's Edgewater Drive lane reduction project appears to have been particularly successful. According to a report published by the City of Orlando's Transportation Planning Bureau in November of 2002[1], the Edgewater Drive project produced the following results:

- Lower crash rates and frequencies.
- Lower injury rates and frequencies.

[1] *Edgewater Drive Before & After Re-Striping Results* by the City of Orlando Transportation Planning Bureau (November 1, 2002).

- A lower percentage of vehicles traveling over 36 mph.
- A reduction in traffic volumes on parallel and connecting streets.
- Increased pedestrian and bicyclist activity.
- Residential and commercial property value increases along and near the corridor that are now consistent with the county's overall annual increases.

Figure 2 shows that the Edgewater Drive lane reduction project also had only a minimal effect on average peak period travel times in a heavily signalized section of the corridor.

Figure 2: Average peak travel times (in minutes) along a heavily signalized section of Edgewater Drive before and after the lane reduction project

	A.M. Peak (7:00 a.m. – 9:00 a.m.)		**P.M. Peak (4:00 p.m. – 6:00 p.m.)**	
Direction	Before Project	After Project	Before Project	After Project
Northbound	3.3 minutes	4.2 minutes	3.5 minutes	3.8 minutes
Southbound	3.2 minutes	4.1 minutes	3.7 minutes	3.5 minutes

Source: *Edgewater Drive Before & After Re-Striping Results* by the City of Orlando Transportation Planning Bureau (November 1, 2002).

Since the average peak period travel times along this signalized segment of Edgewater Drive did not increase significantly (and actually decreased in one instance) when the number of lanes was reduced, it is very possible that travel times could have remained the same or could have even improved if Orlando had also replaced the signals with roundabouts.

The roundabouts will improve safety at major intersections

Based on the findings of local, national, and international roundabout safety studies, roundabouts can significantly reduce intersection-related crashes and injuries along arterial street corridors.

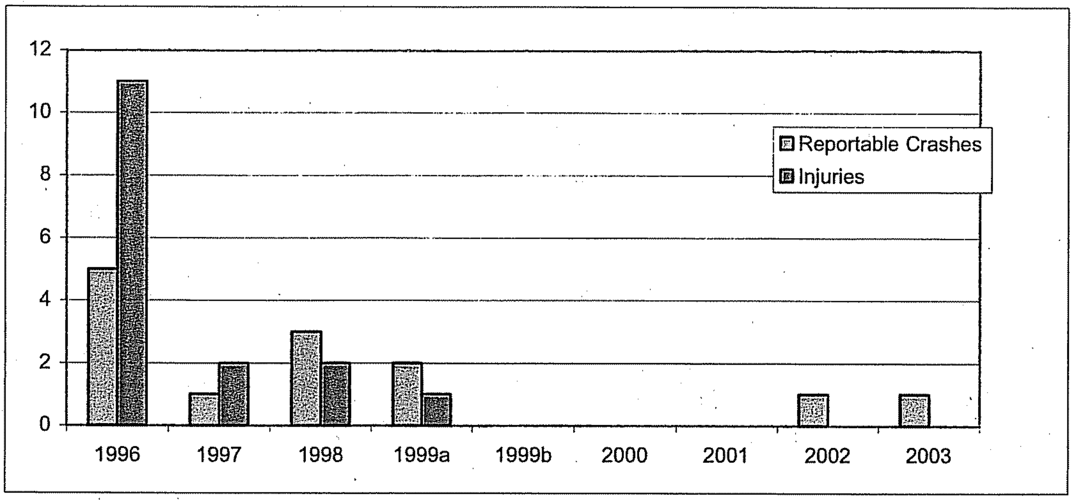
Motorist Safety

Because all vehicles travel the same direction in a roundabout, the number of conflict points is much lower than at intersections controlled by traffic signals or stop signs. The likelihood of crashes is further reduced by forcing vehicles to approach and travel through the roundabout intersections slowly, which maximizes the time that motorists have to avoid conflicts.

Roundabout success story: A school zone intersection in Howard, Wisconsin

Before a roundabout was built at an intersection near two schools in the Village of Howard in Brown County, Wisconsin, the intersection experienced several reportable crashes and injuries each year. In 1996 alone, this intersection experienced five reportable crashes and eleven injuries, and reportable crashes and injuries continued to occur until the spring of 1999. This situation changed when a roundabout was being built and motorists were no longer able to run the stop signs at high speeds and meet other vehicles at right angles. According to the Brown County Sheriff's Department and Wisconsin Department of Transportation, there were only two reportable crashes and no injuries at this intersection between July of 1999 (when the roundabout project began) and the end of 2003. The intersection's annual crash and injury totals between 1996 and 2003 are summarized in Figure 3.

Figure 3: Reportable crashes and injuries at the Lineville Road/Cardinal Lane intersection in the Village of Howard, Wisconsin (1996-2003)



1999a: January 1, 1999 – July 31, 1999 (before roundabout – still a two-way stop)
1999b: August 1, 1999 – December 31, 1999 (during and after roundabout construction)

Sources: Brown County Sheriff's Department crash records (1996-2001), Wisconsin Department of Transportation intersection crash summaries (2002-2003)

The dramatic reduction of reportable crashes and elimination of injuries at this intersection occurred in spite of the introduction of hundreds of inexperienced drivers to the intersection following the opening of a new high school in 2000. This experience prompted the construction of more roundabouts in Brown County, and these roundabouts have also performed very well.

Other experience

The dramatic reduction of reportable crashes and elimination of injuries at the Lineville Road/Cardinal Lane intersection that happened in spite of a significant traffic volume increase is consistent with the performance of roundabouts throughout the world. In 1998, the Transportation Research Board's *Modern Roundabout Practice in the United States* report examined crash frequency and injury severity studies that had been conducted in America and several other countries over a ten-year period. The report indicated that each country experienced a significant reduction of vehicle crashes and a tremendous reduction of injuries at intersections where roundabouts (particularly single-lane facilities) had replaced stop signs and traffic signals.

Example of an arterial street corridor in Green Bay, Wisconsin, where roundabouts could improve safety and dramatically lower the costs of crashes and injuries

The most obvious consequences of a motor vehicle crash are the inconvenience of temporarily or permanently losing a vehicle, the physical pain resulting from the impact, and the emotional distress associated with the event. But a major element of crashes that is often ignored is the financial impact on individuals and society as a whole.

Figure 4 summarizes the annual average crash and injury statistics for five intersections along a typical four-lane arterial street segment in Green Bay, Wisconsin, between 2001 and 2003. In addition to noting the average number of reportable crashes and injuries, the summary includes estimated annual property damage and injury costs for each major intersection along this corridor segment.

Figure 4: Average annual crash statistics and cost estimates for major intersections along a segment of East Mason Street in Green Bay, Wisconsin, between 2001 and 2003

Intersection	Average Number of Reportable Intersection Crashes Per Year	Estimated Property Damage Cost Per Year*	Average Number of Injuries Per Year	Estimated Injury Cost Per Year*
Webster Avenue	10.3	$64,000	7.0	$279,000
Baird Street	10.6	$66,000	8.0	$319,000
Bellevue Street	10.3	$64,000	9.3	$371,000
Lime Kiln Road	11.6	$72,000	9.3	$371,000
Main Street	7.6	$47,000	5.6	$223,000
TOTALS	**50.4**	**$313,000**	**39.2**	**$1,563,000**

*The property damage and injury cost estimates used in this table are based on average property damage and injury cost estimates developed by the National Safety Council in 2002.

Crash Data Source: Wisconsin DOT crash summary data (2001-2003).

This segment of East Mason Street contains 20 intersections between (and including) Webster Avenue and Main Street, but 68 percent of the reportable crashes and 70 percent of the injuries that occurred at the corridor's intersections between 2001 and 2003 happened at the five major intersections shown in Figure 4. Judging by the success of roundabouts in reducing intersection crashes and injuries in Brown County and elsewhere, it can be assumed that most of the reportable crashes and injuries that occur in this arterial corridor segment each year could be eliminated if roundabouts were constructed at these locations. Even if the number of annual reportable crashes and injuries at these five intersections was only reduced by half, the estimated costs associated with incidents at the intersections would decrease by an average of more than $900,000 per year. Since these intersections are similar to thousands of signalized arterial street intersections throughout the United States, it is staggering to imagine how much money (not to mention physical and emotional pain) could be saved each year by replacing even a fraction of these signals with roundabouts.

Pedestrian Safety

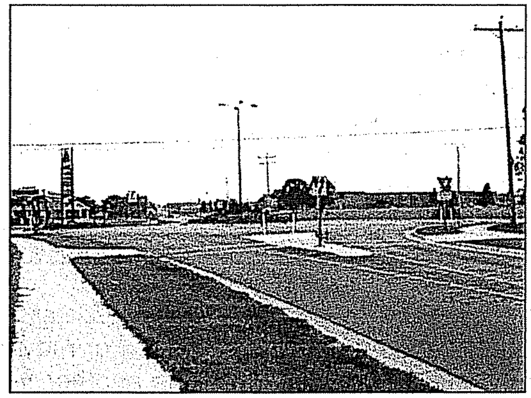
Roundabouts that have replaced traffic signals and stop signs have reduced the number of vehicle/pedestrian crashes and drastically reduced the severity of these crashes at intersections throughout the world. Three reasons that roundabouts are safer for pedestrians are summarized below.

The number of conflict points is much lower. Because all vehicles travel in the same direction in a roundabout, the number of vehicle/pedestrian conflict points is much lower than at intersections controlled by traffic signals. The likelihood of crashes is further reduced by forcing vehicles to approach and travel through a roundabout intersection slowly, which maximizes the time that pedestrians and motorists have to avoid conflicts.

Severe crashes caused by non-attentive driving are eliminated. For example, vehicle/pedestrian crashes that occur when motorists run red lights, ignore stop signs, and make right turns on red do not happen at roundabout intersections. The roundabouts force drivers to pay attention to their surroundings as they approach and pass through the intersections.

Pedestrian exposure to traffic is much lower because the crossings are shorter. The splitter islands at the roundabout approaches allow people to cross one narrow lane of slow moving traffic at a time (or two lanes of traffic at two-lane roundabouts) instead of four (or more) lanes of vehicles that would likely be traveling quickly through a typical arterial street corridor's signalized intersections.

View of roundabout splitter island from curb



View of splitter island from an intersection's approach

The Transportation Research Board's 1998 *Modern Roundabout Practice in the United States* report also addressed pedestrian safety at roundabouts throughout the world. The studies that were conducted in the United States, the Netherlands, Germany, and in other countries found that pedestrian crashes and injuries were reduced (sometimes dramatically) at intersections that had been converted from stop signs and signals to roundabouts.

Bicyclist Safety

Studies conducted by the TRB, Federal Highway Administration (FHWA), and other agencies found that roundabouts that have replaced signals and stop signs have significantly reduced the *severity* of vehicle/bicycle crashes, but the reduction in the *number* of crashes has not been as substantial as that experienced by motorists and pedestrians.

Traffic capacity and efficiency along arterial streets could improve

The roundabouts, access control measures, shared left turn lane, left turn bays, and other features addressed in this paper could make arterial street corridors more efficient and safe for motorists (and others) even after the streets are narrowed from four lanes to three (or two). As odd as this might sound, it makes sense when the following factors are considered:

Factor 1: Constant and predictable traffic flow can be achieved

Left turn pockets might not exist at some or many of an arterial street corridor's intersections, and few arterial corridor driveways are typically served by left turn lanes. This means that every time one motorist stops to make a left turn at one of these access points, every driver behind this person has to come to a complete stop until the left turn is completed. During periods when traffic is heavy and many people want to make left turns, the streets essentially function as two-lane facilities. Not only does this significantly reduce the capacity of the streets, it can create surprises for drivers that occasionally result in rear-end crashes. However, a center lane and/or turning bays that allow people to exit the main vehicle lanes when making left turns can allow vehicles to flow in a more constant and predictable manner, and these turning lanes (along with the other three factors discussed in this section) could enable two-lane streets to operate at or above the level of many four-lane facilities.

Factor 2: Smaller gaps will typically exist between vehicles

People are often able to drive at relatively high speeds along arterial street corridors, but high speeds are often accompanied by large gaps between vehicles. Since these gaps are often much smaller when people drive at lower speeds, a street's actual capacity tends to rise when speeds fall. Therefore, the lower speeds that will likely result from converting a street from four to three/two lanes will narrow the gaps and further improve a street's capacity.

Factor 3: Greater efficiency and capacity at major intersections can be realized

The capacity of roundabouts is greater than the capacity of signalized intersections because there are no yellow delay or red stop periods. Vehicles do not have to stop at a roundabout intersection unless another vehicle is approaching from the left within the roundabout. The gap size needed to merge into a roundabout intersection is also less than at a signalized intersection because traffic is moving relatively slowly.

In 2000, the Federal Highway Administration (FHWA) published *Roundabouts: An Informational Guide*. This report addresses several characteristics of single- and multi-lane roundabouts and is designed to be the guide for the development of roundabouts in the United States. According to the FHWA guide, the average delay per vehicle at roundabouts is much lower than the average delay per vehicle at signalized intersections:

Example 1: Average delay per vehicle at an intersection that has a total major street volume of 1,000 vehicles per hour and 10 percent left turns.

- Signalized intersection delay per vehicle: 13.5 seconds
- Roundabout intersection delay per vehicle: 1.75 seconds

Delay reduction per vehicle with a roundabout: **11.75 seconds**

Example 2: Average delay per vehicle at an intersection that has a total major street volume of 1,000 vehicles per hour and 50 percent left turns.

- Signalized intersection delay per vehicle: 16 seconds
- Roundabout intersection delay per vehicle: 3 seconds

Delay reduction per vehicle with a roundabout: **13 seconds**

These examples illustrate how much more efficient roundabouts are than traffic signals and show that this efficiency difference becomes even more significant as the percentage of left turning traffic increases at an intersection. The examples also strongly suggest that substituting roundabouts for signals along arterial street corridors can improve traffic capacity by significantly improving efficiency at the corridors' major intersections.

Factor 4: Fewer mid-block friction points will exist

Reducing the number of driveways along arterial street corridors can also help to improve efficiency and safety by reducing the number of friction points between intersections. It might also be possible to place landscaped medians with left turn bays in certain areas if enough driveways are eliminated.

Pedestrian comfort and accessibility could improve significantly

The pedestrian environment along many arterial street corridors can be unpleasant because the sidewalks (if they exist) are often next to or very close to the outside driving lanes, mid-block driveways are potential conflict points for pedestrians who might not be seen by motorists who enter and exit commercial and residential properties, and pedestrians who want to cross the arterial streets have to contend with several lanes of vehicles that are making a variety of movements at the streets' intersections. These conditions likely discourage many people from traveling along and across these streets on foot.

Another component of Orlando's 2002 Edgewater Drive study was an assessment of pedestrian activity before and after the lane narrowing project. According to the study, the number of pedestrians walking along Edgewater Drive increased by 6 percent following the lane reduction project, but the number of pedestrians crossing the street increased by 56 percent after the number of driving lanes was reduced from four to three.

Figure 4: Pedestrians walking along and crossing Edgewater Drive before and after the driving lane reduction project

Direction	Pedestrians Before Project	Pedestrians After Project	Change	% Change
Northbound & Southbound (walking along the street)	1,398	1,481	83	6%
Eastbound & Westbound (crossing the street)	738	1,151	413	56%
TOTALS	**2,136**	**2,632**	**496**	**23%**

Note: The before and after pedestrian counts were completed during a typical fall weekday (excluding Monday and Friday).

Source: *Edgewater Drive Before & After Re-Striping Results* by the City of Orlando Transportation Planning Bureau (November 1, 2002).

The Orlando study concluded that the overall increase in pedestrian activity (especially the increase in the number of crossings) indicates that people find it easier to cross the street now that it has three driving lanes instead of four.

Bicyclist safety and accessibility could also improve significantly

The improvement of bicycling conditions along Edgewater Drive in Orlando appears to have also encouraged more people to bike along and across the street after the number of lanes was reduced and striped bicycle lanes were added.

Figure 5: People bicycling along and across Edgewater Drive before and after the driving lane reduction project

Direction	Bicyclists Before Project	Bicyclists After Project	Change	% Change
Northbound & Southbound (biking along the street)	295	368	73	25%
Eastbound & Westbound (biking across the street)	80	118	38	48%
TOTALS	**375**	**486**	**111**	**30%**

Note: The before and after bicyclist counts were completed during a typical fall weekday (excluding Monday and Friday).

Source: *Edgewater Drive Before & After Re-Striping Results* by the City of Orlando Transportation Planning Bureau (November 1, 2002).

The bicycling environment along other arterial street corridors can also be improved by creating space for striped bicycle lanes, reducing driving speeds and driveway conflicts, establishing a more predictable vehicular flow pattern, and minimizing conflict opportunities at major intersections.

These modifications would help to create a more equitable transportation system

Many arterial street corridors are largely designed to accommodate drivers, which means that many people who tend to rely on other transportation modes (walking, bicycling, and transit) have a difficult time traveling in and around the corridors. But by reducing the number of driving lanes, creating bicycle lanes, and constructing roundabouts at major intersections, arterial corridors can become more horizontally equitable because they will be more accessible to people who are too young or old to drive, those who are economically or physically disadvantaged, and others who must rely on other modes because they are unable to drive.

These modifications could help to improve property values and encourage investment and reinvestment along arterial street corridors

Over the last ten years, cities that have converted four-lane streets to three-lane facilities with features like bicycle lanes, additional streetscaping, wider sidewalks, and on-street parking have realized an additional benefit along these corridors: improved property values and economic investment. Although it does not appear that many studies have been done to assess the precise economic benefits of these street projects, the studies that have been completed suggest that street narrowing and enhancement projects have helped to spur investment and improve property values in areas that were previously suffering. Two examples of successful projects include:

<u>Atlantic Boulevard in Delray Beach, Florida</u> (excerpt from *Road Diets – Fixing the Big Roads* by Dan Burden and Peter Lagerwey)

> Atlantic Boulevard in downtown Delray Beach, Florida, was converted from four-lane to two-lane at the request of retailers. This request was the reverse of previous thinking. Merchants often feel that more traffic passing their doors is better for business. In Delray Beach, the decaying downtown forced merchants to take another look. Retailers worked with the city manager, elected officials, and chamber of commerce to weigh risks and suggest changes. The net result of this street conversion is one

of the more successful downtowns in Florida and a significant increase in local sales and tax base for the town.

Clematis Street in West Palm Beach, Florida (excerpt from *The Economic Benefits of Walkable Communities* by the Local Government Commission Center for Livable Communities)

> The city's first traffic calming retrofit was along 4,500-foot-long Clematis Street, a once lively main street anchored by a plaza, library, and waterfront on one end and a historic train station on the other. By 1993, only 30 percent of the building space on the one-way street was occupied. Property values ranged from $10 to $40 per square foot with commercial rents at $6 per square foot.
>
> The city opened Clematis Street to two-way traffic, narrowed the street at points, raised intersections, and bulbed out the curbs at intervals in a slalom-like pattern to slow traffic. The $10 million project also rebuilt an interactive fountain, restored key buildings, and provided for event spaces.
>
> Property values more than doubled on the street. In 1998, they ranged from $50 to $100 per square foot, with commercial rents at $30 per square foot and with more than 80 percent of building space occupied. The project attracted some $350 million in private investment to the area.

Although these projects helped to bolster investment in and around downtowns, the same positive results could be realized along other arterial street corridors if communities choose to complement the street improvements addressed in this paper with additional streetscaping treatments, investment incentives for new developments, and other features that will make the corridors appealing places to live, work, shop, and travel through. Improving the appearance of arterial corridors can also help to create attractive entrances to downtowns and other parts of communities.

Conclusion

The concepts in this paper are designed to help communities transform their arterial street corridors into pleasant, people-oriented places that attract and retain visitors, residents, businesses, and value while continuing to enable the streets to carry large volumes of traffic. Some of the potential benefits of these concepts include:

- A significant reduction in reportable crashes and injuries at an arterial corridor's major intersections when roundabouts replace traffic signals. The more predictable flow created by access controls, lane reductions, left turn lanes and bays, and roundabouts could also reduce the number of mid-block crashes by minimizing lane changes and sudden stops.

- Improved traffic carrying capacity and efficiency even after the number of overhead driving lanes is reduced.

- Reduced property damage and injury costs associated with motor vehicle crashes.

- Improved safety, comfort, and accessibility for pedestrians and bicyclists.

- Improved comfort for people who live along and near arterial corridors.

- Improved system equity through the enhancement of accessibility for drivers and non-drivers of all ages, physical abilities, and income levels.

- Improved property values and investment potential along arterial corridors that could result from making the corridors more appealing places to live, work, and shop.

- The creation of attractive gateways to the downtowns and other parts of communities.

Most people would agree that a safe, attractive, efficient, and accessible thoroughfare that peacefully coexists with the surrounding land uses is better than a high-speed arterial street that dominates and degrades its surroundings. Since the primary (if not the only) purpose of multi-lane streets is to move large volumes of traffic as quickly as possible, streets with fewer lanes that can move traffic efficiently <u>and</u> are safe, accessible, attractive, and often less expensive to build and maintain than their wider counterparts should be viewed as much more desirable alternatives for communities that truly want to develop balanced transportation systems that can be easily and safely used by people of all ages, physical abilities, and income levels.