Downtown Streets

Are We Strangling Ourselves on One-Way Networks?

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ABSTRACT

As many communities are in the process of revitalizing their downtowns, a common issue is the prevalence of intricate and often confusing one-way street networks. This paper provides a comparison of one-way versus two-way street systems for downtowns and presents an evaluation methodology for considering two-way conversion. The analysis gives equal weight to all modes of travel and includes the non-regular visitor to downtown. Motorist analysis factors include mobility, vehicle miles of travel (VMT), number of turning movements, travel time, vehicle capacity, and parking supply. Pedestrian factors analyzed are number and severity of pedestrian/vehicle crossing conflicts. Direction and symmetry of routes comprise the transit analysis factors, and retail factors measure the visibility of street front locations.

INTRODUCTION

Ever since the explosion of automobile use that occurred after WWII, people have moved their residences further and further from downtown centers, out into new suburban communities. With this exodus came a daily travel ritual in which suburbanites in motor vehicles behave as tides do, placing a tremendous strain on the downtown street network. The historical response to this strain has been to improve the efficiency of moving vehicles into and out of the city at all costs, without considering other system users.

We now understand that downtowns that operate predominantly as a place of work and clear out in the evening are the ones most often struggling to foster new development and business ventures. The longstanding mantra to seek the greatest speed by which commuter motorists can flee the city has accelerated the downtown deterioration process. The sad results are streets congested with fast-moving automobiles and barren of lively pedestrian, cultural, or commercial activity after the mad evening exodus.

As many communities are in the process of revitalizing their downtowns, a common issue is the prevalence of intricate and often confusing one-way street networks. This legacy of one-way streets can be traced back to when the streets' sole mission was to move traffic into and out of the downtown employment center as quickly as possible. An emerging role of downtown as a cultural and entertainment center is now challenging the

embedded mindset that the primary purpose of streets is the unequivocal movement of commuter automobile traffic.

HOW WE GOT HERE: A BRIEF HISTORY OF ONE-WAY NETWORKS

One-way streets in downtowns were not an overnight occurrence; rather, their proliferation was the result of a series of events that occurred over a number of years. The development of one-way downtown networks can be traced through four very distinct periods of evolution.

The *Pre-Freeway Era* encompasses the time from prior to the development of the automobile to just after the conclusion of World War II. Cities were at the height of their development, and downtowns not only served as the seat of the local governments, but were also the hub of all social, civic, and cultural activity within the surrounding region. Downtown streets were home to not only motor vehicles, but also streetcars, trolleys, buses, and most importantly, people. Movement of each of these travel modes was equally balanced, with cars and pedestrians coexisting peacefully in a controlled, slow-speed environment. Retail business activity was at an all-time high, with most goods and services available in the core of the downtown.

It is important to note that during this era most downtown workers did not commute great distances; rather, most lived within 2 to 5 miles of their downtown jobs. Suburbs had not yet been invented, as the transportation facilities of the day did not support long commute distances. However, all this was about to change, in the name of progress.

America learned several important lessons during the course of World War II. Perhaps one of the most profound was the example that Nazi Germany provided through its impressive system of limited-access highways, by which expedient movement of troops and goods across the country was possible. With the passage of the Federal Highway Act of 1956, the *Freeway Proliferation Era* had begun.

The construction of the freeways did exact many benefits for commerce; however, it also opened the door for downtown workers to move farther from their place of work. As downtown workers began to seek out less expensive, more desirable housing in the suburbs, the mode balance on downtown roadways that had been prevalent for many years began to shift toward facilitating the speedy entrance and exodus of commuters. Downtown streets began to be converted to one-way travel to facilitate this expedient movement into the city in the morning and out in the afternoon.

As downtown workers continued the flight to the suburbs, providers of goods and services soon followed. Small downtown shops were recreated in the suburbs as regional shopping malls, supermarkets, and discount stores. Workers no longer patronized the small shops downtown since they could fill their needs closer to home, often at lower prices. Many of the small, family-owned businesses that had been located downtown for years either moved to the suburbs with their market or succumbed to closure as the market dwindled.

This *Post-Freeway Era* reached its peak in the 1980s, when even traditional downtown corporate offices sought out the cheaper land in the suburbs. Many formerly strong downtowns were reduced to blighted, empty streets and boarded-up storefronts, devoid of life after 6 pm.

Downtowns have seen a resurgence, beginning in the 1990s, as communities began to rediscover the attraction of the downtown as a location. Most downtowns never lost the designation of the cultural and governmental hub of their community; however, the ability of the downtowns to adapt to a new role as entertainment centers has aided in their comeback during this, the *Reemerging Era*.

Many people are returning to downtowns as residents and workers now seek to escape the outlying suburbs and office parks. Since most suburban developments rely on one or two major arterial roadways, the traffic impacts associated with these areas have become much worse than ever imagined in the downtown, with its well-defined street network grid. As people return to downtown, there has been a plea for a rebalancing of downtown roadways, to make them safer and friendlier again for all modes of travel. It is in this context that many cities are contemplating the conversion of one-way streets to two-way travel.

CONFLICTING OPINIONS

The return of one-way downtown street networks to two-way travel is a relatively new phenomenon associated with downtown revitalizations. Opinions about the feasibility of two-way conversions vary widely, according to the interest group polled. Three of the most prevalent groups in communities that are investigating the possibility of two-way conversion are discussed in the following paragraphs.

A Traffic Engineer's Perspective

For many years, traffic engineers were mandated to "move as much traffic as possible, as quickly as possible," often resulting in degradation of movement for other modes of travel. The unequivocal movement of the motor vehicle through a downtown network was of paramount concern; all other modes of travel took a back seat. Effectiveness of the network was measured by the amount of delay a motorist would encounter on a given street segment or intersection during either the morning or afternoon peak hours.

Given this context, one-way streets do make sense; the *Transportation and Traffic Engineering Handbook* reports that the conversion to two-way operation generally increases capacity by about 10 to 20 percent. The case is also often made that one-way streets help facilitate good signal progression through a downtown network. One-way streets also offer the opportunity to control their traffic flow at signalized intersection approaches by a single signal phase, freeing up green time for intersecting street movements. One-way streets also have fewer conflicting turning movements at their intersections, reducing the chance for a through vehicle to encounter a turning vehicle. Finally, curbside activity such as service vehicle loading and unloading is less disruptive to the traffic flow on a one-way street, where only one travel lane is usually blocked by this activity.

In traffic engineering circles, however, the operational disadvantages associated with one-way streets are becoming increasingly recognized. The system often forces drivers to follow out-of-direction routes to their destinations, causing an increase in both the number of turning movements required and vehicle miles of travel (VMT). The direct result of this recirculation is an increase in traffic volumes on a given segment or intersection within a one-way system, with a corresponding degradation in air quality within the downtown.

Signal progression can often be maintained on two-way streets to favor the peak direction movement during the morning and afternoon peak hours with minimal effect on through-vehicle delay or the capacity of the network.

The User's Perspective

Another group with a vested interest in what happens to downtown one-way street networks is the users of those facilities. Users can be grouped into three general categories: the motorist, the transit rider, and the pedestrian. Each group views the street network in a different way, as discussed below.

Motorists

Motorists use the street network as a means for navigating the downtown to get to their destination. In most cases, a downtown motorist's destination is someplace to park the car, namely a garage, lot, or on-street parking space; upon parking, the motorist leaves the vehicle as a pedestrian to access the final destination. It is well known that people attempt to park as close to their ultimate destination as possible, in an effort to minimize walking distance.

One-way streets do not pose a major inconvenience for commuters and regular visitors to the downtown; these motorists have learned the downtown network and know the "best route" to their destination. Rather, it is the occasional visitors to downtown who are often confused and disoriented on encountering a one-way street network. Often, these motorists are able to see their destination but are shunted away from it by the one-way streets. But these occasional users are in fact the customers that revitalized downtowns are trying to attract. If circulation in the downtown can be made easier by converting one-way streets, people in this target market segment may be better pleased with their overall downtown experience and become more regular downtown patrons.

Transit Patrons

A one-way street network exacts a similar toll on the downtown transit system and its users. In a one-way network, stops on the same route for opposite directions are forced to be located on two different streets. Again, the most affected users are the occasional downtown visitors, who are not familiar with the system. For instance, a visitor who is dropped off at a stop downtown on a one-way street may not realize that the transit stop for his return trip is actually located one block away on a different street. Regular transit users can even become victims of this system in sections of downtown with which they are not familiar. In a two-way system, transit stops for a particular route can be located across the street from each other, eliminating this confusing situation.

Pedestrians

As stated previously, at some point every downtown visitor becomes a pedestrian. Whether one arrives by private vehicle, taxi, or rail or bus transit, it becomes necessary at

some time to navigate the street system on foot. One-way streets present challenges to the pedestrian due to the speed and direction of adjacent vehicular traffic and pedestrian expectations at intersections.

On a two-way street, pedestrians always have the choice of walking facing the oncoming traffic or with their backs to it. This choice does not exist on a one-way street, where pedestrians moving in the same direction of the vehicular traffic will always have adjacent traffic coming behind them regardless of which side of the street they choose to walk on.

At intersections of two streets that are each two way, pedestrians have an expectation of potential vehicular conflicts with their path as they cross the intersection. This sequence reverses itself for the opposite movement across the intersection, for a total of two conflict sequences that the pedestrian should expect. When a one-way street is included in the intersection, the number of potential conflict sequences increases dramatically. This phenomenon will be discussed in greater detail in the evaluation section of this paper. Suffice it to say, a pedestrian who is crossing an intersection of one-way streets must pay particular attention to the direction of both through and turning traffic to avoid a conflict.

It is also important to remember that a one-way street system always has a greater magnitude of vehicle turning movements compared to a two-way system. Any turning movement, regardless of street configuration as one- or two-way, creates *exactly* the same potential for vehicle/pedestrian conflict, namely, one legally turning vehicle crossing the path of one legally crossing pedestrian. Thus, aside from the complexity of conflict sequences, there are simply more (typically 30–40%) vehicle/pedestrian conflicts within a one-way street network than in a comparable two-way system.

Downtown Community Perspective

Much attention recently has been given to downtown vitality and redevelopment efforts. One-way street conversions to two-way are part of a much bigger effort to make downtowns more livable and economically successful. City leaders, both political and business, are becoming increasingly concerned with the quality of the outdoor environment experienced by downtown visitors.

Some national chains are beginning to develop downtown locations, with an emphasis on service industries such as office supplies, bookstores, and coffeehouses. In our experience, most of these retailers prefer the exposure and accessibility offered by a location on a two-way street. This fact is supported by examples such as Vine Street in Cincinnati, where 40% of businesses in this economically depressed downtown corridor closed after the street was converted from two-way to one-way.

As retail and entertainment activities begin to increase downtown, cities today are experiencing an influx of new downtown residents not seen in decades. Young professionals with no children, looking for an urban lifestyle, as well as “empty-nesters” who are tired of the big house and yard (with a corresponding big commute) are beginning to return to the housing areas within and immediately adjacent to downtown. For these people, livability is of paramount importance. As shown in Figure 1, large gains in overall livability can often be accomplished while exacting only a slight increase in vehicular delay.

The cost of living in downtown neighborhoods is relatively high compared to suburban neighborhoods. Downtown residents expect the high cost of living to be offset

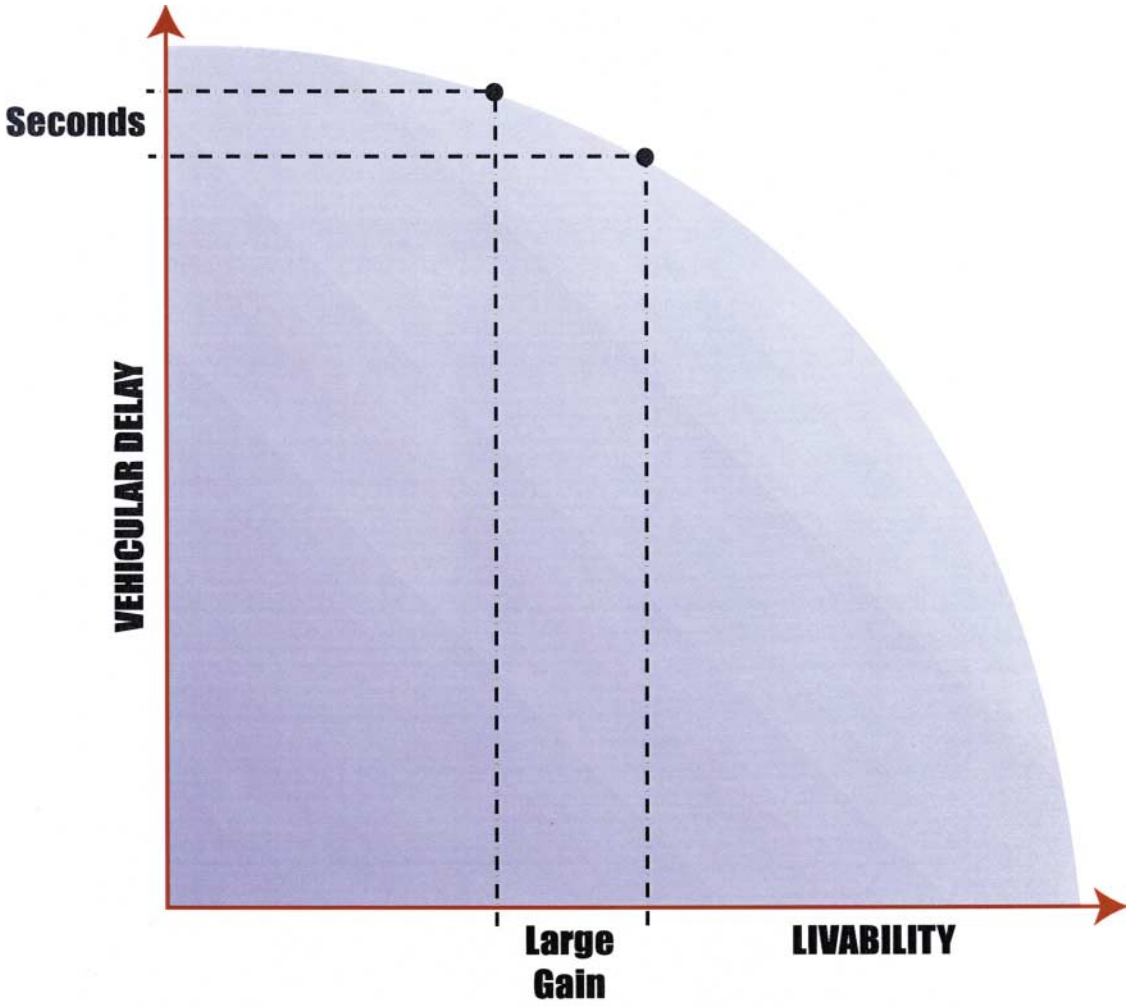

FIGURE 1 Livability index.

by better services, close proximity to public facilities such as parks, walkable streets, and being close to the center of activity. Being able to walk to these attractions is very important to urban residents.

A high level of auto accessibility in a downtown is more important to urban residents than access to regional roadways. By requiring less out-of-direction travel and fewer turning movements, a two-way street network is better for short trips to local establishments than a one-way street network. Livable streets benefit all users of a downtown whether they are using transit, an automobile or walking.

ONE-WAY VERSUS TWO-WAY: EVALUATION MEASURES

In order to effectively evaluate the impacts and benefits of converting a given one-way street network to two-way travel, it is proposed that a combination of evaluation measures be used. As summarized in Figure 2, these measures include traditional travel service impacts such as capacity and vehicular delay, but also take into account livability issues within the downtown street network such as transit routing, pedestrian mobility

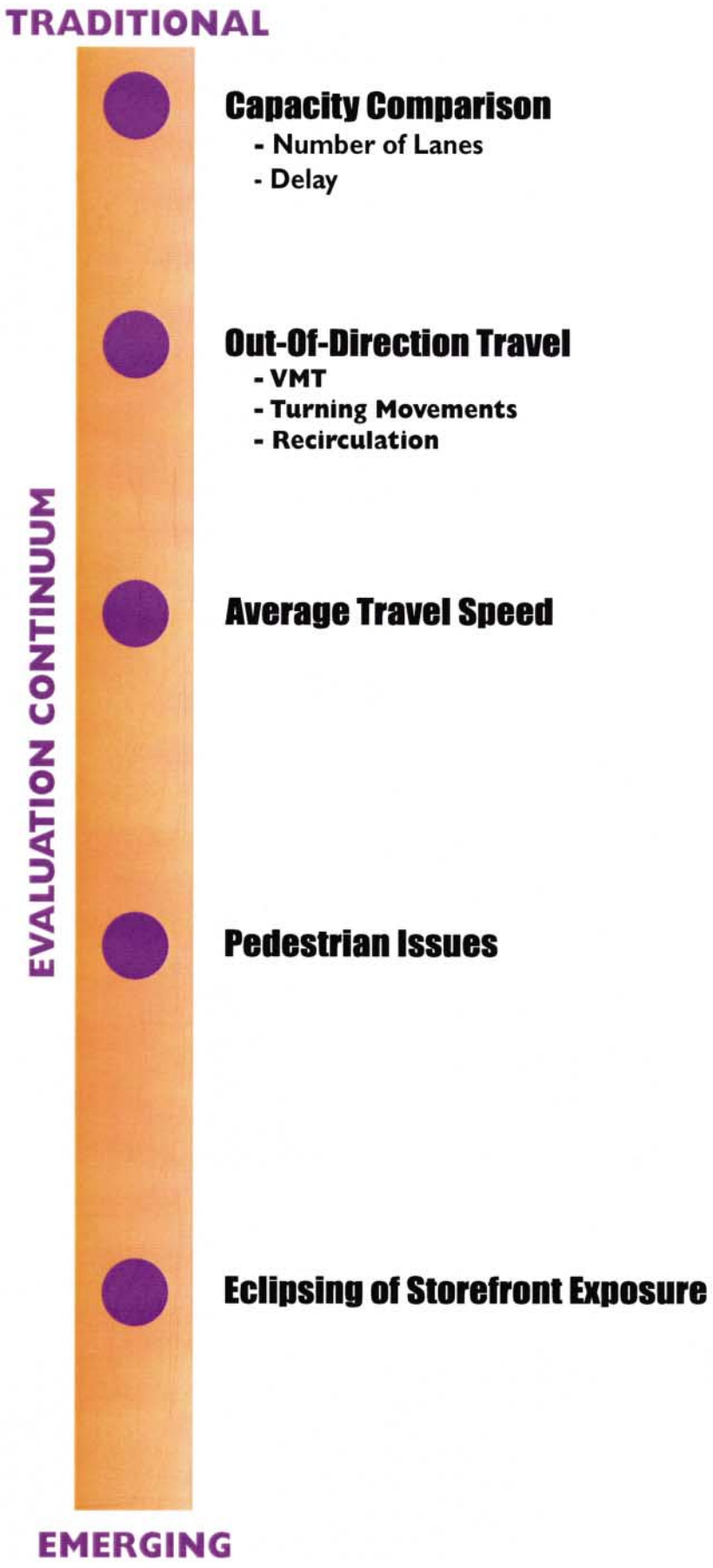

FIGURE 2 One-way vs. two-way measures of effectiveness.

and safety, and retail business street exposure. These measures are defined in detail within this section.

Network Capacity Comparison

The first evaluation measure is a comparison of the total east-west and north-south street capacity for both the existing one-way and proposed two-way travel conditions. To make this comparison, traffic counts on the street segments must be obtained for the a.m. and p.m. peak hours. These existing volumes must then be reassigned on the converted network to allow for the redistribution of traffic that will occur when the one-way restriction on certain streets is lifted. This reassignment can be accomplished through the use of a manual reassignment for small street networks or by using a traffic modeling software package for more detailed networks. Once a set of traffic volumes has been established for both the one-way and two-way scenarios, screenlines can be established to account for all of the east-west and north-south lane capacity through the network. Capacity volume thresholds can then be established for the desired level-of service on the streets contained in the screenline. Since it is acknowledged that a one-way lane does have a slightly greater capacity that a corresponding two-way street, a 10–20 percent reduction in lane capacity is taken for the two-way facilities. Volume-to-capacity ratios (v/c) can then be established for each of the facilities along the screenline in both a one-way and two-way configuration. Aggregated v/c's can be obtained by summing the volumes and capacities for each travel direction, giving an indication of the total available system capacity in both the east-west and north-south travel corridors. An example of this application as used in New Haven, Connecticut, is illustrated in Figure 3.

Most downtowns have a well-developed street grid; this abundance of alternate routes is the inherent advantage that downtowns have over their competitors, suburban office and retail parks, where all traffic is generally forced onto the one or two available arterials. This corridor capacity approach assumes that as one facility begins to approach its capacity, some traffic will divert to other parallel, less-used facilities. This diversion begins to animate some of the downtown roadways that were previously forgotten in the one-way system, making them more visible and attractive for redevelopment.

Out-of-Direction Travel

As stated previously, one of the inherent disadvantages with one-way streets is that they force additional turning movements at the intersections caused by motorists who must travel "out-of-direction" to reach their destination. These additional turning movements increase the chance of a vehicular-pedestrian conflict at any given intersection, and also result in a systemwide increase in VMT over a comparable two-way system due to the amount of recirculating traffic.

The magnitude of these measures can be quickly estimated using the following approach. By choosing several downtown "portals," typically used entry and exit points from the downtown street network, and several major downtown "destinations," usually a high concentration of parking, supply, or office use, vehicular paths can be traced from origin to destination and back assuming both a one-way and two-way street network. This

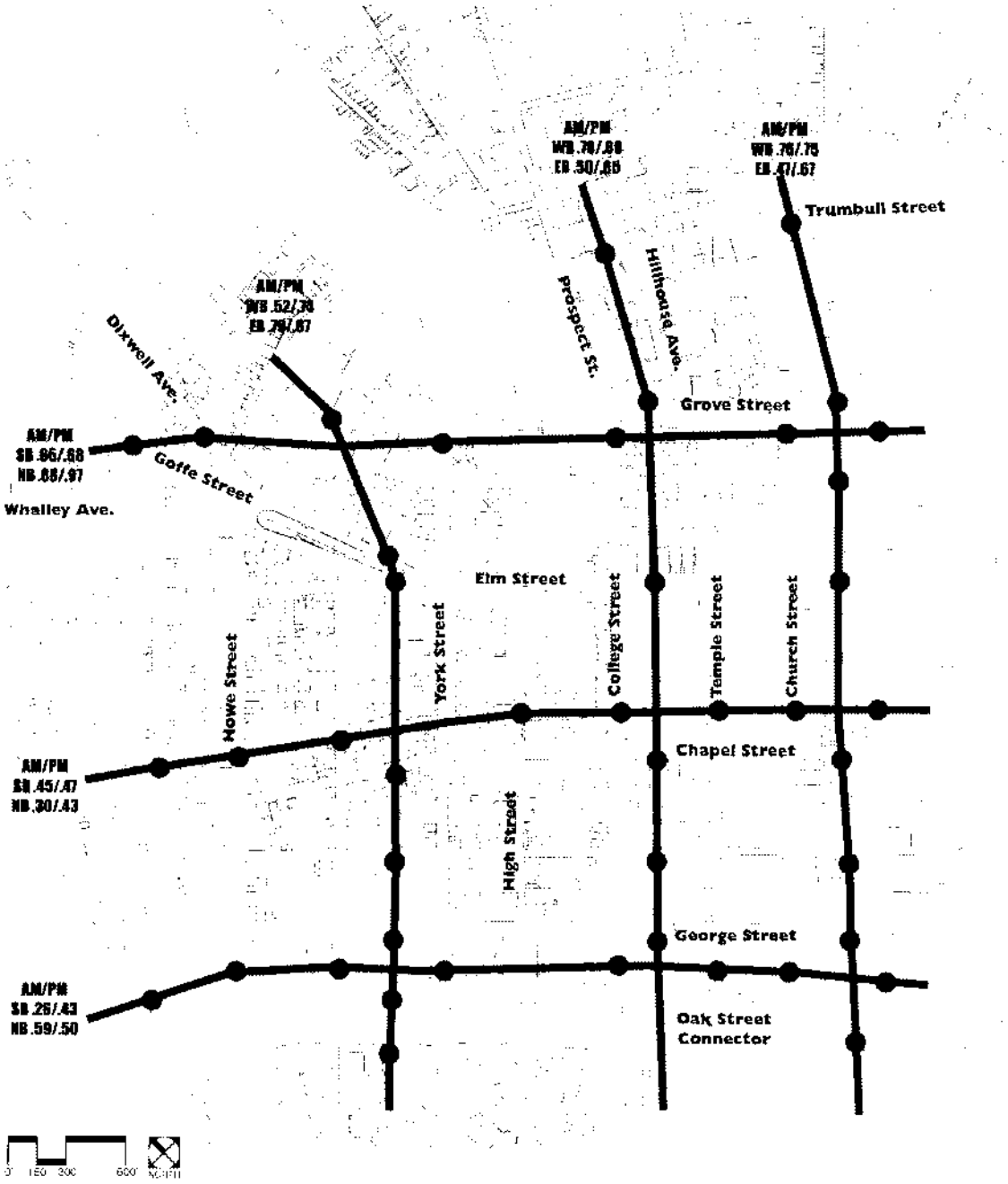

FIGURE 3 Screen lines and traffic volumes New Haven, Conn. (proposed).

method will give a comparison of the number of turning movements and total travel distance for each street configuration. Our experience shows that a one-way system usually yields approximately 120 to 160% of the turning movements when compared to a two-way system, and the travel distance between portal and destination is usually 20 to 50 percent greater in a one-way street system.

An additional measure of this comparison can be made by simulation modeling of both the one-way and two-way networks with TRAF-NETSIM. The simulation program would yield system VMTs and delays for each case, which could then be compared.

Travel Speed Comparison

It is true that overall average through-travel speeds are lower for a two-way street configuration than for a one-way system. However, to achieve a rebalancing of the system, it is important to consider *all* users of the downtown street network, not just the through traveler. Slower vehicular speeds are safer for crossing pedestrians, as they allow longer gaps in the traffic stream for crossing. Additionally, for those travelers with a destination downtown, accessibility and mobility are usually more important than through vehicular delay.

In most downtowns, the delay penalty will be small for the through traveler. For instance, a decrease in average arterial travel speed of five miles per hour over a one-quarter mile segment of network yields an additional three minutes of travel time. This delay incurred by the through traveler must be weighed against the other objectives of the community to determine the acceptability of the impact.

Pedestrian Measures of Effectiveness

Pedestrian measures of effectiveness such as sidewalk capacity and pedestrian LOS will not be covered in this discussion since they do not pertain specifically to the one-way versus two-way argument. Concerns for downtown pedestrians with regard to one-way streets center on convenience, safety and the quality of the walking environment.

The convenience to pedestrians is a key element to the livability and vitality of a successful downtown. A prosperous downtown contains many more offerings of goods and services than a blighted one and is therefore far more attractive to the pedestrian.

The conventional wisdom has always assumed that one-way streets were safer and more comfortable for pedestrians to cross than two-way streets. Superficially, it would seem that crossing the single direction of traffic on a one-way street is always preferable to crossing a two-way street.

As is often the case, the conventional wisdom is wrong. In fact, crossing a one-way street presents greater difficulties to the pedestrian than crossing a two-way street. The explanation lies in the greater number of different vehicle/pedestrian conflict sequences (hereinafter “conflict sequences”) that are encountered in crossing the one-way street. Any given conflict sequence consists of: (1) the kind of turning movement that the vehicle is engaged in, (2) the direction (left-to-right or vice versa) in which the vehicle path intersects with the pedestrians and (3) the location of the vehicle with respect to the pedestrian’s field of view, at the beginning of the vehicle movement. Figure 4 illustrates the conflict sequences for both one-way and two-way intersections.

There are only two possible sequences (sequences #1 and #2 in diagram) that pedestrians can encounter in crossing a two-way street. Regardless of what leg of the intersection they cross, they will never encounter other than these two conflict sequences. Further, these two sequences are closely related, essentially the mirror image of each other.

On one-way streets, by contrast, there are 16 different conflict sequences that pedestrians can encounter, depending upon which leg of the intersection they are crossing. Further, these sequences vary widely in their component parts. For example, some sequences have only a single conflict, while others have two or even three. Further, the

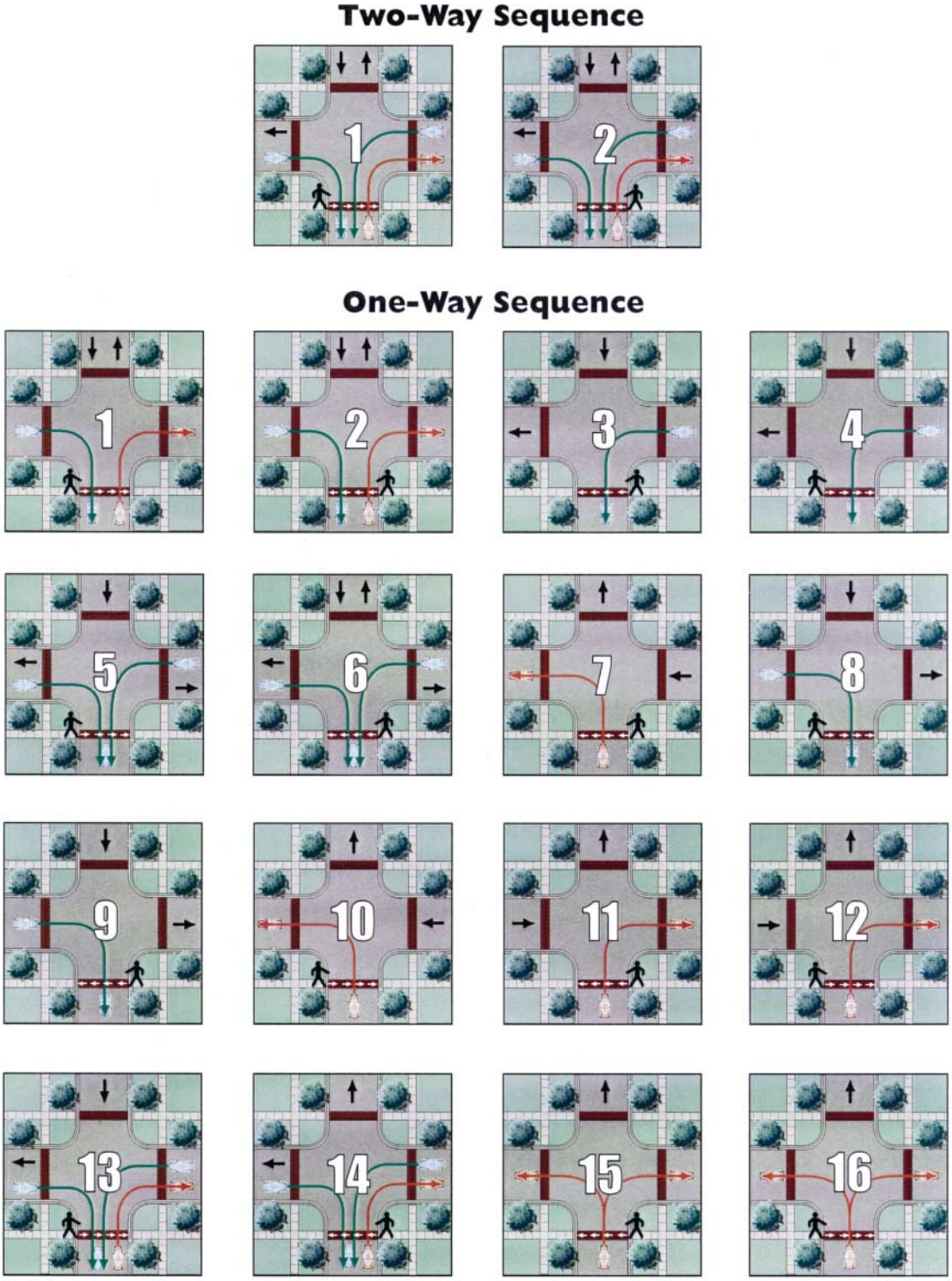

FIGURE 4 Sequence of conflicts created by one-way streets.

sequences involve a wide variety of directions of vehicle flow and pedestrian views of the vehicle. The conventional view of the safety of one-way street crossing usually focuses on crossing the upstream leg of the intersection, in which only a single turning movement is encountered (sequence #11 and #12 in the diagram). However, this situation comprises only 2 of the 16 possible conflict sequences. The complexity and variety of the other 14 are typically overlooked when discussing the merits of one-way streets.

Eclipsing of Storefront Exposure

One-way streets have a negative impact on storefront exposure for those businesses highly dependent on pass-by traffic. As a vehicle stops at or enters an intersection the driver has excellent visibility of the storefronts on the far side of the cross street. On one-way street networks, precious storefront exposure is lost when one direction of travel is removed, causing one side of every cross street to be partially "eclipsed" from view, as illustrated in Figure 5. "Eclipsing" occurs on cross-street storefronts along the

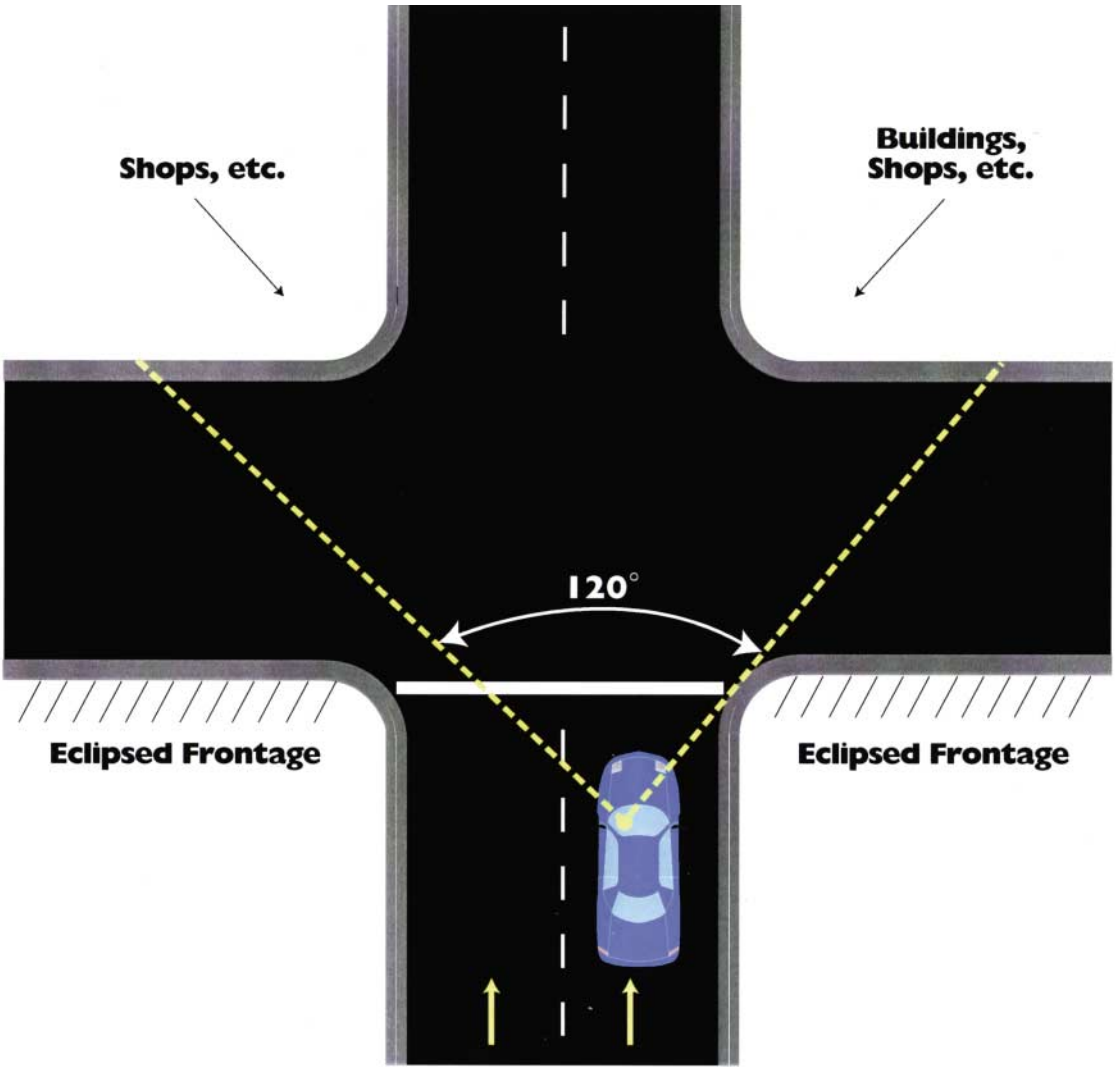

FIGURE 5 Retail eclipsing a diagrammatic summary.

nearside of the intersection relative to the direction of travel, and where downtown street networks contain many one-ways the accumulated negative impacts are significant. A methodology was developed to calculate the loss of exposure to first floor commercial property.

The quantity of eclipsed store frontage is a function of the quantity of one-way street approaches in the intersection, block perimeter size, building setback and street width.

As block perimeter size increases, assuming the store frontage eclipsed remains relatively constant, the percentage of impacted property decreases. The opposite is true when block perimeters decrease, exacting an unfair disadvantage to the downtown with a superior small-block size street grid. Building setback and street width combine to determine the storefront footage visible across the street from the corner to the range of sight limited by the glancing angle. The greater the sum distance from building setback to building setback on the cross street, the more the store frontage eclipsed. An application of the eclipsed frontage analysis is shown in Figure 6.

Once the evaluation measures have been quantified using the presented methodology, they can be summarized in a matrix similar to the one presented in Figure 7. In this way, a clear comparison is readily available for review by all interested parties.

GETTING IT DONE: NEXT STEPS

By carefully evaluating the results of an analysis using the methodology described above, a community can make a better-informed decision about converting one-way streets to two-way travel. Decision makers can weigh these quantitative criteria against the vision and goals a community has for its downtown and determine if the through-traffic impacts are acceptable in gaining livability within the downtown. Once the decision is made to convert to two-way networks, several implementation strategies are available to make the transition as simple and cost-effective as possible.

Figure 8 graphically depicts five options that can be used to implement a systemwide downtown network conversion from one-way to two-way streets. The strategies allow communities to undertake as much or as little conversion as they desire in each phase and provide a systematic approach to deal with specific financial concerns or skeptics. As can be seen from Figure 9, a conversion plan as dramatic and far-reaching as the one recommended for New Haven, Connecticut, can entail significant costs and time and is therefore a candidate for phasing.

Many communities are in the process of converting their one-way streets to two-way networks. Table 1 summarizes some of those communities as well as where they are in the process.

In conclusion, it is important to note that converting the street network from one-way to two-way will not by itself guarantee an immediate resurgence of growth and activity downtown. Most communities have come to this recommendation as a part of a greater vision or urban design plan for their downtown. The conversion of one-way streets is most often accompanied by other initiatives designed to attract additional downtown development or redevelopment and make downtown a more livable community.

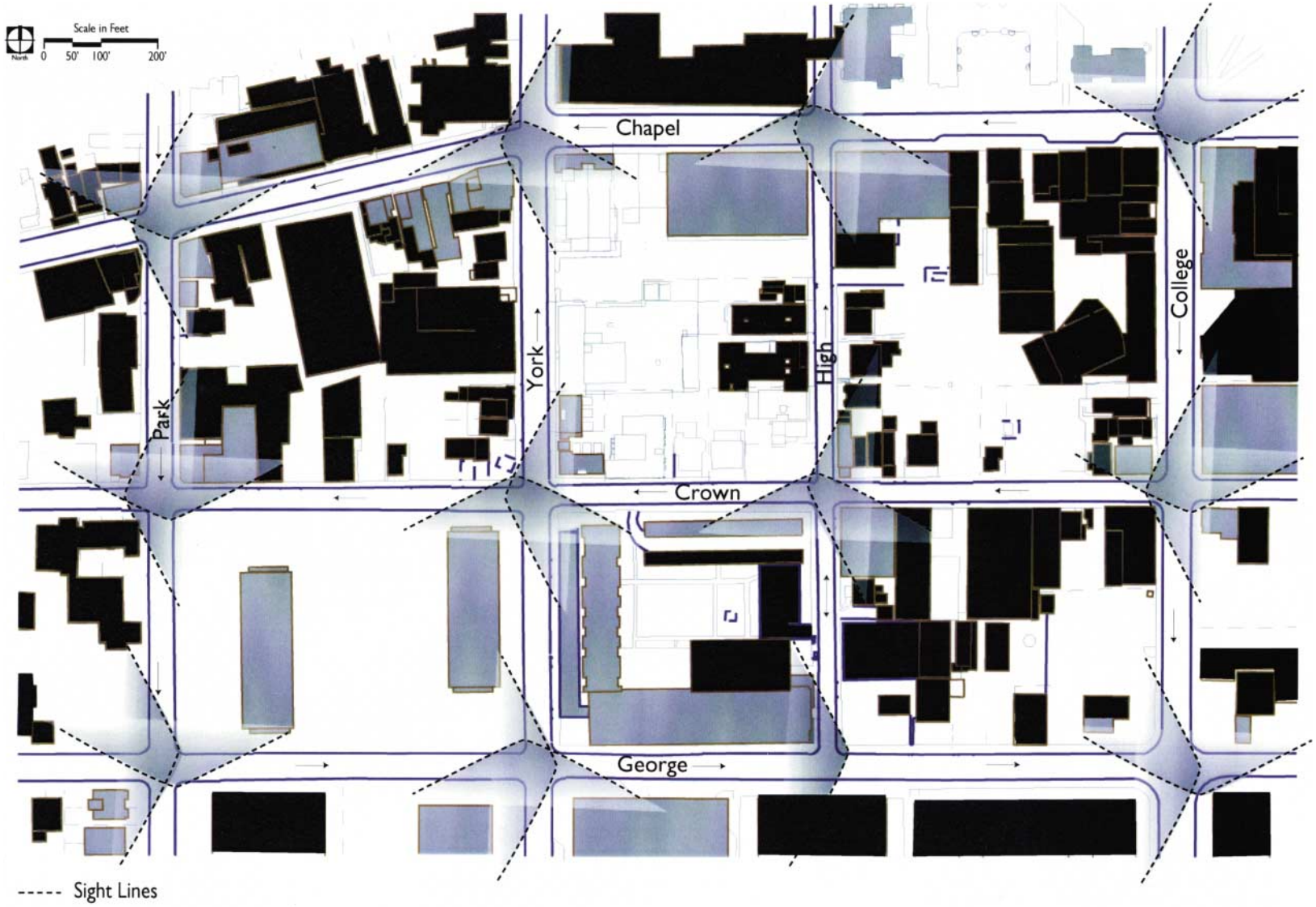

FIGURE 6 Retail/commercial properties eclipsed by one-way streets, New Haven, Conn.

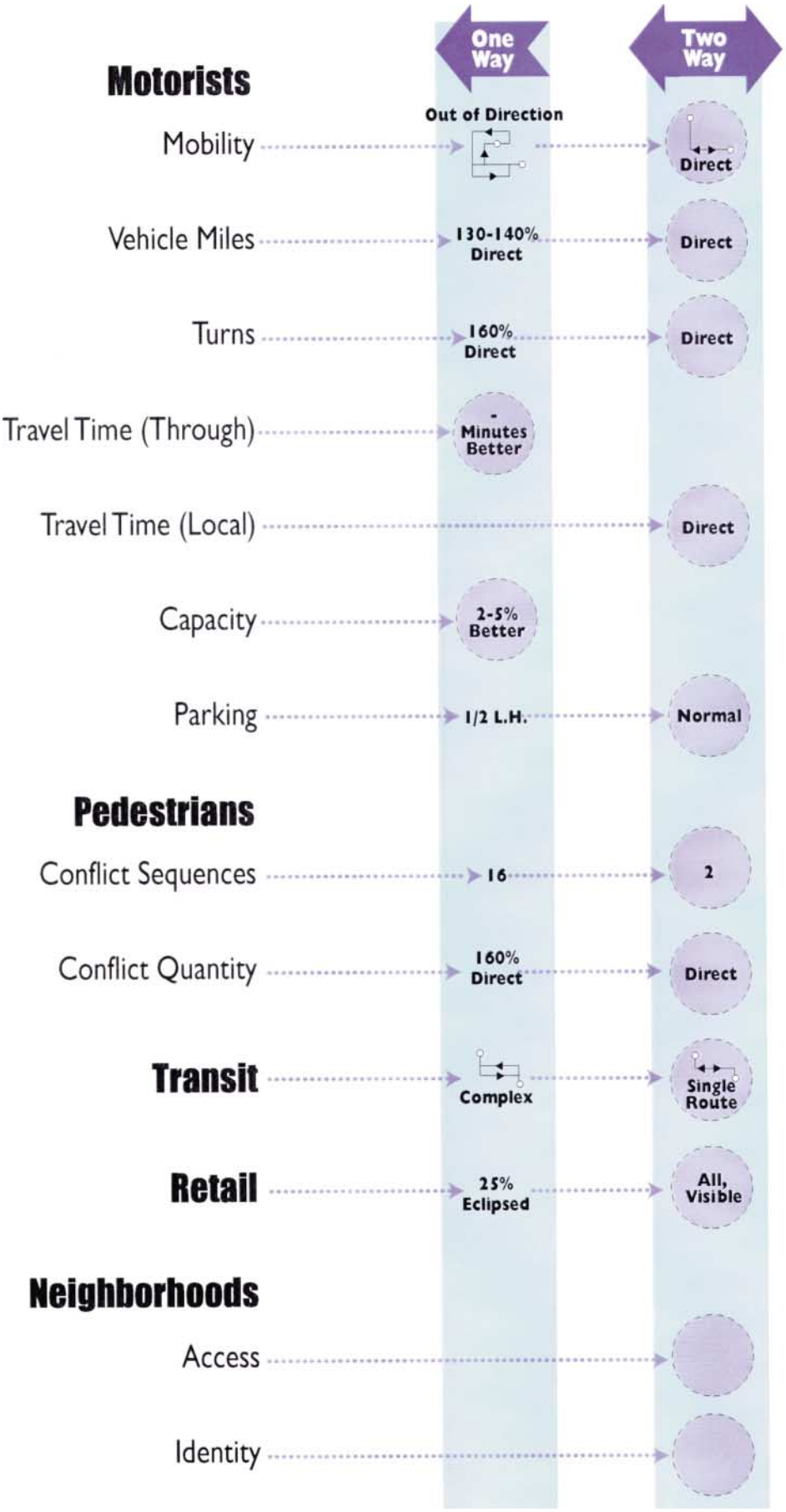

FIGURE 7 Sample evaluation matrix.

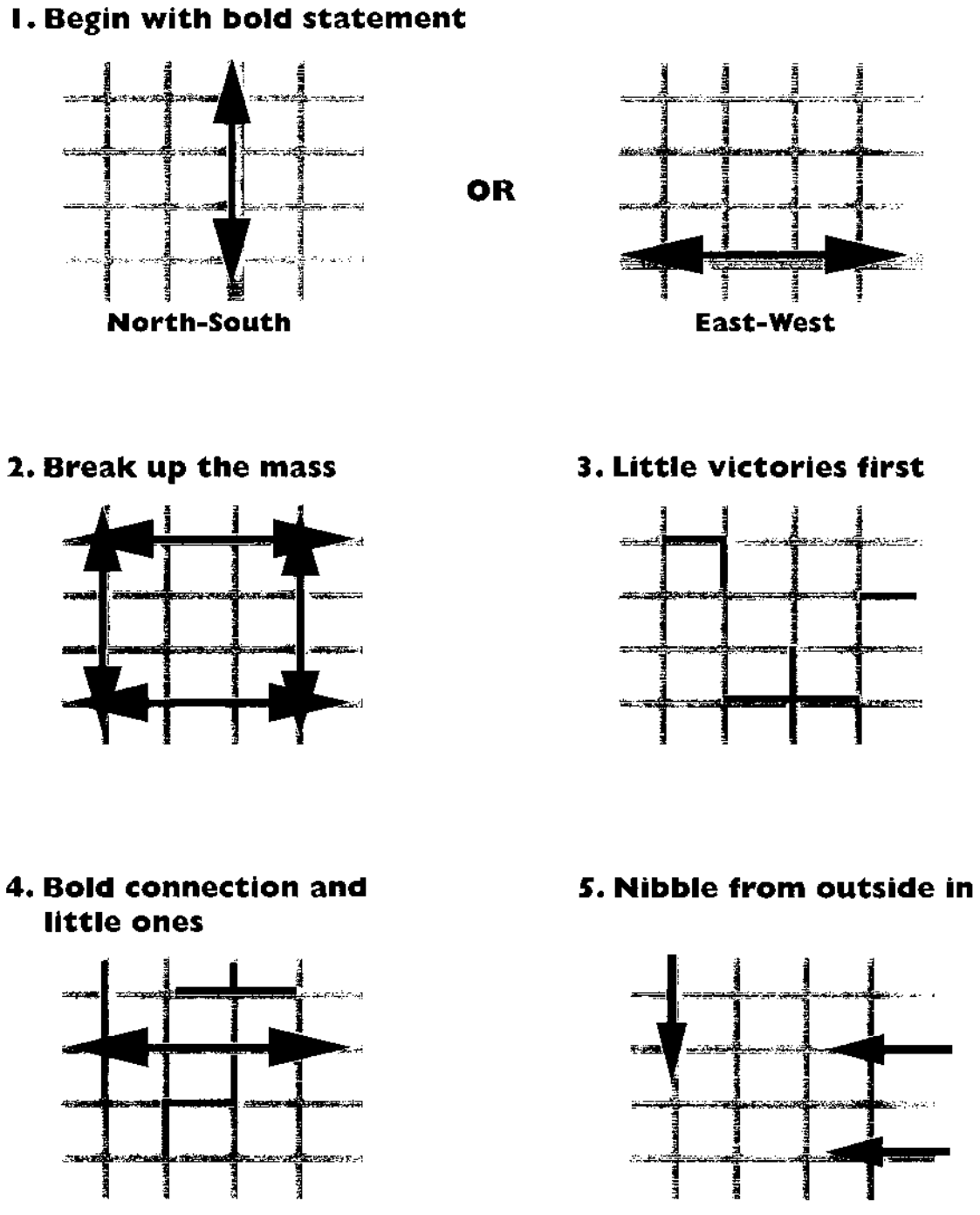

FIGURE 8 Strategies for restoring "two-ways".

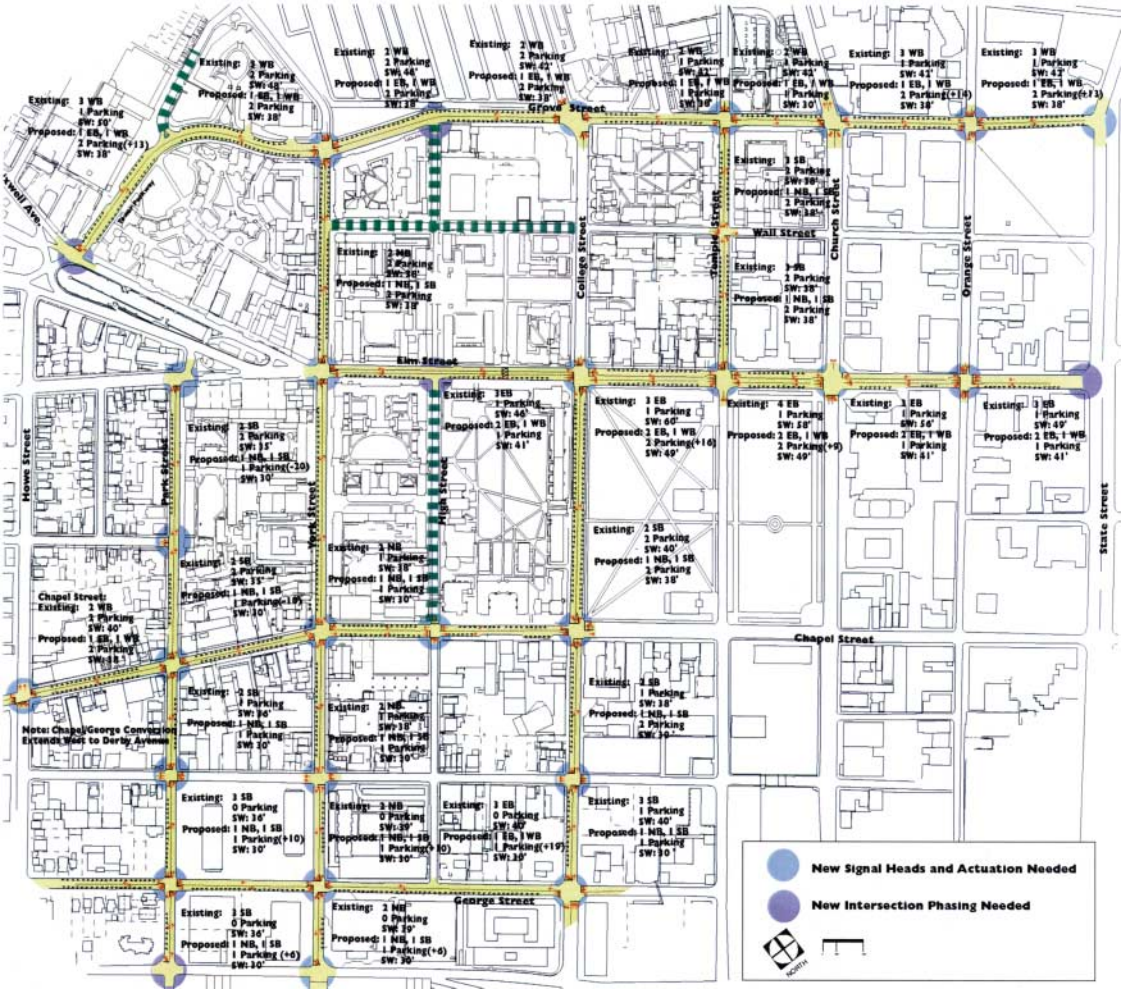

FIGURE 9 Sample conversion plan - New Haven, Conn.

TABLE 1 Communities Undertaking One-Way Conversions

City	*Chief Supporters of Conversion*	*Reasons for Conversion*	*Current Stage in Conversion*	*Primary Contact*
Albuquerque, NM	City transit system and council member	Create a pedestrian-friendly environment near a new intermodal facility and reduce confusion for visitors	City council will approve conversion this year.	Robert Dourte, Transportation Development, (505) 924-3990
Berkeley, CA	Neighborhood association	Accommodate buses and bikes and reduce neighborhood cut-through	Final draft of conversion plan now in preparation.	Charles Deleuw, Traffic Engineering, (510) 644-6540
Cincinnati, OH	Local business community (Over-The-Rhine Chamber of Commerce)	Calming traffic and attract new neighborhood businesses	A city council resolution has called for conversion.	Judith Osbourne, Over the Rhine Chamber of Commerce, (513) 241-2690
Edmonton, Alberta	Business community	Increasing retail activity downtown	A majority of one-way streets to be converted in August, 1998.	Frank Perich, Transportation and Engineering (403) 496-1787
Norfolk, VA	Planning office, local residents, traffic engineering department	Completion of boulevard system surrounding downtown and traffic calming in residential area	Conversion of two streets to be complete by mid-July 1998.	Brian Townsend, Planning, (757) 664-4752
Toledo, OH	Business and government leaders (Downtown ToledoVision)	Create a pedestrian- and visitor-friendly downtown	Two streets were converted in 1997, and plans call for the entire downtown network.	Joe Moran, Downtown ToledoVision, (419) 244-3747
Waukesha, WI	Traffic engineering department/ business community	There is no longer a need for a one-way network	Several streets have been converted, and more on an ad hoc basis.	Don Martinson, Southeastern WI Regional Planning Commission, (414) 547-6721

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