CONVERSION OF STREETS FROM ONE-WAY TO TWO-WAY OPERATION

Final Report
Executive Summary

prepared for

Michigan Department of Transportation

prepared by

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Department of Civil and Environmental Engineering
Michigan State University

26 July 2000

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16. Abstract

The objectives of this study were to perform a traditional literature review and contact practicing traffic engineers in different jurisdictions to establish an understanding of the current "state of the practice" for converting one-way streets (typically one-way pairs) to two-way operation. Two of the most significant findings of this review are that 1) a successful conversion from one-way to two-way operations is highly dependent on a meaningful public involvement process (supported by straightforward technical studies); and 2) that articulated technical/engineering guidelines for such conversions (e.g., threshold volumes) do not seem to exist. The technical desirability of such conversions is highly dependent on very local conditions (e.g., street widths, adjacent land use) and the political viability is dependent on the local support for, or opposition to proposed conversions.

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INTRODUCTION

The Michigan Department of Transportation (MDOT) is receiving inquiries from local jurisdictions and other groups regarding the application of traffic calming and other non-traditional techniques for dealing with traffic circulation/operations in cities and towns. One of these techniques is the conversion of one-way street operations to two-way traffic. Such conversions, or at least consideration of such actions, are being done with increasing frequency in Michigan and elsewhere.

In this context, MDOT is desirous of being able to determine when such conversions are acceptable or desired. Thus, a project was undertaken to: perform a traditional literature search and contact traffic engineers and different jurisdictions to establish an understanding of the current "state of the practice" for converting one-way streets (typically one-way pairs) to two-way operation.

PROJECT SCOPE

Given that the primary purpose of the project was to develop a state-of-the-practice report, it was also expected that outcomes associated with street conversions could be documented. It was not, however, proposed to do any original quantitative analysis. The documentation would include collecting information (to the extent possible) regarding the following outcomes:

- the traffic characteristics before and after conversion (e.g., traffic volumes, operating speeds);
- changes in crash frequencies and/or patterns (e.g., did crash frequency increase, did the type and/or severity of crashes change);
- motorist response to changes;
- guidelines for when conversions are indicated/contraindicated;

- whether conversions are considered "successful" and the criteria used to assess success; and
- costs of conversion.

METHODOLOGY/APPROACH

The traditional literature search was done using the Transportation Research Information System; more specifically, **TRIS Online**. TRIS is the most comprehensive bibliographic listing of published work in the transportation field. Secondary sources of information were identified through review of documents found as a result of the TRIS search.

While the published record was expected to be useful, it had also been expected that much of the recent experience in street conversions may not be published (e.g., traffic engineers working in the public sector are not often represented in the literature). Therefore, attempts were made to identify engineers, consulting firms, and jurisdictions that had experience with such conversions. This experience was documented through review of published reports and informal phone, mail, and e-mail interviews/surveys. Primary sources of individuals to be contacted included: personal contacts with consultants, MDOT identification of field personnel in Michigan, known practitioners active in traffic calming, a list of state-level (e.g., DOT) contacts that had been developed at MSU in the context of another traffic engineering-related project, and referrals from initial sources (e.g., traffic engineers in cities who were recommended by state DOT personnel).

The intent was that a synthesis of the experience represented in the literature and current practice would yield guidelines and suggestions for when (i.e., under what conditions) the conversion of one-way streets to two-way operation would be a reasonable action and when such conversions would be contraindicated.

SYNTHESIS AND DISCUSSION

The literature review and survey of practitioners provided less information that had originally been hoped but the consistency of information that was obtained from a variety of sources indicates that a more than adequate picture of the state of the art/practice with respect to

conversion from one-way to two-way operations has been obtained. The following paragraphs are addressed to the original objectives of the project and how they have been achieved.

Principal Findings

Two of the most significant findings of this review are that the single most important factor in a successful conversion from one-way to two-way operations is a meaningful public involvement process (supported by straightforward technical studies) and that articulated guidelines for such conversions (e.g., threshold volumes) do not seem to exist. Rather, as one engineer (Wood 2000) put it, a (straightforward) traffic study will tell you whether such conversions are technically feasible or not. Beyond that, opinion regarding whether one-way streets are a good idea or not runs the gamut from Burke (2000) "in virtually all [reasonable] circumstances, one-way streets should be removed" to Stemley (1998) "by changing to a two-way system, a large backward step will be taken which will result in a downtown that is less inviting than it is right now."

Beyond these two points, there is great variance in the results of planning and implementing conversions. For example, in largely residential areas where one-way streets are **not** serving high volumes (and two-way volumes could be easily handled), conversion of one-way streets back to two-way operation seems likely to be favored by residents and of little concern to whatever small number of through motorists are present. On the other hand, in established and congested downtown areas or on heavily used commuter routes where development over the years has been predicated on one-way operations, both technical and public acceptance issues are likely to be significantly more substantial.

With respect to more specific objectives of this project:

- The traffic characteristics before and after conversion (e.g., traffic volumes, operating speeds) are completely dependent on local conditions. Depending on pre- and post-conversion traffic patterns, an even daily split in traffic volumes between the two streets of a one-way pair can be expected to shift dramatically—one street becomes the principal two-way route in to or through an area while the other experiences significantly less volume. (Although it can easily be imagined where there would be exceptions to this "rule.") Operating speeds can be expected to decrease, assuming that there are not significant

geometric changes as part of the conversion. This assertion is based on the fact in most instances, conversion **to** one-way operation resulted in higher speeds—it stands to reason that conversion back to two-way will have the opposite effect. Indeed, lowering vehicle speeds is often perceived as an objective and positive benefit of converting to two-way operation. Finally, unless there are geometric changes, capacity and level of service will almost always decrease after a conversion to two-way. Indeed, if the post-conversion level of service is **not** unacceptable, it may well be that the conversion will face minimal opposition (at least from a traffic operations perspective).

- Changes in crash frequencies and/or patterns (e.g., did crash frequency increase, did the type and/or severity of crashes change) are a little less clear. The prevailing wisdom with the original conversions to one-way operation was that there would be significantly fewer crashes (and crash rates) as a result of conversion. This was the result of, for example, fewer conflict points at intersections. Pedestrian safety was also generally perceived to be enhanced with one-way operation because of such things as making the street-crossing maneuver easier to undertake (e.g., the pedestrian only has to be concerned with traffic from one direction at intersections) and the ability to provide mid-block crosswalks. Some recent studies have, however, found that one-way operations are not necessarily inherently safer than two-way operations. Moreover, overall increases in crash frequencies have not been regularly reported. It would seem that the improvement or degradation of general (and specifically pedestrian) safety would be largely dependent on a large number of factors (e.g., conflicting volumes, adjacent land use, whether parking is/was allowed) of which one- versus two-way traffic operation would be only one—these vary significantly on a case-by-case basis.

- Motorist response to changes is often mentioned in the literature on conversions both to and from one-way operations. This typically seems to be an "up front" issue which apparently does not materialize as a significant issue later on (or, at least, has not been fully investigated later). By and large, the implication of most of the studies/experiences seems to be that people adapt reasonably quickly to the changes (whichever way they go).

- Guidelines for when conversions are indicated/contraindicated do not seem to exist in any meaningful way. This was clear from the survey that was undertaken—very few (two) indicated that any sort of guideline existed, and they were never provided. On the other hand, it was fairly clear from larger-scale studies (e.g., in Portland, Oregon) that a standard multi-objective evaluation process was required when the proposed conversion projects were large or expected to be controversial. It should be noted that larger-scale conversions are more likely to involve state-numbered routes and, thus, require more systematic and comprehensive study. Examples were provided earlier in the body of the report and in an appendix of the complete report. This is also discussed in more detail later.

- Whether conversions are considered "successful" appears to be almost exclusively dependent on whether concerned citizens, businesspeople, and/or engineers think they are or not. At the same time, the trend to conversion back to two-way operation is fairly recent and there does not appear to be much in the way of long-term evaluation. If such evaluations are being done, they are not being widely reported. In any event, since conversions are being done in the larger context of traffic calming and executing downtown business enhancement strategies, it will be quite difficult to isolate the effect of the conversions—when many

variables are changed, it is quite difficult to attribute changes (e.g., in crash frequencies or rates) to changes in only one of those variables.

- Similar to other points above, the costs of conversion varies substantially and are completely dependent on the scale of the conversion implementation. For example, if the one-way pair is through a largely residential area with little or no through traffic and carrying very low traffic volumes, a conversion could be accomplished with some minor changes in traffic control devices. On the other hand, a conversion through a congested area may involve substantial changes in signalization (including new and/or improved/updated signals) and geometric changes.

Consideration of One-Way to Two-Way Street Operation Conversions

Notwithstanding the lack of published guidelines on one-way to two-way conversions, the review of the literature does yield suggestions for the variables and issues that should be considered when contemplating them. Recommendations are given below for the two overarching aspects of one-to-two-way conversions: the public involvement process; and the scope of the technical considerations.

Public Involvement Process

The following checklist is offered as a beginning point for the development of a public involvement process for operations conversions. The checklist is based on the review of the literature and the results of the practitioner survey. Of primary concern is the inclusion of different interest groups.

- ✓ Define the "impact area," the spatial extent of the corridor where the impacts will be of most concern when the conversion to two-way operation is implemented.

- ✓ Identify organized groups, jurisdiction-based bodies, and others who have an interest in the impact area. These would include formal (e.g., chamber of commerce) and informal groups of businesspeople in the area, neighborhood associations, special-interest groups (e.g., an organized group of bicyclists), planning and zoning commissions, citizen advisory groups (e.g., traffic advisory commissions, historical preservation groups), emergency services providers (e.g., police, fire, emergency medical service providers), schools, delivery services (e.g., UPS), city councilpersons, the media, and others. Using the impact area definition, all individual citizens and affected businesses should also be identified. Care should be taken to incorporate "special users" in the process (e.g., residents of elderly housing facilities in the corridor, schools).

- ✓ Hold public information meetings early in the conversion planning process. This should be done when the conversion is first considered—the planning and implementation process must

be inclusive rather than presented as a finished, polished proposal. Meetings should also be held with any identified groups—the implementation agency must be willing to go **to** meetings of potentially interested groups and individuals rather than expecting that these people will simply show up at general public information meetings.

- ✓ Disseminate information regarding all aspects of the conversion planning and implementation to the public and all identified interested groups via meetings, informational flyers, and the media. The type of information to be disseminated includes who is responsible for identifying the conversion for consideration, a clear presentation of all pertinent information about the conversion (both "good news" and bad), and details about when/how implementation would occur. To the extent possible, supporters and non-supporters of the conversion should be present at various presentation. The state agency should not appear to be the only active evaluator in the process.

- ✓ Once the decision to implement the conversion is made, it should be clearly articulated why the decision was made. For example, what were the deciding factors.

Technical Evaluation Issues

A preliminary list of the types of things to be covered in the technical evaluation is given below. Depending on the scale, type, and location of the proposed conversion, the list may be considerably shortened (or even expanded). Not all issues will have as much saliency as others in all situations. All analysis should be done for existing conditions and for all defined alternatives (e.g., level-of-service calculations should be done for existing conditions and all alternatives). This list contains the issues/actions identified in the literature review (including items listed in the ITE's *Traffic Engineering Handbook*—see appendix 5 of the full report for additional details) and the state of the practice survey.

overall planning and identification of alternatives

- ✓ define existing conditions
- ✓ define all conversion options to be considered (e.g., are there different limits that could be considered for "converted" segment or is it "all or nothing")
- ✓ identify role of streets in regional transportation network (e.g., is the existing one-way pair of local or regional significance)
- ✓ estimate current and future trip lengths that might be affected by conversion
- ✓ consistency of proposed conversions with neighborhood, city, and regional planning goals and objectives

traffic operations

- ✓ street and intersection capacities before and after conversion

- ✓ street and intersection levels of service before and after conversion
- ✓ geometric adequacy of the affected streets (e.g., pavement width)
- ✓ determine if minimally acceptable levels of service are achieved by all alternatives
- ✓ delay time on and off converted streets
- ✓ diversions to/from local system as a result of conversion
- ✓ estimate diversions to/from other through streets in corridor
- ✓ determine if additional lanes (e.g., through corridor, turning lanes at intersections) required for conversion
- ✓ estimate decrease in (or under-utilization of) lanes on less heavily traveled streets (after conversion)
- ✓ impacts on signal progression
- ✓ changes in left-turn conflicts
- ✓ increase/decrease in crash frequencies (overall and for specific crash types)
- ✓ increase/decrease in on-street parking
- ✓ determine the level of accommodation of through truck and local delivery
- ✓ undertake traffic control device inventories and required changes (including placement of signs, markings, and signals) for different alternatives
- ✓ determine the adequacy of sight distances for new two-way operation (assuming that existing streets had been designed for one-way operation)
- ✓ parking requirements

bicycle and pedestrian operations

- ✓ determine if bicycle lanes can be accommodated
- ✓ vehicle/bicycle interactions
- ✓ determine the location of major pedestrian generators and crossings
- ✓ changes in pedestrian environment (e.g., pedestrian-friendly geometry)
- ✓ pedestrian safety (e.g., adequate intersection and mid-block crossings for expected demand)
- ✓ pedestrian interaction with street traffic
- ✓ enhanced pedestrian signals

transit operations

- ✓ transit route accommodation
- ✓ increased/decreased walking distances to transit stops (e.g., from major attractors)
- ✓ transit interaction with other vehicles (e.g., stop location)
- ✓ enhancement of transit usage (e.g., better access)

neighborhood access

- ✓ neighborhood access improved or degraded (e.g., left turns in to and out of residential neighborhoods)
- ✓ increased/decreased traffic diversion into neighborhoods
- ✓ elimination of through traffic on neighborhood streets
- ✓ increased traffic on some residential streets serving through traffic

commercial/business issues

- ✓ improved access to adjacent properties (primarily businesses)
- ✓ less confusion for motorists, especially visitors
- ✓ reduced travel distance to destination
- ✓ enhancement or degradation of downtown or commercial district
- ✓ access to major generators (e.g., large employers, community centers, parking structures)

other issues/considerations

- ✓ cost of conversion
- ✓ public opinion
- ✓ origination of support (or non-support)
- ✓ environmental impacts (e.g., increased/decreased air pollution due to conversion)
- ✓ timing and duration of implementation

This list of issues is not necessarily comprehensive nor would each item necessarily be relevant for every study. One of the first issues for the public involvement/planning process to consider is to identify which issues should be considered for any specific conversion proposal. In addition, to the extent possible, acceptable thresholds (for those variables that lend themselves to such measurements) should be discussed and established **before** technical analyses are done and results presented. For example, it should be established that level of service C is acceptable for an intersection prior to doing the analysis necessary to compute the level of service.

One of the goals for this project was to establish guidelines for when conversions from one-way to two-way operations might be advisable or acceptable. However, it is clear from the literature review and the survey responses that a single set of criteria is elusive. While traffic operation concerns can be the deciding factor in conversions (and especially if the operations-oriented outcomes are very bad), the ultimate impact of a conversion is extremely case-specific. Degradation in motorist delay, for example, is dependent on everything from simple traffic volumes to be accommodated to width of the streets to cross-street (and turning) volumes—what works in one area may result in an operations disaster elsewhere.

At the same time, the types of analyses that are implied in the "issues list" presented above are straightforward and are the staples of good traffic engineering practice. But, it is equally

clear that not all of the important outcomes are neatly quantified or equally valued by all participants in the process. For example, in general, traffic engineers would probably favor alternatives that resulted in higher vehicle speeds (and lower delay) while it seems clear that others may view reasonably decreased (more pedestrian friendly) speeds in a more positive light. So, while it is important to do "good engineering" with respect to the outcomes of proposed conversions, it is as important to have an effective public involvement process where conflicting goals and objectives can be articulated.

FUTURE WORK

It is clear from the review of the literature and survey of practitioners that converting one-way pairs of streets back to two-way operations is a current fad of sorts. It is often discussed in the context of other projects consistent with traffic calming and generally improving downtowns. It is characteristic of the lack of knowledge about what makes downtowns and neighborhoods "work" that the effects of different traffic operations changes on business are largely unknown. It is similarly largely a matter of conjecture on even what the traffic operations impacts are when the one- to two-way conversions are implemented. There have been and are a fairly large number of conversions being considered in Michigan. The list includes Adrian, Jackson, Kalamazoo, Lansing, Mt. Pleasant, and Battle Creek. While not all of these conversions have (or will) included state trunklines, it seems appropriate that the impacts of some of these conversions on traffic operations should be evaluated in more depth. More ambitious work could also examine the relationship between these conversions and business/downtown development patterns.

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INTRODUCTION

The Michigan Department of Transportation (MDOT) is receiving inquiries from local jurisdictions and other groups regarding the application of traffic calming and other non-traditional techniques for dealing with traffic circulation/operations in cities and towns. One of these techniques is the conversion of one-way street operations to two-way traffic. Such conversions, or at least consideration of such actions, are being done with increasing frequency in Michigan and elsewhere. This is somewhat in opposition to long-standing traffic engineering approaches which tend to favor one-way operation when increased flow must be accommodated with lower travel delays. There may be safety concerns as well.

In this context, MDOT is desirous of being able to determine when such conversions are acceptable or desired. Thus, a project was undertaken to: perform a traditional literature search and contact traffic engineers and different jurisdictions to establish an understanding of the current "state of the practice" for converting one-way streets (typically one-way pairs) to two-way operation.

PROJECT SCOPE

Given that the primary purpose of the project was to develop a state-of-the-practice report, it was also expected that outcomes associated with street conversions could be documented. It was not, however, proposed to do any original quantitative analysis. The documentation would include collecting information (to the extent possible) regarding the following outcomes:

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- changes in crash frequencies and/or patterns (e.g., did crash frequency increase, did the type and/or severity of crashes change);

- motorist response to changes;
- guidelines for when conversions are indicated/contraindicated;
- whether conversions are considered "successful" and the criteria used to assess success; and
- costs of conversion.

The deliverables for the project include:

- a final report documenting the literature review and state-of-the-practice assessment;
- an annotated bibliography;
- a list of individuals, institutions, and jurisdictions (and contact information) that have undertaken conversions; and
- (if they can be supported by the literature and state of the practice) guidelines that MDOT could use for determining whether conversions are appropriate.

METHODOLOGY/APPROACH

The traditional literature search was done using the Transportation Research Information System; more specifically, **TRIS Online**. TRIS is the most comprehensive bibliographic listing of published work in the transportation field. **TRIS Online** is funded by the sponsors of the Transportation Research Board (TRB) and is hosted by the National Transportation Library through an agreement between the Bureau of Transportation Statistics and TRB. Secondary sources of information were identified through review of documents found as a result of the TRIS search. TRIS entries include articles from such sources as TRB's ***Transportation Research Record*** series, the American Society of Civil Engineers' ***Journal of Transportation Engineering***, the Institute of Transportation Engineers' ***ITE Journal***, and reports from various federal and state agencies, among others.

While the published record was expected to be useful, it had also been expected that much of the recent experience in street conversions may not be published (e.g., traffic engineers working in the public sector are not often represented in the literature). Therefore, attempts were made to identify engineers, consulting firms, and jurisdictions that had experience with such conversions.

This experience was documented through review of published reports and informal phone, mail, and e-mail interviews/surveys. Primary sources of individuals to be contacted included: personal contacts with consultants, MDOT identification of field personnel in Michigan, known practitioners active in traffic calming, a list of state-level (e.g., DOT) contacts that had been developed at MSU in the context of another traffic engineering-related project, and referrals from initial sources (e.g., traffic engineers in cities who were recommended by state DOT personnel).

The intent was that a synthesis of the experience represented in the literature and current practice would yield guidelines and suggestions for when (i.e., under what conditions) the conversion of one-way streets to two-way operation would be a reasonable action and when such conversions would be contraindicated.

LITERATURE REVIEW

The traditional literature review produced mixed results. A TRIS Online search on 1) traffic calming yielded over 200 citations, 2) searching on one-way streets yielded just over 100, and 3) the) even more restrictive criterion of searching on one-way/two-way conversions yielded only seven (7). (The listings from the TRIS searches showing title, the journal/source reference, authors, and approximate date are shown in appendices 1, 2, and 3 respectively.) Not unexpectedly, not all of these citations are of use for the current project.

Traffic Calming

Many of the traffic calming citations refer to such things as mid-block speed control devices and specific residential neighborhood traffic concerns. Interestingly, all of the traffic calming citations date from the very late 1980s with the vast majority far more recent than that. This is indicative of the growing interest in these techniques. However, it should be noted that the implication that traffic calming is a relatively recent phenomenon is very misleading. Many so-called traffic calming techniques date back far earlier than these citations, albeit with different names. For example, separation of pedestrian and traffic movement, elimination of through

traffic from residential areas, and the like were key components of the plans for Radburn (a "garden city" in New Jersey), Chatham Village (a planned unit development in Pittsburgh, Pennsylvania), and the so-called Greenbelt towns (e.g., in Wisconsin and Maryland). The planning, design, and implementation of all of these date to the 1920s and 30s (these developments are well documented in any number of references, see, e.g., Roth 1979). Moreover, the philosophical underpinning of these early examples dates back even further, to the late 1800s, and are found in classical city planning literature. Likewise, similar "traffic calming" techniques such as throttling down streets at intersections on collector/arterials, one-way loops for shopping districts, and pedestrian and transit malls were all considered and/or implemented as part of major urban renewal projects in the 1960s and 70s in Pittsburgh (Pennsylvania), St. Paul (Minnesota), and elsewhere (Lyles 2000). The point is that while traffic calming is often labeled as a "new" approach, its fundamental tenets effectively predate motorized vehicular traffic and modern congestion/operations problems. Typically, early (e.g., Pittsburgh in the late 1960s) debates about the use of various techniques pitted architects and city/urban planners against civil and traffic/transportation engineers. The former typically wanted more small-scale so-called walkable or pedestrian-friendly environments while the latter were more concerned about maintaining traffic flow and minimizing delay. Typically, both sides argued that their solutions were "safer." These same issues are being debated today although more traffic/transportation engineers appear to be open to trying traffic calming techniques. Much of the recent literature actually under the rubric of traffic calming deals with the general notion of calming traffic versus enhancing flow and not necessarily with the specifics of "what happened" in terms of measurable outcomes when various traffic calming applications were implemented.

One-Way Street Operations and Two-Way to One-Way Conversions

By contrast to the traffic calming literature, the search on one-way street operation yielded citations going back as far as the 1930s. Much of the "research" is, however, anecdotal and

many conversions, both to and from one-way operation, are likely not reported in the literature as such projects do not often lead to publishable "research results" *per se*. This point notwithstanding, a considerable portion of the material that follows is from practitioners reporting on actual conversions from one-way to two-way operations.

The more specific issue of converting from one-way (back) to two-way street operations is a reversal of a long-standing traffic engineering approach to easing traffic congestion and enhancing traffic flow. Among the earlier references on one-way streets, Canning and Eldridge (1937) and Burch (1938) indicate that one-way streets can be implemented (on an appropriate existing network) virtually without cost, and that they decrease congestion, increase running speed, eliminate certain kinds of crashes (e.g., head-on collisions), are easier to drive on (driver attention needs are decreased through the elimination of the need to consider/monitor oncoming traffic), and signal progression is easier to attain. On the negative side, sometimes travel distances are increased (depending on destination location on the "other" street in the pair) and some kinds of crashes may be increased—e.g., pedestrians have to cross more lanes of traffic and potentially more intersections. Finally, there may be some driver confusion when different parts of the same street operate in different modes (i.e., one segment is two-way, another is one-way).

More recently, a two-to-one-way conversion in Michigan was reported on by Enustun (1969) and included some fairly specific results for trunkline two-way-to-one-way pair conversions in Kalamazoo and Lansing. The average speed increased from 18.1 to 23.5 mph in Kalamazoo and from 25.3 to 28.2 in Lansing. There was some indication that rush-hour volumes also increased—the one-way arterials presumably attracting traffic from other local streets. Travel distances (apparently derived in part from an analysis of volumes) did not appear to have increased—providing at least anecdotal evidence that one of the assumed negative aspects of such conversions was not always realized. The safety-related results were mixed with Kalamazoo experiencing an overall decrease in crashes while Lansing experienced an overall

increase. For both cities, there were "considerable" reductions in rear-end and mid-block crashes and some increase in pedestrian involvement. No information was provided regarding crash severity although it seems possible that with the increase in speed, that severity may have increased as well.

An experiment in Jacksonville, Florida, where a four-lane, two-way bridge (on a larger 2.8 mile section of highway) was converted to one-way operation during peak hours, was reported on by Temple (1983). While not a conversion to a one-way pair *per se*, this experiment (which was later continued) was controlled and monitored reasonably closely. Results included a virtual doubling of capacity in one direction, a reduction in stopped delay at a downstream toll plaza by 78%, and an increase in average running speed of 56%. Travelers in the non-peak direction (who could not use the facility during the peak hour) were forced to use alternative routes. Again, while this action is not consistent with the exact type of conversions of concern here, the results are generally consistent with those experienced elsewhere.

In another related study of two-way to one-way operation, Gattis and Stover (1989) undertook a survey to ascertain citizen perceptions with regard to changing Texas freeway frontage roads from two-way to one-way operation. In Texas cities, access to and from freeways and land uses adjacent to the freeways is often provided by frontage roads. In congested or high-volume areas, the frontage roads are typically one-way, while in less congested/low-volume areas, frontage roads are two-way. As volume/congestion increases, the frontage roads are sometimes changed from two-way to one-way operation. While freeway frontage roads are clearly different than urban arterials, the response of the citizens to such changes is still interesting with respect to perceived impacts. Responses of citizens were also compared to those of an expert advisory panel. In general a slight majority of the respondents favored one-way operation (compared to 92% of the advisory panel) although approximately 90% of the respondents thought adjacent business (relatively far from a cross-over) would be hurt (versus ~60% of the advisory panel).

Only ~3% of the citizens thought two-way operation was safer (versus 8% of the advisory panel) while ~55% thought capacities would increase (versus 83% of the advisory panel). As noted, while freeway frontage roads are significantly different from trunklines operating through cities, the citizen concerns seem (intuitively) to be similar—safety is perceived to be much better while capacity (and presumably delay) is perceived to be somewhat improved while some business may suffer.

Hocherman et al. (1990) examined the safety aspects of one-way versus two-way streets in more detail. In their literature review, the authors note that prior research has shown that, generally, the two-way to one-way conversion results in an increase in travel speed and a decrease in the number of stops and total travel time. In addition, volumes and trip lengths are increased. One-way streets also have fewer points of potential conflict at intersections. They also report that some studies have shown a crash decrease of 20-30% with mid-block crashes being reduced by a greater amount. The safety studies have, however, typically been conducted in central business districts (CBDs) and/or on arterial streets. In the actual study done by the authors (in Jerusalem), crash rates were examined and disaggregated by type of roadway and location and were not restricted to CBD areas or arterials—rather all types of streets were studied. For non-CBD locations, one-way streets resulted in higher crash rates than two-way streets for all street types. The results for CBD streets were inconclusive because of small sample size. The higher rates could not be explained by differences in pavement width, free speed, or pedestrian volumes. The authors suggest that while one-way operation may increase safety in crowded, high-volume areas such as CBDs (based on earlier research), this may not be the case in other, more residential areas where one-way operation may be contraindicated.

One-Way to Two-Way Conversions

More to the point of the current work, in recent years there has been a movement to convert one-way streets (and one-way pairs, sometimes called couplets) back to two-way operation.

Indeed, most of the pre-1990 sources are about conversion TO one-way operation. By contrast most of the post-1990 sources are about conversion FROM one-way operation. The latter has generally been done in the name of traffic calming. One example of this trend has occurred in Denver where apparently long-standing (from the late 1940s and early 50s) one-way streets were converted back to two-way operation (Dorroh and Kochevar 1996). In Denver, they note that one-way operation increases capacity 20-50% as many turning conflicts are eliminated which, in turn, also reduces crash potential. However, many of these relatively long streets (in Denver), which were used to disperse CBD-oriented traffic to the suburbs, went through residential neighborhoods. At least some of the citizens residing in these neighborhoods had sought (since the mid-1970s) to have these facilities converted to two-way operations. Studies in the 1970s, which focused primarily on traffic operations issues, apparently indicated that the congestion that would result from the conversion was untenable, and the streets were not converted. In the early-to-mid 1980s, with a shift in the political power structure with more attention being paid to neighborhood concerns, conversion was again considered with the result that several one-way pairs were converted back to two-way operation. The reactions were mixed. One pair which handled 7,500 and 7,000 vehicles per day (largely directional flows) before conversion handled 600 and 11,600 after conversion. One street of the pair was designated as a local street while the other was designated as an arterial—the arterial street now carried both AM and PM peak traffic rather than just one peak. Predictably, those living on the street with the higher volumes were less favorable than those whose street was now "local." Other conversions were more or less successful depending on a variety of factors: some conversions were very successful because the pair did not carry extensive traffic and there were no significant shifts in congestion; others were perceived to be less successful because of parking problems and more limited access to downtown. Changes in traffic speeds and safety, if any, were not documented in the article. However, the clear lesson that the authors cite was the need for the community to be involved in

the entire planning of the conversion process and that conversions not be undertaken until consensus is reached. The implication of the article is that everyone needs to be involved in the process and to realize what will happen as a result of such conversions and that the affected neighborhoods must "sign off" on the changes in some way. A successful conversion project was as much a political exercise as a technical one.

An example of an evaluation of a proposed conversion of a long-standing one-way pair back to two-way operation is provided by the City of Portland (Oregon). The study is documented in a "technical memorandum" by the city's Office of Transportation and is entitled "Broadway-Weidler Corridor Plan" (City of Portland 1996). Basically, this one-way pair (couplet) of streets (Broadway and Weidler) serves as a "neighborhood collector" supporting neighborhood-oriented commercial development. However, it is also designated as a major multi-modal arterial (including bicycle lanes)—changing the pattern of operation in this corridor was a major undertaking (unlike some of the changes that were accomplished in Denver on relatively under-utilized streets). Alternatives that were investigated ranged from retaining the couplet to a complete "de-coupling" through the entire corridor. Other alternatives were basically de-coupling the streets through part of the corridor. Issues that were considered in the evaluation included: bicycle provisions, pedestrian use, transit operations, traffic operations, on-street parking, heavy vehicle utilization, and neighborhood access. While numerous technical exercises were done (e.g., traffic was assigned to the various links for the different alternatives and capacity analyses were done for current and 2015 volumes for each link and intersection), the impacts of each alternative were summarized (more or less qualitatively) in a typical multi-objective format. Table 1 is an illustration of the layout and the types of comments that were made (selected illustrative comments from only one alternative are shown).

Table 1. Example of "Transportation Summary for Alternative 2, Full De-Couple"

Transportation Element	Advantages	Disadvantages
Bicycles	bike lanes westbound on Broadway and eastbound on Weidler	increased vehicle congestion for greater vehicle/bicycle conflicts
Pedestrians	fewer high volume streets to cross	pedestrian crossing of two-way Broadway more difficult than one-way at unsignalized intersections
Transit	consolidated transit routing on Broadway	bus stopping in traffic on two-way Broadway would delay traffic and impact transit operation
Traffic	significant reduction in traffic volumes on Weidler (from 18,000 to 6,000 daily vehicles)	reduced level of service and difficult crossing two-way Broadway at unsignalized cross streets
On-Street Parking	increased on specific streets	decreased on specific streets
Heavy Vehicles	truck movement patterns would be similar to today	use of travel lanes for loading would not be possible
Neighborhood Access		more difficult neighborhood access at some intersections due to left-turn problems

Source: City of Portland 1996, table 2, page 8

In the final analysis, the conversion back to two-way operation was not recommended based (it would appear) on the grounds of increased congestion and the non-fulfillment of some neighborhood goals. The types of impacts that were explicitly considered included the following:

- ✓ bicycle lanes accommodation
- ✓ vehicle/bicycle interactions
- ✓ pedestrian environment (e.g., pedestrian-friendly geometry)
- ✓ pedestrian safety (e.g., crossing one-way street is easier)
- ✓ pedestrian interaction with street traffic
- ✓ enhanced pedestrian signals
- ✓ transit routes
- ✓ transit interaction with other vehicles (e.g., stop location)

- ✓ enhancement of transit usage (e.g., better access)
- ✓ increasing/decreasing volumes on different streets
- ✓ increase in number of lanes on more heavily traveled streets (after conversion)
- ✓ decrease in (or under-utilization of) lanes on less heavily traveled streets (after conversion)
- ✓ level of service mid-block and intersections during peak and off-peak hours
- ✓ signal progression
- ✓ left-turn conflicts
- ✓ increase/decrease in crash frequencies
- ✓ increase/decrease in on-street parking
- ✓ truck accommodation—both through trucks and local deliveries
- ✓ neighborhood access (e.g., left turns in to and out of residential neighborhoods
- ✓ increased/decreased traffic diversion into neighborhoods

In addition to the traffic-oriented impacts just listed, there was also considerable attention given to the impacts that the conversion alternatives would have on neighborhood goals and objectives (including public acceptance), businesses in the area, accomplishing regional objectives, and other broader-scale concerns. In the analysis/evaluation no thresholds were given for what was "acceptable" (e.g., intersection LOS must be maintained at C or better), rather the evaluation seemed to deal primarily with absolute and relative differences between the alternatives. This study serves to illustrate the complexity that can be involved in street operation conversions and how the important issues are often "local" in nature.

Another study from Portland (City of Portland 2000) was directed to the consideration of another couplet, the Belmont-Morrison project. The approach that was used was quite similar to that for the Broadway-Weidler corridor. This investigation also resulted in a recommendation to not de-couple the existing one-way pair. The primary factors mitigating against de-coupling were degradation of traffic operations, failure of other alternatives to meet a citizen advisory committee's design objective, elimination of parking near businesses, and lack of support for the de-coupling option. The latter was gauged through a broad survey of corridor residents and an "open house" that was held to explain the alternatives to interested parties. The overall "alternatives evaluation summary matrix" is provided in appendix 4. The exercise for this corridor again supports the notion that there needs to be a thorough and comprehensive review of

impacts of proposed changes, that the affected interest groups (e.g., residents, business interests) need to be fully involved in the planning and evaluation process, and that decisions to "convert" or not are likely to be based on not only traditional traffic operations considerations but also specific local concerns.

Brown and Fitzsimons (1997) report on a similar process that took place in Sacramento (California). Although the source article did not contain as much detail as the Portland case studies, the traffic calming plan for downtown Sacramento was seven years in the making and a very politically-charged undertaking. The conversion of a one-way pair to two-way operation was one part of the overall calming plan. Of interest in this report was the fact that the expressed need for traffic calming originated in two neighborhoods adjacent to the CBD which were experiencing considerable through commuter traffic. Related issues that arose included the need to accommodate buses and emergency vehicles (a one-day field simulation using traffic cones was actually undertaken) and where diverted traffic would end up (e.g., are adjacent neighborhoods negatively impacted when one neighborhood is "calmed?"). It was also noted that a full Environmental Impact Report (as required by the California Environmental Quality Act) had to be prepared as part of the process. The most salient feature of this article was the identified need for a consistent and meaningful interaction among the various players (e.g., political figures, technical staff, different neighborhood interest groups) when developing, discussing, and implementing the traffic calming plan. It is interesting to note that this "finding" (and similar comments from several other sources) are no different than those historically made regarding the planning process for ANY significant transportation-related project. The need for effective and ongoing community involvement in planning transportation system elements is no different now than it was in the 1960s when there were major debates over projects such as the Embarcadero Freeway in San Francisco and the proposed I-95 route through the Boston area which resulted in the well-documented Boston Transportation Planning Review. The topics and

scale may be different (i.e., freeway alignments versus traffic calming), but the concerns of citizens and how to deal with them are not.

A less controversial conversion of one-way to two-way operation occurred in the Lubbock (Texas) CBD in 1995 (Hart 1998). The initial impetus for the conversion came from an ad hoc group of citizens which, in turn, resulted in a review by a formal citizens' advisory commission and, eventually, professional staff. Throughout the process, the professional staff was highly responsive to community needs and a good relationship was developed—the staff was viewed as being very inclusive with respect to planning and implementing traffic operations changes. The eventual recommendation was to convert to two-way operations. The advantages and disadvantages that were cited included:

advantages

- ✓ less confusion for motorists, especially visitors
- ✓ improved access to adjacent properties (primarily businesses)
- ✓ reduced travel distance to destination

disadvantages

- ✓ cost of conversion (approximately $50,000)
- ✓ increased congestion
- ✓ reduced effectiveness of two-way signal progression
- ✓ small town look
- ✓ unlikely conversion back to one-way operation if additional capacity was needed later

With respect to the traffic operations-related concerns, the highest peak hour volume on either existing street of the one-way pair was less than 600 vph and two-way volumes were less than 1,000 vph. Thus, the congestion-related disadvantages were not significant. The conversion was accomplished and monitored with the result that traffic volumes have remained approximately the same and crash frequencies have increased slightly (but the change was within the limits of year-to-year fluctuations). The responses from businesses and others have virtually all been positive with businesses actually reporting minor growth after several years of decline. Indeed,

the "small town look" which was originally perceived as a negative has been turned in to a positive for this medium-sized city of 200,000.

The relatively easy and "stress-free" conversion in Lubbock, versus the more controversial experiences elsewhere, can be attributed to the relatively low level of impact of the conversion (e.g., traffic volumes are quite low in comparison), the fact that the original proposal for the conversion came from the affected community, and the positive way in which professional staff and the community interacted. The conversion was also a "stand-alone" project, not related to other traffic calming changes or public issues.

Another relatively low profile change from one-way to two-way operation on selected streets was accomplished in Lansing (Michigan) in 1999 (City of Lansing 1999). The changes were proposed as part of an overall comprehensive planning process for the downtown area which had been developed by technical staff with considerable input from citizens and various interest groups in the city. The driving factors in the consideration of the reversal of the long-standing one-way system were considered to be to make the downtown area more accessible for local residents and more "driver-friendly" for visitors. It should also be noted that there is considerable unused capacity in the downtown Lansing street system. Public involvement was accomplished in the original comprehensive planning exercise, through flyers to residents and businesses in the affected areas, and in presentations at various public meetings. The technical analysis that was done showed that there would be some loss of on-street parking, the intersections could easily handle off-peak flows and peak flows would be handled at an acceptable level. An analysis of traffic crashes indicated that no significant change in safety was predicted—the potential increase because of increased conflict points in some intersections would be offset by savings in other types of mid-block and some pedestrian crashes. Finally, it was recommended that conversions be undertaken in two phases to mitigate confusion. The first

phase of the conversion has been completed (at this point), and there have not been significant problems encountered.

Jossi (1998) also notes that downtown one-way to two-way conversions have also been done in Toledo (Ohio) and are being considered in St. Paul (Minnesota) and Albuquerque (New Mexico). Although not technically detailed, Jossi notes that these conversions are being considered or done as part of downtown rejuvenation/growth activities. The fears are basically related to the added congestion of operating two-way streets on sometimes limited street widths. Not all of the downtown interests have been in favor of these changes, although detailed arguments were not presented. The conflicts reported by Jossi appear to be classic ones between planners/downtown development coordinators and traffic operations-oriented concerns.

Folks et al. (1998) report on a significant project undertaken in San Francisco which, in addition to conversion of a one-way street to two-way operations, also included provision of improved transit service. The message that the authors deliver with respect to this successful conversion is one of process rather than resolving particularly thorny technical issues. Unlike some of the other successful conversion projects, this one was conceived by technical staff as a remedy for transit operations (delay) problems. Once identified as an alternative, the conversion of the one-way street was evaluated from a technical perspective (i.e., was it technically feasible) and, when determined to be feasible, presented to the public through a long and specified review procedure to ensure both public understanding and acceptance of the proposed project. The public process included public meetings, informational flyers, numerous press releases, meetings with key businesses and others that might be affected (adversely or otherwise), and working with several layers of commissions and review panels. While this project is viewed as a "public relations success" (Folks et al. 1998: p36), it should be noted that this was a project that was largely conceived of by technical staff and then "sold" (albeit very effectively) to the public

instead of being conceived by a citizens or other interest group. Nonetheless, the well-run process is still identified as a key factor in the ultimate decision to implement the changes.

Providing more of an overview of the current interest in converting one-way operations back to two-way is work by Forbes (1998) where the reasons and conventional wisdom ***for converting to*** one-way operations starting in the 1950s are outlined as well as the current reasons (and conventional wisdom) for ***converting from*** one-way to two-way operations in the 1990s. In the 1950s, one-way streets were seen as an opportunity to rid CBDs of congestion without construction of new facilities and as being supportive of increasing business and shopping activity in downtown areas. Indeed, Forbes cites the advocacy of the US Chamber of Commerce for one-way streets as being characteristic of the support that this technique had garnered (Chamber of Commerce of the United States 1954). Interestingly, increased business is also seen as a prime reason for the current interest in converting back to two-way operations. Forbes addresses this apparent contradiction (Forbes 1998: p27):

> It is not that the one-way street strategy has failed, or that traffic volumes have subsided to levels commensurate with two-way streets. The one-way streets achieved the objective of ameliorating traffic congestion, and traffic volumes are higher than ever. However, in the 1990s the prevailing wisdom among urban planners and designers is that a busy street, a *somewhat* congested street, is an indicator of a healthy business environment. Moving cars into and/or through the downtown is no longer the objective. The new objective is to reduce speeds and volumes of vehicular volume to a level that is compatible with pedestrian traffic. One of the strategies for achieving this objective is converting from one-way streets to two-way streets.

Forbes goes on to indicate that economic decline was perceived to be a symptom of the congestion problem (and that one-way streets were, therefore, solutions). However, he indicates that this linkage has never been made in any substantive way. He does relate an experience in Hamilton (Ontario, Canada) where the Canadian Automobile Association commissioned a poll to examine the stated preferences of downtown shoppers for one-way and two-way street systems (Hamilton currently has many one-way streets). In response to a question regarding whether their shopping habits would change (as a result of such a conversion downtown), 82% said they

would not change, 10% would increase their downtown shopping visits (with a change), and 8% would decrease their downtown shopping visits. Overall, Forbes posits the relationship between economic activity and access/circulation patterns as being extremely difficult to adequately define and that to link significant changes of any one independent variable such as conversion from one-way to two-way street operations to downtown economic vitality is extremely questionable (at least as a general rule).

Finally, Stemley (1998) outlines the general case against converting from one-way street operations back to two-way operations in downtown areas. While acknowledging certain shortcomings of one-way patterns (e.g., confusion of some visitors, some extra travel distances, longer walk paths to transit stops, possible delay of emergency vehicles), he disposes of them as being relatively minor inconveniences (and most likely easily remedied for the most part). He also takes issue with the concerns of businesses about the adverse affect of such patterns (with arguments similar to those of Forbes noted earlier). He then reiterates the key reasons for one-way systems, grouping the benefits in three areas: safety (decreases in pedestrian and certain types of intersection crashes due to lower numbers of conflict points at intersections and elsewhere), capacity (increases in capacity and operating speed along with decreases in delay time), and convenience (mid-block pedestrian crossings are easier to accomplish, allowing on-street parking is more likely, RTOR and LTOR movements are safer and easier). An unabashed supporter of one-way streets, he closes with the statement that "By changing to a two-way system, a large backward step will be taken which will result in downtown that is less inviting than it is now" (Stemley 1998: p50). While not questioning the findings that he cites, it should be noted that many are based on studies in New York City (done in the 1950s and 70s).

The consensus on one-way streets may well be represented in a couple of basic references on traffic engineering. For example, in ITE's ***Residential Street Design and Traffic Control*** (Homburger et al. 1989) it is noted that one-way streets (and/or pairs) have the effect of:

reducing through volumes when used to create discontinuities in residential areas; increasing speeds (which can be countered in residential areas by shortening the one-way links); minimizing starts and stops (as a result, for example, of good signal progression) and reducing noise, pollutant emission, and energy consumption; and being inherently safer than two-way streets due to the elimination of two-way friction. A similar list of advantages is presented by McShane et al. (1998) who cited the ease of signal progression, the elimination of many left-turn conflicts, and general safety and capacity benefits as advantages for one-way streets (they were not restricted to the residential street context). Finally, the ITE's *Traffic Engineering Handbook* (Pline 1992) summarizes the one- versus two-way operations issues in the following way: advantages include positive effects on capacity and delay, positive effects on traffic safety (in general), and a reduction in congestion; and disadvantages include some motorists traveling extra distances to their destinations, some migration of turning movement problems, confusion of some motorists (especially strangers), some potential adverse impacts on transit operations (e.g., increased distances to stops), and some possibly adverse impacts on emergency vehicle access. The excerpted section on one-way street operation from this important and widely-used reference is provided in appendix 5. Included in this excerpt is a listing of "criteria for use of one-way streets" which is useful in general and also as a guide in undertaking evaluations of one-way to two-way conversions. This is also discussed later in the last section of this report.

PRACTITIONER SURVEY

In addition to a review of the literature, a survey of practitioners was also undertaken. As noted earlier, in this instance several of the journal publications recounted in the prior section were from practitioners. Moreover, some of the materials received as a result of the survey were also reported in the previous section (e.g., the corridor reports from Portland, Oregon). The survey was distributed by e-mail although there were both telephone and e-mail follow-ups. The primary purpose of the survey was to ascertain whether there was much activity in terms of

conversions from one-way to two-way operation. The basic list of e-mail contacts had been assembled as part of a prior research project where responsive representatives of state DOTs and state police agencies had been identified. This list was then supplemented through the identification of consultants thought to be active in traffic calming, practitioners identified by MDOT, and referrals from the original list (i.e., any one receiving the survey was asked for referrals to others who might have something to offer). The survey instrument for the conversion project was combined with a similar instrument for a related project about allowing parking on state trunklines. The survey was sent out and then a follow-up was sent to anyone who had not responded to the first solicitation. Separate copies were also sent to individuals identified in some other way or who were referrals from initial respondents. In total, contact was attempted with 193 individuals. A full listing of contact names, type of agency, survey response status, and follow-up status is provided in a spreadsheet in appendix 6.

A copy of the complete instrument (which includes introductory information, respondent identification information, and so forth) is provided in appendix 7 while the basic questions that were asked about one-way to two-way conversions are reproduced below:

- Has your organization done any projects that involved changing one-way operations to two-way?
- Has your organization produced any reports on the impacts of specific one-to-two-way conversions or on such conversions in general?
- Does your organization have policies, guidelines, or warrants on allowing (or when to do) one-to-two-way conversions?
- Has your organization done any projects, produced any reports, or have any policies or guidelines on the REVERSE type of conversions (i.e., two-way to one-way conversions)?

While the overall response rate was reasonable (72 responses [of some sort] from 193 total contacts), the number that had information to offer on conversions from one-way to two-way operations, 14, was disappointing. Even fewer of these, five (5), had written information (e.g.,

reports) that could be shared. Still fewer, two (2) had any sort of policy actually relating to such conversions. The remaining nine (9) had done conversion projects but did not have documentation that could be readily shared. A table showing the individual responses to the e-mail survey (not counting some other interview-type responses) is provided in appendix 8.

There were follow-up conversations (either phone or e-mail) with several sources. These are reported in anecdotal form. The traffic engineer for Jackson (Michigan) (Smith 2000), where the conversion of several one-way streets is being considered, indicated that the rationale for the current proposal was similar to that noted in the literature review: when the original conversion was made (25 years ago) the goal was to get traffic to go around downtown whereas now the goal is to get people to go downtown (for business enhancement).

This same sort of view was expressed by a representative of Mountain View (California) (Burke 2000). While Mountain View has not had one-to-two-way conversions *per se*, Burke indicated that the city wanted to decrease the number of lanes through the downtown area, make the area more pedestrian friendly, and generally de-emphasize the goal of maximizing vehicle speeds through downtown. He viewed one-way streets, in general, as being counterproductive in this context and cited several cities (that he knew of) that had "awful" one-way street systems, specifically Tulsa (Oklahoma) and Astoria (Oregon).

While not necessarily the avowed advocate for enhancing the pedestrian environment that Burke purported to be, an Oregon DOT representative (Wood 2000) noted that Oregon conversion projects that he was aware of (including the Portland projects discussed in the literature review and a project in Salem) were primarily done to enhance neighborhood livability and bicycle and/or pedestrian environments. He characterized the interests who favor conversion as citizens and sometimes city councils while those opposed are more likely to include traffic engineers and sometimes businesspeople who perceive that their businesses will be hurt.

Some interesting comments were made by Duane Ellis (2000), an engineer for the City of Mt. Pleasant (Michigan) where a conversion had been done in the downtown area. Ironically, in Mt. Pleasant, the original one-way system had been implemented in the late 1970s as part of a larger "streetscape" project with the goal of making a more pedestrian friendly downtown. More recently, a downtown business group proposed the conversion back to two-way operation to enhance business in the area. There was some opposition from nearby residents who were afraid that the conversion back to two-way operation would be too confusing and safety would deteriorate. Upon conversion, there have apparently been no negative results and most of the businesses and residents are at least satisfied with the conversion.

Contact with staff in San Luis Obispo (California), Battle Creek (Michigan), and in West Virginia (Smith 2000, Pheres 2000, and Lewis 2000, respectively) yielded reasons for proposed or implemented conversions as: increasing safety, reducing congestion, merchant/business complaints about congestion, and reducing high speeds. These comments are reasonably consistent with those noted elsewhere (although some contradictions were also noted—these will be discussed later).

Overall, the survey results were somewhat disappointing (while the response rate was adequate, the substantive responses were relatively few in number). However, assuming that the responses that were received are characteristic of the state of the practice, it would appear that the rationale for changes in one-way to two-way operation is generally consistent with what was noted in the literature review. While the original impetus for converting to one-way operation was to ease traffic flow/operations, the current "reverse" conversions are concerned with downtown and/or neighborhood enhancement.

SYNTHESIS AND DISCUSSION

The literature review and survey of practitioners provided less information that had originally been hoped but the consistency of information that was obtained from a variety of sources

indicates that a more than adequate picture of the state of the art/practice with respect to conversion from one-way to two-way operations has been obtained. The following paragraphs are addressed to the original objectives of the project and how they have been achieved.

Principal Findings

Two of the most significant findings of this review are that the single most important factor in a successful conversion from one-way to two-way operations is a meaningful public involvement process (supported by straightforward technical studies) and that articulated guidelines for such conversions (e.g., threshold volumes) do not seem to exist. Rather, as one engineer (Wood 2000) put it, a (straightforward) traffic study will tell you whether such conversions are technically feasible or not. Beyond that, opinion regarding whether one-way streets are a good idea or not runs the gamut from Burke (2000) "in virtually all [reasonable] circumstances, one-way streets should be removed" to Stemley (1998) "by changing to a two-way system, a large backward step will be taken which will result in a downtown that is less inviting than it is right now."

Beyond these two points, there is great variance in the results of planning and implementing conversions. For example, in largely residential areas where one-way streets are **not** serving high volumes (and two-way volumes could be easily handled), conversion of one-way streets back to two-way operation seems likely to be favored by residents and of little concern to whatever small number of through motorists are present. On the other hand, in established and congested downtown areas or on heavily used commuter routes where development over the years has been predicated on one-way operations, both technical and public acceptance issues are likely to be significantly more substantial.

With respect to more specific objectives of this project:

- The traffic characteristics before and after conversion (e.g., traffic volumes, operating speeds) are completely dependent on local conditions. Depending on pre- and post-conversion traffic patterns, an even daily split in traffic volumes between the two streets of a one-way pair can be expected to shift dramatically—one street becomes the principal two-way route in to or through an area while the other experiences significantly less volume.

(Although it can easily be imagined where there would be exceptions to this "rule.") Operating speeds can be expected to decrease, assuming that there are not significant geometric changes as part of the conversion. This assertion is based on the fact in most instances, conversion **to** one-way operation resulted in higher speeds—it stands to reason that conversion back to two-way will have the opposite effect. Indeed, lowering vehicle speeds is often perceived as an objective and positive benefit of converting to two-way operation. Finally, unless there are geometric changes, capacity and level of service will almost always decrease after a conversion to two-way. Indeed, if the post-conversion level of service is **not** unacceptable, it may well be that the conversion will face minimal opposition (at least from a traffic operations perspective).

- Changes in crash frequencies and/or patterns (e.g., did crash frequency increase, did the type and/or severity of crashes change) are a little less clear. The prevailing wisdom with the original conversions to one-way operation was that there would be significantly fewer crashes (and crash rates) as a result of conversion. This was the result of, for example, fewer conflict points at intersections. Pedestrian safety was also generally perceived to be enhanced with one-way operation because of such things as making the street-crossing maneuver easier to undertake (e.g., the pedestrian only has to be concerned with traffic from one direction at intersections) and the ability to provide mid-block crosswalks. Some recent studies have, however, found that one-way operations are not necessarily inherently safer than two-way operations. Moreover, overall increases in crash frequencies have not been regularly reported. It would seem that the improvement or degradation of general (and specifically pedestrian) safety would be largely dependent on a large number of factors (e.g., conflicting volumes, adjacent land use, whether parking is/was allowed) of which one- versus two-way traffic operation would be only one—these vary significantly on a case-by-case basis.

- Motorist response to changes is often mentioned in the literature on conversions both to and from one-way operations. This typically seems to be an "up front" issue which apparently does not materialize as a significant issue later on (or, at least, has not been fully investigated later). By and large, the implication of most of the studies/experiences seems to be that people adapt reasonably quickly to the changes (whichever way they go).

- Guidelines for when conversions are indicated/contraindicated do not seem to exist in any meaningful way. This was clear from the survey that was undertaken—very few (two) indicated that any sort of guideline existed, and they were never provided. On the other hand, it was fairly clear from larger-scale studies (e.g., in Portland, Oregon) that a standard multi-objective evaluation process was required when the proposed conversion projects were large or expected to be controversial. It should be noted that larger-scale conversions are more likely to involve state-numbered routes and, thus, require more systematic and comprehensive study. Examples were provided earlier in the body of the report and in an appendix. This is also discussed in more detail later.

- Whether conversions are considered "successful" appears to be almost exclusively dependent on whether concerned citizens, businesspeople, and/or engineers think they are or not. At the same time, the trend to conversion back to two-way operation is fairly recent and there does not appear to be much in the way of long-term evaluation. If such evaluations are being done, they are not being widely reported. In any event, since conversions are being done in the larger context of traffic calming and executing downtown business enhancement

strategies, it will be quite difficult to isolate the effect of the conversions—when many variables are changed, it is quite difficult to attribute changes (e.g., in crash frequencies or rates) to changes in only one of those variables.

- Similar to other points above, the costs of conversion varies substantially and are completely dependent on the scale of the conversion implementation. For example, if the one-way pair is through a largely residential area with little or no through traffic and carrying very low traffic volumes, a conversion could be accomplished with some minor changes in traffic control devices. On the other hand, a conversion through a congested area may involve substantial changes in signalization (including new and/or improved/updated signals) and geometric changes.

Consideration of One-Way to Two-Way Street Operation Conversions

Notwithstanding the lack of published guidelines on one-way to two-way conversions, the review of the literature does yield suggestions for the variables and issues that should be considered when contemplating them. Recommendations are given below for the two overarching aspects of one-to-two-way conversions: the public involvement process; and the scope of the technical considerations.

Public Involvement Process

The following checklist is offered as a beginning point for the development of a public involvement process for operations conversions. The checklist is based on the review of the literature and the results of the practitioner survey. Of primary concern is the inclusion of different interest groups.

- ✓ Define the "impact area," the spatial extent of the corridor where the impacts will be of most concern when the conversion to two-way operation is implemented.

- ✓ Identify organized groups, jurisdiction-based bodies, and others who have an interest in the impact area. These would include formal (e.g., chamber of commerce) and informal groups of businesspeople in the area, neighborhood associations, special-interest groups (e.g., an organized group of bicyclists), planning and zoning commissions, citizen advisory groups (e.g., traffic advisory commissions, historical preservation groups), emergency services providers (e.g., police, fire, emergency medical service providers), schools, delivery services (e.g., UPS), city councilpersons, the media, and others. Using the impact area definition, all individual citizens and affected businesses should also be identified. Care should be taken to incorporate "special users" in the process (e.g., residents of elderly housing facilities in the corridor, schools).

- ✓ Hold public information meetings early in the conversion planning process. This should be done when the conversion is first considered—the planning and implementation process must be inclusive rather than presented as a finished, polished proposal. Meetings should also be held with any identified groups—the implementation agency must be willing to go **to** meetings of potentially interested groups and individuals rather than expecting that these people will simply show up at general public information meetings.

- ✓ Disseminate information regarding all aspects of the conversion planning and implementation to the public and all identified interested groups via meetings, informational flyers, and the media. The type of information to be disseminated includes who is responsible for identifying the conversion for consideration, a clear presentation of all pertinent information about the conversion (both "good news" and bad), and details about when/how implementation would occur. To the extent possible, supporters and non-supporters of the conversion should be present at various presentation. The state agency should not appear to be the only active evaluator in the process.

- ✓ Once the decision to implement the conversion is made, it should be clearly articulated why the decision was made. For example, what were the deciding factors.

Technical Evaluation Issues

A preliminary list of the types of things to be covered in the technical evaluation is given below. Depending on the scale, type, and location of the proposed conversion, the list may be considerably shortened (or even expanded). Not all issues will have as much saliency as others in all situations. All analysis should be done for existing conditions and for all defined alternatives (e.g., level-of-service calculations should be done for existing conditions and all alternatives). This list contains the issues/actions identified in the literature review (including items listed in the ITE's *Traffic Engineering Handbook*—see appendix 5 for additional details) and the state of the practice survey.

overall planning and identification of alternatives

- ✓ define existing conditions
- ✓ define all conversion options to be considered (e.g., are there different limits that could be considered for "converted" segment or is it "all or nothing")
- ✓ identify role of streets in regional transportation network (e.g., is the existing one-way pair of local or regional significance)
- ✓ estimate current and future trip lengths that might be affected by conversion
- ✓ consistency of proposed conversions with neighborhood, city, and regional planning goals and objectives

traffic operations

- ✓ street and intersection capacities before and after conversion
- ✓ street and intersection levels of service before and after conversion
- ✓ geometric adequacy of the affected streets (e.g., pavement width)
- ✓ determine if minimally acceptable levels of service are achieved by all alternatives
- ✓ delay time on and off converted streets
- ✓ diversions to/from local system as a result of conversion
- ✓ estimate diversions to/from other through streets in corridor
- ✓ determine if additional lanes (e.g., through corridor, turning lanes at intersections) required for conversion
- ✓ estimate decrease in (or under-utilization of) lanes on less heavily traveled streets (after conversion)
- ✓ impacts on signal progression
- ✓ changes in left-turn conflicts
- ✓ increase/decrease in crash frequencies (overall and for specific crash types)
- ✓ increase/decrease in on-street parking
- ✓ determine the level of accommodation of through truck and local delivery
- ✓ undertake traffic control device inventories and required changes (including placement of signs, markings, and signals) for different alternatives
- ✓ determine the adequacy of sight distances for new two-way operation (assuming that existing streets had been designed for one-way operation)
- ✓ parking requirements

bicycle and pedestrian operations

- ✓ determine if bicycle lanes can be accommodated
- ✓ vehicle/bicycle interactions
- ✓ determine the location of major pedestrian generators and crossings
- ✓ changes in pedestrian environment (e.g., pedestrian-friendly geometry)
- ✓ pedestrian safety (e.g., adequate intersection and mid-block crossings for expected demand)
- ✓ pedestrian interaction with street traffic
- ✓ enhanced pedestrian signals

transit operations

- ✓ transit route accommodation
- ✓ increased/decreased walking distances to transit stops (e.g., from major attractors)
- ✓ transit interaction with other vehicles (e.g., stop location)
- ✓ enhancement of transit usage (e.g., better access)

neighborhood access

- ✓ neighborhood access improved or degraded (e.g., left turns in to and out of residential neighborhoods)
- ✓ increased/decreased traffic diversion into neighborhoods
- ✓ elimination of through traffic on neighborhood streets
- ✓ increased traffic on some residential streets serving through traffic

commercial/business issues

- ✓ improved access to adjacent properties (primarily businesses)
- ✓ less confusion for motorists, especially visitors
- ✓ reduced travel distance to destination
- ✓ enhancement or degradation of downtown or commercial district
- ✓ access to major generators (e.g., large employers, community centers, parking structures)

other issues/considerations

- ✓ cost of conversion
- ✓ public opinion
- ✓ origination of support (or non-support)
- ✓ environmental impacts (e.g., increased/decreased air pollution due to conversion)
- ✓ timing and duration of implementation

This list of issues is not necessarily comprehensive nor would each item necessarily be relevant for every study. One of the first issues for the public involvement/planning process to consider is to identify which issues should be considered for any specific conversion proposal. In addition, to the extent possible, acceptable thresholds (for those variables that lend themselves to such measurements) should be discussed and established **before** technical analyses are done and results presented. For example, it should be established that level of service C is acceptable for an intersection prior to doing the analysis necessary to compute the level of service.

One of the goals for this project was to establish guidelines for when conversions from one-way to two-way operations might be advisable or acceptable. However, it is clear from the literature review and the survey responses that a single set of criteria is elusive. While traffic operation concerns can be the deciding factor in conversions (and especially if the operations-oriented outcomes are very bad), the ultimate impact of a conversion is extremely case-specific. Degradation in motorist delay, for example, is dependent on everything from simple traffic volumes to be accommodated to width of the streets to cross-street (and turning) volumes—what works in one area may result in an operations disaster elsewhere.

At the same time, the types of analyses that are implied in the "issues list" presented above are straightforward and are the staples of good traffic engineering practice. But, it is equally clear that not all of the important outcomes are neatly quantified or equally valued by all participants in the process. For example, in general, traffic engineers would probably favor alternatives that resulted in higher vehicle speeds (and lower delay) while it seems clear that others may view reasonably decreased (more pedestrian friendly) speeds in a more positive light. So, while it is important to do "good engineering" with respect to the outcomes of proposed conversions, it is as important to have an effective public involvement process where conflicting goals and objectives can be articulated.

FUTURE WORK

It is clear from the review of the literature and survey of practitioners that converting one-way pairs of streets back to two-way operations is a current fad of sorts. It is often discussed in the context of other projects consistent with traffic calming and generally improving downtowns. It is characteristic of the lack of knowledge about what makes downtowns and neighborhoods "work" that the effects of different traffic operations changes on business are largely unknown. It is similarly largely a matter of conjecture on even what the traffic operations impacts are when the one- to two-way conversions are implemented. There have been and are a fairly large number of conversions being considered in Michigan. The list includes Adrian, Jackson, Kalamazoo, Lansing, Mt. Pleasant, and Battle Creek. While not all of these conversions have (or will) included state trunklines, it seems appropriate that the impacts of some of these conversions on traffic operations should be evaluated in more depth. More ambitious work could also examine the relationship between these conversions and business/downtown development patterns.

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12/00/1992	ROAD HUMS FOR THE CONTROL OF VEHICLE SPEEDS **Journal:** Traffic Engineering and Control **Vol:** 34 **No:** 1 **AUTHOR(S):** Lines, CJ	☐ More...
00/00/1993	AN IMPROVED TRAFFIC ENVIRONMENT: A CATALOGUE OF IDEAS	☐ More...
09/00/1993	RESIDENTIAL STREET DESIGN - DO THE BRITISH AND AUSTRALIANS KNOW SOMETHING WE AMERICANS DON'T? **Conference:** Compendium of Technical Papers, ITE, 63rd Annual Meeting **AUTHOR(S):** Ewing, R	☐ More...
04/00/1994	A VERKEHRSBERUHIGUNG DESIGN FOR AN AMERICAN ROAD **Journal:** ITE Journal **Vol:** 64 **No:** 4 **AUTHOR(S):** Halperin, K	☐ More...
00/00/1994	RESIDENTIAL STREET DESIGN: DO THE BRITISH AND AUSTRALIANS KNOW SOMETHING AMERICANS DO NOT? **Journal:** Transportation Research Record **No:** 1455 **AUTHOR(S):** Ewing, R	☐ More...
00/00/1995	THE MODERN ROUNDABOUT ARRIVES IN VERMONT **Journal:** AASHTO Quarterly Magazine **Vol:** 75 **No:** 1 **AUTHOR(S):** Redington, T	☐ More...

07/00/1997	ROUNDABOUTS - CURRENT SWEDISH PRACTICE AND RESEARCH **Conference:** Third International Symposium on Intersections Without Traffic Signals **AUTHOR(S):** Bergh, T	More...
01/00/1998	NEIGHBORHOOD TRAFFIC MANAGEMENT: DADE COUNTY, FLORIDA'S STREET CLOSURE EXPERIENCE **Journal:** ITE Journal **Vol:** 68 **No:** 1 **AUTHOR(S):** Castellone, AJ	More...
02/00/1998	SPEED HUMP EFFECTIVENESS AND PUBLIC ACCEPTANCE **Journal:** ITE Journal **Vol:** 68 **No:** 2 **AUTHOR(S):** Ballard, A	More...
00/00/1997	TRANSPORTATION AND SUSTAINABLE COMMUNITIES: CHALLENGES AND OPPORTUNITIES FOR TRANSPORTATION PROFESSIONALS. RESOURCE PAPERS	More...
08/00/1998	TWO FOR TEA **Journal:** Planning **Vol:** 64 **No:** 6 **AUTHOR(S):** Wormser, L	More...
09/00/1998	BETTER USE OF ROAD CAPACITY - WHAT HAPPENS TO THE TRAFFIC? **Journal:** Public Transport International **Vol:** 47 **No:** 5 **AUTHOR(S):** Cairns, S	More...
00/00/1998	MEASURES TO REDUCE THE CO2-EMISSIONS FROM THE TRANSPORT SECTOR IN THE CITY OF STOCKHOLM **Conference:** Fourth International Conference on Urban Transport and Environment for the 21st Century (Edited by C Borrego and L Sucharov) **AUTHOR(S):** Lindqvist, E	More...
00/00/1997	CHAPTER 18: ALTERNATIVE POLICIES FOR REDUCING DEPENDENCE ON THE CAR. FROM THE GREENING OF URBAN TRANSPORT, EDITION 2. **AUTHOR(S):** Adams, J	More...
06/00/1999	CENTRAL ARTERY TO PUMP NEW LIFE INTO BOSTON **Journal:** American City and County **Vol:** 114 **No:** 6 **AUTHOR(S):** Beck, D	More...
02/00/1999	INVESTIGATING THE EFFECTS OF ROADWAY DESIGN ON DRIVER BEHAVIOR: APPLICATIONS FOR MINNESOTA HIGHWAY DESIGN **AUTHOR(S):** Carmody, J	More...
00/00/1999	HARMONIZATION PROGRAMS--WHAT IS THE ROLE OF LIABILITY? **Conference:** Enhancing Transportation Safety in the 21st Century ITE International Conference **AUTHOR(S):** Beaubien, RF	More...

00/00/1999	MULTI-WAY STOPS--THE RESEARCH SHOWS THE MUTCD IS CORRECT! **Conference:** Transportation Frontiers for the Next Millennium: 69th Annual Meeting of the Institute of Transportation Engineers **AUTHOR(S):** Bretherton, WM, Jr	More...
00/00/1999	PUBLIC INVOLVEMENT IN THE ATHENS-CLARKE COUNTY NEIGHBORHOOD TRAFFIC MANAGEMENT PROGRAM **Conference:** Transportation Frontiers for the Next Millennium: 69th Annual Meeting of the Institute of Transportation Engineers **AUTHOR(S):** Clark, DE	More...
00/00/1994	DEVELOPMENTS IN TRANSPORT TELEMATICS IN EUROPE : THE CASE OF AUTOMATIC DEBITING AT SPEED **Journal:** IEEE Gallium Arsenide Integrated Circuit Symposium (16th : 1994 : Philadelphia, Pa.). Technical digest **AUTHOR(S):** Hills, P.	More...
01/00/2000	TOWARDS A NORTH AMERICAN GEOMETRIC DESIGN STANDARD FOR SPEED HUMPS **Journal:** ITE Journal **Vol:** 70 **No:** 1 **AUTHOR(S):** Braaksma, JP	More...
00/00/1999	STREET RECLAIMING: CREATING LIVABLE STREETS AND VIBRANT COMMUNITIES **AUTHOR(S):** Engwicht, D	More...
00/00/1995	A WORD ON THE STREET. **Journal:** WORLD TRANSPORT POLICY & PRACTICE, **AUTHOR(S):** JAMES, ALAN.	More...
00/00/1998	TRANSPORT POLICY-MAKING: THE CURSE OF THE UNCOMFORTABLE CONSEQUENCE **Journal:** JOURNAL OF TRANSPORT GEOGRAPHY, **AUTHOR(S):** BLACK, COLIN.	More...
12/18/1998	SPOKANE IMPLEMENTS ANGLED PARKING TO PROVIDE FOR EXTRA PARKING.. **Journal:** URBAN TRANSPORTATION MONITOR,	More...

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07/00/1993	CYCLING MOTORISTS: HOW TO ENCOURAGE THEM	☐ More...
01/00/1992	NATIONAL BICYCLING AND WALKING STUDY. CASE STUDY NO. 16: A STUDY OF BICYCLE AND PEDESTRIAN PROGRAMS IN EUROPEAN COUNTRIES **AUTHOR(S):** Wynne, GG	☐ More...
00/00/1992	WINNING BACK THE CITIES **AUTHOR(S):** Kenworthy, J	☐ More...
12/00/1994	A GUIDEBOOK FOR RESIDENTIAL TRAFFIC MANAGEMENT. FINAL REPORT **AUTHOR(S):** Ewell, J	☐ More...
11/00/1994	BICYCLING & WALKING IN THE NINETIES AND BEYOND: APPLYING SCANDINAVIAN EXPERIENCE TO AMERICA'S CHALLENGES **AUTHOR(S):** Gilleran, BF	☐ More...
05/00/1995	TAKE BACK YOUR STREETS: HOW TO PROTECT COMMUNITIES FROM ASPHALT AND TRAFFIC	☐ More...
00/00/1993	SPEED BEHAVIOUR AND TRAFFIC SECURITY AT REGIONALLY SMOOTHED TRAFFIC. **AUTHOR(S):** Blanke, H	☐ More...
00/00/1995	EVALUATION OF DIFFERENT TYPES OF PEDESTRIAN-VEHICLE SEPARATIONS Journal: Transportation Research Record No: 1502	☐ More...

	AUTHOR(S): Sarkar, S	
10/00/1995	BICYCLE FACILITY PLANNING: A RESOURCE FOR LOCAL GOVERNMENTS **AUTHOR(S):** Musser, T	More...
00/00/1995	TECHNOLOGY TOOLS FOR TRANSPORTATION PROFESSIONALS - MOVING INTO THE 21ST CENTURY **Conference:** Technology Tools for Transportation Professionals - Moving into the 21st Century	More...
04/00/1995	BICYCLE SAFETY-RELATED RESEARCH SYNTHESIS **AUTHOR(S):** Clarke, A	More...
12/00/1995	SUMMARY REPORT OF THE FHWA STUDY TOUR FOR SPEED MANAGEMENT AND ENFORCEMENT TECHNOLOGY	More...
00/00/1996	PEDESTRIAN FACILITIES IN SOUTH AFRICA: RESEARCH AND PRACTICE **Journal:** Transportation Research Record **No:** 1538 **AUTHOR(S):** Ribbens, H	More...
00/00/1996	DOWNTOWN TRAFFIC AND PARKING NEEDS RELATED TO DOWNTOWN ECONOMIC TRENDS **Journal:** Transportation Research Record **No:** 1552 **AUTHOR(S):** Edwards, JD	More...
00/00/1997	TRAFFIC CONGESTION AND TRAFFIC SAFETY IN THE 21ST CENTURY: CHALLENGES, INNOVATIONS, AND OPPORTUNITIES. PROCEEDINGS OF THE CONFERENCE, CHICAGO, ILLINOIS, JUNE 8-11, 1997 **Conference:** Traffic Congestion and Traffic Safety in the 21st Century: Challenges, Innovations, and Opportunities	More...
08/00/1997	INTEGRATION OF TRANSPORTATION AND LAND USE PLANNING THROUGH RESIDENTIAL STREET DESIGN **Journal:** ITE Journal **Vol:** 67 **No:** 8 **AUTHOR(S):** Lowe, A	More...
00/00/1997	WINDOWED TRANSPORTATION PLANNING MODEL **Journal:** Transportation Research Record **No:** 1607 **AUTHOR(S):** Huang, Y	More...
00/00/1998	DRIVING OUT SUBSIDIES **Journal:** ALTERNATIVES JOURNAL **Vol:** 24 **No:** 1 **AUTHOR(S):** Litman, T	More...
01/00/1998	WILL 'FEEWAYS' LOOSEN L.A. COUNTY GRIDLOCK? **Journal:** Civil Engineering News **Vol:** 9 **No:** 12	More...
01/12/1998	ROADS LESS TAKEN **Journal:** ENR **Vol:** 240 **No:** 2 **AUTHOR(S):** Cho, A	More...
03/00/1998	PARTNERS IN MOTION: D.C. CONGESTION BUSTERS **Journal:** Public Roads **Vol:** 61 **No:** 5 **AUTHOR(S):** Marston, P	More...

00/00/1997	NEIGHBORHOOD TRAFFIC CONTROLS IN CHICAGO **Conference:** Institute of Transportation Engineers 67th Annual Meeting **AUTHOR(S):** Krueger, CL	More...
07/00/1998	PIONEERING CHANGE IN PENNSYLVANIA **Journal:** Roads and Bridges **Vol:** 36 **No:** 7 **AUTHOR(S):** Schneider, K	More...
12/00/1996	AN AUSTRALIAN REVIEW OF ACCESS MANAGEMENT AND THE LAND PLANNING CONNECTION **Conference:** Second National Access Management Conference **AUTHOR(S):** Brindle, RE	More...
00/00/1998	MEASURING THE SAFETY EFFECT OF RAISED BICYCLE CROSSINGS USING A NEW RESEARCH METHODOLOGY **Journal:** Transportation Research Record **No:** 1636 **AUTHOR(S):** Garder, P	More...

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00/00/1991	CALMER, NOT FASTER: A NEW DIRECTION FOR THE STREETS OF LOS ANGELES **Journal:** Transportation Research Record **No:** 1305 **AUTHOR(S):** Woodhull, J	☐ More...
12/00/1992	A QUALITY MARGIN IN TRANSPORT **Journal:** Traffic Engineering and Control **Vol:** 33 **No:** 12 **AUTHOR(S):** Goodwin, PB	☐ More...
00/00/1999	TRANSPORTATION FRONTIERS FOR THE NEXT MILLENNIUM: 1999 ITE ANNUAL MEETING COMPENDIUM OF TECHNICAL PAPERS **Conference:** Transportation Frontiers for the Next Millennium: 69th Annual Meeting of the Institute of Transportation Engineers	☐ More...
00/00/1999	NEW DESIGN STANDARDS FOR NEO-TRADITIONAL AND LOW SPEED NEIGHBORHOOD STREETS **Conference:** Transportation Frontiers for the Next Millennium: 69th Annual Meeting of the Institute of Transportation Engineers **AUTHOR(S):** O'Brien, AP	☐ More...
00/00/1999	A CITIZEN TASK FORCE APPROACH TO NEIGHBORHOOD TRAFFIC MANAGEMENT **Conference:** Transportation Frontiers for the Next Millennium: 69th Annual Meeting of the Institute of Transportation Engineers	☐ More...

	AUTHOR(S): Siemer, BC	
00/00/1999	TRAFFIC MITIGATION SUCCESS STORIES IN PHOENIX **Conference:** Transportation Frontiers for the Next Millennium: 69th Annual Meeting of the Institute of Transportation Engineers **AUTHOR(S):** Dittberner, RA	More...
00/00/1999	ROUNDABOUTS--THE ROUND SOLUTION DOES NOT ALWAYS FIT THE SQUARE PROBLEM **Conference:** Transportation Frontiers for the Next Millennium: 69th Annual Meeting of the Institute of Transportation Engineers **AUTHOR(S):** Henry, MJ	More...
00/00/1999	SCHOOL CROSSING SAFETY IMPROVEMENT STUDY **Conference:** Transportation Frontiers for the Next Millennium: 69th Annual Meeting of the Institute of Transportation Engineers **AUTHOR(S):** Yu, L	More...
00/00/1998	NEIGHBORHOOD TRAFFIC CONTROL PLANNING FOR SMALL CITIES **Conference:** Crossroads 2000 **AUTHOR(S):** Hartman, L	More...
07/00/1999	CITY OF PLANO NEIGHBORHOOD TRAFFIC MANAGEMENT PROGRAM **Journal:** ITE Journal **Vol:** 69 **No:** 7 **AUTHOR(S):** Langston, AC	More...
00/00/1999	SMART GROWTH FACE-OFF SPARKS DEBATE **Journal:** HMAT **Vol:** 4 **No:** 3	More...
01/00/2000	THE ECONOMIC IMPACT OF SPEED HUMPS ON HOUSING VALUES **Journal:** ITE Journal **Vol:** 70 **No:** 1 **AUTHOR(S):** Bretherton, WM, Jr	More...
00/00/1999	STREET DESIGN GUIDELINES FOR HEALTHY NEIGHBORHOODS	More...
00/00/1999	TRAFFIC ENGINEERING HANDBOOK. FIFTH EDITION	More...
03/00/2000	HITTING THEM WITH THE HARDWARE **Journal:** Roads and Bridges **Vol:** 38 **No:** 3 **AUTHOR(S):** Wilkins, W	More...
03/00/2000	SIGNS OF THINGS TO COME: SAFETY INNOVATIONS ARE UNVEILED AT ATSSA'S 30TH ANNUAL CONVENTION AND TRAFFIC EXPO **Journal:** Roads and Bridges **Vol:** 38 **No:** 3	More...
03/00/2000	ANALYSIS AND DEVELOPMENT OF NEW INSIGHT INTO SUBSTITUTION (ADONIS) OF SHORT CAR TRIPS BY CYCLING AND WALKING **Journal:** ITE Journal **Vol:** 70 **No:** 3	More...

04/00/2000	ROUNDABOUTS: AN INFORMATIONAL GUIDE **Journal:** ITE Journal **Vol:** 70 **No:** 4	More...
00/00/2000	BUILDING BETTER COMMUNITIES: A TOOLKIT FOR QUALITY GROWTH **AUTHOR(S):** Bauer, D	More...
00/00/1998	SPEED AND SPEED MANAGEMENT SYNTHESIS	More...
00/00/2000	HARMONIZING PLANO'S NEIGHBORHOOD TRAFFIC MANAGEMENT PROGRAM **Conference:** Transportation Operations: Moving into the 21st Century **AUTHOR(S):** Lalani, N	More...
10/00/1999	LITERATURE REVIEW ON VEHICLE TRAVEL SPEEDS AND PEDESTRIAN INJURIES **AUTHOR(S):** Leaf, WA	More...
00/00/1998	HARMONIZING TRANSPORTATION & COMMUNITY GOALS THE CHALLENGE FOR TODAY'S TRANSPORTATION PROFESSIONAL.. **Conference:** ITE INTERNATIONAL CONFERENCE	More...

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APPENDIX 2

TRIS Citations for "One-Way Streets"

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09/00/1978	ANALYSIS OF PEDESTRIAN CROSSWALK SAFETY ON ONE-WAY STREET NETWORKS **AUTHOR(S):** Edelstein, RP	☐ More...
11/00/1978	ANALYSIS OF PEDESTRIAN ACCIDENTS ON ONE-WAY STREET NETWORKS: USERS MANUAL **AUTHOR(S):** Habib, PA	☐ More...
00/00/1971	TRAFFIC CONTROL & ROADWAY ELEMENTS - THEIR RELATIONSHIP TO HIGHWAY SAFETY/REVISED. CHAPTER 10 ONE-WAY STREETS AND PARKING **AUTHOR(S):** Mayer, PA	☐ More...
09/00/1966	A REVERSIBLE ONE-WAY STREET SYSTEM **Journal:** Canadian Good Roads Association Proc **AUTHOR(S):** Ewens, WE	☐ More...
05/00/1967	TRAFFIC SIGNAL SYNCHRONIZATION ON A ONE-WAY STREET **Journal:** Transportation Science **AUTHOR(S):** Bavarez, E	☐ More...
12/00/1950	ONE-WAY STREETS: PANEL DISCUSSION **Journal:** Highway Research Board Bulletin **AUTHOR(S):** Holmes, EH	☐ More...
01/00/1969	STUDY OF THE OPERATIONAL ASPECTS OF ONE-WAY AND TWO-WAY STREETS **AUTHOR(S):** Enustun, N	☐ More...

00/00/1937	REPORT OF COMMITTEE ON TRAFFIC REGULATION IN MUNICIPALITIES- ONE-WAY STREETS **Journal:** Highway Research Board Proceedings **AUTHOR(S):** Canning, WS	More...
00/00/1938	REPORT OF COMMITTEE ON TRAFFIC REGULATION IN MUNICIPALITIES; ONE-WAY STREETS **Journal:** Highway Research Board Proceedings **AUTHOR(S):** Burch, JS DISCUSSER	More...
10/00/1972	STUDY OF THE OPERATIONAL ASPECTS OF ONE-WAY AND TWO-WAY STREETS **AUTHOR(S):** Enustun, N	More...
00/00/1955	CAPACITIES OF ONE-WAY AND TWO-WAY STREETS WITH SIGNALS AND WITH STOP SIGNS **Journal:** Highway Research Board Bulletin **AUTHOR(S):** French, A	More...
07/00/1969	THE ECONOMIC AND ENVIRONMENTAL EFFECTS OF ONE-WAY STREETS IN RESIDENTIAL AREAS	More...
10/00/1971	ECONOMIC AND ENVIRONMENTAL EFFECTS OF ONE-WAY STREETS IN RESIDENTIAL AREAS **Journal:** Appraisal Journal **AUTHOR(S):** Hill, D	More...
00/00/1970	ECONOMIC AND ENVIRONMENTAL EFFECTS OF ONE-WAY STREETS IN RESIDENTIAL AREAS **Journal:** Highway Research Record **No:** 305 **AUTHOR(S):** Hill, D	More...
00/00/1962	ACCELERATED D.C. HIGHWAY PROGRAM AND ONE-WAY STREET PLAN: REPORT OF THE SPECIAL SUBCOMMITTEE ON TRAFFIC, STREETS, AND HIGHWAYS OF THE COMMITTEE ON THE DISTRIC	More...
06/00/1962	ACCELERATED D.C. HIGHWAY PROGRAM AND ONE-WAY STREET PLAN: HEARINGS BEFORE THE SPECIAL SUBCOMMITTEE ON TRAFFIC, STREETS, AND HIGHWAYS OF THE COMMITTEE ON THE D	More...
01/00/1985	INCREASING THE ROAD NETWORK CAPACITY BY INTRODUCING THE ONE-WAY STREET SYSTEM **Journal:** Japan Society of Civil Engineers, Proceedings **AUTHOR(S):** Masuya, Y	More...
00/00/1990	SAFETY OF ONE-WAY URBAN STREETS **Journal:** Transportation Research Record **No:** 1270 **AUTHOR(S):** Bar-Ziv, J	More...
00/00/1992	OPTIMAL ONE-WAY STREETS ASSIGNMENT IN A RECTANGULAR CITY **AUTHOR(S):** Ai, CM	More...
00/00/1996	ONE-WAY CONVERSIONS FOR CALMING DENVER'S STREETS **Conference:** Moving Forward in a Scaled-Back World.	More...

	Challenges and Opportunities for the Transportation Professional. 1996 ITE International Conference. **AUTHOR(S):** Dorroh, RF	
08/00/1998	ONE-WAY STREETS PROVIDE SUPERIOR SAFETY AND CONVENIENCE **Journal:** ITE Journal **Vol:** 68 **No:** 8 **AUTHOR(S):** Stemley, JJ	More...
06/00/1998	ONE-WAY DOWNTOWN STREETS MOVE IN TWO DIRECTIONS **Journal:** Planning **Vol:** 64 **No:** 6 **AUTHOR(S):** Jossi, F	More...
00/00/1994	NETWORK DESIGN OF ONE-WAY STREETS WITH SIMULATED ANNEALING. **Journal:** PAPERS IN REGIONAL SCIENCE. **AUTHOR(S):** LEE, CHI-KANG.	More...
09/00/1996	THE EFFECT OF VEHICULAR FLOW PATTERNS ON CRIME AND EMERGENCY SERVICES -- THE LOCATION OF CUL-DE-SACS AND ONE-WAY STREETS. **Journal:** JOURNAL OF THE OPERATIONAL RESEARCH SOCIETY, **AUTHOR(S):** HURTER, ARTHUR P.	More...
08/00/1963	RIGHT OF WAY -- MULTI-LANE ONE-WAY STREETS.. **Journal:** TRAFFIC DIGEST AND REVIEW,	More...

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06/00/1973	THE CORPORATION: JUST A GRANFALLOON? **Journal:** IEEE Spectrum **Vol:** 10 **No:** N6 **AUTHOR(S):** West, JS	☐ More...
00/00/1974	A FEASIBILITY STUDY OF A REVERSIBLE-LANE FACILITY FOR A DENVER STREET CORRIDOR (ABRIDGMENT) **Journal:** Transportation Research Record **No:** 514 **AUTHOR(S):** Hemphill, J	☐ More...
12/00/1977	RIGHT TURN ON RED -- A TRAFFIC MANAGEMENT SIMULATION **Journal:** Simulation **Vol:** 29 **No:** 6 **AUTHOR(S):** Lidor, G	☐ More...
00/00/1965	ANALYSIS OF A THREE-STREET TRAFFIC SYSTEM **Journal:** Highway Research Record, Hwy Res Board **AUTHOR(S):** Bissell, HH	☐ More...
00/00/1967	IMPROVED STREET UTILIZATION THROUGH TRAFFIC ENGINEERING **Journal:** Highway Research Board Special Reports	☐ More...
00/00/1960	EFFECT OF CURB PARKING ON INTERSECTION CAPACITY **Journal:** Highway Research Board Bulletin **AUTHOR(S):** Galioto, AJ	☐ More...
00/00/1971	OPTIMIZING FLOW ON EXISTING STREET NETWORKS **Journal:** Highway Research Board Nchrp Report	☐ More...

	AUTHOR(S): Kraft, WH	
00/00/1970	UTS-1: A MACRO SYSTEM FOR TRAFFIC NETWORK SIMULATION **AUTHOR(S):** Morgan, HL	More...
07/00/1979	MODERN ROTARIES **Journal:** ITE Journal **Vol:** 49 **No:** 7 **AUTHOR(S):** Todd, K	More...
04/00/1980	PEDESTRIAN SAFETY: THE HAZARDS OF LEFT-TURNING VEHICLES **Journal:** ITE Journal **Vol:** 50 **No:** 4 **AUTHOR(S):** Habib, PA	More...
02/00/1983	FEASIBILITY OF ROADWAY COUNTERMEASURES FOR PEDESTRIAN ACCIDENT EXPERIENCE **AUTHOR(S):** Zegeer, CV	More...
03/00/1985	JAPAN-U.S. TECHNICAL INFORMATION EXCHANGE : A ONE-WAY STREET? **Journal:** AUTOMOTIVE ENGINEERING **Vol:** 93 **No:** 3 **AUTHOR(S):** RUBINGER, B	More...
12/00/1985	BELLEVUE ONE-WAY STREET STUDY	More...
00/00/1962	ONE-WAY STREET REPORT, SAN JOSE	More...
00/00/1954	ONE WAY BUSINESS STREETS	More...
00/00/1965	INVESTIGATION AND STUDY OF URBAN RENEWAL AND REDEVELOPMENT PROGRAMS AND PARKING AND ONE-WAY STREET PLANNING IN THE DISTRICT OF COLUMBIA: REPORT OF THE COMMITTEE ON THE DISTRICT OF COLUMBIA, HOUSE OF R- **Journal:** HOUSE REPORT 88TH CONGRESS, 2D SESSION ; NO 1947 **No:** 1947	More...
09/00/1986	WORK ZONE SAFETY. UTILITIES, STREET DEPARTMENT COORDINATE WORK **Journal:** Better Roads **Vol:** 56 **No:** 9	More...
00/00/1988	SAFETY IMPACTS OF BICYCLE LANES **Journal:** Transportation Research Record **No:** 1168 **AUTHOR(S):** Smith, RL, Jr	More...
04/00/1986	CONSOLIDATION OF LOCAL HIGHWAY DEPARTMENTS: THE CASE OF ADAMS COUNTY AND THE CITY OF HETTINGER **AUTHOR(S):** Zink, DL	More...
09/00/1993	LICENSE TAG SURVEYS - DATA COLLECTION, PROCESSING AND ANALYSIS: THE PENSACOLA STREET REALIGNMENT STUDY (TALLAHASSEE, FLORIDA) **Conference:** 4th National Conference on Transportation	More...

	Planning Methods Applications, Volumes I and II. A Compendium of Papers **AUTHOR(S):** Schiffer, RG	
00/00/1995	CAPACITY OF ONE-WAY YIELD-CONTROLLED INTERSECTIONS **Journal:** Transportation Research Record **No:** 1484 **AUTHOR(S):** Al-Masaeid, HR	More...
08/00/1998	VITAL SIGNS: CIRCULATION IN THE HEART OF THE CITY--AN OVERVIEW OF DOWNTOWN TRAFFIC **Journal:** ITE Journal **Vol:** 68 **No:** 8 **AUTHOR(S):** Forbes, G	More...
08/00/1998	CONVERTING BACK TO TWO-WAY STREETS IN DOWNTOWN LUBBOCK **Journal:** ITE Journal **Vol:** 68 **No:** 8 **AUTHOR(S):** Hart, J	More...
00/00/1999	REDUCING CRASHES IN MULTIPLE TURN LANES ON ONE-WAY STREETS **Conference:** Transportation Frontiers for the Next Millennium: 69th Annual Meeting of the Institute of Transportation Engineers **AUTHOR(S):** Forbes, G	More...
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APPENDIX 3

TRIS Citations for "One-Way/Two-Way Conversions"

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06/00/1988	A STUDY TO DEVELOP WARRANTS FOR CONVERSION TO ONE-WAY FRONTAGE ROADS. FINAL REPORT **AUTHOR(S):** Gattis, JL	☐ More...
08/00/1998	SANSOME STREET CONTRAFLOW TRANSIT LANE: A PUBLIC PARTICIPATION SUCCESS STORY **Journal:** ITE Journal **Vol:** 68 **No:** 8 **AUTHOR(S):** Folks, TP	☐ More...
08/00/1998	CONVERTING BACK TO TWO-WAY STREETS IN DOWNTOWN LUBBOCK **Journal:** ITE Journal **Vol:** 68 **No:** 8 **AUTHOR(S):** Hart, J	☐ More...
06/00/1998	ONE-WAY DOWNTOWN STREETS MOVE IN TWO DIRECTIONS **Journal:** Planning **Vol:** 64 **No:** 6 **AUTHOR(S):** Jossi, F	☐ More...

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APPENDIX 4

Alternatives Evaluation Summary Matrix

This matrix is taken from the "Belmont-Morrison Project Report & Recommendations" done by the Office of Transportation of the City of Portland (Oregon). It is illustrative of the type of evaluation done in support of determining whether a one-way pair of streets (couplet) should be converted to two-way operations.

BELMONT-MORRISON PROJECT

Alternatives Evalution Summary Matrix

Evalution Criteria	No-Build	Alternative A 9th Avenue	Alternative B 12th Avenue	Alternative B 13th Avenue
Traffic Operations • Volume Average Daily volume, 12th–20th Ave. (2015)	Belmont: 15,900 Morrison: 11,750	Belmont: 19,300 Morrison: 5,350	Belmont: 22,200 Morrison: 4,700	Belmont: 22,950 Morrison: 4,700
• Over-capacity intersections Intersections with level-of-service 'E' or worse	0	3	3	0
• Queuing at intersections % increase in cumulative length compared to No-Build	–	AM: +560% PM: +150%	AM: +230% PM: +220%	AM: +160% PM: +120%
• Diversion # of cars diverted during PM peak period	0	300	75	0
• Speed Belmont	AM: 23 mph PM: 27 mph	AM: 22 mph PM: 20 mph	AM: 21 mph PM: 20 mph	AM: 21 mph PM: 16 mph
Morrison	AM: 20 mph PM: 19 mph	AM: 25 mph PM: 18 mph	AM: 23 mph PM: 18 mph	AM: 23 mph PM: 20 mph
Transit Operations	• Least impact to travel times due to congestion	• Increased travel time due to congestion • Greater difficulty moving in and out of stops	• Same as Alt. A	• Less travel time impact due to congestion than Alts. A or B • Same as Alt. A
Bicycle Operations	• Speeding makes bicycling unsafe • One-way travel safer for bicycles	• Reduced traffic speeds • Two-way travel less safe for bicycles	• Same as Alt. A	• Same as Alt. A
On-Street Parking Supply Loss of spaces	-23 spaces	-53 spaces	-58 spaces	-83 spaces
Pedestrian Environment	• Faster traffic speeds, less safe for pedestrians • More gaps in traffic for crossing one-way streets at unsignalized intersections	• Slower traffic speeds • Fewer gaps in traffic crossing two-way streets	• Same as Alt. A • Same as Alt. A	• Same as Alt. A • Same as Alt. A

Evalution Criteria	No-Build	Alternative A 9th Avenue	Alternative B 12th Avenue	Alternative B 13th Avenue
Land Use Impacts	• East-west access to properties separated, impairs business visibility • Most street capacity and on-street parking supply available for redevelopmemt	• East-west access on same street • Business visibility on Belmont improved, reduced on Morrison • Driveway access more difficult on Belmont, less on Morrison • Parking and volume impacts associated with transition zone outside of residential neighborhood • Significant potential for diversion of traffic on to adjacent streets during peak periods	• Same as Alt. A • Same as Alt. A • Same as Alt. A • Parking and volume impacts associated with transition zone at edge of residential neighborhood • Significant potential for diversion of traffic to adjacent streets during peak periods	• Same as Alt. A • Same as Alt. A • Same as Alt. A • Parking and volume impacts associated with transition zone within neighborhood, adjacent business impacts • No traffic diversion to adjacent streets anticipated

APPENDIX 5

Excerpts from ITE's *Traffic Engineering Handbook*

These excerpts are regarding one-way streets including a listing of "criteria for use of one-way streets."

One-way streets

Most major streets and highways are originally designed for use by two-way traffic. The need for the adoption of one-way traffic regulations may arise from increased traffic usage, conflicts among vehicular flows and between pedestrians and vehicles, and the resulting congestion and accidents. Conversion to one-way street operation (often in conjunction with parking restrictions) may also be needed to provide additional capacity to serve new development.

In major activity centers, such as the central business district of a city with many high-traffic, closely spaced intersections, one-way regulations are frequently used because of traffic signal timing considerations and to improve street capacity. In the development of new activity centers such as shopping malls, sports arenas, and industrial parks, one-way regulations are sometimes included in original street and traffic plans.

Some minor street and alleys are also designated for one-way operation because of limited width or in order to prevent through traffic within a neighborhood.

One-way streets are generally operated in one of three ways:

1. A street on which traffic moves in one direction at all times.
2. A street that is normally one-way in a particular direction but at certain times is operated in the reverse direction to provide additional capacity in the predominant direction of flow.
3. A street that normally carries two-way traffic but which during peak traffic hours is operated as a one-way street. Such a street may be operated in one direction during the

morning peak hour and in the opposite direction during the evening peak hour, with two-way traffic during all other hours.

Advantages and disadvantages

One-way regulations are generally used to reduce congestion and to increase the capacity of a street network. One-way streets may also affect safety and the types of uses on adjacent land. An intersection of two one-way streets has substantially fewer potential conflicts than does an intersection with two two-way streets, as shown by Figure 11–1.

The following advantages may be expected in terms of capacity, safety, and operating conditions:

Effect on capacity. Traffic conflicts and delay at intersections are a principal cause of congestion and longer travel time on two-way urban streets. On one-way streets, turning movements are not delayed by opposing vehicular traffic, but they may be obstructed by heavy pedestrian volumes and thus encounter significant delay. With one-way streets, more complete use may be made of street pavements with unusual width. The capacity of a street may be increased by as much as 50% by use of one-way regulations (see Chapter 5).

The increased capacity afforded by one-way regulations may also make it possible to permit parking either part- or full-time on streets that, if operated as two-way streets, could not be used for parking. More efficient signal timing can also increase street capacity because of improved traffic progression between signalized intersections, as discussed in Chapter 9.

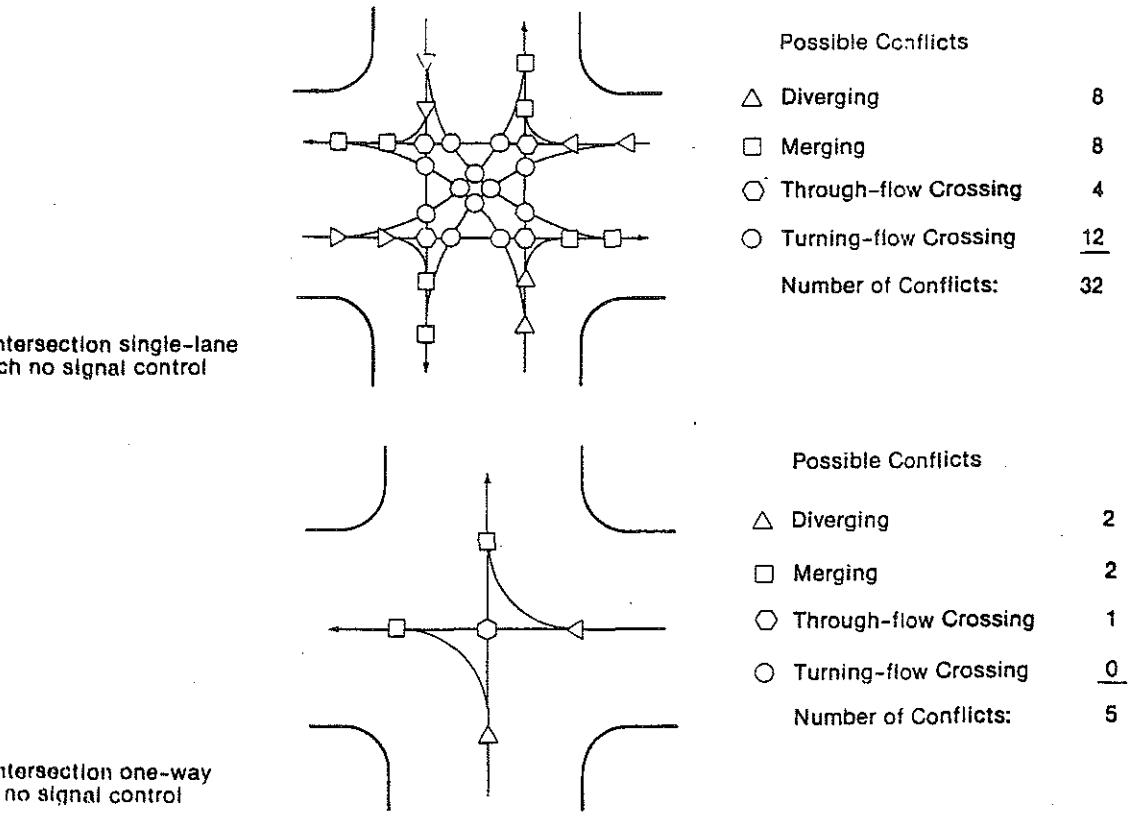
Effect on safety. One-way streets with traffic signal controls at major intersections are more likely to have gaps in traffic for safer crossing movements by pedestrians and vehicles at other cross streets and driveways along the route. In addition, drivers and pedestrians crossing one-way streets need be concerned with and wait for traffic from only one direction.

Numerous studies have shown that the conversion of two-way streets to one-way operation reduces total accidents on an order of 10% to 50%.[4] In some cases, specific kinds of accidents are reduced even more.

However, vehicles turning left out of one-way streets appear to hit pedestrians significantly more frequently than do all other turning vehicles, probably because of automobile roof support pillars blocking the view of the crosswalk, which

[4] J.A. Bruce, "One-Way Major Arterial Streets." *Improved Street Utilization Through Traffic Engineering*. Highway Research Board Special Report 93. Washington, DC, May 1967.

Figure 11–1. Intersection conflicts.
SOURCE: *Manual of Geometric Design Standards for Canadian Roads*, Roads and Transportation Association of Canada, Ottawa, 1986, p. D15.



is parallel to the original direction of travel.[5] Minor midblock collisions have been known to increase as a result of improper weaving by drivers to position themselves for an available parking space or to get in the proper lane for a turn. In addition, transition areas between one-way and two-way operations are frequently hazardous and require special traffic control treatment.

Effect on operating conditions. A primary reason for use of one-way streets is to improve traffic operations and reduce congestion. The degree of improvement in operating conditions, travel time, and safety depends, of course, upon the particular operating elements of the previous situation. Generally, travel times can be reduced from 10% to 50% and accidents by the same rate even with a slight increase in total traffic volumes.[6] (See Tables 11–1 to 11–3.)

Such general improvement in traffic operations must be balanced against the following disadvantages:

1. Some motorists must travel extra distances to reach their destination. Overall, this extra distance will likely increase the amount of fuel used and the travel time.
2. Changes in travel patterns will eliminate turning movements at some intersections and increase them at others, possibly resulting in new control problems at different locations in the area.
3. Strangers may become confused with the one-way street pattern, especially if network geometry is irregular or the one-way pattern is not uniform. Additional directional signing, pavement markings, channelization, and signal indications may be required to handle unexpected travel routing.
4. Transit operations may be adversely affected if vehicles are forced to operate on two streets instead of one. Where a narrow strip of trip generators exists along one street, walking distances to the nearest bus stop for the desired travel direction may increase.
5. Emergency vehicles may need to take a more circuitous route to reach some destinations.

Effect on area economic conditions. In many cases, improved traffic movement and increased safety can produce broad economic benefits both to adjacent land users and to the general public. Nevertheless, when implementing a one-way street system, especially one involving commercial

[5] P.A. Habib and others, *Analysis of Pedestrian Crosswalk Safety on One-Way Street Networks*. Report DOT-OS-70057, U.S. Department of Transportation, Washington, DC, September 1978.

[6] P.A. Mayer, "One-Way Streets," *Traffic Control and Roadway Elements—Their Relationship to Highway Safety*. Highway Users Federation for Safety and Mobility, Washington, DC, 1971, Chapter 10.

TABLE 11–1

Change in Traffic Volume, Trip Time, and Number of Stops after Conversion to One-Way Operation, Fifth Avenue, New York City

Section	Average Daily Traffic Volume			Average Trip Time (min)			Average Number of Stops		
	Before	After	Change (%)	Before	After	Change (%)	Before	After	Change (%)
Washington Sq. to 23rd St. [0.8 mi (1.3 km)]	15,265	18,722	+23	4.7	2.4	−49	3	1	−67
23rd St. to 42nd St. [0.9 mi (1.45 km)]	21,725	23,591	+ 9	7.3	2.9	−60	5	1	−80
42nd St. to 57th St. [0.7 mi (1.1 km)]	26,130	29,965	+15	7.4	4.4	−39	5	3	−40
57th St. to 138th St. [4.1 mi (6.6 km)]	11,592	14,953	+29	22.4	16.4	−28	14.8	7	−53
Totals (averages)	(16,411)	(19,595)	(+19)	42.1	26.4	−37	27.8	11	−60

SOURCE: J. A. BRUCE, "One-Way Streets," *Improved Street Utilization through Traffic Engineering*, Highway Research Board Special Report 93, May 1967.

TABLE 11–2

Accident Changes and Traffic Characteristics on One-Way Streets, London, England

Street	Percent Change in Traffic (Average Weekday)			Percent Change in Travel Time				Percent Change in Accidents	
				Off Peak Each Direction		PM Peak Each Direction			
	Mileage	Volume	Vehicle-Miles					Injury	Pedestrian
Tottenham Ct. Rd.*	5.1	+4	+8	−49	−34	−43	−14	−21	−33
Baker St.*	2.1	+2	+3	−48	−35	−65	−55	+4	−3
Earls Ct. Rd.†	6.3	+10	+12	−33	−15	−27	−16	−27	−13
Kings X*	2.5	−2	+18	−28	0	−27	+40	−33	−40
Bond St.†	1.3	+9	+14	−26	−38	−15	−38	0	0
Piccadilly*	1.3	−4	0	−19	−12	−5	−12	−14	−32

*6 months before and after.
†3 months before and after.

SOURCE: J. T. DUFF, "Traffic Management," Conference on Engineering for *Traffic*, 1963, p. 49.

TABLE 11-3

Accidents and One-Way Streets, New York City

Street and Length Made One-Way	Period	Number of Accidents					Total Accidents	Total Injured	Acc[illegible] Ra
		Angle	Rear End	Turning	Other	Pedestrian			
Madison Ave., 23rd St. to 135th St. [5.7 mi (9.2 km)]	Before	23	49	53	67	54	246	167	16.7
	After	23	34	24	45	52	158	101	9.[illegible]
	% change	0	−31	−49	−33	−41	−36	−40	−[illegible]
Fifth Ave., Washington Sq. to 38th St., [6.5 mi (10.5 km)]	Before	40	65	68	84	69	326	190	20.4
	After	38	53	52	73	45	261	156	13.7
	% change	− 5	−18	−23	−13	−29	−18	−18	−33
Both streets	Before	63	114	121	151	123	572	357	18[illegible]
	After	61	87	76	118	77	419	257	11.[illegible]
	% change	− 3	−24	−37	−22	−34	−27	−28	−38

*Accidents per million vehicle-miles.

SOURCE: J. A. BRUCE, "One-Way Major Arterial Streets," *Improved Street Utilization through Traffic Engineering*, Highway Research Board Special Report 93, May 1967.

streets, traffic engineers should expect objections from affected business owners, who may contend that one-way streets will adversely affect their trade.

Studies made in various parts of the United States have generally tended to disprove such claims. Moreover, where one-way systems have once been implemented, many business owners formerly opposed to the one-way street plan have become supporters.

Although the economic and environmental impact on converting to a one-way street system will undoubtedly vary from one place to another, a study by the Michigan Department of State Highways revealed that opposition tended to come from property owners immediately adjacent to one-way streets, with more support from others in the area. Despite fears of losses in business and property values, there was no indication of adverse economic impact on either business activity or residential property values.[7]

Trends in one-way street usage

The number and total mileage of one-way streets have increased significantly over the years. In 32 European towns, the total mileage of one-way streets increased from 225 to 575 km in a 10-year period after the end of World War II.[8] Figures are not readily available for the United States, but general observation suggests a similar trend. It may not be realistic to expect continued expansion of one-way street systems in large cities, but increased usage in many smaller and medium-sized cities has been noted.

Criteria for use of one-way streets

Legal background. Although the Model Traffic Ordinance[9] directs that the traffic engineer be authorized to determine and designate one-way streets and alleys (Section 32-301), many cities and counties require the approval of the governing body. Following such approval, if needed, the traffic engineer arranges for the placement and maintenance of the necessary traffic control devices, giving public notice thereof. The *Manual on Uniform Traffic Control Devices* (MUTCD) specifies the design and location of such signs.

Traffic studies. An engineering evaluation is needed to determine the advisability of one-way operation in a given street network. Such a network may range in size from two parallel streets to all streets in an area. The evaluation should include:

1. Physical inventory of existing system to determine:
   a. Widths and adaptability to one-way operation.
   b. Termination points where needed traffic control devices can be effectively provided.
   c. Transit operational needs within the network.
   d. Existing traffic control devices.
   e. Parking needs and practices.
   f. Major street and driveway intersection locations.
   g. Heavy pedestrian crossings.
2. Traffic volume studies on each street involved, including:
   a. Hourly directional counts.
   b. Turning movement counts during peak hours at critical intersections with streets and major driveways.
   c. Counts on streets parallel to the one-way pair(s) being considered, to estimate the effects of possible traffic diversion.
3. Speed and delay studies in both peak and off-peak periods to provide data on overall travel times and the locations and causes of major delays.
4. Traffic signal studies to evaluate existing progression programs and to determine the improvement that might be gained from one-way operation.
5. Parking studies to determine the feasibility of curb parking prohibitions on one or both sides during all hours or only in peak periods as an alternative or supporting measure to one-way operation.

[7] *The Economic and Environmental Effects of One-Way Streets in Residential Areas*, Department of State Highways, Lansing, MI, 1969.

[8] E. Nielsen, "Experience from 10 Years' Fight against Traffic Congestion," 36th International Congress, International Union of Public Transport, Brussels, Belgium, 1965, p. 15.

[9] National Committee on Uniform Traffic Laws and Ordinances, *Uniform Vehicle Code and Model Traffic Ordinance*.

6. Comparative capacity analyses of various alternative forms of operations.
   a. Capacity restrictions in the existing system that might be alleviated.
   b. Directional capacity of the existing network.
   c. Directional capacity of the proposed network.
   d. Directional capacity with parking prohibitions on the existing and proposed systems.
   e. Directional capacity using unbalanced operation techniques (two-way streets with off-center movement to encourage traffic to use one street in one direction and the other in the opposite direction, with progressive signal timing favoring the direction having more lanes) or reversible lanes (see next section).
7. Estimates of added travel distance and increase in total travel time in the network.
8. Feasibility studies with respect to transit routing and location of stops.
9. Investigation of probable effect on movement of emergency vehicles.
10. Investigation of probable effect of one-way operation on businesses, passenger loading zones (hotels, theaters, etc., may be on the "wrong" side of street), parking facility entrances and exits, and other land-use or curb-use activities.
11. Analysis of frequency, severity, and types of accidents along the proposed one-way street, with estimates of possible changes.
12. Pedestrian studies to evaluate the possible effects of one-way operation.
13. Economic evaluation of the costs of various types of operation in relation to the overall benefits that are anticipated.[10]

Planning considerations. The amount of data to be collected and analyzed in planning for one-way traffic regulations will depend largely on the size and complexity of the one-way system under consideration. The following questions should be considered:

1. Is the layout of the street system such that one or more pairs of one-way streets can be implemented on a practical basis? In other words, will it be logical and make sense and be accepted by the public?
2. What effect would the proposed one-way street(s) have on transit operations and patronage?
3. Must parking be restricted in certain areas to provide the proper number of traffic lanes?
4. What changes need to be made in signs, markings, parking meters, traffic signal indications and detectors, and other traffic control devices?
5. What impact would one-way traffic have on freight delivery and truck routing?
6. Are there major traffic generators on the streets to be considered for one-way operation, and what, if any, effect would there be on such generators?
7. Are the geometric elements of the street sections proposed for one-way operation such that the transition to two-way traffic (or termination at an intersection) would not cause safety or congestion problems?

As a general rule, two-way streets should be made one-way only if:

1. It can be shown that a specific traffic problem will be alleviated and the overall efficiency of the transportation system will be improved.
2. One-way operation is more efficient, safe, and cost-effective than alternative solutions.
3. Parallel streets of adequate capacity, preferably not more than a block apart, are available or can be constructed.
4. Such streets provide adequate traffic service to the area traversed and carry traffic through and beyond the congested area.
5. Safe transition to two-way operation can be provided at the end points of the one-way sections.
6. Proper transit service can be maintained.
7. Such streets are consistent with the master street or highway plan and compatible with abutting land uses.
8. Thorough study shows that the overall advantages significantly outweigh any disadvantages.

Benefits of one-way traffic regulations

Increased capacity. One-way streets will often:

1. Reduce intersection delays caused by vehicle turning movement conflicts and pedestrian-vehicle conflicts.
2. Allow lane-width adjustments that increase the capacity of existing lanes or provide an additional lane.
3. Reduce travel time.
4. Permit improvements in public transit operations, such as routings without turnback loops (out on one street and return on a parallel street).
5. Permit turns from more than one lane and doing so at more intersections than would be possible with two-way operation. (Care must be taken that designated turning lanes are clearly marked and do not block needed through lanes.)
6. Redistribute traffic onto adjacent streets to relieve congestion.
7. Simplify traffic signal timing by:
   a. Permitting a wider range of offsets for progressive movement of traffic.
   b. Permitting offsets to achieve wider through bands.
   c. Reducing multiphase requirements by eliminating left-turn conflicts and/or making minor streets one-way away from complex intersections.

Increased safety. One-way streets are likely to:

1. Reduce vehicle-pedestrian and vehicle-vehicle conflicts at many intersections.
2. Prevent pedestrian entrapment between opposing traffic streams.
3. Improve drivers' fields of vision at some intersection approaches.

[10] W. S. Homburger and J. H. Kell, *Fundamentals of Traffic Engineering*, 12th edition (Berkeley: University of California, Institute of Transportation Studies, 1988), p. 25-2.

Improved economy and environmental protection. One-way streets may:

1. Provide additional capacity to satisfy traffic requirements for a substantial period of time without large capital expenditures for new street construction.
2. Permit stage development of a master plan.
3. Meet changing traffic patterns quickly and at a relatively low cost.
4. Facilitate the loading and unloading of commercial vehicles with minimal impact on traffic flows.
5. Preserve sidewalks, trees, and other valuable frontage assets that would otherwise be lost because of the widening of existing two-way streets.
6. Be used to prohibit traffic from entering a residential neighborhood by making short lengths of street one-way outbound from the neighborhood.
7. Provide for parking on one side of a street that would otherwise be too narrow to permit parking and adequate clearance or sight distance for safe operation.
8. Be part of a freeway, expressway, rotary, or other system utilizing ramps, frontage roads, or connecting streets that handle movements that are essentially unidirectional in nature.

Roadway requirements

Although one-way systems will differ in details, there are certain basic factors to consider in developing a network of one-way streets:

1. The capacity of the street(s) in one direction should approximately balance the capacity of the street(s) in the opposite direction. If capacities cannot be balanced, the street having the lower capacity must have adequate capacity for current traffic and, if possible, for some time into the future.
2. Preferably, the one-way pair should be adjacent streets (although systems are operating satisfactorily where there are intervening parallel streets).

Design of termini

Some street patterns readily lend themselves to good traffic operations at one-way system termini—as when two streets join in a "Y" pattern to become one. In a gridiron pattern, however, the one-way system usually ends at a typical four-way intersection. When the one-way system would normally terminate at a major cross arterial, it is usually desirable to extend the system one block beyond that point. This is particularly true of the one-way street carrying traffic toward the crossing arterial. Construction of diagonal connections to facilitate transition from two-way traffic to one-way traffic should be considered when one-way streets are part of an arterial system.

APPENDIX 6

List of Contacts and Response Status

Date Printed: 5/31/00 Date Updated 4/25/00

STATE	STATE	NAME	SOURCE	PHONE	EMAIL	Response to Survey: Answered Survey	1 to 2 way	Parking	Bus	No Info	Follow Up	Type of follow-up		Forwarded to	Suggested by	Agency/Position
Alaska	AK	Gary Oliver	DOT		Gary_Oliver@dot.state.ak.us									Kurt Smith		DOT
	AK	Kurt Smith	DOT		Kurt_Smith@dot.state.ak.us										Kurt Smith	DOT
Alabama	AL	David Brown	DOT	(205) 348-6363	brown@ce.ua.edu	yes				X	No					
	AL	Cecil Colson	DOT	(334) 242-6393	colsonc@dot.state.al.us											DOT
	AL	Charles Turney	DOT	(334) 242-6393	turneyc@dot.state.al.us											DOT
	AL	real name unknown	DOT	(334) 242-6128	benifield@dot.state.al.us										David Brown	state traffic engineer
	AL	William J. Metzger	internet search		metzger@ci.mobile.al.us											
Arkansas	AR	Keith Stevens	DOT	(501) 569-2000	kasd212@ahtd.state.ar.us											
	AR	Scott Bennett	DOT	(501) 569-2542	sebd154@ahtd.state.ar.us											
Arizona	AZ	Paul Basha	internet search		pbasha@ci.scottsdale.az.us											
California	CA	Debbie Sylva	DOT	(916) 653-3076	debbie_sylva@dot.ca.gov											
	CA	Anciel F. Khorshid	internet search		akhorsid@ci.calabasas.ca.us											
	CA	Barney Burke	internet search		barney.burke@ci.mtnview.ca.us	yes			BP		25-Apr	email	responded			
	CA	Craig Smith	internet search	(805) 783-7719	csmith@ci.san-luis-obispo.ca.us	yes	SP				20-Apr	phone				
	CA	E. Camia	internet search		ecamia@ci.calabasas.ca.us	yes				X	No					
	CA	Gian C. Aggarwal			gaggarwal@ci.vacaville.ca.us											
	CA	James Hanson	internet search		jhanson@ci.san-luis-obispo.ca.us											
	CA	Raymond E. Davis	internet search		rdavis@ci.san-leandro.ca.us	yes				X	No					
	CA	Robert B. Yalda	internet search		ryalda@ci.calabasas.ca.us											
Canada	Can.	H. Chuan Kuu	referred by OrDOT		Chuan.Kuu@gov.edmonton.ab.ca										Jeff Bender	Plan/Dev. Edmonton,Alberta
Colorado	CO	Tamara Maurer	DOT	(303) 757.9348	Tamara.Maurer@dot.state.co.us											DOT
	CO	Santiago	DOT	(303) 512-5112	santiago.encinias@dot.state.co.us	yes				X	No					DOT
Connecticut	CT	Susan Reynolds	DOT		susan.reynolds@po.state.ct.us	yes				X	No			Busch & Howard		DOT
	CT	Frank Busch	DOT		Frank.Busch@po.state.ct.us											
	CT	John A. Vivari	DOT		John.Vivari@po.state.ct.us	yes				X	No					
	CT	Richard J. Howard	DOT		Richard.Howard@po.state.ct.us	yes				X	No			John Vivari		
Dist of Columbia	DC	Montgomery County			trafparks@co.mo.md.us											
Florida	FL	Patrick Brady	DOT	(850) 488-3546	patrick.brady@dot.state.fl.us											DOT
	FL	Ahmed E. Aburahmah	internet search	(941) 748-4501 ext 5293	ahmed.aburahmah@co.manatee.fl.us	yes		FP			24-Apr	phone				
	FL	Chuck Lovell	internet search		Chuck.LOVELL@dot.state.fl.us											DOT
	FL	Donald Galloway	internet search	(941) 316-1460	dgalloway@co.sarasota.fl.us										Ahmed Aburahmah	
	FL	Gene O'Dell	internet search		gene.odell@dot.state.fl.us	yes				X	No			Traffic oper. Dept.		DOT
	FL	Jeff Dodge	internet search		jeffrey.dodge@dot.state.fl.us	yes	SP				25-Apr	email				DOT
	FL	Jeffrey Morgan	internet search		jeffrey.morgan@dot.state.fl.us											DOT
	FL	Mike Cornejo	internet search		Mike.Cornejo@dot.state.fl.us										Steve Homan	DOT
	FL	Rafinel De Arazoza	internet search	(305) 377-5900	rafael.dearazoza@dot.state.fl.us										Jeff Dodge	
	FL	Steve Homan	internet search		steve.homan@dot.state.fl.us	yes				X	No			Mike Cornejo		
	FL	Tom Speights	internet search		tommie.speights@dot.state.fl.us	yes				X	No					
Georgia	GA	Dick Graves	DOT	(404) 635-8381	dick.graves@dot.state.fl.us											DOT
	GA	Joseph Fletcher	DOT		Joseph.Fletcher@dot.state.ga.us	yes				X	No	email				
	GA	Marion Waters	DOT	(404) 635-8038	marion.waters@dot.state.ga.us	yes				X	No			Joseph Fletcher		
Iowa	IA	Tim Crouch	DOT	(515) 239-1513	tcrouch@iadot.e-mail.com	yes				X	No					DOT
	IA	Scott Logan		(515)-239-5160												Ames, IA traffic eng.
Idaho	ID	Steve Rich	DOT	(208) 334-8116	srich@itd.state.id.us	yes	X					email		Lance Johnson		
	ID	Joe Rosenlund	DOT	(208) 387-6140	jrosenlu@achd.ada.id.us											
	ID	Lance Johnson	DOT		Ljohnson@itd.state.id.us	yes			BP		20-Apr	email	responded			
	ID	Marty Jensvold	DOT		martin.r.jensvold@odot.state.or.us										Steve Rich	
	ID	Rob Burchfield	DOT		burch@syseng.ci.portland.or.us										Steve Rich	Bureau Traffic Management
	ID	Terry Little	DOT	(208) 387-6141	tlittle@achd.ada.id.us	yes	SR				20-Apr	phone				
Illinois	IL	Rick Meyers	DOT	(217) 782-2575	meyersrs@nt.dot.state.il.us											DOT
	IL	Lawrence W. Gregg	DOT	(217) 782-7414	greggiw@nt.dot.state.il.us											DOT
Indiana	IN	Nisar Kahn	DOT	(765) 494-9310	nisar@ecn.purdue.edu											Univ. of Purdue
Kansas	KS	Nancy Mattson	DOT		NancyM@ksdot.org	yes				X	No			Thomas Dow		DOT
	KS	Arron Bartlett	referred by DOT	(785) 832-3153	nbartlett@ci.lawrence.ks.us										Thomas Dow	MPO
	KS	David Warm	referred by DOT	(816) 474-4240	dwarm@marc.org										Thomas Dow	MPO
	KS	Jamsheed Mehta	referred by DOT	(316) 268-4561	mehta_j@ci.wichita.ks.us										Thomas Dow	MPO
	KS	John Dugan	referred by DOT	(785) 295-3728	jdugan@topeka.org										Thomas Dow	MPO
	KS	Ken Donaldson	referred by DOT		kdonaldson@topeka.org	yes				X	No				Todd Girdler	
	KS	Linda Finger	referred by DOT	(785) 832-3153	lfinger@ci.lawrence.ks.us										Thomas Dow	MPO
	KS	Linda Voss	DOT	(785) 296-3618	voss@ksdot.org	yes				X	No					DOT
	KS	Marvin Krout	referred by DOT	(316) 268-4561	krout_m@ci.wichita.ks.us										Thomas Dow	MPO
	KS	Mell Henderson	referred by DOT	(816) 474-4240	mellH@marc.org										Thomas Dow	MPO
	KS	Thomas Dow	referred by DOT	(785) 296-2552											Nancy Mattson	Urban Planning Manager
	KS	Todd Girdler	referred by DOT	(785) 295-3729	tgirdler@topeka.org	yes				X	No			Ken Donaldson	Thomas Dow	MPO
Kentucky	KY	Simon Cornett	DOT	(502) 564-3020	scornett@mail.kytc.state.ky.us,										Gregg Witt	
	KY	Duane Thomas	DOT	502-564-3020	dthomas@mail.kytc.state.ky.us	yes				X	No					
	KY	Gregg Witt	DOT	(502) 564-7183	gwitt@mail.kytc.state.ky.us	yes				X	No			Simon Cornett		KYTC
	KY	Pat Johnson	referred by DOT	502-574-3111											Duane Thomas	Louisville City Engineer
	KY	Ron Herrington	referred by DOT	859-258-3480											Duane Thomas	Lexington City Engineer
Louisiana	LA	real name unknown	DOT	(225) 935-0103	pallain@dotdmail.dotd.state.la.us											
	MA	Arnie Soolman			arnie@ctps.org											
	MA	Efi Pagitsas	internet search		efip@ctps.org											Public Safety

Date Printed: 5/31/00 Date Updated 4/25/00

STATE	STATE	NAME	SOURCE	PHONE	EMAIL	Response to Survey: Answered Survey	1 to 2 way	Parking	Both	No Info	Follow Up	Type of follow-up		Forwarded to	Suggested by	Agency/Position
	MA	Lauren Preston	internet search		lpreston@ci.cambridge.ma.us											
	MA	Susanne Rasmussen			srasmussen@ci.cambridge.ma.us											
Maryland	MD	Manu Shah	DOT	(410) 787-5825	mshah@sha.state.md.us									Bob French		
	MD	Bob French	DOT		Bfrench@sha.state.md.us	yes				X	No					
	MD	Darla Lynch	internet search		Dlynch1@mdot.state.md.us	yes				X	No				Manu Shah	MDDOT
	MD	Kimberly TRAN	DOT		ktran@sha.state.md.us	yes				X	No					
	MD	Ron Lipps	DOT	(410) 787-4017	rlipps@shj.state.md.us											
	MD	Thomas Hicks	internet search		thicks@sha.state.md.us										Carlton Robinson	
Maine	ME	Robert Baker	DOT	(207) 287-3134	robert.baker@state.me.us											
Michigan	MI	Robert Briere	MDOT	(616) 337-3920	brierer@mdot.state.mi.us											DOT
	MI	David Berridge	referred by MDOT	(517)773-7971 wrong		yes	X								Paul Ajegba	City of Lansing Engineer
	MI	Duane Ellis	referred by MDOT	(517) 773-7971	duaneellis@rocketmail.com	yes	SP				25-Apr	phone			John Salter	City of Mt. Pleasant
	MI	John Matuszak	internet search		jmatusz@ci.east-lansing.mi.us	yes				X	No					City of East Lansing
	MI	John Salter	MDOT	(517) 754-0878	SalterJ@mdot.state.mi.us											DOT
	MI	Jon Start	referred by MDOT	(616) 337-8533 wrong #											Robert Briere	City of Kalamazoo
	MI	Ken Feldt	referred by MDOT	(517) 463-8346	kfeldt@ci.alma.mi.us										John Salter	City of Alma
	MI	Kenneth Tiffany	referred by MDOT	(517) 780-7870	tiffanyk@mdot.state.mi.us	yes	SG				20-Apr	phone			Paul Ajegba	DOT
	MI	Max Pheres	referred by MDOT	(616) 966-3538	MVPheres@ci.battle-creek.mi.us	yes			BP		20-Apr	phone			Robert Briere	City of Battle Creek
	MI	Paul Ajegba	MDOT	(517) 780-7500	Ajegbap@mdot.state.mi.us											DOT
	MI	Warren Renanado	referred by MDOT	(517) 788-4025	jksmcitymgr@dmci.net(kludwig@dmci.net)										Paul Ajegba	City of Jackson Manager
Minnesota	MN	Loren Hill	DOT		Loren.Hill@dot.state.mn.us	yes				X	No			John Maczko		DOT
	MN	Daniel.Brannan	DOT	(651) 582-1063	Daniel.Brannan@dot.state.mn.us											DOT
	MN	John Anderson	DOT	(651) 284-3456	jon.anderson@dot.state.mn.us	yes				X	No					DOT
	MN	John Maczko	DOT		john.maczko.@stpaul.gov	yes	SR				13-Apr	email			Loren Hill	
	MN	Mike Weiss	DOT	(651) 284-3440	mike.weiss@dot.state.mn.us	yes				X	No					
	MN	Paul Stein	DOT	(651)-286-9973	paul.stine@dot.state.mn.us											
	MN	Tom Campbell	internet search		tom.campbell@dot.state.mn.us	yes				X	No					
Mississippi	MS	Dan Gaillet	internet search		dgaillet@city.jackson.ms.us	yes				X	No					City of Jackson
	MS	Bob Mabry	DOT		bmabry@mdot.state.ms.us	yes			PP		25-Apr	email	responded	Eddie Robinson		DOT
	MS	Eddie Robinson	DOT		erobinson@mdot.state.ms.us											DOT
	MS	Wayne Parrish	DOT	(601) 359-7707	wparrish@mdot.state.ms.us									Bob Mabry		DOT
Montana	MT	Al Goke	DOT		agoke@state.mt.us	yes				X	No			Don Dusek		DOT
	MT	Don Dusek	DOT	(406) 444-6217	ddusek@state.mt.us										Al Goke	
	MT	Duane Williams	DOT		duwilliams@state.mt.us	yes				X	No			Don Dusek		DOT
North Carolina	NC	John H. Grant	DOT		jgrant@dot.state.nc.us											DOT
	NC	A.D. (Tony) Wyatt	DOT		awyatt@doh.dot.state.nc.us	yes			BR		13-Apr	email				
	NC	Gary Faulkner	DOT		glaulkner@dot.state.nc.us										A.D. (Tony) Wyatt	
	NC	Jimmy Lynch	DOT	(919) 733-3915	jlynch@dot.state.nc.us											DOT
North Dakota	ND	Joel Cranford	DOT	(701) 328-4397	ajunde@state.nd.us											
	ND	Al Covlin	DOT	(701) 328-4398	acovlin@state.nd.us											
Nebraska	NE	Bob Grant	DOT	(402) 479-4645	bgrant@dor.state.ne.us											DOR
	NE	Randy Peters	DOT	(402) 479-4594	Randy_Peters@dor.state.ne.us											DOT
New Hampshire	NH	Lyle Knowlton	DOT	(603) 271-2291	lknowlton@dot.state.nh.us											DOT
	NH	W. Lambert	DOT		WLambert@dot.state.nh.us	yes				X	No					
New Jersey	NJ	state police	DOT		webmaster@spm.dot.state.nj.us											DOT
	NJ	Joe Moore	DOT		jmoore@spm.dot.state.nj.us	yes				X	No			Staff		DOT
	NJ	real name unknown	DOT		correspondenceunit@dot.state.nj.us									Joe Moore		DOT
New Mexico	NM	James Davis	DOT	(505) 277-3305	jwdavis@unm.edu											
	NM	Diane CDeBaca	DOT	(505) 827-5289	dianecdebaca@nmshtd.state.nm.us											
	NM	Elizer Pena	DOT	(505) 827-5529	e.pena@nmshtd.nm.us											
Nevada	NV	Kelly Anrig	DOT	(775) 888-7468	kanrig@dot.state.nv.us											DOT
	NV	Frederick M. Droes	DOT	(775) 888-7490	fdroes@dot.state.nv.us										Mike Lawson	DOT
	NV	Mike Lawson	DOT	(775) 888-7443	mlawson@dot.state.nv.us	yes				X	No			Frederick M. Droes		DOT
New York	NY	Sandra Rosner	DOT		SROSNER@gw.dot.state.ny.us	yes				X	No			Jon Bray		DOT
	NY	Barbara Abrahamer	DOT		BABRAHAMER@gw.dot.state.ny.us	yes				X	No					DOT
	NY	Jon Bray	DOT		jsbray@gw.dot.state.ny.us										Sandra Rosner	
Ohio	OH	Arthur Garrett	DOT	(614) 644-8159	agarrett@dot.state.oh.us											DOT
Oklahoma	OK	Ginger Miller	DOT	(405) 522-0985	gmiller@odot.org	yes				X	No			Urban Tran. Plan. Dept.		DOT
Oregon	OR	Steven.L.Reed	DOT		Steven.L.REED@odot.state.or.us											DOT
	OR	Crystal Atkins	internet search		CAC@trans.ci.portland.or.us											
	OR	Jackson.R.Shepard	DOT		Jackson.R.SHEPARD@odot.state.or.us									Samuel Johnston	Richard Wood	DOT
	OR	Michael A. Coleman	internet search		COLEMAN@trans.ci.portland.or.us	yes				X						
	OR	Paul.M. Davis	DOT		Paul.M.DAVIS@odot.state.or.us											DOT
	OR	Rich Newlands	internet search		RICHN@trans.ci.portland.or.us	yes	SR				13-Apr	email				
	OR	Richard M. Wood	DOT	(503)986-3589	Richard.M.WOOD@odot.state.or.us	yes	SP				25-Apr	email	responded			
	OR	Richard T. Heinemann	DOT	(503)986-3611	Richard.T.HEINEMANN@odot.state.or.us	yes		PP			25-Apr	email	responded			DOT
	OR	Rob Burchfield			burch@sysseng.ci.portland.or.us											
	OR	Samuel A Johnston	DOT		Samuel.A.JOHNSTON@odot.state.or.us	yes				X	No			Heinemann & Wood	Richard Wood	DOT
Rhode Island	RI	Parker	DOT		elparker@dot.state.ri.us											DOT
South Carolina	SC	Riddle, Joey D	DOT		RiddleJD@dot.state.sc.us	yes			PP							DOT
	SC	David Brewer			trafengr@columbiasc.net											
	SC	Don Turner	DOT	(803) 737-1461	TurnerD@dot.state.sc.us										Joey Riddle	

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STATE	STATE	NAME	SOURCE	PHONE	EMAIL	Response to Survey: Answered Survey	1 to 2 way	Parking	Both	Yet to do	Follow Up	Type of Follow-up		Forwarded to	Suggested by	Agency/Position
	SC	John Adler	DOT	(605) 773-3704	John.Adler@state.sd.us											
	SC	Stanley Shealy	internet search		ShealySE@dot.state.sc.us											DOT
Tennessee	TN	David Lollar	DOT	(615) 741-0968	dlollar@mail.state.tn.us											
Texas	TX	Jerri Hays	DOT	(512) 424-2298	accident.records@txdps.state.tx.us	yes				X	No					Department of Public Safety
	TX	David G. Gerard,			david.gerard@ci.austin.tx.us											
	TX	Debrah Graham	DOT	(512) 486-5100	dgraham@dot.state.tx.us											DOT
Utah	UT	Mack Christiensen	DOT	(801) 965-4264	mchrist@dot.state.ut.us											DOT
	UT	Marie Chitman	DOT		wsadmpo.mchrist@state.ut.us	yes				X	No					DOT
	UT	Tammy Kaeser	DOT	(801) 965-4137	tkaeser@dot.state.ut.us											
Virginia	VA	real name unknown	DOT	(804) 786-4567	kmy_rm@vdot.state.va.us											DOT
	VA	Elena Kastenhofer	internet search		kastenhofer_je@vdot.state.va.us											DOT
Vermont	VT	Amy Gamble	DOT	(802) 828-2685	amy.gamble@state.vt.us											
	VT	Mark Ljungvall	DOT		MLJUNGVALL@STATE.VT.US											
Washington	WA	Rae Bennett	DOT		BENNETR@WSDOT.WA.GOV											DOT
	WA	Jeff Bender			jeff.bender@ci.seattle.wa.us	yes				X	No					
	WA	Noelle Million	internet search		noelle.million@ci.seattle.wa.us											DOT
	WA	Rick Mowlds	DOT	(360) 705-7988	MowldsR@WSDOT.WA.GOV	yes				X	No					DOT
	WA	Wayne Wentz	internet search		Wwentz@ci.everett.wa.us											
Wisconsin	WI	Mark Morrison	DOT	(608) 266-1675	mark.morrison@dot.state.wi.us	yes				X	No			Peter Rusch		DOT
	WI	Mark Truby	DOT	(608) 266-9349	mark.truby@dot.state.wi.us										Richard Lange	DOT
	WI	Peter Rusch	DOT		peter.rusch@dot.state.wi.us										Mark Morrison	DOT
	WI	Richard Lange	DOT		richard.lange@dot.state.wi.us	yes		PPO			25-Apr	email		Mark Truby		DOT
West Virginia	WV	Ray Lewis	DOT	(304) 558-8912	rlewis@dot.state.wv.us	yes			BP		20-Apr	phone				DOT
Wyoming	WY	Kevin Messman	DOT	(307) 777-3944	kmessman@state.wy.us											DOT
	xx unknown	Andrew O'Brien	internet search		andyob@ibm.net											
	xx unknown	Angela M. Christo	internet search		angela.m.christo@parsons.com											
	xx unknown	Brenda C. Krugh	internet search		brenda.krugh@fhwa.dot.gov	yes				X	No			Douwes, Stills, Sillian,Berman		FHWA
	xx unknown	Carlton C. Robinson	internet search		ccarlton@erols.com	yes				X	No					
	xx unknown	Christopher Douwes	internet search	(202) 366-5013	christopher.douwes@fhwa.dot.gov										Brenda Krugh	
	xx unknown	Crawford Jencks	internet search		CJencks@nas.edu	yes				X	No			Derr, Maher	Jon Williams	TRB contact
	xx unknown	Dale L. Picha	internet search		d-picha@tamu.edu											
	xx unknown	Davey Warren	internet search		Davey.Warren@fhwa.dot.gov											FHWA
	xx unknown	Ed Cline	internet search	(562) 908-6244		yes				X	No					
	xx unknown	Frederick C. Dock	internet search		frederick.dock@parsons.com											
	xx unknown	George E. Frangos	internet search		traffic@ci.ht.md.us											
	xx unknown	Henry Mohle	internet search		hmaeng@earthlink.net											
	xx unknown	John W. Van Winkle	internet search		vanwinkle@Al.cps.k12.tn.us											
	xx unknown	Jon Williams	internet search	(202) 334-2938	JWilliam@nas.edu	yes	SR				14-Apr	email			Brenda Krugh	TRB contact
	xx unknown	Lauren Suarez	internet search		Lsuarez@WILLDAN.com	yes				X	No			Ed Cline		
	xx unknown	Lisa Finlana	internet search	(202) 554-8050 ext 116							waiting				Brenda Krugh	
	xx unknown	Michael J. Workosky	internet search		mjworkosky@mjwells.com	yes				X	No					
	xx unknown	Paul Mackey	internet search		ruesecur@qbc.clic.net											
	xx unknown	Ray Derr	internet search		RDerr@nas.edu	yes				X	No				Crawford Jencks	TRB contact
	xx unknown	Reid H. Ewing	internet search		r.ewing@fehrandpeers.com											
	xx unknown	Rose Marie Zigenfus	internet search		outs@evansville.net											
	xx unknown	Seppo Sillan	internet search		seppo.sillan@fhwa.dot.gov										Brenda Krugh	
	xx unknown	Stephen Maher	internet search		SMaher@nas.edu	yes				X	No				Crawford Jencks	TRB contact
	xx unknown	Wayne Berman	internet search		berman.wayne@fhwa.dot.gov										Brenda Krugh	
	xx unknown	Wendell Stills	internet search		stills_wendel@fhwa.dot.gov										Brenda Krugh	

Summary total contacts = 192 total responses to survey (incl follow-up) = 72 9 5

This person has done
PP = parking projects
SP = 1 to 2 projects
BP = Both projects

These people have info on
PPO = parking policy
SPO = 1 to 2 policy
BPO = policy info on both topics

these people have reports on
PR = parking reports
SR = 1 to 2 reports
BR = reports on both projects

APPENDIX 7

Practitioner E-Mail Survey Instrument

We are working with the Michigan Department of Transportation on two topics: A) the conversion of one-way streets to two-way operation; and B) allowing parking where none had been allowed) on through and/or state-numbered streets and roads. You have been identified as an individual in your organization who might be aware of your organization's views/policies on these issues OR who could forward this inquiry to someone who is.

Basically, we are looking for experiences and/or studies that articulate the impacts of such conversions. If your experiences have been with the "reverse" of these actions (e.g., the impacts of converting from two-way to one-way operation), that would be useful as well. In this regard, your completion of the short survey below would be greatly appreciated.

If you forward this inquiry to someone else, please let us know who received it so that we can follow up with them.

Inquiry was forwarded to (please include e-mail address):_____

A. ONE-WAY TO TWO-WAY STREET CONVERSIONS

1. Has your organization done any projects that involved changing one-way operations to two-way? ___yes ___no

2. Has your organization produced any reports on the impacts of specific one to-two-way conversions or on such conversions in general?
___yes (specific projects) ___yes (general idea) ___no

3. Does your organization have policies, guidelines, or warrants on allowing (or when to do) one-to-two-way conversions?
___yes (policies) ___yes (guidelines) ___no

4. Has your organization done any projects, produced any reports, or have any policies or guidelines on the REVERSE type of conversions (i.e., two-way to one-way conversions)?
___yes (projects) ___yes (reports) ___yes (policies/guidelines) ___no

5. Who is the best person in your organization to contact for more detailed information about getting reports, policies, and generally discussing this topic in more detail?

name and title:_____
e-mail:_____
phone:_____

6. Do you know of any other individuals or agencies in your state who have experience with one-to-two-way operation conversions (e.g., a city traffic engineer)?

name and title:_____
e-mail:_____
phone:_____
city and state:_____

B. CONVERSION TO PERMITTED PARKING ON STATE-NUMBERED ROUTES WHERE NONE HAD EXISTED

1. Has your organization done any projects that involved changing to permitted parking on state-numbered routes? ___yes ___no

2. Has your organization produced any reports on the impacts of allowing parking on state-numbered routes?
___yes (specific projects) ___yes (general idea) ___no

3. Does your organization have policies or guidelines on describing conditions that warrant permitted parking on state-numbered routes?
___yes (policies) ___yes (guidelines) ___no

4. Has your organization done any projects, produced any reports, or developed any policies or guidelines on the REVERSE type of conversions (i.e., parking removal)?
___yes (projects) ___yes (reports) ___yes (policies/guidelines) ___no

5. Who is the most appropriate person in your organization to contact for more detailed information about getting reports, policies, and generally discussing this topic in more detail?

name and title:_____
e-mail:_____
phone:_____

6. Do you know of any other individuals or agencies in your state who have experience with conversions to permitted parking (e.g., a city traffic engineer, parking task force)?

name and title:_____
e-mail:_____
phone:_____
city and state:_____

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Richard Lyles, Professor
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APPENDIX 8

Summary of Responses to E-Mail Survey

SUMMARY OF RESPONSES TO E-MAIL SURVEY

Today's Date
May 27, 2000

Last Update
May 4, 2000

STATE	NAME	AGENCY	ONE-WAY TO TWO-WAY STREET CONVERSION						CONVERSION TO PERMITTED PARKING					
			PROJECTS	REPORTS	POLICIES	REVERSE	CONTACT	OTHER	PROJECTS	REPORTS	POLICIES	REVERSE	CONTACT	OTHER
AK	Gary Oliver	AK-DOT						YES						YES
AK	Duane F. Doerflinger	AK-DOT	NO	NO	NO	Y-PR	YES	NO	YES	NO	NO	Y-PR	YES	NO
AL	David Brown	Univ. of AL	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	YES	NO
CA	Elaine Camia		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CA	Craig Smith		YES	NO	NO	NO	YES							
CA	Raymond E. Davis		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CA	Ed Celine		NO	NO	NO	NO	NO	YES	NO	NO	NO	Y-PR	NO	YES
CT	John A. Vivari	CT-DOT	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	YES	NO
DC	Brenda Kragh	FHWA					YES	YES					YES	YES
DC	Stephan Maher	TRB	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
FL	Jeffrey Dodge	FL-DOT	YES	NO	NO	NO	YES	YES	NO	NO	NO	NO	NO	YES
FL	Gene O'Dell	FL-DOT						YES						YES
FL	Steve Homan	FL-DOT						YES						YES
FL	Jeffrey Morgan	FL-DOT					YES						YES	
FL	Mike Cornejo	FL-DOT	YES		NO		YES	YES					YES	
GA	Joseph Fletcher	GA-DOT	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
IA	Tim Crouch	IA-DOT	NO	NO	NO	NO	YES	YES	NO	NO	NO	NO	YES	NO
ID	Terry Little	ID-DOT	YES	NO	NO	Y-R	YES	NO	NO	NO	NO	NO	NO	NO
ID	Lance Johnson	ID-DOT	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO
KS	Carol Folkmann						YES	YES					YES	YES
KS	Linda Voss	KS-DOT	NO	NO	NO	NO								
KY	Duane Thomas	KY-DOT	YES	NO	NO	NO	YES	YES	YES	NO	Y-P	Y-PR	YES	YES
MD	Kimberley Tran	SHA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
MD	Bob French	SHA												
MD	Carlton C. Robinson						YES						YES	
MI	Kenneth V. Tiffany	MI-DOT	NO	Y-Gen	Y-G	Y-PR	YES	NO	NO	Y-Gen	Y-G	Y-R	YES	NO
MI	Duane Ellis		YES	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	YES
MN	John Maczko	MN-DOT	YES	Y-SP	NO	NO	YES	YES	NO	NO	NO	NO	YES	NO

STATE	NAME	AGENCY	ONE-WAY TO TWO-WAY STREET CONVERSION						CONVERSION TO PERMITTED PARKING					
			PROJECTS	REPORTS	POLICIES	REVERSE	CONTACT	OTHER	PROJECTS	REPORTS	POLICIES	REVERSE	CONTACT	OTHER
MN	Mike Weiss	MN-DOT						YES						YES
MN	Tom Campbell	MN-DOT					YES			Y-R			YES	
MS	Dan Gaillet		NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	YES	YES
NC	Anthony D. Wyatt	NC-DOT	YES	Y-SP	Y-G	Y-R	YES	NO	YES	NO	Y-P	Y-PR	YES	NO
NH	Bill Lambert	NH-DOT	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	YES
NJ	Reid	Rutgers					YES						YES	
NY	Sandra Rosner	NY-DOT					YES						YES	
OK	Ginger Miller	OK-DOT						YES						YES
OR	Rich Newlands		YES	Y-SP	NO	NO	YES	NO						
OR	Samuel A. Johnston	OR-DOT												
OR	Michael A. Coleman		NO	NO	NO	NO	NO	NO						
OR	Richard M. Wood	OR-DOT	YES				YES						YES	
SC	Joey D Riddle	SC-DOT	NO	NO	NO	Y-PG	YES	NO	YES	NO	NO	NO	YES	NO
UT	Tammy Kaeser	UT-DOT					YES						YES	
VT	Amy L. Gamble	VT-DOT							NO	NO			YES	YES
WA	Noelle Million							YES						YES
WA	Jeff Bender						YES						YES	

SUMMARY OF COUNTS

	ONE-WAY TO TWO-WAY STREET CONVERSION						CONVERSION TO PERMITTED PARKING					
	PROJECTS	REPORTS	POLICIES	REVERSE	CONTACT	OTHER	PROJECTS	REPORTS	POLICIES	REVERSE	CONTACT	OTHER
YES	10	0	0	0	27	15	4	0	0	0	22	15
NO	17	21	24	20	8	17	18	21	18	16	11	15
Y-SP: Yes (Specific Projects)	0	3	0	0	0	0	0	0	0	0	0	0
Y-Gen:Yes (General Idea)	0	1	0	0	0	0	0	1	0	0	0	0
Y-P: Yes (Policies)	0	0	0	0	0	0	0	0	2	0	0	0
Y-PG: Yes(Policies/ Guidelines)	0	0	0	1	0	0	0	0	0	0	0	0
Y-PR: Yes (Projects)	0	0	0	2	0	0	0	0	0	4	0	0
Y-R: Yes (Reports)	0	0	0	2	0	0	0	1	0	1	0	0
Y-G: Yes (Guidelines)	0	0	2	0	0	0	0	0	1	0	0	0
NO RESPONSE	18	20	19	20	10	13	23	22	24	24	12	15