PARKING ON THE STATE TRUNKLINE SYSTEM

Executive Summary

prepared for

Michigan Department of Transportation

prepared by

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Background

On-street parking is an important element of the urban transportation system and a controversial issue among traffic engineers, urban planners, and public agencies. On one hand, on-street parking reduces roadway capacity, and level of service, and increases the potential for traffic crash occurrence. On the other hand, on-street parking results in user convenience and accessibility, which in turn foster economic development and sustainable communities, and help to achieve a wide variety of community objectives, ranging from improved air quality to increased neighborhood amenity.

Various local issues arise which often compel MDOT to consider changing traffic lanes into on-street parking on the state trunkline. In this context, MDOT was desirous of being able to determine the potential implications of such action and where the conversion can be considered, while minimizing traffic impacts.

This project was undertaken to examine and summarize the state of the practice regarding placement of on-street parking on state-numbered roads. More specifically, the objective of this project was to perform a literature review and a survey of practitioners in order to determine where such changes are practical and desirable.

Approach

To achieve the study objective, a three-step process was followed. The first step included an extensive literature review, the second one focussed on the state-of-practice review, and the third provided a synthesis of information and development of a set of proposed recommendations.

The literature search focused on the impacts from the conversion of traffic lanes into on-street parking on capacity, safety, accessibility, development and economic growth, traffic calming, and the environment. Consideration was also given to the determination of the need for on-street parking, on-street parking design alternatives, and parking management and enforcement policies.

The state-of-the practice review involved an e-mail survey and interviews with practitioners with experience in the conversion of traffic lanes into on-street parking. They were questioned on their agencies' motivation for implementation of on-street parking, potential payoffs, availability of policies or guidelines describing conditions that warrant permitted parking on state-numbered routes, and availability of reports documenting results from evaluation studies.

Results

Over a hundred technical references were consulted and one hundred ninety three practitioners were approached to obtain information within the scope of the project. Approximately half of the literature sources contained relevant information and are cited in this report and one fifth of all contacts contributed some sort of useful information.

The main conclusions of this study are as follows:

1. As far as capacity is concerned, on-street parking is permissible on state-numbered roads only when the speed is low and the traffic demand is well below capacity. At higher speeds and during periods of heavy traffic movement, on-street parking is incompatible with trunkline system service and should be avoided.
2. On-street parking is known to be a contributory cause in road traffic crashes. The effect of on-street parking on crash frequency and severity differs from location to location and is found to depend on functional classification of the street, utilization of parking, and abutting land. There are contradictory results regarding the correlation between parking configuration and safety. Overall, it is concluded that placement of parking on the state trunkline has adverse effects on traffic safety and should be avoided, when practical.
3. When on-street parking on state-numbered roads is deemed necessary, it should be of parallel, rather than angle type. Parallel parking minimizes through flow disruption and the potential for a crash occurrence. Flat-angle parking can be used alternatively without any significant compromise on safety.
4. When on-street parking is present, available street space must meet requirements for emergency vehicle maneuvering and fire hose laying. From the design point of view, the total parking lane width for passenger cars should be 3.0 to 3.6 m. Narrower lane widths (up to 2.4 m) are feasible, but compromise safety, and operational efficiency and should be avoided on the state trunkline.
5. Provision of on-street parking space plays an important supporting role in development decisions and may affect the economic growth of businesses along the state trunkline.

6. On-street parking has many benefits as a traffic calming measure. Still, the use of on-street parking for traffic calming should be restricted to facilities with speed limits at or below 25 miles per hour and is not justified on state-numbered streets.
7. Strategically located and properly controlled on-street parking spaces can reduce the environmental impact of vehicles, whilst ensuring the vitality and viability of an area.
8. Detailed studies of parking characteristics and analysis of parking demands and needs are necessary in order to quantifying costs and impacts, and establish appropriate plans and programs.
9. On-street parking space is a scarce resource, thus, priorities for its use should be established in the public interest. Managing scarce parking resources means determining if and how parking should be regulated, ensuring adequate compliance with regulations, and following up on those who do not comply through enforcement and adjudication.
10. Rapid advancements in Intelligent Transportation Systems started affecting parking needs, parking related technologies, and parking management strategies. This trend will become more common in the future. It is recommended that parking authorities in the United States follow the new developments closely and remain current on emerging parking industry trends.
11. The responses of practitioners regarding the use of on-street parking on state-numbered roads were in general agreement with the findings in the literature search.
12. Although numerous states experimented with placement of on-street parking on their state highways, there are virtually no comprehensive studies available on quantitative/qualitative assessment of benefits and disadvantages from such actions. Furthermore, the lack of coherent policies and guidelines on the subject was confirmed.

Overall, it was concluded that on-street parking policies for the state trunkline are not clear cut. It is generally desirable to avoid parking on state-numbered roads for the sake of safety and operational efficiency. However, curb parking is acceptable when the moving traffic lanes can accommodate the traffic volume, and additional parking is deemed necessary. Site specific studies are recommended to assess potential benefits and implications from the presence on-street parking on a case by case basis.

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Final Report

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16. Abstract

Various local issues arise which often compel MDOT to consider changing traffic lanes into on-street parking on the state trunkline. The objective of this project was to perform a literature review and a survey of practitioners in order to determine where such changes are practical and advisable.

This report presents results from a detailed review of implications of on-street parking on operations, safety, economic growth, and the environment. Practical issues related to design, parking management, and enforcement are also addressed. Motivations behind parking placement in case studies, existing policies and guidelines, and results from evaluation results were solicited through a nationwide survey of practitioners.

It was concluded that, in general, on-street parking on the state trunkline should be avoided based on capacity and safety considerations. However, when capacity is enough to accommodate traffic volumes and off-street parking is not adequate, on-street parking is an acceptable practice. Current experience indicates that public response is generally positive, and many benefits result from such action including speed control, convenience, economic benefits to businesses, revenues from parking meters, etc. On-street parking on state-numbered roads should be limited to parallel parking as angle parking compromises safety and operational efficiency severely. Proper regulation and enforcement are key elements to ensure proper use of on-street parking spaces. Decisions on conversion of travel lanes into on-street parking on state-numbered roads should be made on a case-by-case basis. Detailed studies are essential to determine needs and potential benefits as is the local public support for the proposed conversion.

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DISCLAIMER

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INTRODUCTION

With the dramatic increase of the automobile use in the U.S. since World War II, parking has become an integral part of the modern urban setting and an important land use. Today, parking related concerns are no longer confined to the city center; they extend throughout the urban region. Parking contributes to the appearance of city and suburbs; affects traffic congestion and traffic operations; and is a vital component of the urban street and transit systems. Its availability influences the choice of mode and route of travel, affecting the viability and competitive posture of commercial areas (Weant R.A. and Levinson H.S., 1990).

For many years, the role of parking policy in most U.S. cities was to accommodate the automobile commuter by providing convenient spaces to park. Thus, decision makers favored removal of on-street parking from major arterials. They argued that this action might increase road capacity and improve safety. On the other hand, arguments for allowing on-street parking have traditionally based on the potential benefits to the local merchants. Accessibility and parking convenience are among major factors that affect shoppers' destination choices (Innes D. et al, 1990). In addition to potential economic development impacts, some policy makers and advocates have argued that on-street parking may be an effective traffic calming measure. In recent years, several communities around the world have used on-street parking placement and management strategies as means of achieving a wide variety of community objectives, ranging from improved air quality to increased neighborhood amenity (Meyer M.D. et al, 1983).

Furthermore, the correlation between on-street parking and traffic safety is still a controversial issue. Many engineers are concerned about the increase in the number of "dart-out" accidents typically associated with on-street parking. On the other hand, proponents of neo-traditional design projects argue that a row of parked vehicles acts as a buffer between moving traffic and pedestrians, and that the overall street design slows moving traffic, resulting in safer conditions.

In this context, the Michigan Department of Transportation (MDOT) is desirous in determining under what conditions placement of on-street parking on state trunkline system is appropriate and what are the potential implications of such an action. Thus, this project was undertaken to provide a thorough survey of the current state of the practice regarding placement and management of on-street parking via an extensive literature review, telephone survey, and field reviews. The objectives of the project include:

1. Review of published research on parking policies, practices, and evaluation studies;
2. Collection and synthesis of information on state-of-practice; and
3. Development of recommendations for appropriate use of on-street parking on the state trunkline system.

PROJECT SCOPE

To achieve the study objectives, a three-step process was followed. The first step included an extensive literature review, the second one focussed on the state-of-practice review, and the third provided a synthesis of information and recommendations on criteria to be considered when changing traffic lanes into on-street parking.

More specifically, a search of available literature was conducted to determine what is known about the operational, safety, and other potential impacts associated with the change of traffic lanes into on-street parking lanes. Of particular interest were studies, which have looked at the direction and magnitude of such impacts, as well as those that have investigated benefits and problems emerging from the implementation of on-street parking strategies.

The focus of the literature search was on the impacts from the conversion of traffic lanes into on-street parking on:

a. Capacity,
b. Safety,
c. Accessibility,
d. Development and economic growth,
e. Traffic calming, and
f. The environment.

Consideration was also given to other relevant issues such as:

a. Analytical models to estimate quantitatively the demand for on-street parking,
b. Effect of on-street parking design on traffic operations and safety,
c. Parking management and pricing policies,
d. Parking enforcement, and
e. Potential impact of emerging new technologies on parking.

The state-of-the practice review involved interviews of state, county, and municipal agencies, neighborhood associations, and community-based groups with experience in the conversion of traffic lanes into on-street parking. Information that was solicited included the following:

a. Availability of policies or guidelines on describing conditions that warrant permitted parking on state-numbered routes;
b. Reasons for implementing the conversion strategy and anticipated payoffs;
c. Documented results from the evaluation of the performance of on-street parking with respect to traffic safety and operations;
d. Subjective comments on the performance of on-street parking, including qualitative benefits and observed problems;
e. Practical guides that were supported by experience as to where it is appropriate to proceed with the conversion; and
f. Identification of problems resulting from the conversion and countermeasures implemented (if any) to address them.

Finally, a synthesis of the experience represented in the literature and current practice yielded guidelines and recommendations regarding the conditions under which the use of on-street parking on the state trunkline appears as a reasonable or desirable implementation action.

Overall, this project provides information on anticipated impacts from changing traffic lanes into on-street parking, together with recommendations on where this action shall be considered. The findings summarized below are expected to assist decision makers in making informed decisions regarding the implementation of on-street parking on the state trunkline system.

LITERATURE REVIEW

METHODOLOGY

The main search of published research was conducted via traditional automated library databases. More specifically, the Transportation Research Information System (TRIS Online)

was used extensively to identify and access relevant documents. TRIS is funded by the Transportation Research Board (TRB) and hosted by the National Transportation Library. It is considered as the most comprehensive bibliographic listing of published work in the transportation field. The TRIS search resulted in numerous journal and conference publications, technical reports, and books addressing issues related to parking. Many of those reports contained little or no information regarding on-street parking and were, thus, excluded from the literature review. Relevant reports are summarized below and are listed in the annotated list of references. First, the effects of on-street parking on operations, safety, and the environment are presented, followed by a discussion of practical issues including design, parking management, and enforcement strategies.

EFFECTS OF PARKING

Capacity

The effect of on-street parking on roadway capacity is well known. Substitution of a road lane by a parking lane has an important impact on capacity and a potential effect on traffic operations. This is expected to be the case when on-street parking is introduced to the state trunkline system.

On-street parking limits street capacity in two ways. First, it preempts lanes that otherwise would be used by moving traffic. Second, parking and unparking maneuvers frequently reduce the capacity of the adjacent lanes. Even a single vehicle parked within a curb lane can effectively close the lane to moving traffic. An early study on traffic signal design by Webster and Cobbe (Webster F.V. and Cobbe B.M., 1966) reported that a single parked vehicle at or within 7.6 m of the stop line caused a loss in the effective width of the roadway directly equivalent to the width of the vehicle. As the distance between the stop line and the nearest parked vehicle increased, the effective loss of carriage width at the stop line could be expressed as:

$$1.68 - \frac{0.9(Z - 7.72)}{K} \quad \ldots\ldots\ldots\ldots \quad \text{Equ. 1}$$

where Z is the clear distance of the nearest parked vehicle from the stop line (in meters) and K is the green duration, in seconds. The expression above applies for values of Z greater than 7.62 m, otherwise the distance should be taken as 7.62 meters.

Work carried out by the Transport and Road Research Laboratory in the United Kingdom (Kimber R.M. et al, 1986) showed that the prediction of saturation flows were not a linear relationship as first thought by Webster and Cobbe, but rather a stepped function, roughly proportional to minimum lane widths. In this respect, a single parked vehicle on or within 7 m of the stop line would generally have an even greater effect on saturation flows than that predicted by Webster and Cobbe.

The effect that parked vehicles have on capacity is clearly demonstrated in Table 1 (Ministry of Transport, 1965). It can be seen that small numbers of parked vehicles have relatively large effects in reducing capacity, and that the effect of a given increase in parking diminishes as the intensity increases. This means that waiting restrictions will only have a limited effect on the capacity of a road if, for instance, just a few vehicles are distributed along its length whilst loading and off-loading.

Table 1. Effect of Parked Vehicles on Capacity

Parked Vehicles per Mile (both sides together), Vehicles	5	10	50	100	200	500
Effective Loss of Carriageway Width, Feet	3	4	7	8.5	10	12
Loss of Capacity at 15 mph, pcu's/hr	200	275	475	575	675	800

Source: Ministry of Transport, 1965.

The American Association of State Highway and Transportation Officials (AASHTO, 1994) also confirms that on-street parking reduces capacity and interferes with the free flow of adjacent traffic. Eliminating curb parking can increase the capacity of four- to six-lane (curb-to-curb) arterials by 50 to 80%. More specifically, literature reports indicate that the prohibition of parking on a four-lane street doubles street capacity (Weant R.A. and Levinson H.S., 1990). Similarly, prohibiting parking on a six-lane street achieves a 67% capacity gain. Capacity gains might be greater in specific cases, since the added lanes would not be subject to blockage by left-turning vehicles.

Table 2 shows the effect of on-street parking on the capacity of adjacent travel lanes. It can be seen that reductions are greatest where there is a high parking turnover, especially on narrow streets. In the case of more than 3 lanes or more than 40 parking maneuvers per hour, the

Table 2. Effect of Parking on Capacity of Adjacent Traffic Lanes

No. of Lanes in Group, N	No parking	Number of Parking Maneuvers per Hour, N_m				
		0	10	20	30	40
1	1.000	0.900*	0.850	0.800	0.750	0.700
2	1.000	0.950	0.925	0.900	0.875	0.850
3	1.000	0.967	0.950	0.933	0.917	0.900

*: Adjustment Factor for Parking

Source: Transportation Research Board, 1994

Highway Capacity Manual recommends the application of Equation 2 to determine the proper adjustment factor for parking (Transportation Research Board, 1994):

$$f_p = \frac{N - 0.1 - N_M / 200}{N} \qquad \text{..... Equ. 2}$$

where:

f_p = Adjustment factor for parking;

N = Number of lanes in group; and

N_m = Number of parking maneuvers per hour.

Note that the parking adjustment factor, f_p, accounts for the frictional effect of a parking lane on flow in an adjacent lane group, as well as, for the occasional blocking of an adjacent lane by vehicles moving into and out of parking spaces.

In conclusion, as far as capacity is concerned, on-street parking is permissible on arterials only when the speed is low and the traffic demand is well below capacity. At higher speeds and during periods of heavy traffic movement, on-street parking is incompatible with arterial street service and should not be permitted (AASHTO, 1994).

Safety

On-street parking adversely affects the safety of the street system. Early sources estimated that about 20% of all urban crashes are related to on-street parking (Highway Research Board, 1971). More recent reports attribute approximately 15% of all crashes to the presence of parked vehicles. About 5% of all pedestrian fatalities involve people who entered the roadway from between parked cars (Weant R.A. and Levinson H.S., 1990). These proportions vary from city to city. An early study in Chicago examined the frequency of crashes involving parking (Chicago Police Department, 1974). It was found that moving vehicles striking parked vehicles accounted for 2% of all fatal crashes, 6% of all injury crashes, and 26% of all property damage crashes.

An analysis of 1994 crashes within the Greater London area (London Accident Analysis Unit, 1995) revealed that nearly 6% of all crashes in London were directly attributable to a parked vehicle (Table 3). However, this only represents crashes where it is recognized that the parked vehicle is the direct contributory cause. One should keep in mind that these figures may actually be much higher since there are also many incidences where a parked vehicle is involved but not recorded as the main contributory factor.

Table 3. Comparison of Crashes Involving a Parked Vehicle to Total Number of Crashes, 1994

	Fatal	Serious	Slight	Total
All Crashes in the Greater London Area	264	5,386	32,766	38,416
Crashes Involving a Parked Vehicle	12	291	1,932	2,235
% of Crashes Involving a Parked Vehicle	4.5%	5.4%	5.9%	5.8%

Source: London Accident Analysis Unit, 1995

Analysis of state highways in Nebraska concluded that, whenever practical, parking should not be allowed on the urban sections of these routes, and whenever parking cannot be restricted, it should be of parallel rather than angle type (McCoy P.T. et al, 1990).

In smaller communities, higher percentages of local and collector street crashes involve curb parking. One study in a community of 65,000 population found that 43% of all local and collector street crashes involved on-street parking (Box P.C., 1968a). In the same city, annual frequencies of 14 parking crashes per mile were found on major streets, but only 1.8 parking crashes per mile on local and collector streets (Box P.C, 1966). Another related study reported that parking-related midblock crashes accounted for 49% of all crashes along major streets, 68% along collector streets, and 72% along local streets (Humphreys J.B. et al, 1979).

A comprehensive study of curb-parking crashes in 10 cities and five states gathered street and crash data for over 170 miles of urban streets. This study related the magnitude and characteristics of urban street crashes to varying parking configurations, land uses, street widths, and street classifications (Humphreys K.B. et al, 1979). Variables found to be associated with crash rates include functional classification of the street, utilization of parking, and abutting land use. Of major interest, and most surprising, is the fact that parking configuration did not emerge as a variable that in itself was related to the crash rate. Humphrey K.B. et al noted that increases in parking utilization (i.e., annual number of space hours occupied per mile) result in increase in crash rates for up to 1.5 million annual space-hours per mile. For greater parking utilization rates, the crash rate was not found to increase. Results from the analysis of the relationship between land use and parking crash frequency suggest an increase in parking crashes as the intensity of land use increases. As expected, businesses and retail land uses have the highest parking turnover as well as the highest crash rates.

Literature review also reveals that the arrangement of parking spaces, either parallel to the curb or at an angle, affects safety. Most of research work reported in the literature confirms that angle parking is more hazardous than parallel. The principal hazard in angle parking is the lack of adequate visibility for the driver during the back-out maneuver. Additional hazard results from the drivers who stop suddenly upon seeing a vehicle ahead in the process of backing out. Moreover, drivers searching for a parking spot must either proceed slowly (thus tying up traffic) in order to see the empty stall, or slow abruptly when they come upon an empty space.

Several more studies have compared the crash experience of angle and parallel parking and reported crash rates for parallel parking to be from 19 to 71% lower than those for angle parking

(U.S. Department of Transportation, 1982). For example, studies in nine Utah cities showed that changes from angle to parallel layout were accompanied by a reduction in parking crashes of 57% and a 31% overall decrease in injury or fatal crashes for the study section (Box P.C., 1968b). A similar study of two business blocks in Salem, Oregon, revealed a 65% reduction in parking crashes.

Many of the studies in the literature were before-and-after studies of changes from parallel to angle parking, and none of the studies accounted for the change in crash exposure associated with the change in parking configuration. A study (McCoy P.T. et al, 1991) on the safety effects of converting on-street parking from parallel to angle found that the conversion resulted in a significant increase in the number of parking-related crashes as well as the number of parking related crashes per million vehicle miles. But when the increase in crash exposure was considered, there was no significant increase in the parking-related crash rate, nor was there a significant change in the severity of the parking-related crashes. This finding was confirmed by Humphreys et al who examined data from five states and ten cities and concluded that heavily used parallel parking produced crash rates comparable to heavily used high-angle parking, while the prohibition of parking resulted in the lowest crash rate measured (Humphreys K.B. et al, 1979).

Another ground breaking research study was that of Zeigler in 1971 who challenged the conclusions of many previous studies of angle parking and the assumption that safety and delay characteristics apply equally to all angle-parking arrangements. He tested an arrangement where angle parking spaces were laid out at an angle of 22.5^{0} to the curb line, as opposed to the more conventional angle. This layout is called flat-angle parking. The following conclusions were reported (Zeigler C.D., 1971):

1. Flat-angle parking does not adversely affect the safety or capacity of travel lanes when compared with the generally accepted arrangement of parallel parking. This is true, provided that adequate widths of travel lanes are available, and
2. Flat-angle parking results in improved safety for pedestrians entering or leaving parking vehicles.

Contradictory standpoints are found in the literature with respect to the effect of on-street parking on pedestrian safety. Many sources agree that improperly designed and/or controlled parking facilities can invite pedestrian crashes. Parked vehicles can block sight distance that is necessary for safe pedestrian and vehicular crossings. Dart-out crashes (where pedestrians, especially children, dart out from between parked vehicles into the traffic stream) increase when on-street parking is encouraged. However, proponents of Neo-Traditional Neighborhood Design projects argue that a row of parked vehicles enhances pedestrian activity by creating a buffer between pedestrians on the sidewalk and moving traffic (Institute of Transportation Engineers, 1994). Moreover, replacement of a traffic lane with a parking lane slows moving traffic so that any crashes that do occur are less severe. They therefore recommend on-street parking on streets where the design fosters low speeds for moving traffic.

In conclusion, on-street parking is known to be a contributory cause in road traffic crashes. The effect of on-street parking on crash frequency and severity differs from location to location and is found to depend on functional classification of the street, utilization of parking, and abutting land. There are contradictory results regarding the correlation between parking configuration and safety. Overall, it is concluded that placement of parking on the state trunkline has adverse effects on traffic safety and should be avoided. When on-street parking is deemed necessary, it

should be of parallel rather than angle type. Flat-angle parking can be used alternatively without any significant compromise on safety.

Emergency Vehicle Access

On-street parking constitutes a serious emergency hazard wherever cars block fire hydrants or obstruct fire apparatus. Parking restrictions in the vicinity of fire stations and fire hydrants are essential public safety requirements. When placement of on-street parking is necessary or desirable, available street space must meet requirements for emergency vehicle maneuvering and fire hose laying. Alternatively, on-street parking bays may be designated for use by ambulances or police, where proper road markings alongside the bay are used to indicate the type of vehicle allowed to use the bay (Chick C., 1996).

Economic Development

There is a strong argument that convenient parking fosters economic growth and development. The placement of on-street parking near businesses and retail uses improves accessibility and convenience to customers and has been used as a strategy for revitalization of central business districts and attraction of renewed consumer patronage to the downtown areas.

A number of behavioral studies cited availability of parking as a factor affecting shoppers' travel decisions. For example, an analysis of shoppers' behavioral patterns used data from Fredericton, Canada and a binary logit disaggregate behavioral model to determine the major factors affecting shoppers' destination choices. The study revealed that the availability of parking and the accessibility to the shopping area were among the most important factors in trip decision-making (Innes D., 1990). On the other hand, elimination of free on-street parking near Alltel Stadium in

Jacksonville, Florida created negative relationships between government officials and fans (Pfankuch T., 1997).

Several studies in the literature assessed the impact of various parking policies on economic development. Case studies of parking policies in Baltimore and Seattle investigated the impact of four types of parking strategies in fostering economic development including spatial distribution of parking supply, access to parking, control of aggregate level of parking supply, and price (Meyer M.D. et al, 1983; Parker M.R. Jr. and Demetsky M.J., 1980). An examination of the characteristics of the developer decision making process lead to the conclusion that the provision by government of parking space plays an important supporting role in development decisions.

Traffic Calming

For many years replacement of on-street parking by traffic lanes was a common practice as a countermeasure to reduce congestion and increase road capacity. However, a 1990 ASCE report admits that "the tendency of many communities to equate wider streets with better streets and to design traffic and parking lanes as if the street were a 'microfreeway' is a highly questionable practice" (Residential Streets Task Force, 1990).

Urban planners promoting new urbanism and neo-traditional street designs, as well as advocates of livable and walkable communities and proponents of traffic calming all agree that use of on-street parking can have many benefits. On-street parking is viewed as part of the strategy to reduce motorists speeding through increased side friction. Replacement of traffic lanes by parking lanes, or reduction of traffic lane widths to allow for on-street parking show reduction in motorists speeds and better compliance with posted speed limits. Moreover, alternating of on-

street parking from one side of the road to another can create a chicane-like effect in residential settings. This technique is a proven traffic calming measure that can reduce travel speed and result in benefits similar to those of actual chicanes at a fraction of the cost (Ewing, R., 1999).

Among other benefits cited in the literature, properly designed and placed on-street parking is viewed as a means to create conditions where large vehicles can use the added space at intersections to improve their effective turning radii. Sight lines are preserved at intersections with 30- to 50-foot parking setbacks from intersecting legs (Burden D., 1999; ITE, 1995). Finally, on-street parking supplements off-street parking and thereby reduces the need for large parking lots.

For the reasons listed above, reports on desirable features for pedestrian-oriented neighborhoods recommend the use of on-street parking (Duany A., 1990; Lerner-Lam E., 1992). Still, the use of on-street parking as a traffic calming measure should be restricted to facilities with speed limits at or below 25 miles per hour and shall be avoided on major arterial and collector streets.

Environment

Over the years many organizations and research reports demonstrated the link between traffic and the environment. Noise, exhaust pollution, visual intrusion, vibration, and effects on animal, plant life and buildings are some of the negative consequences of traffic on the environment. In 1976, the Organization for Economic Co-operation and Development claimed that as the level of traffic increases, so does the negative impact on humans' health (OECD, 1976). Since then many publications confirmed the correlation between increase in traffic flows and adverse effects on health (Whitelegg L. et al, 1993; Royal Commission on Environmental Pollution, 1994).

Properly planned, managed, and enforced parking controls can be used as a restraint measure to reduce traffic volumes and hence reduce the environmental effects (Chick C., 1996). Lack of sufficient on-street parking worsens the environmental effects as vehicles circle an area looking for parking places close to their destination. In conclusion, strategically located and properly controlled on-street parking spaces can reduce the environmental impact of vehicles, whilst ensuring the vitality and viability of an area.

A GUIDE TO PRACTICE

Parking Demands and Needs

Understanding parking needs and developing appropriate responses requires assembling and assessing of facts within the context of site specific circumstances and resources. Parking studies and parking demand analyses can be employed for this purpose.

Parking studies include collection of information on:

1. Parker characteristics (when, where, why, and how many people park);
2. Parking supply characteristics (number, location, control type, and cost of spaces); and
3. Parking needs for new or existing developments.

Parking demand studies determine the number of parkers attracted to a particular area or activity during specific times of day. When compared to available parking space within acceptable walking distance it provides a factual basis for determining parking needs.

Parking studies are designated to identify inadequacies in the supply of parking, or to determine existing demand in order to plan for future parking. The existing demand may be in terms of actual vehicles parked at a specific site (or in a given vicinity) or may be translated into a parking

rate. The study size can vary from an individual private lot to a city-wide study incorporating public and private lots as well as on-street parking (Institute of Transportation Engineers, 1992).

Detailed descriptions of several techniques to conduct parking studies can be found in several literature sources (see National Committee on Urban Transportation, 1958a; National Committee on Urban Transportation 1958b; Highway Research Board, 1971; Weant R., and Levinson H.S., 1990; Institute of Transportation Engineers, 1992). In brief, parking study requirements include:

a. Inventory of parking supply;
b. Current parking characteristics;
c. Current and future demands; and
d. Current and future revenue forecasts (when parking revenues are expected to pay for new parking facilities).

Types of studies for the assessment of parking needs include the following (Institute of Transportation Engineers, 1992):

1. *Occupancy studies*. They involve field observations and help determine the number of parking spaces occupied at various times of the day so as to determine the peak demand, the location of the peak demand, and surplus parking, if any.
2. *Duration and turnover studies*. These are conducted to determine the length of time vehicles are parked in a given space and the rate of space usage in the facility (turnover). Time limits at on-street parking spaces as well as the geometric and operational design are influenced by such information.
3. *Truck loading studies*. They usually involve the study of whether existing or new loading zones are appropriate at the curbside (on-street) or on off-street locations.

4. *Special parking studies.* These are used to corroborate or develop zoning regulations based on realistic needs.
5. *Parking demand and generation studies.* These studies can be conducted using field survey techniques such as in occupancy surveys. This information can be also determined using interview techniques or postcard surveys.

The Manual of Traffic Engineering Studies (Box P. and Oppenlander J., 1976) contains details of various study techniques including useful forms for field work and data compilation. Some other references examine the use of statistical models for space occupancy prediction. The work by McGuiness et al, for example, applied simple regression analysis principles to data from the Pittsburgh, Pennsylvania, central business district (McGuiness E., and McNeil S., 1991). Al-Masaeid H. et al developed statistical models to estimate vehicle parking demands at different land uses in Jordan (Al-Masaeid H.R. et al, 1999).

Other literature sources describe advanced techniques for conducting parking studies, which involve the use of gravity models with the aid of computers. Examples of such references include the work of Bullen (Bullen A.G.R., 1982) on the analysis of supply and management of parking facilities and that of Levinson and Pratt (Levinson H.S., and Pratt C.O., 1984) on the estimation and allocation of parking demand in downtown areas.

In conclusion, studies of parking characteristics and analysis of parking demands and needs provide the basis for quantifying costs and impacts, and establishing appropriate plans and programs.

Design Considerations

When a decision is made to place on-street parking, consideration of design alternatives is recommended. Key considerations in design of on-street parking include the following:

- Angle of parking;
- Width of parking lanes;
- Stall layouts and dimensions; and
- Signage and markings.

The choice of parking angles has important bearing on the design of on-street space. Arranging parking at an angle to the curb length results in more parking spaces per unit of curb length than parallel parking. On the other hand, as the parking angle increases, there is a corresponding need for more road space for vehicle maneuvering and the potential risk for traffic crashes. The latter is due to the lack of visibility in leaving the stall and the fact that the backing maneuver conflicts with one additional lane of moving traffic (Institute of Traffic Engineers, 1941). Where parking is an element of street design, parallel parking is usually more acceptable and should be used wherever parking is permitted on arterial and collector streets (Weant R.A. and Levinson H.S., 1990).

Many engineering handbooks offer guidelines on geometric requirements for parking stalls (see Institute of Traffic Engineers, 1941; Burrage R.H., and Morgen E.G., 1957; Carter E.C. and Homburger H.S., 1978; AASHTO, 1994). In brief, when parallel parking is designed the parking lane width should provide a clearance of 1 to 2 m from the edge of the through traffic to the parked vehicle. Although the minimum width for a parking lane for passenger vehicles is 2.4 m (AASHTO, 1994), a minimum parking lane width of 3.0 to 3.6 m is the recommended standard for state numbered roads.

The marking of parking space limits on arterial streets encourages more orderly and efficient use where parking turnover is substantial and tends to prevent encroachment on fire hydrant zones, bus stops, loading zones, approaches to corners, and other zones where parking is prohibited. Typical parking-space markings are shown in the MUTCD (U.S. Department of Transportation, 1988).

In summary, on-street parking geometry depends on space availability, parking duration, turnover, space occupancy and distribution of vehicle size. For state numbered roads, parallel parking is recommended to minimize through flow disruption and the potential for a crash occurrence. Parking stalls should be properly marked in order to discourage erratic parking maneuvers and reduce the average time required for parking or unparking a vehicle.

Parking Management

On-street parking space is a scarce resource, thus, priorities for its use should be established in the public interest. Managing scarce parking resources means determining if and how parking should be regulated, ensuring adequate compliance with regulations, and following up on those who do not comply.

A broad range of parking management tactics are available including: on-street parking supply tactics, pricing actions, marketing initiatives, and enforcement and adjudication programs. Details on such tactics and programs can be found in reference guides (see U.S. Department of Transportation, 1980a; U.S. Department of Transportation, 1980b; U.S. Department of Transportation, 1981). An extensive list of on-street parking supply management actions is given in Table 4 (DiRenzo J.F. et al, 1981).

Table 4. Types of On-Street Parking Supply Management Actions

On-Street Parking Supply Management Action	Proposed Activity
Add or remove spaces	
Change mix of short- and long-term parking	
Parking restrictions	❑ Peak-period restrictions ❑ Off-peak restrictions ❑ Alternate side parking by time of day and/or day of the week ❑ Permissible parking durations ❑ Prohibitions on parking before specified hours
Residential Parking Permit Programs (RPPP)	
Carpool/vanpool preferential parking	❑ Carpool/vanpool meters ❑ Carpool/vanpool stickers
Loading zone regulations	❑ Bus ❑ Taxi ❑ Delivery ❑ Diplomat

Source: DiRenzo J.F. et al, 1981.

The most commonly used on-street parking supply tactics are:

- Residential permit parking program (RPPP), and
- Preferential on-street parking for carpools and vanpools.

Residential permit parking programs are now successfully used by many communities. Positive results from the implementation of such programs were reported by the majority of the first jurisdictions that implemented them (U.S. Department of Transportation, 1981). These include Alexandria, VA; Arlington, VA; Baltimore, MD; Boston, MA; Cambridge MA; Eugene, OR; Milwaukee WI; Montgomery County, MD; San Francisco, CA; Vancouver, B.C.; and Washington, D.C. Most of the programs were intended to reduce long term commuter parking in

residential areas. Residential permit parking programs are commonly utilized in the vicinity of major generators such as universities, sports arenas, hospitals, commercial areas, and transit stations.

Institution of on-street carpool/vanpool preferential parking programs in Portland and Seattle was successful and the public's response to the programs has been favorable. In the City of New Orleans implementation of a new comprehensive parking management program was initially greeted with skepticism and animosity. As the program proceeded, community reaction has been positive and supportive. The program created additional on-street parking spaces through increased turnover, reduced the number of illegally parked vehicles by over 70%, and eliminated all long-term parking at on-street parking meters (St. Martin M.A., 1986).

Parking management policies generate a variety of quantitative and qualitative impacts related to transportation, development, the environment, neighborhood, and revenue that should be carefully considered. For example, increasing short-term on-street parking while decreasing long-term parking may attract additional short-term parkers and constrain long-term parking, promote transit patronage among long-term parkers, improve highway level of service and air quality, reduce energy consumption, and promote economic growth through increased retail sales. Depending upon the actual new mix of short- and long-term parkers, parking revenue may either increase or decrease.

Enforcement

On-street parking restrictions are effective only if they are properly enforced. Thus, strong and active enforcement and adjudication programs are essential. On-street parking enforcement should be considered as a sub-system of the total parking management system that aims at

improving use of existing parking supply, increasing revenues, improving public and traffic safety, and enhancing quality of life and business climate.

Enforcement tactics, such as aggressive ticketing, towing, and booting illegally on-street parked vehicles, have been used in many communities around the nation (U.S. Department of Transportation, 1981). They are not new, yet the use and integration of such tactics to meet broader transportation, economic, environmental and related objectives has received little attention, at least in the literature.

In most communities, the police department is responsible for parking enforcement. Police priorities and sparse resources frequently become issues that deserve consideration. In times of budget restrictions, parking enforcement is often one of the first targets for cuts (Kennedy J., 1994). Consequently, there is an increasing trend toward using civilian personnel to enforce parking regulations. Another national trend is consolidating and streamlining parking functions. This promotes efficiency by integrating the components of the parking management system: planning, analysis, operations, enforcement, citation processing, and adjudication.

Integration of parking management programs, including enforcement, took place in the District of Columbia. An analysis of the District's parking management program indicated that implementation of the parking management and enforcement programs has resulted in reduced parking violation, increased on-street parking availability for short-term parkers, and significant increased revenues from meter operations and fines (Ellis R., 1987).

In conclusion, on-street parking space represents a valuable resource, and it should be priced accordingly. Demands on curb space for pedestrian crossings, bus stops, delivery vehicles, and

moving traffic generally should take precedence over on-street parking. Enforcement policies should help to assure that regulations are observed and the revenue potentials of on-street parking facilities are realized. Strict on-street parking enforcement can reduce abuse of short-term parking space, create greater turnover of parked vehicles, and increase meter revenues.

New Technologies

The proliferation of Intelligent Transportation Systems in the nineties resulted in many changes in the development and delivery of transportation in the U.S. and abroad. As a result, parking is certainly affected in many ways. Traveler information systems, electronic fare collection, and travel demand management strategies will affect parking demand, as well as parking management and operations.

For example, in recent years, parking meter technology expanded to include new meter heads and machines that take various types of currency. In West Hollywood, CA, motorists have the opportunity to use one of three flexible payment options, i.e., bills, credit cards, and even pre-paid keys. This increases users' convenience and satisfaction as well as the revenue from parking meters.

More elaborate experiments are underway including electronic payment and Parking Guidance systems. Electronic payment involves the use of electronic cards or license plate tags which, coupled with properly installed detection devices, will allow vehicles to make virtually free flow entries and exits to such lots. Parking Guidance Systems have been tested in 40 cities in Japan and several locations in Europe. Their purpose is to provide guidance about parking availability through displays mounted on roads (Toyama Y., 1995). This is important as studies of parking behavior in five British and German cities found that on average between 10 to 25% of total in

vehicle time is spend in searching or queueing for parking (Polak J.W., and Axhausen K.W., 1990). In Europe there is a considerable interest in the scope for advanced parking management systems based on in-vehicle, roadside and broadcast information (Polak J. et al, 1993). The first Advanced Parking Guidance system was installed in Aachen, Germany over 20 years ago, and since that time the number of systems has grown to over 75 locations (Swanson, H.A., 2000).

It is recommended that parking authorities in the United States follow the new developments closely and remain current on emerging parking industry trends (Barr M., 1997).

PRACTITIONER SURVEY

In addition to a review of the literature, a survey of practitioners was undertaken. The main purpose of the survey was to identify examples of projects that recommended and/or implemented conversion of traffic lanes to on-street parking on state numbered roads, and document reasons and effects of such actions.

The survey was distributed by e-mail to an original list of contacts 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 expanded to include practitioners identified by MDOT, consultants, and other referrals from the original list. Both the list of contacts and the survey instrument for the on-street parking project were combined with the similar for a related MDOT funded project on the conversion from one- to two-way streets and vice versa.

The e-mail survey instrument for the on-street parking project included introductory information regarding the scope of the project and solicited the following types of information:

1. Respondent's identification and contact information

2. Participation of respondent's organization in projects that involved changing traffic lanes to permitted parking on state-numbered routes;
3. Availability of reports on the impacts of allowing parking on state-numbered routes;
4. Availability of policies or guidelines on conditions that warrant permitted parking on state-numbered routes;
5. Involvement in projects, production of reports, or development of policies/guidelines on the reverse type of conversions (i.e., parking removal); and
6. Identification of additional contact persons involved in conversions to permitted parking (e.g., a city traffic engineer, parking task force).

The survey was sent out initially via e-mail, and then a follow-up message 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, electronic contact was attempted with 193 individuals. In addition to e-mail exchanges, numerous follow-up telephone calls were placed to interview individuals and obtain relevant information. During the telephone interviews individuals were asked the following questions:

1. What was the motivation behind the parking placement projects?
2. Where there any studies performed to evaluate the impacts of installation of parking on safety, operations, economic growth etc?
3. What were the criteria used to determine if the placement of parking was a positive action?
4. Are there any proposals or reports on these studies?
5. Did you get any input from users before or after the installation of parking?
6. Where there any major complaints or problems reported?
7. Based on your experience, under what types of conditions parking should be placed on state-numbered routes?
8. Overall, do you view placement of parking as a successful practice or not and why?

Table 5 summarizes the names of contacts that offered some sort of information, together with the type of information provided. It can be seen that only 38 out of the 193 attempted contacts were fruitful, and only a handful of contacts had some experience with placement of on-street parking on state numbered roads.

On the other hand, it was encouraging that the responses of contacts were in general agreement with the findings in the literature search. In summary, a number of city engineers and state DOT officials suggested that allowing on-street parking on state roads should be kept to a minimum as on-street parking tends to increase vehicle friction and the potential for crashes (Dodge J., 2000, Shealy S., 2000, Marby Bob, 2000). However, it may be allowed in order to not seriously impact businesses (Dodge J., 2000). Where necessary, parallel or low angle parking configuration should be used to minimize accident risk and flow disruption (Marby R., 2000). Angle parking on state highways is illegal on the state highway system in some states (by statute) as in Florida (Lovell, C., 2000). Angle parking is particularly hazardous to bicycles and should be avoided if the facility is used by bicyclists (Burke B., 2000).

Several of the respondents argued that placement of on-street parking is generally a good policy for traffic calming purposes. Benefits cited include slowing traffic, providing a buffer zone between moving traffic and pedestrians, added convenience, street beautification etc (Burke B., 2000; Pagitsas E., 2000). It was also reported that many cities and towns recently introduced alternating on-street parking in conjunction with chicanes for slower speeds. Examples include Boulder, CO; Fernandina Beach, FL; Cambridge, MA; and many other cities and towns in the US, Australia, and Canada (Pagitsas E., 2000). In general, the response to the use of parking as a traffic calming measure is positive both by the town officials and the public (Burke B., 2000; Pagitsas E., 2000).

Table 5. Summary of Survey Responses

LEGEND

Y-SP: Yes (Specific Projects) Y-P: Yes (Policies) Y-PR: Yes (Projects)
Y-Gen:Yes (General Idea) Y-PG: Yes(Policies/ Guidelines) Y-R: Yes (Reports)
Y-G: Yes Guidelines)

	STATE	NAME	AGENCY ID#	CONVERSION TO PERMITTED PARKING					
				PROJECTS	REPORTS	POLICIES	REVERSE	CONTACT	OTHER
1	AK	Gary Oliver	AK-DOT						YES
2	AK	Duane F. Doerflinger	AK-DOT	YES	NO	NO	Y-PR	YES	NO
3	AL	David Brown	Univ. of AL	NO	NO	NO	NO	YES	NO
4	CA	Barney Burke	City Mountain View	YES	NO	NO	NO	NO	YES
5	CA	Ray Davis	City San Leandro	YES	NO	NO	NO	N	NO
6	CA	Ed Cline	Willdan Ass.	NO	NO	NO	Y-PR	NO	YES
7	CT	John A. Vivari	CT-DOT	NO	NO	NO	NO	YES	NO
8	DC	Brenda Kragh	FHWA					YES	YES
9	FL	Jeffrey Dodge	FL-DOT	NO	NO	NO	NO	NO	YES
10	FL	Gene O'Dell	FL-DOT						YES
11	FL	Chuck Lovell	FL-DOT	YES	NO	YES	NO	YES	YES
12	FL	Steve Homan	FL-DOT						YES
13	FL	Jeffrey Morgan	FL-DOT					YES	
14	FL	Mike Cornejo	FL-DOT					YES	
15	IA	Tim Crouch	IA-DOT	NO	NO	NO	NO	YES	NO
16	KS	Carol Folkmann						YES	YES
17	KY	Duane Thomas	KY-DOT	YES	NO	Y-P	Y-PR	YES	YES
18	MA	Efi Pagitsas	CTPS	YES	NO	NO	NO	NO	YES
19	MD	Carlton C. Robinson						YES	
20	MI	Kenneth V. Tiffany	MI-DOT	NO	Y-Gen	Y-G	Y-R	YES	NO
21	MI	Duane Ellis		NO	NO	NO	NO	NO	YES
22	MN	John Maczko	MN-DOT	NO	NO	NO	NO	YES	NO
23	MN	Mike Weiss	MN-DOT						YES
24	MN	Tom Campbell	MN-DOT		Y-R			YES	
25	MS	Dan Gaillet	City -Jackson	NO	NO	NO	NO	YES	YES
26	NC	Anthony D. Wyatt	NC-DOT	YES	NO	Y-P	Y-PR	YES	NO
27	NH	Bill Lambert	NH-DOT	NO	NO	NO	NO	NO	YES
28	NJ	Reid	Rutgers					YES	
29	NY	Sandra Rosner	NY-DOT					YES	
30	OK	Ginger Miller	OK-DOT						YES
31	OR	Richard Heineman		YES	NO	NO	Y-G		
32	OR	Richard M. Wood	OR-DOT					YES	
33	SC	Joey D Riddle	SC-DOT	YES	NO	NO	NO	YES	NO
34	SC	Stanley Shealy	SC-DOT	NO	NO	NO	NO	NO	YES
35	UT	Tammy Kaeser	UT-DOT					YES	
36	VT	Amy L. Gamble	VT-DOT	NO	NO			YES	YES
37	WA	Noelle Million	City of Seattle						YES
38	WA	Jeff Bender	City of Seattle					YES	

Removal of on-street parking for capacity reasons was a topic addressed only by two survey respondents. In Oregon, removal of on-street parking is usually proposed for one of the following reasons: 1) Safety concerns (usually sight distance), 2) Congestion, 3) Damage to the facility (such as sloughing shoulders), and 4) Inappropriate use of parking space (overnight camping, trash dumping, etc.) (Heinemann R., 2000). Allowing parking where it was previously prohibited is usually the result of changed geometry and/or roadside culture that eliminates some safety hazard or congestion problem which made a parking prohibition necessary in the first place.

Finally, a lack of guidelines and policies was apparent from the responses received. This often lead to confusion or inconsistencies such as in the case on the City of San Leandro, CA where one of the two state highways that serve as major arterials for the city has on-street parking, and the other does not (Davis R., 2000). In some instances placement of parking does not required action, only removal of parking does. This is because, except for roadways where parking is prohibited by statute (e.g., freeways and expressways), parking is assumed to be allowed until a specific order prohibiting it at a particular location is issued (Heinemann R., 2000).

Overall, the responses from the practitioners' survey were consistent with motivations and implications from conversion of traffic lanes to on-street parking noted in the literature review. Although numerous states experimented with placement of on-street parking on their state highways, there are virtually no comprehensive studies available on quantitative/qualitative assessment of benefits and disadvantages from such actions. Furthermore, a lack of coherent policies and guidelines on the subject was found nationwide. Recognizing this need, in 1999, the Institute of Transportation Engineers has established a Parking Task Force to examine how ITE can address parking issues in a more consistent basis (Swanson H. A. and Swanson K.L., 2000).

CONCLUSIONS AND RECOMMENDATIONS

This project reviewed issues and practices related to on-street parking placement on state-numbered roads. Extensive literature review on the topic and analysis of responses from a survey of practitioners reveal the following:

- It can be generally stated that on-street parking decreases roadway capacity, impedes traffic flow and increases crash potential. For these reasons, it is desirable to avoid on-street parking on the state trunkline system, when practical, since its primary service role is the movement, not the storage of vehicles.

- However, within urban areas and in rural communities located along state-numbered roads, existing and developing land uses often necessitate the consideration of on-street parking. When off-street parking is not available or feasible, on-street parking must be a design consideration to ensure user convenience, and economic well being of abutting properties.

- Potentially, on-street parking can be used for sustainable development and traffic calming purposes. In this case, on-street parking is preferred to off-street parking because it provides friction that reduces the speed of moving vehicles, acts as a barrier between pedestrians and moving traffic and minimizes pedestrian-vehicle conflicts, and reduces the need for off-street parking and environmental impacts from traffic (Forbes G., 1998).

- Public involvement in decision-making regarding the placement of on-street parking is the cornerstone of the success of such process. On-street parking must be provided on many

highway improvement projects in order to receive support for the proposed work from the local community (Zeigler C.D., 1971).

- Given the necessity (as indicated by parking studies), the desire for on-street parking placement on the state trunkline, and adequate roadway capacity to accommodate the through demand, on-street parking can be provided, parallel to the curb. Compared to parallel parking, angle parking poses increased capacity and safety problems, and should be avoided on state numbered roads.

- The total parking lane width for passenger cars on the state trunkline should be 3.0 to 3.6 m. Narrower lane widths (up to 2.4 m) are feasible, but compromise safety, and operational efficiency and should be avoided.

- Prohibition of on-street parking for traffic capacity or safety reasons during peak periods is recommended along state-numbered roads.

- Experience has demonstrated that a comprehensive and well-managed parking program results in significant reductions in parking violations, substantial increases in on-street parking space availability, and major increases in parking related revenues (Ellis R., 1987). Policies relating to the frequency and intensity of on-street parking enforcement should be determined by local factors, such as public policy, traffic circulation, and traffic/public safety.

- Consolidation of all parking-related functions, including on-street parking enforcement, encourages the development of an integrated set of parking goals, policies, and programs,

and is the recommended practice. It also provides the administrative structure for implementation of established policies and programs (Kennedy J., 1994).

- There is a lack of uniform guidelines on conditions that justify placement of on-street parking on state-numbered roads and design specifications.

- Addition of on-street parking is often coupled with other roadway changes such as lane reduction, conversion to two-way operation, widening of sidewalks, improved streetscaping etc. Although this strategy is meaningful and effective, it limits the ability to evaluate the effect of each change independently and understand clearly its economic, social, and operational impact.

- On-street parking policies for state-numbered roads passing through built-up commercial areas are not clear cut. Decisions must be made on a case-by-case basis. Detailed studies are essential to determine if the benefits of curb parking exceed the benefits of removing permanently or on a part-time basis and are strongly encouraged.

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