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16. Abstract

Urban arterial work zones have several unique characteristics which have not been addressed in previous work zone research. This research study was established to identify these characteristics and to develop guidelines for traffic control in urban arterial work zones.

Study activities -- including a literature review, analysis of accident, traffic volume, and travel time data from three study sites, surveys of motorists, a study of arterial lane closure capacity, and analysis of other factors -- were used to identify the unique characteristics of urban arterial work zones and develop the guidelines related to those unique characteristics. A number of guidelines were developed addressing several topics including: project and work activity scheduling, construction planning, speed control, intersections, signalized intersections, construction signing, lane closures, channelizing devices, median crossovers, pavement markings, public relations, accidents, and inspection of traffic control devices.

This Executive Summary (Volume 1) contains all of the guidelines developed in the course of this research study. It also includes a very brief description of the research activities. Volume 2 is the technical report which describes all of the study activities in detail. It also describes the basis for each of the guidelines developed in the course of this research study.

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METRIC (SI*) CONVERSION FACTORS

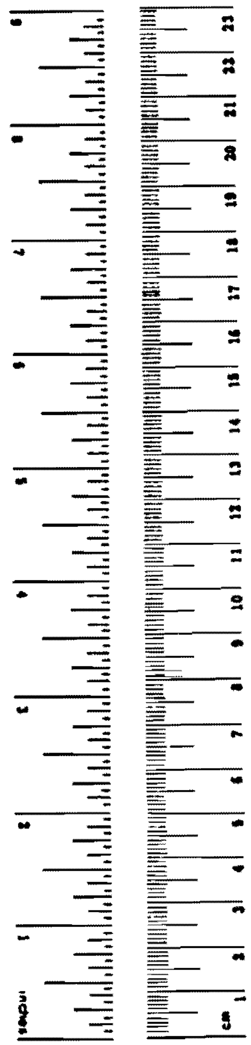
APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	2.54	centimetres	cm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
	AREA			
in^2	square inches	645.2	centimetres squared	cm^2
ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha
	MASS (weight)			
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
	VOLUME			
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

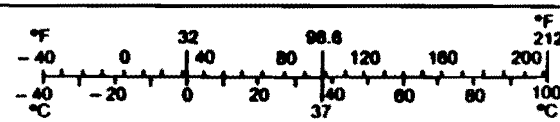


APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
	AREA			
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectores (10 000 m^2)	2.53	acres	ac
	MASS (weight)			
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
	VOLUME			
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3

TEMPERATURE (exact)

°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

TRAFFIC CONTROL GUIDELINES FOR URBAN ARTERIAL WORK ZONES

VOLUME 1 - EXECUTIVE SUMMARY

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Research Report 1161-5, Volume 1
Study Number 2-18-89-1161

Design Process for Work Zone Speed Control
and
Traffic Control Guidelines for Urban Arterial Street Work Zones

Sponsored by
Texas Department of Transportation
in Cooperation with the
U.S. Department of Transportation
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Texas Transportation Institute
The Texas A&M University System
College Station, Texas 77843

February 1992

IMPLEMENTATION STATEMENT

The objective of this study was to develop improved traffic control guidelines applicable to urban arterial work zones. The study identified many characteristics unique to urban arterial work zones and developed numerous guidelines related to the planning of urban arterial work zones and the implementation of traffic control in these work zones. These guidelines should lead to improved operations and safety for both workers and drivers in urban arterial work zones.

DISCLAIMER

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SUMMARY

This three-year study evaluated two aspects of work zone traffic control. One objective of the study was to develop guidelines for traffic control in urban arterial work zones. This report describes the activities and findings of that objective. The second objective of the study was to develop a comprehensive design process for selecting and implementing appropriate speed zones, devices, and techniques for speed control in work zones. The results of research on the second objective are reported in Research Report 1161-6.

Urban arterial work zones have several unique characteristics which distinguish them from rural highway or freeway work zones. Among the most important of these characteristics are relatively low speeds, higher speed variation, high volumes, limited maneuvering space, frequent turns and cross movements, limited right-of-way, multiple access points, higher pedestrian movement, and frequent traffic obstructions. These characteristics were evaluated through the completion of several research activities which included a literature review, analysis of accident, traffic volume, and travel time data from three study sites, surveys of motorists, and a study of arterial lane closure capacity.

The literature review indicated that there is a lack of information and previous research on urban arterial work zones. However, some of the information identified in the literature review has application to specific aspects of urban arterial work zones. Three urban arterial work zone study sites, two in Houston and one in Dallas, were selected for study. Accident, traffic volume, and travel time data were collected at all three sites. This data was then analyzed to determine trends specific to urban arterial work zones and to identify characteristics of arterial work zones which needed to be addressed in the guidelines. The analysis of accident data indicated that accidents do increase when construction begins on an urban arterial. Intersection and driveway related accidents increased more than the average amount due to the construction. The analysis of traffic data indicated that traffic volumes typically decrease during construction, and they are lowest when the work area is in the center of the road between opposing traffic flow. No specific trends could be determined from the travel time data.

Motorists were surveyed in two separate surveys conducted in Houston and Dallas. These surveys attempted to evaluate driver comprehension of a variety of construction traffic control devices and to identify some of the more significant driver concerns related to urban arterial construction.

Other study activities included a survey of local traffic engineers addressing their concerns about urban arterial work zones. This survey confirmed earlier findings about the lack of useful guidelines and helped to identify specific concerns. The capacity of a urban arterial lane closure was also measured and found to be approximately 57 percent of the capacity of a freeway lane closure. This information was used in an analysis of traffic flow at a lane closure located downstream of a traffic signal. The analysis provided the minimum separation needed between the intersection and lane closure to prevent queue backup.

A research activity related to this topic, but not part of this study, was the development of a low-profile temporary barrier for use on low speed arterials. This barrier was developed by TTI at the same time that this research was taking place. It is briefly described in this report.

The results of these research activities were used to develop a series of guidelines addressing traffic control planning and implementation of urban arterial work zones. The guidelines address a variety of topics including: project and work activity scheduling, construction planning, speed control, intersections, signalized intersections, construction signing, lane closures, channelizing devices, median crossovers, pavement markings, public relations, accidents, and inspection of traffic control devices. These guidelines are described in Chapter 2 of this volume. Chapter 9 of Volume 2 describes the basis for developing each guideline.

CHAPTER 1

DESCRIPTION OF STUDY ACTIVITIES

Introduction

The unique characteristics of urban arterial work zones require special consideration when preparing a traffic control plan for construction. Unfortunately, urban arterial work zones are not sufficiently addressed in current work zone guidelines, and the topic has not been adequately addressed in previous research. Therefore, this three-year research study was funded in order to identify the unique characteristics of urban arterial work zones and to develop guidelines addressing the planning and implementation of traffic control for major urban arterial work zones.

This volume (Volume 1) is an executive summary of the work performed for this project. It briefly describes the study activities and some of the results of those activities. This volume also contains the guidelines developed from the research activities. Volume 2 describes the study activities in much greater detail and provides the basis for developing the specific guidelines. The reader should refer to Volume 2 to answer questions about the specifics of individual research activities or to determine the need or justification for any guideline.

Urban arterial work zones possess many unique characteristics not found in rural or freeway work zones. Some of the major differences between typical work zones and urban arterial work zones are described in Chapter 1 of Volume 2. These characteristics are primarily related to geometrics, traffic conditions, traffic signals, and limitations on work zone traffic control. Some of the more significant urban arterial characteristics include lower speeds, higher speed variance, high volumes, limited maneuvering space, more driveways and intersections per mile, frequent turns and cross movements, many more traffic signals, more pedestrian movement, and greater competition for driver attention.

Literature Review

The literature review found a lack of material addressing traffic control for urban arterial work zones. Some information was identified which addresses specific aspects of urban arterial work zones, but there are no comprehensive guidelines for this type of situation. The majority of useful information continues to be located in the *Texas Manual on Uniform Traffic Control Devices* (MUTCD) (1). The *Traffic Control Devices Handbook* (2) also contains some useful information on the subject. The guidelines in the MUTCD for locating and spacing advance signing and channelizing devices should be used for urban arterial work zones. Several references identified in the literature review indicated the benefits of using raised pavement markers for temporary delineation of lanes in work zones. A detailed description of the literature review is in Chapter 2 of Volume 2.

Study Site Selection

Three sites were selected for study as part of this research effort -- F.M. 1960 in northwest Houston, S.H. 6 in northwest Houston, and Abrams Road in north Dallas. Each of these roadways were four-lane arterials which were being widened to six lanes. The Houston sites had a center two-way left-turn lane which was retained in the reconstructed roadway. The Dallas site was an undivided roadway which was being reconstructed with a raised median. Construction at all three sites took place during the time of the research study. Only the F.M. 1960 site was completed before the study ended. Pre-construction and during-construction traffic accident data were collected for all three sites. Post-construction accident data were also obtained for the F.M. 1960 site. The accident data for the Houston sites were obtained from the Texas Department of Public Safety, and the accident data for the Dallas site were obtained from the Dallas Police Department. Traffic volume and travel time data were collected at all three sites during construction. The same data were collected before construction at the Houston sites and after construction for F.M. 1960. Chapter 3 of Volume 2 describes various aspects related to the selection of the study sites.

Traffic Accident Analysis

The safety impacts of work zones on urban arterials were assessed by evaluating the accident data for the three study sites. Accidents were analyzed by dividing the data into several different categories and comparing the differences between the pre-construction and during-construction accidents for the three study sites. The categories into which the accidents were divided include: accident frequency, accident rates, accident type and cause, location of accidents, and accident periods. It should be noted that the accident data analyzed as part of this project represent only three urban arterial work zone sites. Therefore, caution should be used in generalizing any findings of the accident analysis to other urban arterial work zones.

Statistical analysis of the data indicated that there is an overall increase in accident frequency and accident rate when an urban arterial is under construction. Accident frequency may increase from 35 to 77 percent, and the accident rate may increase from 59 to 106 percent. The urban arterial construction appears to have caused a statistically significant increase in the number of accidents occurring at or near intersections and driveways, and in the number of accidents occurring during dark conditions in lighted sections of the arterials. Chapter 4 of Volume 2 describes the accident analysis in detail.

Traffic Volume and Travel Time Analysis

Average weekday roadway volumes for each phase of construction were obtained for several sections of roadway by using automatic traffic counters. Twenty-four hour volumes were collected from Monday afternoon to Friday morning at all three study sites. The volumes were converted to average daily volume and peak-period volumes.

Travel time data were also collected for each study site during each phase of construction (and after construction on F.M. 1960). Multiple travel time runs were made for the morning, off, and evening peak-periods for each individual day of data collection. From this data, an average travel time and average travel speed was calculated for each roadway during each phase of construction. It should be noted that travel times include delays incurred at signalized intersections.

The traffic volume and travel time data did not indicate any specific trends in traffic flow which would lead to the development of guidelines for urban arterial work zones. It does appear that the traffic volumes are lower when the area of construction is located in the middle of the roadway between opposing traffic flow. In general, traffic volumes during construction were about 85 percent of the pre-construction traffic volume. However, there is wide variation in the traffic volumes and therefore, the traffic control plan should be prepared to accommodate traffic volumes which are comparable to pre-construction volumes. Chapter 5 of Volume 2 describes the traffic volume and travel time data analysis in detail.

Motorist Surveys

Two motorist surveys were conducted in conjunction with this project. They were administered at the F.M. 1960 and Abrams Road study sites in Houston and Dallas. These surveys evaluated motorist understanding of selected work zone traffic control devices and also identified motorist concerns related to construction activities at the study sites.

The Houston and Dallas surveys were conducted by personal interview at retail centers and drivers license offices in the areas adjacent to the work zones. Participants were asked to respond to pictures of signs and work zone scenes and were also asked for their opinions on various aspects of the local arterial work zone. The motorist surveys revealed that drivers are not primarily concerned with traffic control devices within the construction zone. More important issues involve the length of the project, duration of construction and travel delay. The surveys also indicated that motorists do have problems understanding arterial work zone signing. Problematic devices included the **NO CENTER LANE, NO CENTER TURN LANE, Lane Reduction Transition, Low Shoulder,** and **Advance Road Construction** signs, the **Vertical Panel**, and differences in sign color. Chapter 6 of Volume 2 describes all of the motorist surveys in detail.

Current Practice

The results of the literature review indicated a lack of information about traffic control for urban arterial work zones. Therefore, local and state level traffic professionals were contacted in order to determine the status of current practice in this area. The contacts included telephone surveys of traffic engineers and an examination of city manuals for traffic control in work zones. Chapter 7 of Volume 2 describes these activities in detail.

The telephone survey indicated that, among the local agencies surveyed, there is variation in the degree in which traffic control is stressed. Several agencies indicated the Texas MUTCD did not sufficiently address work zone traffic control on urban arterials. The local agencies indicated that the most significant problem areas are related to intersections and intersection related traffic control. Several cities described the positive benefits of having one or more inspectors whose only responsibility was inspecting the traffic control aspects of work zones within the city.

Work zone traffic control manuals produced by various local agencies rely heavily on the guidelines in the MUTCD, although some of these guidelines have been modified by the agencies. However, these differences were not determined to be significant, and no basis for the differences were given in the manuals.

During this study, a low-profile barrier was developed by TTI as part of another project. This barrier has the potential to eliminate many of the limitations presented by the guardrail on drum barrier currently used on urban arterials. Research is continuing on the development of an effective end treatment for this barrier.

Other Arterial Work Zone Factors

Several factors for which no information could be identified were selected for further evaluation. These factors include the capacity of a lane closure on an arterial street, the impacts of a lane closure on traffic signal operation, and the geometric design of a arterial work zone median crossover. Chapter 8 of Volume 2 describes these analyses in detail.

Traffic operations at an urban arterial lane closure in Arlington were videotaped, and the video was analyzed to determine capacity of the lane closure. The geometrics of the lane closure were two normal lanes being closed to one lane. The highest average flow of the lane closure was 760 vehicles per hour. This represents about 57 percent of the capacity of a freeway lane closure with similar geometrics. This percentage was applied to the freeway lane closure capacities contained in the *Highway Capacity Manual* (3) to estimate the capacity of various configurations of arterial lane closures, as shown in Table 1. **These capacity values should be used with caution, as they are based on a sample size of 1 and may not represent actual capacity of an urban arterial lane closure.** However, previous research has not addressed the capacity of urban arterial lane closures, therefore, the capacity values in Table 1 are the best estimate of urban arterial lane closure capacities.

Table 1. Estimate of Urban Arterial Lane Closure Capacities
(This table represents estimates of capacity and should be used with caution)

Number of Lanes		Number of Studies[1]	Total Average Capacity (vph)	
Normal	Open		Freeway[2]	Arterial[3]
2	1	8	1,340	760[4]
3	1	7	1,170	667
3	2	9	2,980	1,699
4	2	4	2,960	1,687
4	3	4	4,560	2,599
5	2	8	2,740	1,562

Notes:
1 Number of studies upon which freeway lane closure capacity is based.
2 Total capacity of open freeway lanes. From Table 6-1 of Highway Capacity Manual.
3 Total capacity of open arterial lanes. Calculated by multiplying freeway capacity by 0.57.
4 Total capacity based on actual field data.

An analysis of lane closures located downstream of traffic signals was performed to determine the impact of the lane closure on signal operations. It was determined that if the lane closure is located too close to the intersection, the queue from the lane closure will back into the intersection and block cross-street traffic. Figures 1 and 2 provide guidelines for the separation distance needed between the intersection and lane closure in order to prevent the queue from blocking the intersection for various probabilities of performance.

Figure 1 also contains an example of how to use the plots. The plot is started in the upper left with the arterial street volume. A horizontal line is drawn to the proper length of arterial red and then a vertical line is drawn to the desired probability of performance. Another horizontal line is then drawn to the right side of the lower plot to the required separation distance. If this separation distance cannot be obtained, then the beginning of the lane closure should be relocated upstream of the traffic signal.

The third analysis developed a desirable design for a temporary median crossover in an urban arterial work zone. The crossover itself should be wide enough to permit vehicles to turn into the crossover when it is already occupied by another vehicle. The required width of a crossover is a function of the design vehicle and the width of the travel lanes. Figure 3 illustrates that for 10-foot lanes and a work area 42 feet wide, the crossover should be 49 feet wide in order to accommodate passenger vehicles.

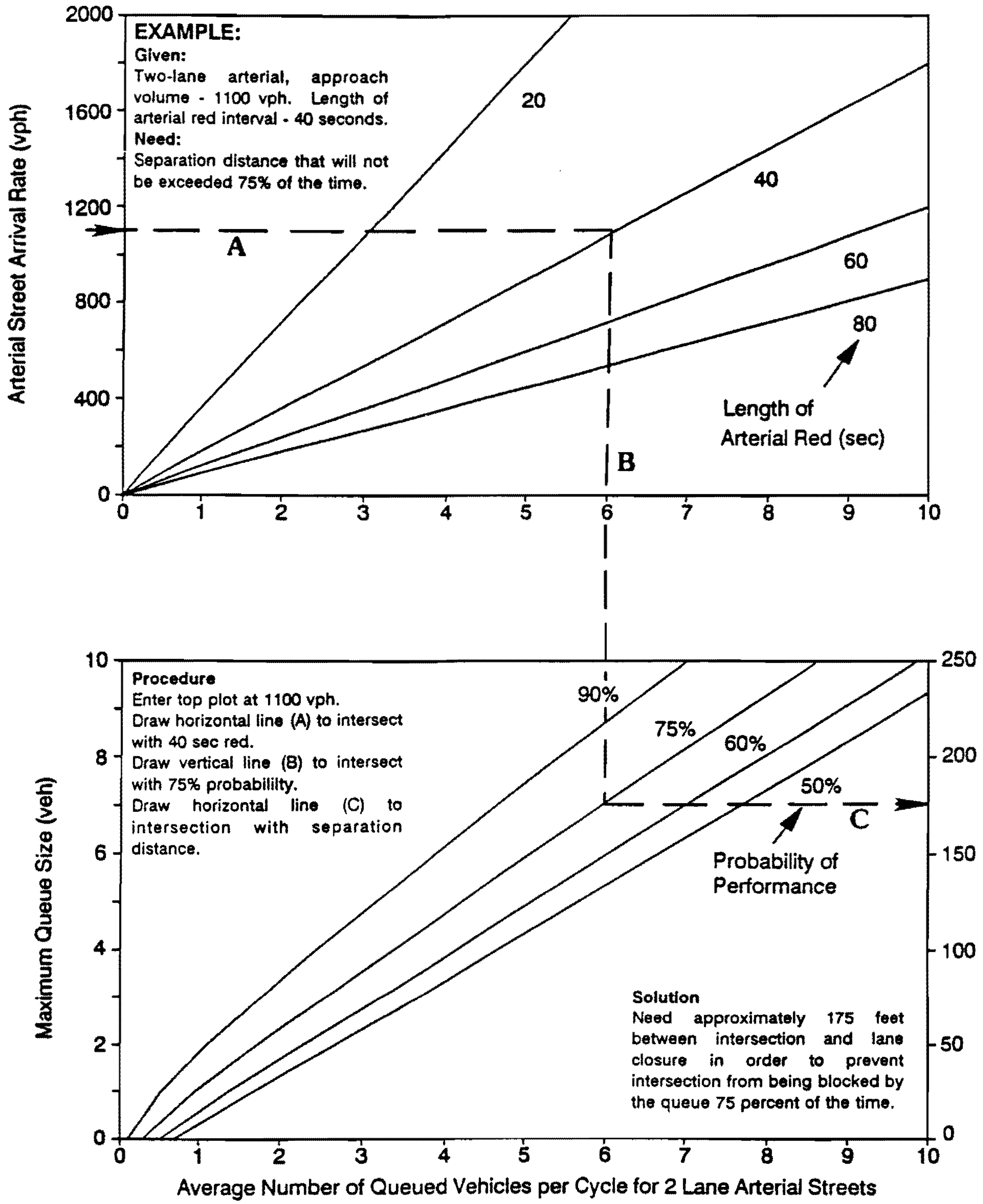


Figure 1. Lane Closure Separation Distance Probability Curves for Two-Lane Arterials

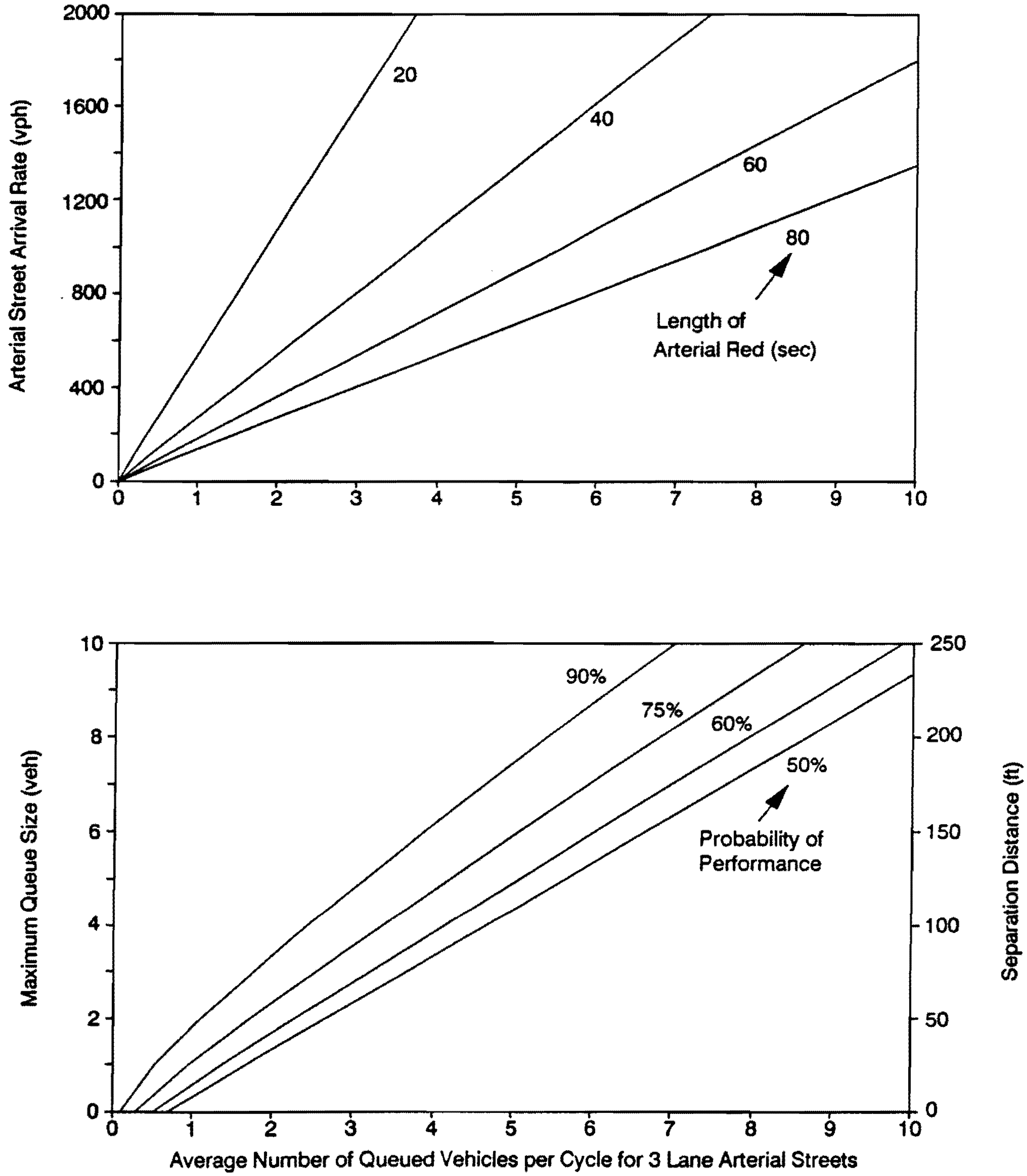
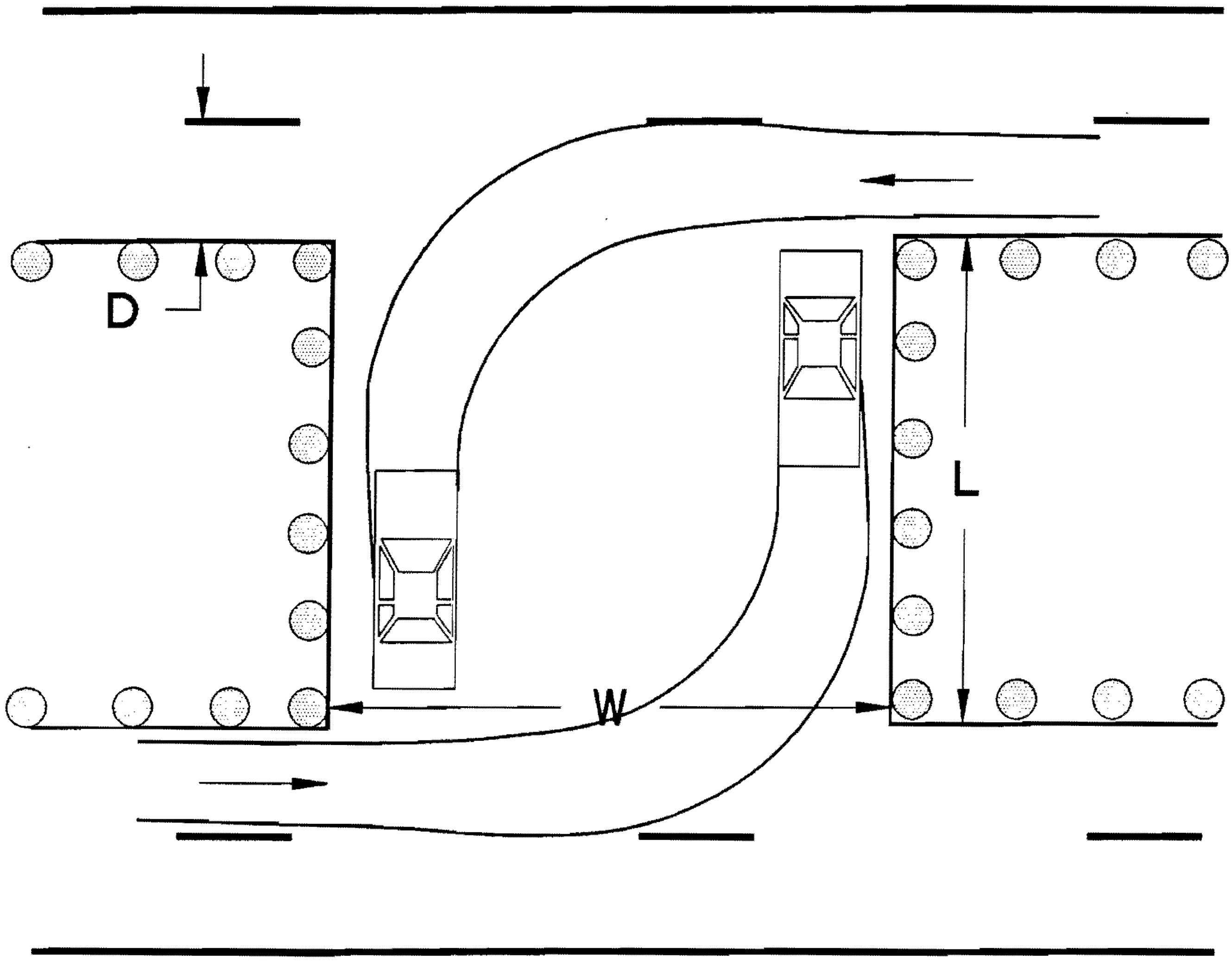


Figure 2. Lane Closure Separation Distance Probability Curves for Three-Lane Arterials



D=10', W=49', L=42'

Note: Recommended design based on passenger vehicle.

Figure 3. Recommended Temporary Median Crossover Design for Urban Arterial Work Zones

CHAPTER 2
GUIDELINES

The information obtained during the course of this research project was collected and analyzed to develop guidelines for planning, implementing, and operating traffic control in urban arterial work zones. The guidelines developed in the course of this project have not undergone an extensive experimentation or evaluation period in the field. **Therefore, the these guidelines should be implemented with care, and the effects of the guidelines should be closely monitored.** Chapter 9 of Volume 2 contains the basis for developing each specific guideline.

Guidelines for Project and Work Activity Scheduling

- Avoid lane and intersection closures during the morning, noon, and evening peak in order to minimize traffic conflicts.
- If possible, projects should not be scheduled to begin construction between Thanksgiving and New Year's Day in heavy retail areas.

Guidelines for Construction Planning

- Plan the construction phasing to minimize, as much as possible, the length of arterial which is under construction at any one time.
- Do not leave unused construction equipment in public view for extended periods of time.
- Use high-early strength concrete to minimize the duration of construction as much as possible.
- Use low-profile barrier in areas needing barrier protection.
- If the travel lanes are not the same width, the outside lane should be wider in areas with large numbers of driveways and intersections.
- Relocate bus stops to appropriate locations.
- Consider improving alternate routes prior to starting construction on a major arterial.
- Remove parking from the arterial prior to initiating construction.

Guidelines for Work Zone Speed Control

- Do not utilize speed restrictions in work zones, if possible. If speed restrictions are necessary, they should be carefully selected, recognizing that it may be necessary to supplement such speed guidance with other more positive means of controlling driver behavior. Advisory speeds should be selected to be consistent with site conditions.
- Check for consistent appearance of speed information. Advisory speed plates and speed limit signs with different speeds should not be placed within view of one another.
- Provide an enforcement area or areas for police activities.
- Request police presence on the project if traffic speeds are excessive even if enforcement is not possible.

Guidelines for Intersections

- Provide large street name signs with block numbers at major signalized intersections as a minimum, and at all intersection if possible. Whenever possible, these street signs should be placed overhead (on signal mast arms or span wire) to increase their visibility.
- Maintain as large a turning radius as possible at driveways and intersections.
- Driveways should be clearly marked and safe sight distances checked for each driveway.

Guidelines for Signalized Intersections

- Signal phasing and timing should be adjusted with each change in construction phasing. Signal operation should be checked in the field after each adjustment.
- Short cycle lengths may be useful in reducing queue backup into the intersection.
- The positions of traffic signal heads should be shifted to line up with lane arrangements anytime lane positions are modified. Signal heads should be located within the cone of visibility described in Section 4B-12 of the MUTCD.
- The operation of actuated signal detectors should be checked on a regular basis. If detection capability is lost, then actuated controllers should be converted to pretimed operation.
- Time base coordination should be used to provide progression through a work zone encompassing several traffic signals if the interconnection between signals is disrupted.

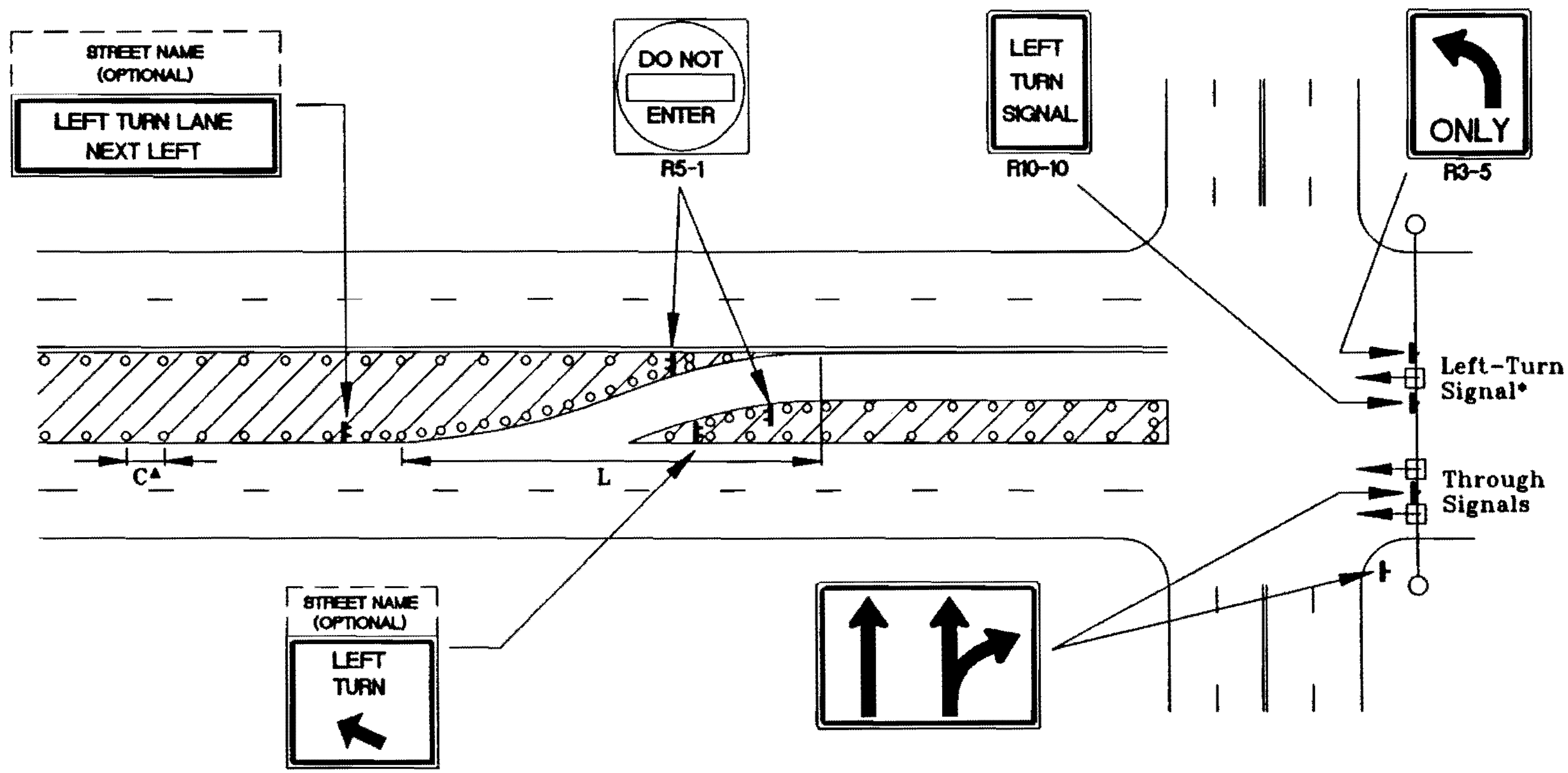
- Minimum pedestrian crossing time should be checked whenever signal timing is modified. If sufficient pedestrian crossing time cannot be provided, then the affected pedestrian movements should be prohibited with appropriate signing.
- An actuated pedestrian phase may be used to reduce the impacts of pedestrians on signal operation, even if the signal is operating as a pretimed signal due to the loss of vehicle detection capability.
- New or temporary signals in arterial work zones should use 12-inch signal lenses.
- Left-turn lanes should be provided at major signalized intersections. Figure 4 is a suggested design for providing a left-turn lane when the work area is in the center of the road.

Guidelines for Work Zone Signing

- Signs should not block the view of vehicles entering the area from gas stations, restaurants, cross roads, etc.
- High-intensity reflective sheeting may be appropriate for use on traffic control devices which indicate a change in the travel path of traffic.
- The **CROSSOVER** sign (D13-1) should be placed immediately beyond the crossover opening, as called for in the MUTCD and in a manner consistent with permanent crossover locations.
- Educational plaques should be used with construction symbol signs.
- The **Advance Road Construction** sign (CW20-1A, CW20-1B, or CW20-1C) should not be used as only a single sign. At least two **Advance Road Construction** signs indicating decreasing distances to the start of construction should be used in advance of a work zone to give the motorist the message that they are approaching a work zone.
- Traffic control devices which are no longer applicable should be removed or covered.
- Construction warning signs should be spaced according to the requirements of the Texas MUTCD (page 6B-2.2)

Guidelines for Lane Closures

- Use a flashing arrow panel for lane closures on major arterial streets.
- Provide the minimum separation distance between the lane closure and upstream signalized intersection as indicated in Figures 1 and 2.
- Lane closures should be located on a tangent section of roadway, if possible.



Note:

- * Left-turn signal should be positioned over the left-turn lane
- ▲ Channelizing devices should be spaced at 1/2 C on the taper

LEGEND

- ▨ - Work Area
- ○ - Channelizing Device
- L - Taper Length
  - $= WS^2/60$ for $S \leq 40$ mph
  - $= WS$ for $S \geq 45$ mph
- C - Spacing of Channelizing Devices

Figure 4. Possible Design for Left-Turn Lane in Work Zone

- If possible, the lane closure should be located so that there are no intersections, driveways, or median crossovers in the area between 200-300 feet upstream of the beginning of the taper and the end of the taper, as illustrated in Figure 5.
- The capacity of an arterial lane closure should be assumed to be approximately 57 percent of the capacity of a freeway lane closure.
- Lane closure signing should be located upstream of a signalized intersection if the lane closure is located within 1,500 feet of the signalized intersection and traffic volumes on the arterial are high.

Guidelines for Channelizing Devices

- The minimum taper length for channelization should be $W \times S^2/60$ for speeds of 40 mph and less and $W \times S$ for speeds of 45 mph and greater, where W is the width of the offset in feet and S is the speed in miles per hour.
- Spacing between channelizing devices should be reduced in areas where vehicles may want to encroach on the construction area (such as onto new pavement to make a turn). At these locations, a spacing in feet equal to or less than the speed limit in miles per hour may be appropriate.

Guidelines for Median Crossovers

- In areas with heavy retail development and many access points on the arterial, it may be appropriate to locate one or more median crossovers between each pair of traffic signals when the spacing between the signals exceeds 1,000 feet. However, median crossovers may not be necessary if through and left-turn movements at the intersection are light and the intersection can accommodate the increase in left-turn and U-turn volumes.
- The width of a crossover (parallel to the traffic direction) should be 45 to 50 feet as shown in Figure 3 in order to accommodate passenger vehicles.
- Crossovers should be located to provide the greatest access to properties adjacent to the arterial.
- The grade of a crossover should be as level as possible within 20 feet of the higher elevation roadway in order to reduce sight distance restrictions.

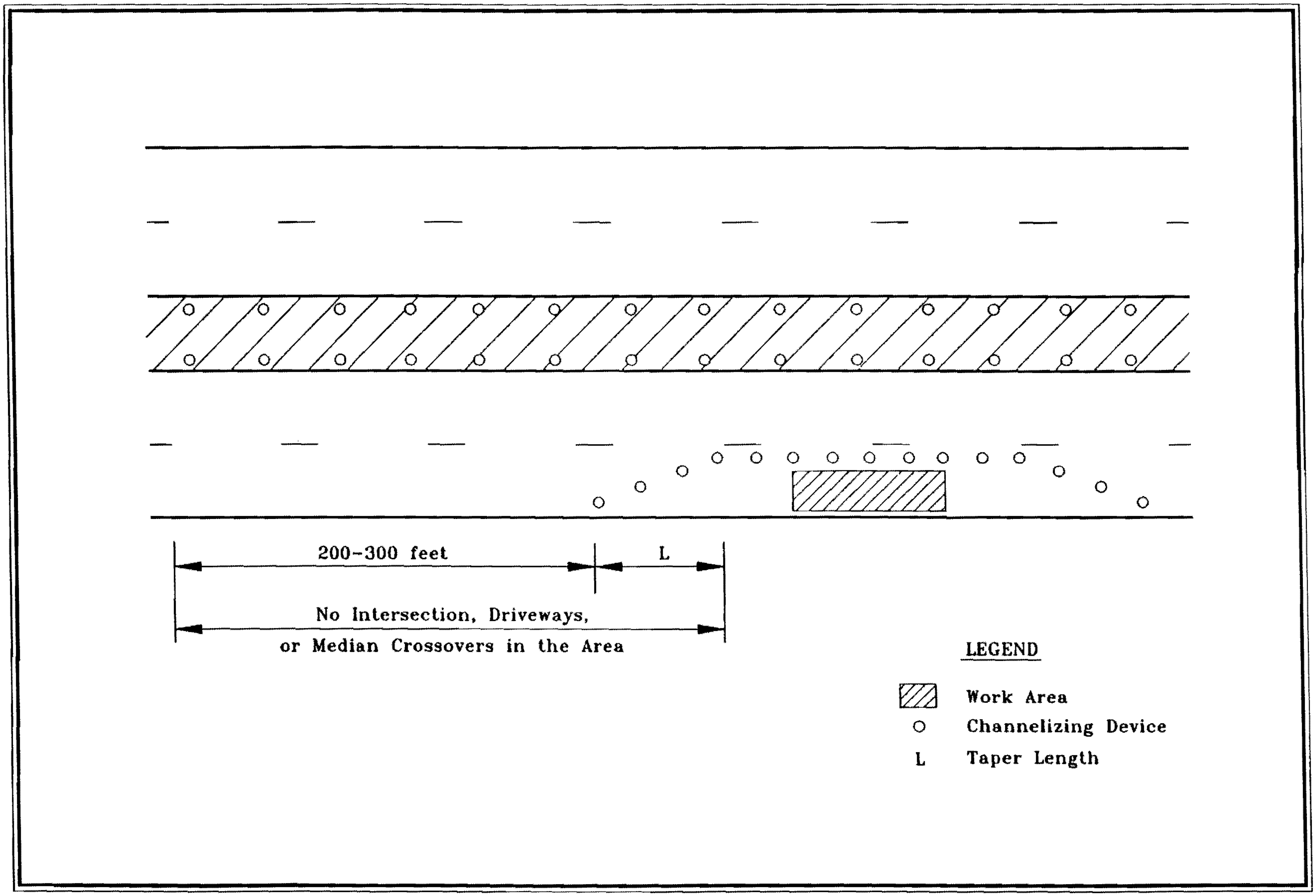


Figure 5. Locations of Lane Closure and Nearby Intersections

- U-turns should be permitted at traffic signals if a median crossover is not provided between the signal and the previous signal.

Guidelines for Pavement Markings

- Use raised pavement markers, in conjunction with or in lieu of painted markings, to enhance lane delineation in potential hazard areas.

Guidelines for Public Relations

- Hold a public hearing to explain the traffic plan whether requested or not and work hard to generate attendance.
- Hold regular public meetings during the construction period to update progress of the project, answer questions, and identify problem areas.

Guidelines for Urban Arterial Work Zone Accidents

- Accidents within the work zone should be monitored in order to identify accident trends and determine areas where increased traffic control emphasis should be placed.

Guidelines for Work Zone Inspection

- Inspectors with specific training in work zone traffic control should inspect urban arterial work zones on a regular basis.
- Traffic control in the work zone should be checked during periods of darkness on a regular basis.

CHAPTER 3
REFERENCES

1. *Texas Manual on Uniform Traffic Control Devices for Streets and Highways*, Texas Department of Transportation, 1980, revised to 1988.
2. *Traffic Control Devices Handbook*, Federal Highway Administration, U.S. Department of Transportation, 1983.
3. *Special Report 209, Highway Capacity Manual*, Transportation Research Board, Washington, D.C., 1985.