TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/TX-86/75+410-7F		

4. Title and Subtitle	5. Report Date
Guidelines for Utilization of Police Officers in Traffic Control and Enforcement on Urban Freeways	September 1986
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
John M. Mounce, Robert W. Stokes, Robert Q. Brackett, and William R. McCasland	Research Report 410-7F

9. Performing Organization Name and Address	10. Work Unit No.
Texas Transportation Institute The Texas A&M University System College Station, Texas 77843	11. Contract or Grant No. Study No. 2-18-84-410
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address Texas State Department of Highways and Public Transportation; Transportation Planning Division P. O. Box 5051 Austin, Texas 78763	Final - September 1983 September 1986
	14. Sponsoring Agency Code

15. Supplementary Notes
Research performed in cooperation with DOT, FHWA.
Research Study Title: A Study of Traffic Enforcement Requirements for Highway Maintenance, Construction, and Other Traffic Management Functions.

16. Abstract

This report presents general guidelines for the use of uniformed police officers in highway maintenance, construction, and other traffic management activities, such as incident management and the operation of high-occupancy vehicle facilities. The guidelines distinguish between "traffic control" and "enforcement" roles for uniformed police officers. The traffic control and enforcement guidelines are discussed in terms of: 1) Objectives of using uniformed police officers; 2) Requirements for implementing the guidelines; and 3) Measuring the effectiveness of the guidelines. Example set-ups of possible applications of the guidelines are given for illustrative purposes. The report also discusses key issues which may need to be resolved if the guidelines are to be disseminated and implemented. These implementation issues are discussed under the general headings of institutional, legal and economic issues. Due to the large number of variables, site characteristics, and transportation agencies involved, the guidelines presented in this report are necessarily broad and general in nature. However, the report outlines some general recommendations regarding procedures for reviewing and refining the guidelines for possible adoption, dissemination, and implementation by the those agencies responsible for enforcement and traffic control activities on our highway systems.

17. Key Words	18. Distribution Statement
Traffic law enforcement, Traffic control, Work zone, Incident management, Priority treatment, Transportation System Management.	No restrictions. This document is available to the public through the National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161

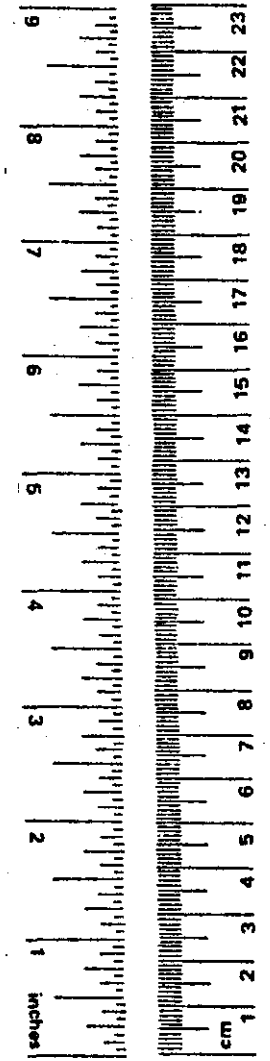
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	89	

Form DOT F 1700.7 (8-69)

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
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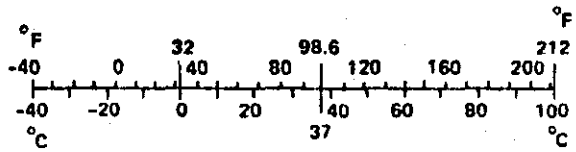

* 1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

GUIDELINES
FOR
UTILIZATION OF POLICE OFFICERS
IN
TRAFFIC CONTROL AND ENFORCEMENT
ON
URBAN FREEWAYS

Prepared for

Texas State Department of Highways and Public Transportation
Under
Research Report 410-7F
HPR Study No. 2-18-84-410
Titled
"A Study of Traffic Enforcement Requirements for Highway Maintenance, Construction, and Other Traffic Management Functions"

by

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Final Report
September 1986

ABSTRACT

This report presents general guidelines for the use of uniformed police officers in highway maintenance, construction, and other traffic management activities, such as incident management and the operation of high-occupancy vehicle facilities. The guidelines distinguish between "traffic control" and "enforcement" roles for uniformed police officers. The traffic control and enforcement guidelines are discussed in terms of: 1) Objectives of using uniformed police officers; 2) Requirements for implementing the guidelines; and 3) Measuring the effectiveness of the guidelines. Example set-ups of possible applications of the guidelines are given for illustrative purposes. The report also discusses key issues which may need to be resolved if the guidelines are to be disseminated and implemented. These implementation issues are discussed under the general headings of institutional, legal and economic issues. Due to the large number of variables, site characteristics and transportation agencies involved, the guidelines presented in this report are necessarily broad and general in nature. However, the report outlines some general recommendations regarding procedures for reviewing and refining the guidelines for possible adoption, dissemination, and implementation by those agencies responsible for enforcement and traffic control activities on our highway systems.

Keywords: Traffic law enforcement, Traffic control, Work zone, Incident management, Priority treatment, Transportation System Management

SUMMARY

To safely and efficiently accommodate traffic movement on urban freeways in future years an increasing presence and/or enforcement level by police agencies will be required. The necessity for cooperation between agencies responsible for transportation and law enforcement to bring this about is obvious. This report presents guidelines for the utilization of police officers to optimize traffic control and enforcement for the following areas:

1. Maintenance and Construction. Traffic demands require that traffic control plans provide for high traffic flows through the work zones, while providing for protection of the workers and the safety of the motorists. Acceptable levels of compliance to signs, signals and markings are generally not being achieved using current enforcement strategies.

2. Preferential Facilities for High Occupancy Vehicles (HOV). Often these operations are difficult to understand or are resented by those motorists who are not authorized to use the special facilities. Violations of the preferential facilities must be controlled to promote the safety and effectiveness of the operation.

3. Special Transportation System Management (TSM) Techniques. Examples of these are ramp control, truck routes, speed zones, narrow lanes, shoulder conversions, lane reversals, as well as HOV treatments. Adherence to the special regulations associated with these techniques is essential.

4. Normal Traffic Congestion. Traffic congestion has increased to a point that severe delays may be encountered at any time of the day on the transportation networks of major urban areas. Incidents occurring on the freeway system require immediate and decisive responses by enforcement personnel.

The guidelines developed in this research have been categorized as "traffic control" or "enforcement". Traffic control guidelines relate to those situations occurring on urban freeways in which a uniformed officer is needed to reinforce an existing traffic control plan for optimum vehicular

movement. The officer functions as an authority figure with the capability of citation; however, for the purposes of traffic control, only the threat of citation is necessary.

The second category of guidelines, enforcement, refers to those transportation facilities or techniques which require unique or special restrictions to operate successfully. Compliance with these restrictions is dependent upon the level and effectiveness of active enforcement.

Both traffic control and enforcement guidelines are discussed relative to the objectives of police utilization, requirements for implementation, and assessment of effectiveness. Example layouts of possible applications are given for illustrative purposes.

The requirements for traffic control in maintenance and construction zones will vary from site to site. Choice of the appropriate technique and manpower requirements will depand upon the type of work being performed, the length and duration of the work, and the time of day during which the work is being conducted. Typical traffic control plans for a range of freeway maintenance and construction activities are illustrated. Each and every situation on urban freeways with the potential to utilize police officers for traffic control or enforcement must be considered independently. In all cases, the Manual on Uniform Traffic Control Devices (MUTCD) for work zone traffic control devices should be adhered to and police officer traffic control implemented in concert and complement to these standards.

Table S-1 summarizes goals, objectives and measures of effectiveness for the traffic control strategies which may be used in conjunction with maintenance and construction activities.

This study presents general guidelines for use of uniformed police officers for traffic control at major freeway incident sites; where a major incident is defined as one that cannot be effectively managed by a single patrolman or patrol vehicle.

Table S-1. Goals, Objectives and Measures of Effectiveness for Urban Freeway Maintenance and Construction Traffic Control Strategies Utilizing Police Officers.

Urban Freeway Goal	Traffic Control Objectives	Enforcement Strategies	Measures of Effectiveness
Insure safety of the work zone	• Maximize safety	• Maximize visibility of site and personnel control personnel • Position personnel and traffic control devices immediately adjacent to conflict points • Provide advance warning of work zone	• Accidents (personal injury and property damage) • Accident rates • Conflicts
Maintain acceptable traffic flows through the work zone	• Minimize motorist delays	• Active traffic control by police personnel in cooperation with the supervising project engineer	• Travel times • Speeds • Length of queues

General guidelines for two general incident management strategies (techniques for increasing capacity and techniques for managing demand) are presented. Techniques for increasing capacity in the vicinity of an incident include: 1) Use of freeway shoulders; 2) Merging techniques, and 3) Contraflow operations. Demand management strategies include off-freeway diversion and advance warning signs.

Since the primary objective of incident management is to restore freeway traffic services as quickly and as safely as possible, the effectiveness of incident management techniques utilizing police officer should be measured in terms of: 1) How quickly the incident can be cleared and normal traffic services restored; and 2) How effective the techniques are in preventing or minimizing secondary incidents. Table S-2 summarizes freeway incident management traffic control strategies in terms of goals, objectives, and measures of effectiveness.

Table S-2. Goals, Objectives and Measures of Effectiveness for Major Freeway Incident Traffic Control Strategies Utilizing Police Officers.

Response Goal	Incident Control Objectives	Enforcement Strategies	Measures of Effectiveness
Protect the incident site	• Minimize secondary Incidents • Insure emergency vehicle access	• Maximize visibility of incident site • Provide advance warning	• Accidents • Accident rates • Emergency veh. response time
Maintain traffic flow and clear incident	• Minimize motorist delay • Maximize safety	• Use of shoulders • Manually-controlled merging • Contraflow diversion • Advance warning signs • Off-freeway diversion • Pre-planning (types and location of equipment and personnel)	• Travel times • Speeds • Accident rates • Emergency veh. response times • Time required to return to normal operations

Many of the basic techniques used in freeway incident management are also applicable to special events. However, since the occurrence of special events is generally known in advance, police officer manpower requirements may be reduced by using transportation agency personnel to implement much of the traffic control plan.

The general traffic flow goals, objectives and measures of effectiveness presented for freeway incident management strategies (Table S-2) also apply to special event traffic control strategies.

The objectives of police enforcement on priority treatment facilities (transitways, concurrent flow lanes, contraflow lanes, HOV by-pass ramps) are to maintain the operational integrity and safety of the facilities. Consequently, a strict and active enforcement program is necessary. Detection and apprehension, issuance of citations, and effective prosecution of violators is essential.

For priority treatment facilities which do not have full access controls and/or are not physically separated from the general use freeway lanes, tandem enforcement at strategic locations along the facility may be applicable. In this technique, one officer detects violators and a second officer stationed downstream apprehends and cites violators. Typical set-ups for priority treatment enforcement procedures are presented. Table S-3 summarizes goals, objectives and measures of effectiveness for priority treatment enforcement techniques.

Transportation System Management (TSM) strategies are actions or groups of actions intended to produce shifts in the supply-demand equlibrium of the transportation system. Many of these strategies involve a rearrangement of physical facilities and/or operating practices, requiring users to face new situations and to learn new rules. Consequently, the success of many TSM

Table S-3. Goals, Objectives and Measures of Effectiveness for Priority Treatment Enforcement Strategies.

System Goal	Priority Treatment Objectives	Enforcement Strategies	Measures of Effectiveness
Maintain operational integrity	• Minimize travel times • Maximize vehicle occupancy levels • Minimize violation rates	• Strict enforcement of occupancy requirements • Clear communication • of nature of facility • High visibility of • enforcement officers • Swift, safe removal of violators	• Violations • Violation rates • Travel times
Maintain safe operations	• Minimize accidents • Minimize incident response and clearance times	• Strict enforcement of authorization requirements • Clear communication • of nature of facility • Swift, safe removal of violators	• Accidents • Accident rates • Incident response and clearance times

strategies, such as ramp metering, commercial vehicle routing, speed zoning, lane restrictions, and shoulder usage, depends, in large part, on the effectiveness of the enforcement program which accompanies them.

There are three basic enforcement strategies which may be used in conjunction with TSM projects: 1) Routine enforcement; 2) Special enforcement; and 3) Selective enforcement. Specific enforcement procedures for TSM projects may include one or more of the following apprehension and citation procedures: 1) Standard; 2) Stationary; and/or 3) Signaling. Line and stationary patrols with standard or stationary apprehension and citation methods are the most commonly used enforcement procedures associated with TSM improvement projects.

As with priority treatment facilities, the effectiveness of TSM enforcement activities may be evaluated in terms of compliance with posted restrictions and regulations. Table S-4 summarizes goals, objectives and measures of effectiveness for selected TSM project enforcement strategies.

The implementation of guidelines for utilization of police officers in traffic control and enforcement faces numerous difficulties; yet, holds great potential. The institutional, legal and economic constraints and opportunities which may affect the implementation of the guidelines are identified and discussed.

It is the recommendation of this report that the State prepare supplemental reports, training courses, informational case studies and other informational materials for use by the agencies responsible for implementation.

Table S-4. Goals, Objectives and Measures of Effectiveness for Selected TSM Project Enforcement Strategies.

System Goal	Transportation Mgmt. Objectives	Enforcement Strategies	Measures of Effectiveness
Manage System Demand	• Meter freeway input (ramp metering) • Reduce commercial vehicle congestion (commercial vehicle routing) • Segregate vehicle types (Lane restrictions) • Reduce incidents and conflicts (e.g., speed zoning)	• Strict enforcement of ramp metering • Strict enforcement of truck/commercial vehicle route regulations • Stringent enforcement of lane restrictions • Stringent enforcement of speed limits • High visibility of enforcement officers • Institution of selective enforcement programs	• Violations • Violation rates • Travel times
Increase system capacity	• Maximize capacity (Shoulder usage) • Minimize travel times	• Institution of selective enforcement programs	• Travel times • Accident rates

IMPLEMENTATION STATEMENT

Increased demands for law enforcement support in transportation planning have occurred at a time when governmental agencies face shortages in finances and manpower. As a result, it has become difficult for transportation agencies to define and obtain a desirable level of enforcement support. The recent emphasis on obtaining a more efficient utilization of the existing transportation system, however, has brought about a shift toward transportation planning that is service-oriented (rather than facility-oriented). Many of these service-oriented improvements involve a rearrangement of physical facilities and/or operating practices, requiring users to face new situations and to learn new rules. Consequently, enforcement activities and considerations have become increasingly important in transportation planning in recent years.

This report presents general guidelines for the use of uniformed police officers in traffic control and traffic law enforcement roles for highway maintenance, construction, and traffic management activities. These guidelines should be useful to the Texas State Department of Highways and Public Transportation, state and local enforcement agencies, and other transportation-related agencies responsible for the management and operations of our highway systems.

DISCLAIMER

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1. INTRODUCTION

1.1 BACKGROUND

Traffic law enforcement and safety are only parts, though important parts, of an enforcement agency's responsibilities. Demands for enforcement personnel are increasing at a time when governments face shortages in finances and manpower. The construction, maintenance, and operation of transportation facilities are vitally dependent upon the effective utilization of police personnel for the safe and efficient control of traffic, and the enforcement of traffic regulations.

Historically, there has been considerable reluctance on the part of engineers to accept and involve enforcement agencies in the processes of planning and implementation of transportation systems. Likewise, law enforcement administrators separated themselves from this activity as it was not traditional "police work". Two factors have brought about the need for increased cooperation between these two groups.

First, legislation at both the federal and state levels will induce unprecedented levels of construction, re-construction, and maintenance of the highway network within Texas. The work zones associated with construction and maintenance activities are susceptible to becoming locations of high accident frequency and/or sources of considerable traffic delay. The effective use of police officers in these areas should enhance safety and expedite traffic movement.

Second, growth in traffic demands in Texas exceeds the development of the transportation infrastructure. New and innovative techniques in traffic system management (TSM) have been introduced with the objectives of moving more people faster on existing systems. Examples include priority facilities for high occupancy vehicles (HOV), ramp meter control, commercial vehicle routing, special speed zones and lane restrictions, shoulder usage, etc. Many of these techniques require a significant level of regulation compliance. Active enforcement by police personnel to insure acceptable

compliance to these special regulations is essential for sustained and successful operation.

To safely and efficiently accommodate traffic movement on urban freeways in future years an increasing presence and/or enforcement by police agencies will be required. The necessity for cooperation and mutual advisement between agencies responsible for transportation and law enforcement to effect this is obvious. The intent of this report is to document guidelines for the utilization of police officers to optimize traffic control and enforcement under compounding roadway situations (work zones, incidents, etc.) or special transportation management strategies (HOV, ramp control, restrictions).

1.2 OBJECTIVES

The purposes of this report are: (1) to acquaint law enforcement agencies and officers with some of the unique characteristics of work zones and TSM projects and to define law enforcement's role in traffic management, (2) to provide guidelines to both transportation and law enforcement officials concerning the numbers and placement of personnel for traffic management and control in various work zone configurations, (3) to provide guidelines concerning the levels of enforcement and the techniques necessary for obtaining motorist compliance with TSM regulations, and (4) to provide transportation and law enforcement officials with information concerning implementation procedures and issues.

The following objectives were established for direction of the study:

1. Define the need and requirements for uniformed police officers engaged in traffic management or priority enforcement activities on urban freeways.

2. Identify alternative techniques and strategies for utilization of enforcement personnel to effect optimum traffic control and/or levels of compliance.

3. Prepare guidelines for the effective deployment of uniformed police officers in traffic management or special enforcement functions on urban transportation facilities.

4. Examine guideline implementation alternatives and problems such as funding, manpower, legislation, and adjudication.

An extensive literature review (1) was conducted in response to the first study objective. This review highlighted the critical need for support by police agencies to transportation officials responsible for urban freeway management. The following areas of need were identified:

1. Maintenance and Construction activities on urban streets and freeways are increasing. Traffic demands require that traffic control plans provide for high traffic flows through the work zones, while providing for protection of the workers and the safety of the motorists. Acceptable levels of compliance to signs, signals and markings are generally not being achieved using current enforcement strategies.

2. Preferential Facilities for High Occupancy Vehicles (HOV) are being installed on streets and freeways. Often the operations are difficult to understand or are resented by those motorists who are not authorized to use the special facilities. Violations of the preferential facilities must be controlled to promote the safety and effectiveness of the operation.

3. Special Transportation System Management (TSM) techniques are being implemented to improve the level of service and safety of the roadway. Examples of these are ramp control, truck routes, speed zones, narrow lanes, shoulder conversions, lane reversals, as well as HOV treatments. Adherence to the special regulations associated with these techniques is essential.

4. Normal Traffic Congestion has increased to a point that severe delays may be encountered at any time of the day on the transportation networks of major urban areas. Incidents occurring on the freeway system require immediate and decisive responses by enforcement personnel.

The literature review also provided information addressing the second study objective. Various alternative strategies to "standard" techniques utilizing enforcement personnel for traffic control and management are as follows (2):

1. Use of photographic systems;
2. Mailing of traffic citations;
3. Remote apprehension (one officer detects violations, another officer downstream apprehends the violator);
4. Mass screening techniques (computer storage of license tags information on violating vehicles); and
5. Use of paraprofessional enforcement personnel.

Each of these alternative strategies has disadvantages related to technology, economics, manpower, or legal issues which inhibit their acceptable implementation. Discussions of each alternative enforcement strategy are available in the literature review report.

This report is directed to the third and fourth objectives of the study - the formulation of guidelines for the utilization of enforcement officers and the assessment of alternative implementation issues.

1.3 SCOPE

The guidelines have been categorized as "traffic control" or "enforcement". Traffic control guidelines relate to those situations occurring on urban freeways in which a uniformed officer is needed to reinforce an existing traffic control plan for optimum traffic flow. The officer functions as an authority figure with the capability of citation; however, for the purposes of traffic control, only the threat of citation is necessary.

Traffic control guidelines also encompass those situations requiring incident or emergency response on urban freeways. Enforcement personnel must be reactive to protect and clear the involvement, and to effectively manage

the associated impacted traffic to minimize delay. The magnitude of traffic impacts on freeways due to incidents or emergencies cannot be overstated.

Special events must also be included under traffic control guidelines. These activities impose significant increased demands on the urban freeway system. The utilization of police officers to expedite traffic flow is vital during the periods of peak loading.

The second category of guidelines, enforcement, refers to those transportation facilities or techniques which incorporate unique or special regulation restrictions to operate successfully. Compliance with these restrictions is dependent upon the level and effectiveness of active enforcement. These "enforcement" guidelines are not intended in any way as instruction to police officers in how to enforce traffic laws. Instead, the enforcement guidelines are presented to formalize, clarify, and highlight the essential role of police officers in effecting and maintaining the integrity of these selected improvements.

Both traffic control and enforcement guidelines are discussed relative to the objectives of police utilization, requirements for implementation, and assessment of effectiveness. Example layouts of possible applications are given for illustrative purposes. These layouts should not be considered strictly as standards and in no context do they constitute a "police traffic control plan". Each and every situation on urban freeways with the potential to utilize police officers for traffic control or enforcement must be considered independently. The number and location of police officers and flagmen discussed in the following examples are only examples and the locations and numbers are completely dependent on the needs of the project and sight conditions.

The implementation of guidelines for utilization of police officers in traffic control and enforcement faces numerous difficulties; yet, holds great potential. The institutional, legal, and economic constraints and opportunities which may affect the implementation of the guidelines are identified and discussed.

2. TRAFFIC CONTROL GUIDELINES

2.1 CONSTRUCTION AND MAINTENANCE WORK ZONES

2.1.1 General

The Manual on Uniform Traffic Control Devices (MUTCD) defines the following four categories or types of work zones (3):

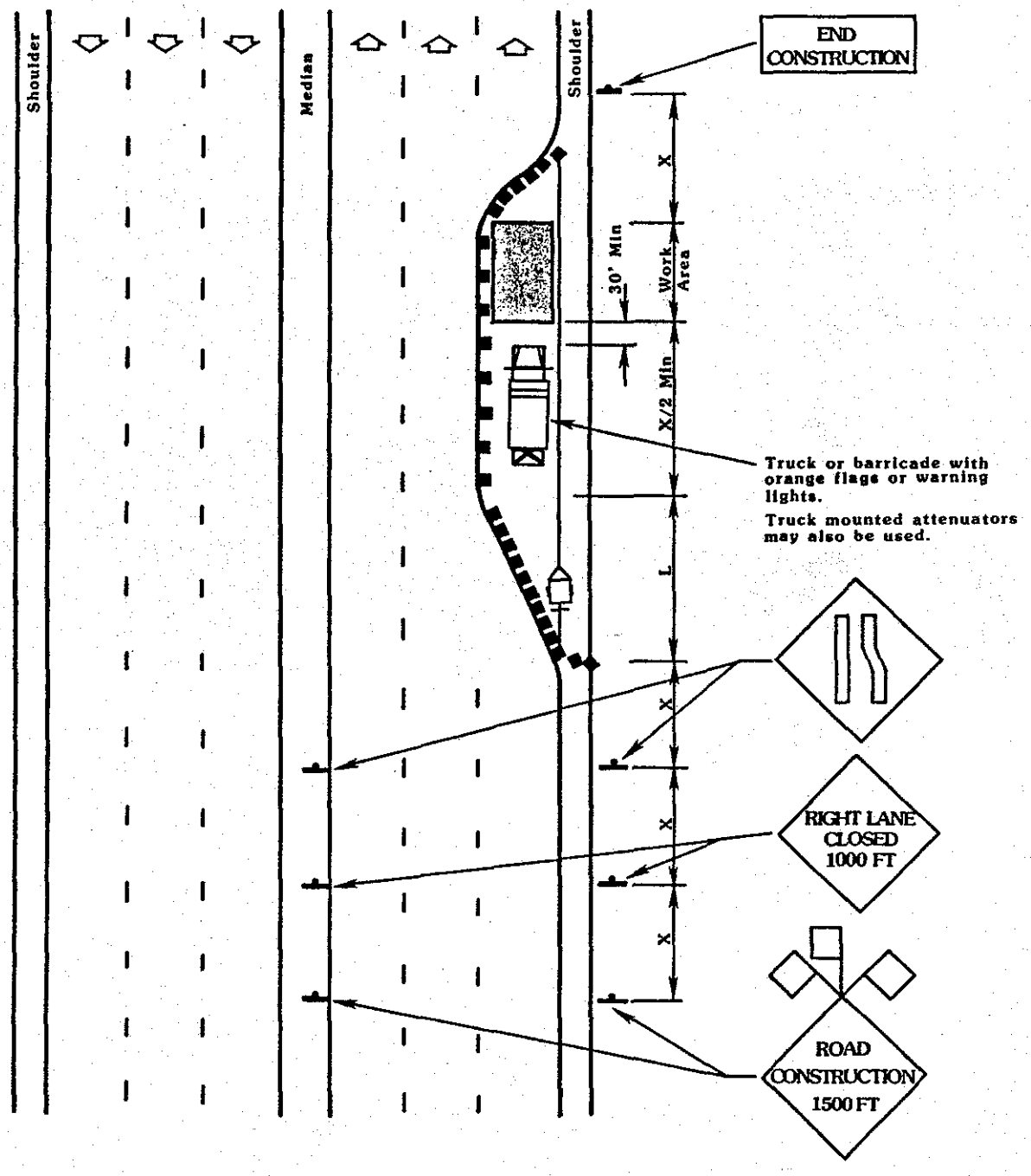
1. Major Construction or Major Maintenance. Major Construction or Major Maintenance are those activities that last for more than a normal workday and occur on the roadway, within 12 feet of a roadway without curbs, or within 2 feet of a roadway with curbs. In addition, operations on the roadway lasting only a few hours should be considered major if the work is done under conditions of high volumes and high speeds.

2. Minor Construction or Minor Maintenance. Minor Construction or Minor Maintenance are those work activities the duration of which is usually not more than a normal workday which occur on the roadway or within 30 feet of the roadway. The particular job is normally completed during the workday and the roadway is cleared of obstructions at the end of the workday. Minor construction or minor maintenance are often referred to as "minor activities or operations" in the illustrations.

3. Fast Moving Work Zone Activities. A fast moving activity may involve operations such as sweeping and striping, which move at a relatively rapid pace, making traffic control device set ups for stationary work zones impractical.

4. Slow Moving or Intermittent Stop Work Zone Activities. Slow moving operations may involve such work as raised pavement marker placement, while intermittent stop operations may involve such work as pothole patching.

Traffic control plans for each category of work zone identify the requirements for signing and pavement markings. Figures 1 to 3 present standard traffic control layouts as recommended by the MUTCD for various work

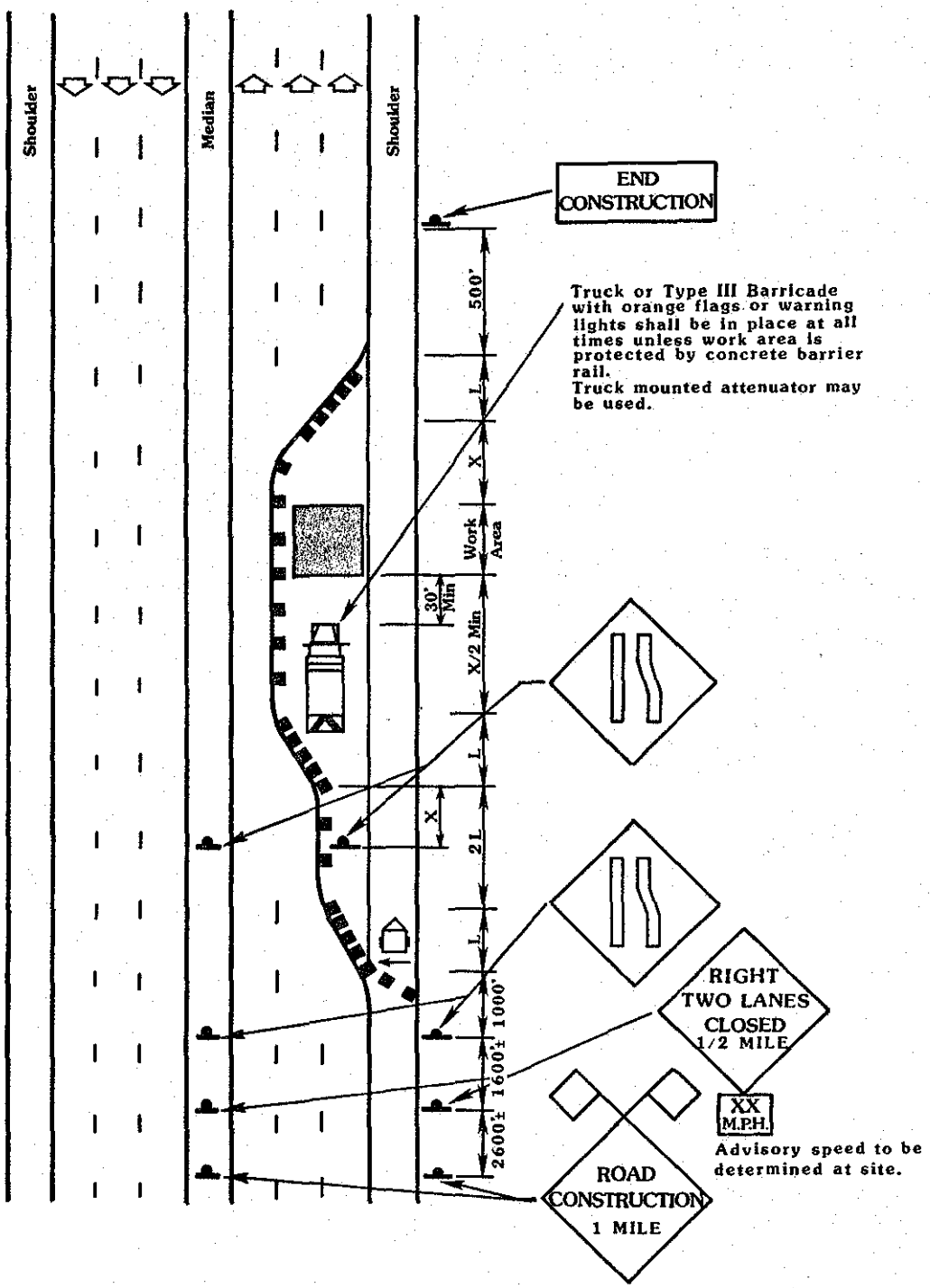


Posted Speed or 85% Speed (MPH)	X Min. Distance (feet)
30 or less	80
35	120
40	160
45	240
50	320
55	500

Taper Formula
L = (S) x (W) for speeds of 45 or more
L = (W) x (S) x (S)/60 for speeds of 40 or less
Where:
L = Minimum length of taper
S = Numerical value of posted speed limit prior to work or 85% speed
W = Width of offset

Legend:
Barricade
Heavy Work Vehicle
Channelizing devices
Traffic Sign
Truck Mounted Attenuator (optional)
Trailer mounted flashing arrow board

Figure 1. Traffic Control Plan: Single Lane Closure



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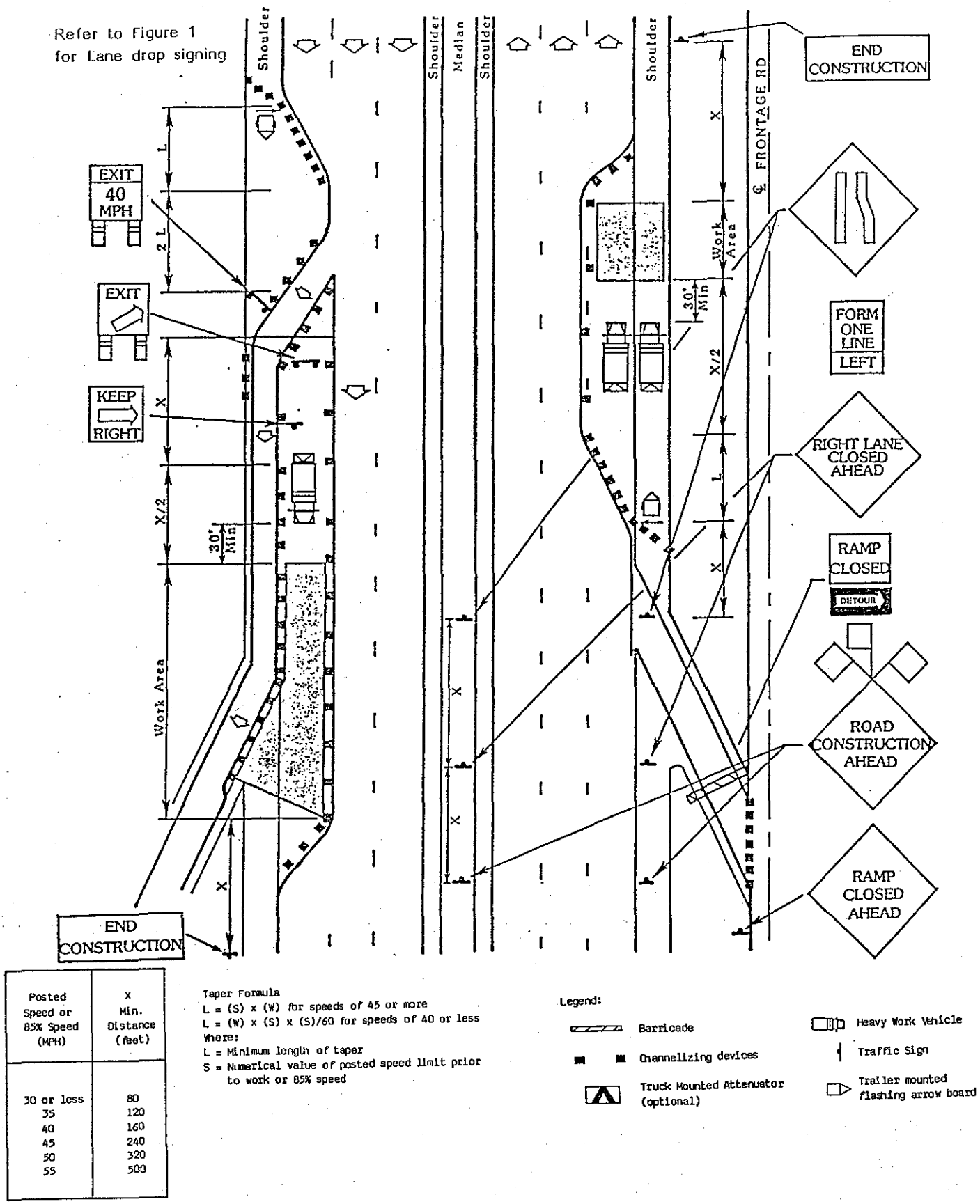
Legend:
Barricade
Heavy Work Vehicle
Channelizing devices
Traffic Sign
Truck Mounted Attenuator (optional)
Trailer mounted flashing arrow board

Figure 2. Traffic Control Plan: Two Lane Closure



Posted Speed or 85% Speed (MPH)	X Min. Distance (feet)
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35	120
40	160
45	240
50	320
55	500

Taper Formula
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Where:
L = Minimum length of taper
S = Numerical value of posted speed limit prior to work or 85% speed

Legend:
Barricade
Channelizing devices
Truck Mounted Attenuator (optional)
Heavy Work Vehicle
Traffic Sign
Trailer mounted flashing arrow board

Figure 3. Traffic Control Plan: Lane Closure Near Ramps

zone operations. In that construction and maintenance activities are planned functions, adequate opportunity exists to incorporate all standards for traffic control. Attention to and compliance with these traffic control devices are further reinforced by utilization of police officers to enhance safety and traffic movement.

2.1.2 Objectives of Police Utilization

The primary objective of police utilization in construction and maintenance work zones is to insure the safety of the project site. This includes not only the safety of personnel and equipment within the work zone, but also the safety of motorists traversing the roadway through the work zone. The visible, uniformed officer calls attention to potentially hazardous situations by his presence and authority. This reinforces warnings given by other traffic control devices within the work zone.

A secondary objective of utilizing police officers in construction and maintenance work areas is the expeditious movement of traffic through the site. Work zones along congested sections of roadway which reduce capacity (i.e., lane encroachment, lane narrowing, lane closure) for an extended period of time create critical operational problems. Police officers may be utilized to enhance the traffic control plan at a work site to minimize motorist delay. This is accomplished through timely and active traffic control by police personnel in cooperation with the supervising project engineer to maintain movement of traffic as efficiently and safely as possible.

Effective traffic control by police officers does not have to involve enforcement (citation), only the threat thereof. However, where safety and movement of traffic through a construction or maintenance work zone is jeopardized by the non-adherence to posted traffic warnings/regulations, then additional police personnel are required for enforcement and should be present in official vehicles. Each project is different by nature and should be monitored to determine if there is a problem with compliance which could be solved by enforcement. The supervising engineer is responsible for this decision based on his experience and field observations.

2.1.3 Requirements for Implementation

The requirements for traffic control by police officers in construction and maintenance work zones are unique to each project site. The applied traffic control techniques will vary depending on the following factors:

1) Type of work - major, minor, fixed, moving
2) Encroachment of roadway - off, adjacent, narrowing, blockage, closure
3) Length of work zone - short (feet), long (miles)
4) Duration of activity - short (hours, days) or long (weeks, months)
5) Period of time - peak, off-peak, nighttime, 24 hour

Each and all of these factors influence the requirements for police traffic control at a specific work area. Several general requirements for implementation are discussed below.

1) High Visibility of a police authority by motorists is extremely important. The officer, by his position and actions, should be in clear view of traffic moving through the construction and maintenance work zone. Attention value of the police officer is further heightened by the clearly visible and near presence of a marked patrol vehicle. "Floating" enforcement personnel through the work area is not effective.

2) Advance Location of a police officer to points of transition from normal to impeded traffic flow is also extremely important. These transition areas (such as lane changes, lane narrowing, lane blockage, detours, etc.) require increased driver attention and caution. The visible presence of a uniformed officer accentuates communication of essential operational information. Police officers have been effective in speed control when pointing to or situated by posted speed information (4).

3) Immediate Location of a uniformed police officer adjacent to critical safety points of conflict (equipment, personnel, work activity, etc.) or imperative traffic control devices (signing, delineation, flagmen, etc.) is equally important. The authority of the officer reinforces the

communication to motorists of special conditions within the work zone and the necessary driving adjustments for safe operation.

4) Additional Support by police personnel for traffic control in construction and maintenance work zones may be required on projects of extended length to reinforce initial regulatory advisements, or on projects where it is necessary to close a freeway and establish diversion routing. In the case of the latter, the number and location of additional police officers depends on the specific project site, along with length and time duration of closure.

Other factors in a specific construction or maintenance work site that may increase the requirements for traffic control by police personnel are compounding roadway geometrics, restrictive sight distance, and high traffic volumes. The appropriate utilization of uniformed officers under these conditions may enhance traffic flow and safety.

2.1.4 Assessment of Effectiveness

As the primary objective for utilization of police officers in construction and maintenance zones is the protection of the work site and motorists traveling through the site, assessment of effectiveness must be measured in terms of safety records. Accidents, near accidents (conflicts), potential accidents (physical encroachments, tire marks on pavement or concrete median), or violations may be used as comparative measures between similar projects with varying levels and utilization techniques of police personnel. However, accidents are not always a dependable measure. Control parameters would include type of roadway facility, traffic volume, construction and/or maintenance activity, and traffic control plan. Significant time duration of projects is necessary to collect sufficient data for evaluation. Desirably, accident rates will not be significantly higher during time of construction or maintenance than comparable time periods before or after under the same operating conditions.

Operational measures of traffic control effectiveness (service volume, travel time, etc.) have not proven successful in the assessment of police

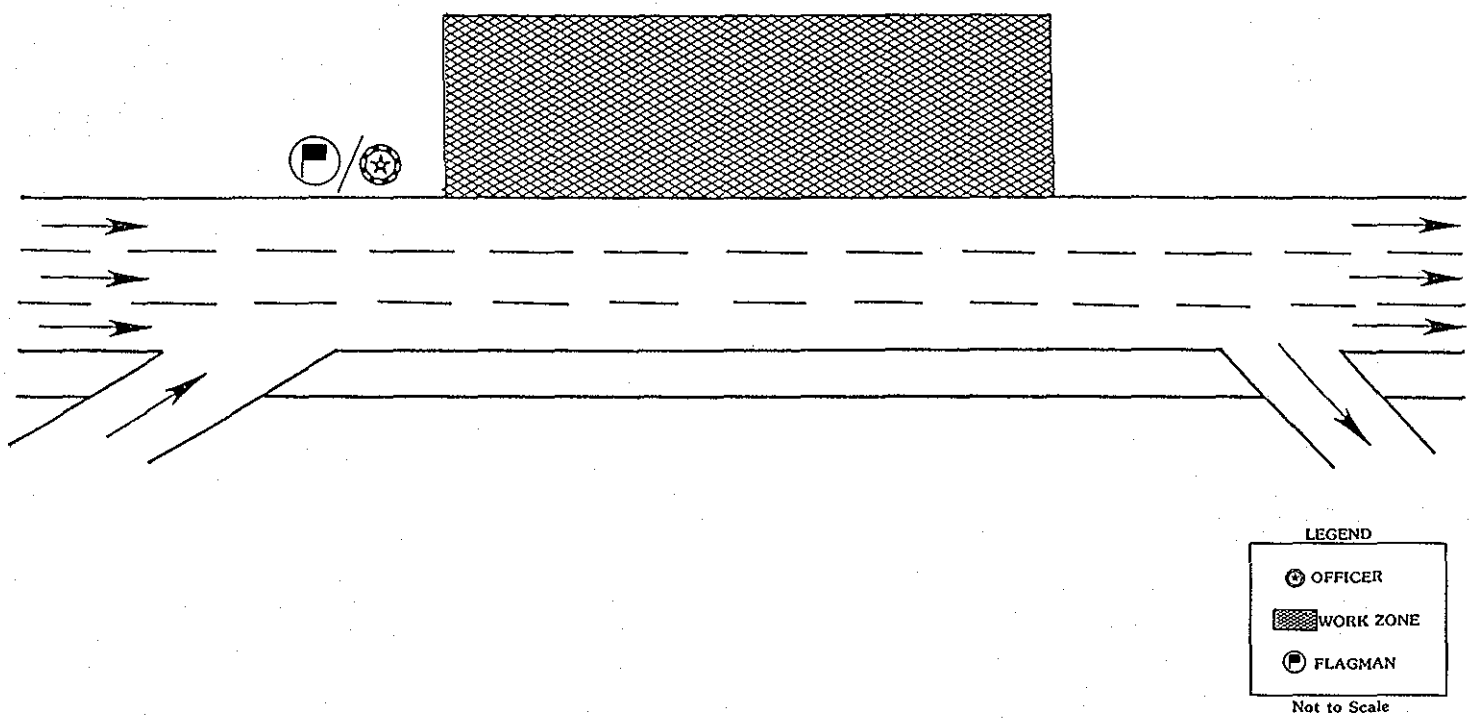
utilization at work zones. Too many uncontrollable factors exist surrounding construction and maintenance activities which confound any measurable results. However, one clear and measurable effect is the compliance to specific speed advisements when reinforced by the presence of a police officer directly adjacent to a stated sign regulation (4). Traffic conditions on alternative diversion routes can also be significantly affected by control decisions of police officers.

2.1.5 Examples of Application

Urban freeway traffic through many construction and maintenance projects can be managed adequately by following an effective traffic control plan utilizing competent flagmen. However, under conditions of high traffic demand, stressful geometrics, unprotected and/or unusual work activity, or nighttime operations, the support and authority conveyed by a uniformed police officer at the work site facilitates safe and efficient traffic control. Specifically, officers may be most effective in speed control.

Figure 4 illustrates an example of minimal utilization of police officer support for traffic control in work zones. The project site is adjacent to freeway mainlanes. No transition, constriction, or blockage of the freeway lanes is required. An active flagman located off the roadway prior to the work zone should provide adequate warning, protection, and control of any potential traffic encroachment. But, if any of the mitigating factors cited previously exist at the site causing a degradation in safety or operations, the utilization of a uniformed police officer is recommended either in place of or in conjunction with the flagman.

For construction or maintenance work sites which physically close one freeway lane, as shown in Figure 5, a flagman or police officer should be positioned just prior to the delineated point of transition. The transition may be from multiple full width lanes to an equal number of narrow lanes or from multiple lanes to a single lane. In either case, the flagman or officer should reinforce the advisements of other traffic control devices and physically provide demarcation of the point necessary for driving adjustment.



Notes:

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2. The officer/flagman symbol indicates the possible location of either a flagman or a police officer (or both) depending upon specific site conditions and the judgement of the supervising project engineer.

Figure 4. Work Zone Adjacent to Freeway

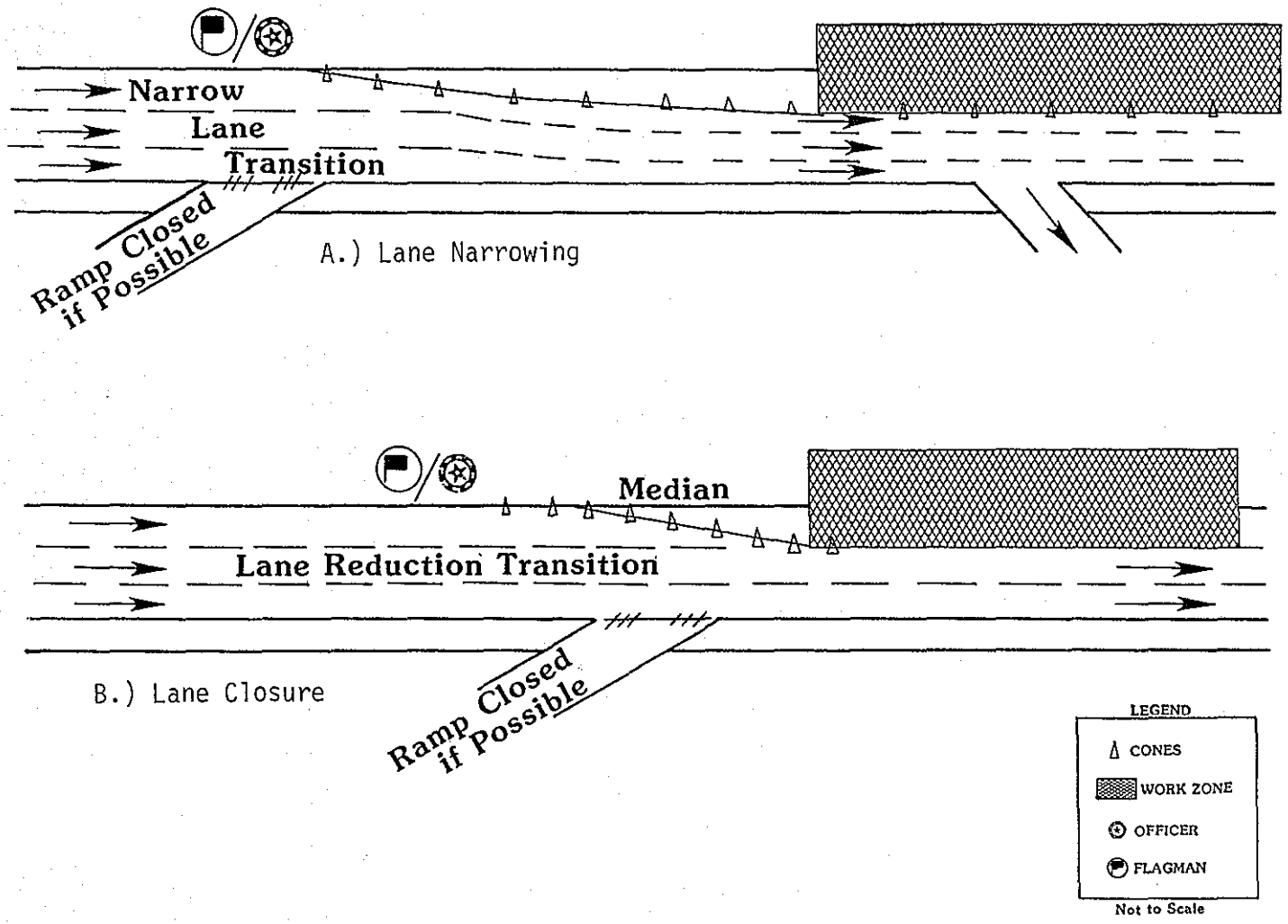

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Figure 5. Single Lane Closure

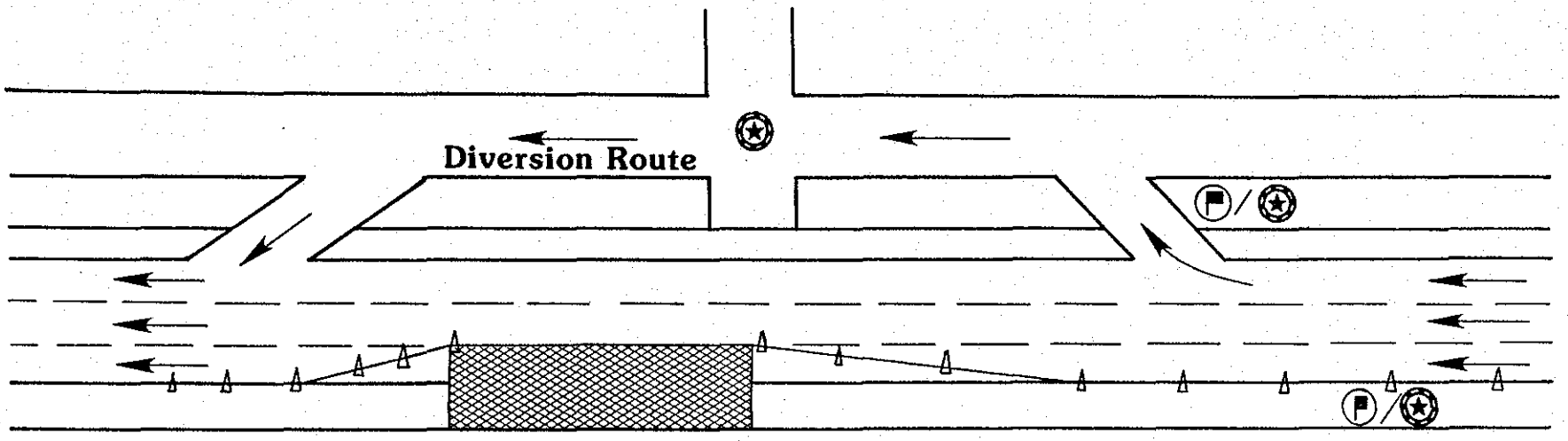
The decision to utilize a police officer for traffic control authority at this location should reside with the project engineer.

Additional flagmen and police support may also be necessary in advance of the transition for speed control and/or immediately adjacent to the exposed site if no other physical protection is provided to equipment and work personnel. This decision should be at the discretion of the project engineer based on safety and operational considerations.

For those locations where construction or maintenance activities reduce the capacity of heavily congested freeways or where work must be conducted during peak commuter periods, excessive queueing and delay may result. As illustrated in Figure 6, one option to minimize delay may be to divert a portion of the mainlane traffic to parallel frontage roads. This is only possible if the work site is contained within the limits of an exit-entrance ramp pair. Officers should be at locations indicated to intercept, expedite movement, and re-route onto the freeway beyond the work zone. Each site should be considered unique as to utilization of police support in this regard.

Figure 7 provides two examples of more extensive and major work sites necessitating the closure of two or more lanes on a multi-lane freeway facility. A flagman or police officer should be located just prior to the first point of physical transition. Additional flagmen or officers may be required in advance of the transition itself to reinforce the signing advisements and to positively effect the desired merge maneuvers. Other flagmen or officers may need to be positioned at the secondary transition or adjacent to the work site itself. All of these possible locations utilizing police officer support for traffic control are shown on Figure 7.

The decision to utilize police support at any or all of these positions to optimize traffic flow and safety within the work zone should be made by the project engineer. Where several officers are used for a long period of time, provisions should be made for breaks and specified officers should be designated as supervisors.



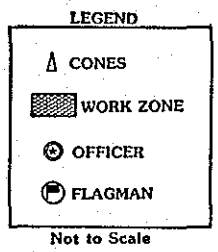


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Figure 6. Lane Closure Queue Diversion

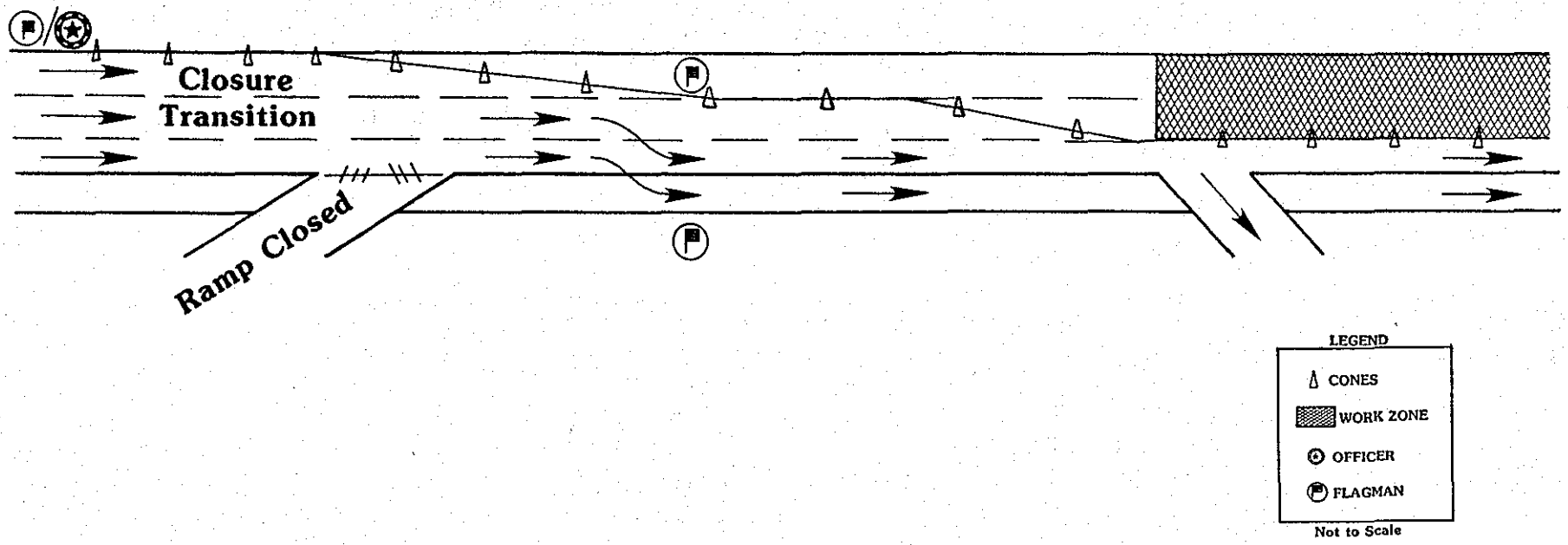

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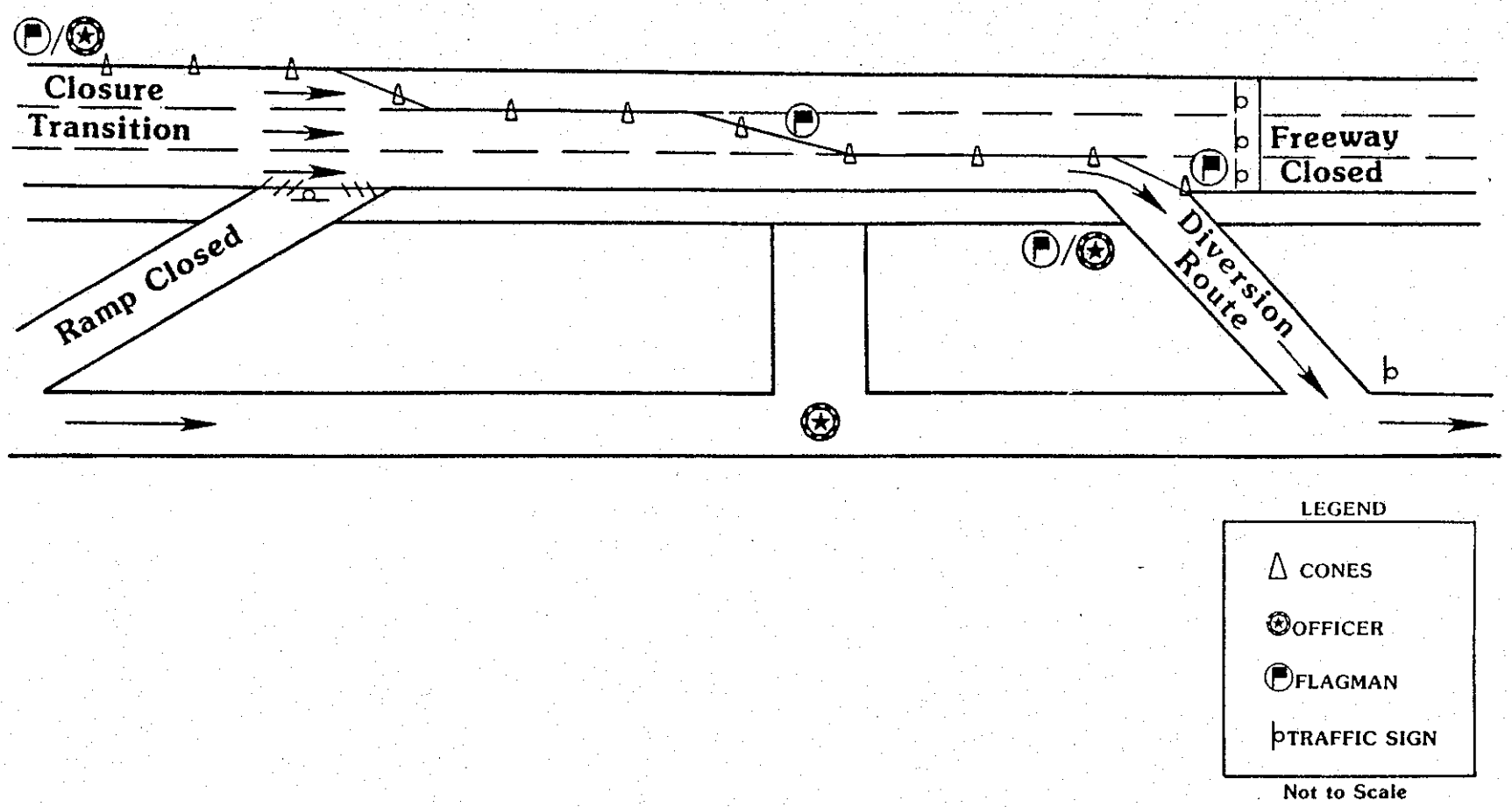
Figure 7. Lane Closures With Diversion

Maximum utilization of uniformed police officer support occurs under conditions of a complete freeway closure due to major construction or maintenance operation. Freeway traffic would be intercepted at some point prior to the work site, transitioned off the freeway, diverted along a parallel route around the project area, and directed back onto the freeway. Obviously, extensive signing and delineation would be employed for warning, advisement, and routing. Flagmen and/or uniformed police officers would be utilized to reinforce traffic communication in advance of the closure. Flagmen and/or officers positioned at all transition points would enhance timely and appropriate traffic maneuvers for diversion. Police personnel would also be desirable for authority support at all locations (intersections) requiring manual traffic control.

Figure 8 illustrates two possible scenarios of freeway closure and locations of police officers for traffic control support. One scenario could involve work activity closing the freeway between exit/entrance ramp pairs such that the ramps served as the diversion route links to and from the frontage road. The second scenario could involve diverting traffic off the freeway by an exit ramp and onto a nearby parallel arterial. Either scenario could involve several officers and additional support as indicated for traffic control. These same scenarios for complete diversion and example applications of police utilization could follow from a major incident (accident, breakdown, emergency, weather, etc.) closing the freeway.

It should be noted that Figures 4 to 8 are simple illustrations to provide reference positions of flagmen/officers relative to a type and location of construction and maintenance work area. Signing and delineation details of the traffic control plan associated with a particular work site are not included. However, in all cases, the MUTCD for work zone traffic control devices as illustrated in Figures 1 to 3 should be adhered to and police officer traffic control implemented in concert and complement to these standards.



Note: Traffic control plan depicted is for illustration purposes only. It is not a standard or specification. In all cases, the MUTCD should be adhered to for location and placement of traffic control devices.

Figure 8. Complete Freeway Closure and Diversion

2.2 MAJOR INCIDENT RESPONSE

2.2.1 General

An incident on a freeway is defined as an accident, mechanical breakdown, cargo spillage, or other unexpected traffic impacting event on a freeway that results in traffic congestion.

An incident may involve injuries or constitute a potential hazard necessitating emergency response by medical and/or fire personnel. Or an incident may only create operational problems resulting in traffic congestion. Freeway incidents may be classified as either "minor" or "major" in terms of their impacts on traffic safety and operations. In this study, freeway incidents are classified in terms of the traffic control (including police officers) manpower required to effectively manage the incident. A minor incident is one that can be managed by the primary respondent, usually a single patrolman or patrol vehicle. Minor incidents would typically be handled by the patrolman using the enforcement agency's "standard operating procedures". These type of incidents would be cleared quickly from the freeway with a minimum of traffic operational impacts. No emergency response would be required for minor incidents.

The guidelines discussed in this study for utilization of police officers in traffic control are restricted to major incidents on urban freeways. These are incidents of sufficient consequence and time of impact to require more than a single patrol and/or operating agency involvement to handle effectively.

2.2.2 Objectives of Police Utilization

The patrol officer is usually the initial agency authority at a major incident site on a freeway. His first objective is generally to secure and protect the incident location while assessing the need for medical or other emergency support. The officer also provides information on the type of emergency equipment that might be necessary to clear the scene.

From an incident traffic management standpoint, the initial contact officer determines and conveys information relative to type and extent of the freeway incident. This will allow decisions to follow regarding impacts on freeway operations in advance of the scene and implementation of necessary traffic control to minimize these impacts. The primary objective of incident traffic management is to restore freeway operations as quickly and safely as possible. The utilization of police officers for traffic control in this regard is critical. Police personnel provide the authority necessary to effect immediate, real-time direction of traffic adjacent to or in complete bypass of a major freeway incident. Officers provide the manual traffic control support necessary, in absence of pre-designated traffic control devices, to facilitate lane closure transitions, merge maneuvers, or diversion re-routing of freeway vehicles. If necessary, and with time to mobilize, traffic control by police can be supplemented by portable devices (such as signs, cones, flares, etc.) or flagmen. Also, an incident response plan (if available) may provide assistance in assessing police traffic control needs.

2.2.3 Requirements for Implementation

The management of traffic flow during a major freeway incident requires one or both of two general techniques. These are: 1) Techniques for increasing capacity past the incident site; and 2) Techniques for reducing (or managing) demand on freeway segments affected by the incident. Each of these techniques are discussed independently with respect to technical implementation and associated requirements for utilization of police officers.

2.2.3.1 Increasing Capacity

In those situations where traffic volumes are relatively low and adequate freeway capacity exists, traffic flow may be maintained through the incident scene by: 1) use of the freeway shoulders; 2) merging techniques; 3) re-timing frontage road signals or manually controlling traffic through frontage road intersections; or, in special situations, 4) contraflow operations.

The freeway shoulder can be used as an interim measure to increase capacity until the incident is removed from the freeway. The decision to use the freeways shoulders should be based on the following considerations (5):

1. The shoulder is paved and there is at least 10 feet of clearance from the far edge of the shoulder to the edge of the incident.
2. Use of the shoulder for traffic will not interfere with emergency vehicle requirements.
3. There are no unusual geometrics on the roadway, such as an on-ramp that would conflict with traffic on the shoulder.

Manually-controlled merging should be limited to those lanes that absolutely require it to get traffic past the incident. Merging lanes should be regulated according to the number of vehicles queued in each lane. Also, manually-controlled merging requires that special attention be given to ramp movements to avoid problems on adjacent roads.

Contraflow diversion involves use of a lane on the opposite side of the freeway and may be applicable when one direction of the freeway has been completely closed by an incident.

General manpower requirements for utilization of uniformed police officers for each of these basic techniques are outlined below.

1. Use of Shoulders. Use of the freeway shoulders to increase capacity should be implemented by patrolmen to insure motorist compliance. The patrolmen should be positioned at the upstream end of the taper. Normally, two patrolmen would be required. In addition to the uniformed patrolmen, one to two transportation agency personnel may be used to position traffic control devices (flares, cones, etc.).

2. Manually-Controlled Merging. Manually-controlled merging should generally be directed by uniformed police officers. The patrolmen should be positioned at the upstream end of the taper. As a general rule-of-thumb, the number of police officers needed may be assumed to equal two more than the

number of lanes closed. Highway department personnel may be used to position and remove cones and flares.

3. Contraflow Diversion. Contraflow operation will, in most cases, be the responsibility of the local transportation agency. Manpower requirements for contraflow operations will vary, but typically a minimum of six transportation agency personnel (including one traffic engineer) and three uniformed patrolmen will be required.

2.2.3.2 Demand Management

Techniques for managing demand on freeway segments affected by a major incident are intended to advise motorists of the incident so that they may reduce speed, avoid secondary incidents, or consider leaving the freeway and taking an alternate route. These techniques require pre-planning and are generally more labor-intensive than most of the techniques discussed earlier. Pre-designed incident response plans on maps of the freeway and arterial street systems should be developed with alternate routes designated for all possible incident locations. Requirements for personnel and control devices can be shown on the routes.

The manpower requirements will include personnel to place signs and cones, personnel for traffic control at exit ramps and intersections (if off freeway diversion is used), and personnel at the incident site. Generally, a minimum of 5 and possibly as many as 10 individuals would be needed, depending on the severity and duration of the incident. The majority of the personnel required would typically be available from the local highway department office. The primary responsibility of police personnel would be at the incident site and at the freeway entry and exit points in the immediate vicinity of the incident.

2.2.4 Assessment of Effectiveness

Since the primary objective of incident management is to restore freeway traffic services as quickly and as safely as possible, the effectiveness of incident management techniques utilizing police officers should be measured

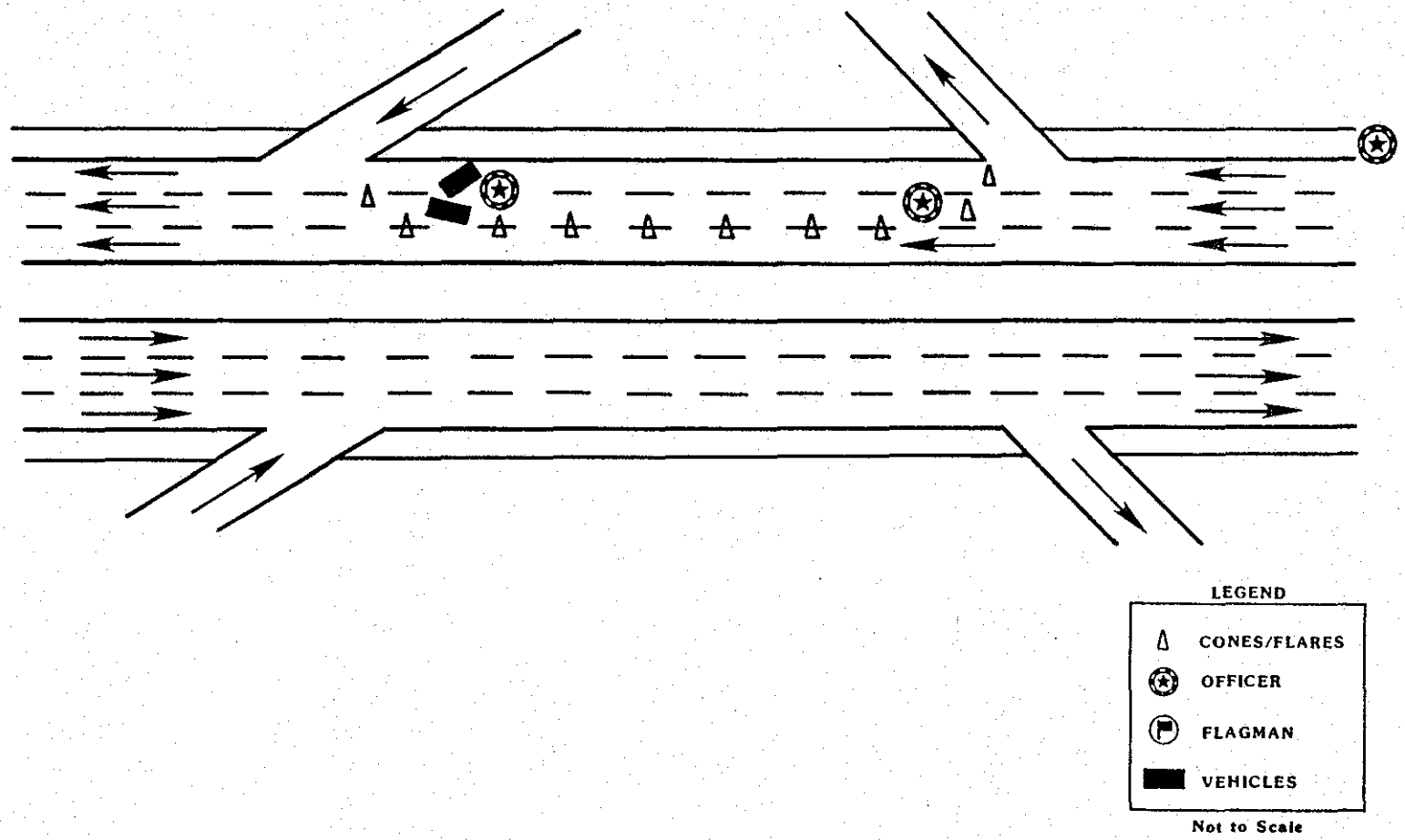
in terms of: 1) How quickly the incident can be cleared and normal traffic services restored; and 2) How effective the techniques are in preventing or minimizing secondary incidents. These measures provide a means of calculating the delay experienced by motorists as a result of the major freeway incident and can be used to assess the overall effectiveness of various incident management techniques utilizing patrolmen to assist with traffic control.

2.2.5 Examples of Application

Figures 9 - 12 illustrate typical applications of freeway incident management techniques utilizing police officers. Figure 9 depicts an incident requiring patrolmen to effect a manual merging of traffic into the remaining open freeway lane. One patrolman should always be positioned to protect the incident site while other officers are responsible for traffic control associated with the merge transition (or diversion), if necessary. Transportation agency personnel, as available, should provide assistance with traffic control device placement and flagging support and other traffic management support. Flagging support should be of a traffic-direction approach carried out by specially trained personnel.

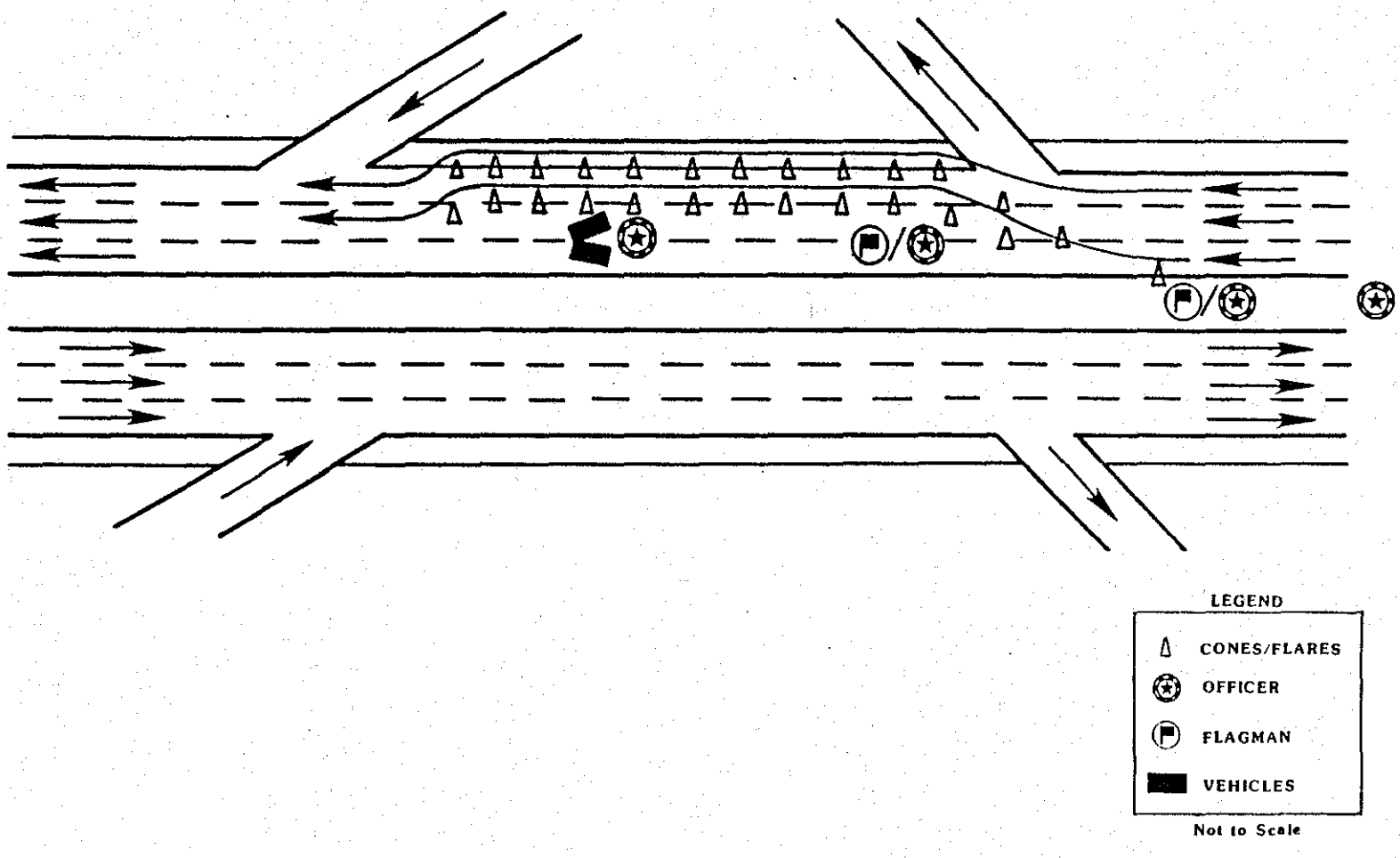
Figures 10 and 11 provide two examples of freeway incident management to make maximum use of available capacity. Figure 10 presents a freeway incident blocking the inside lanes. Police officers are utilized to transition traffic into the remaining open lane and along the shoulder for an additional lane. Figure 11 indicates a major incident closing the freeway. Patrolmen and/or flagging support are located to transition traffic to take advantage of capacity in the opposite direction. Obviously, this scenario would only be possible where there was no physical median obstruction.

In either case of shoulder usage (Figure 10) or contraflow diversion (Figure 11) extensive delineation and flagging support is needed in addition to uniformed officers. The exact requirements for both police and other support are dependent upon the duration of blockage along with location of incident and time of day (peak, off-peak).



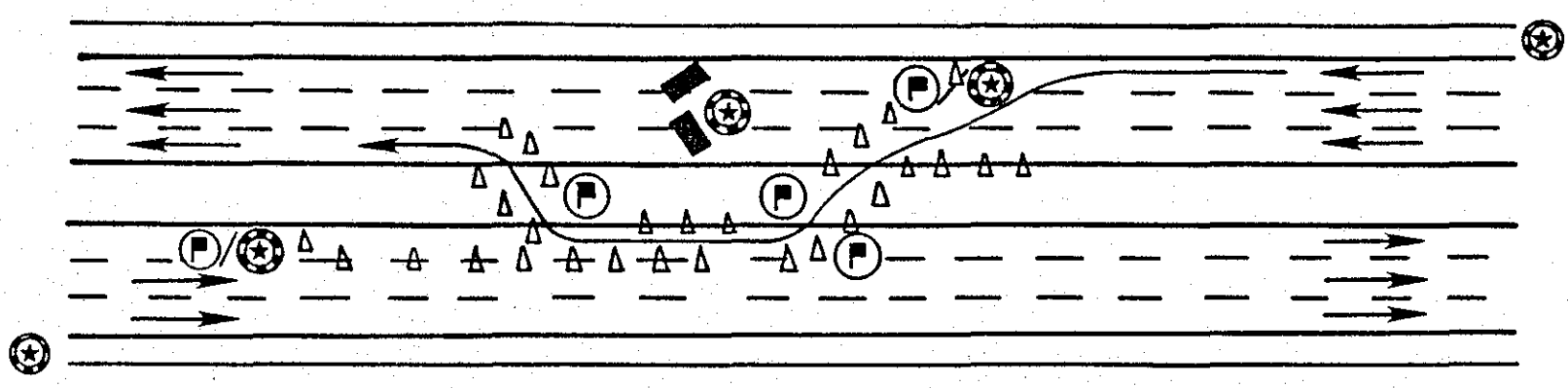
Note: Traffic control plan depicted is for illustration purposes only under emergency conditions.

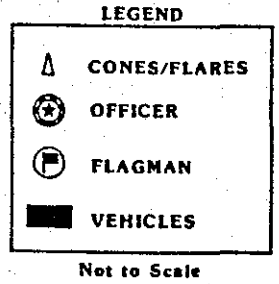
Figure 9. Freeway Incident Manual Merge



Note: Traffic control plan depicted is for illustration purposes only under emergency conditions.

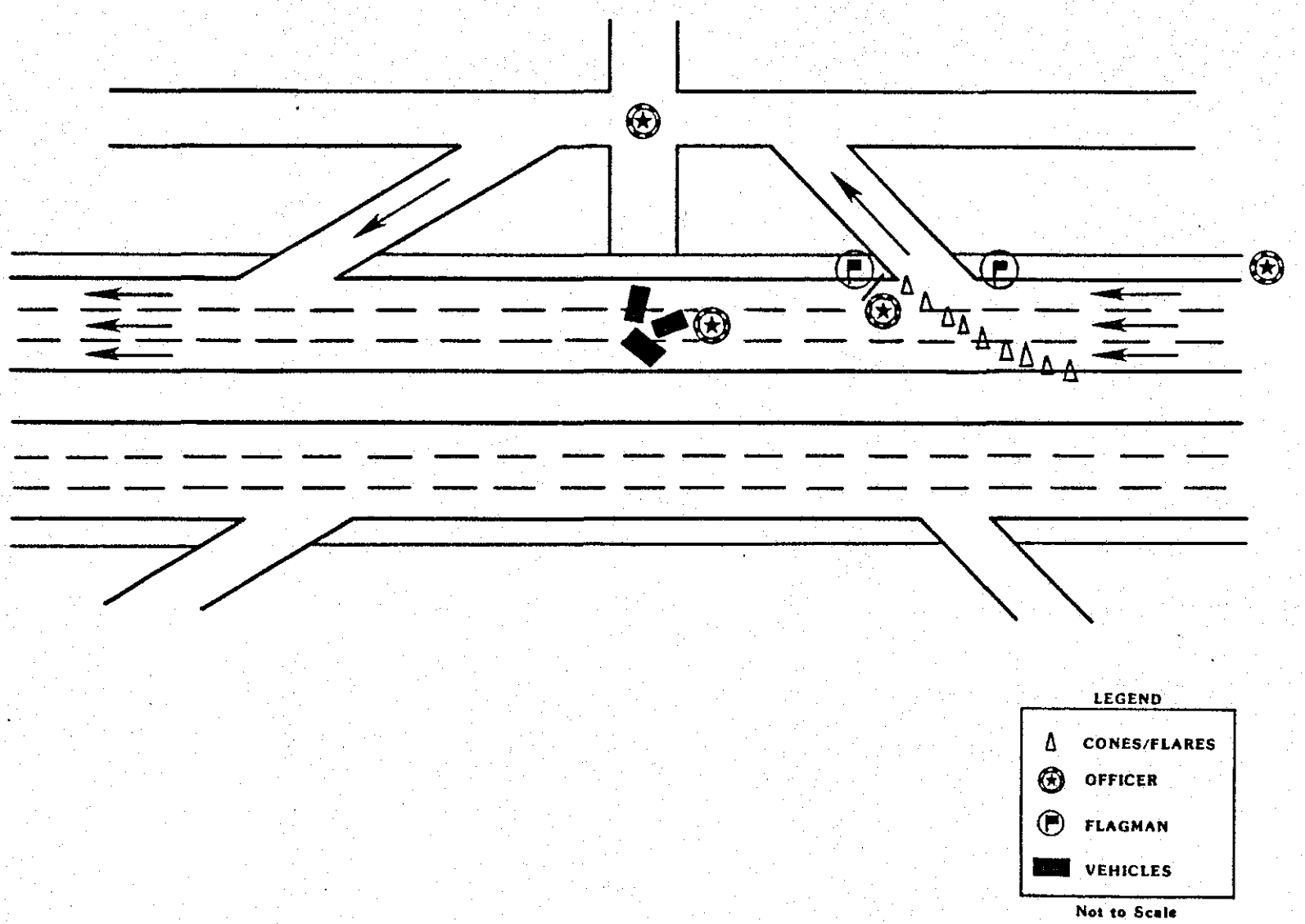
Figure 10. Freeway Incident: Shoulder Usage





Note: Traffic control plan depicted is for illustration purposes only under emergency conditions.

Figure 11. Major Freeway Incident: Contraflow Diversion



Note: Traffic control plan depicted is for illustration purposes only under emergency conditions.

Figure 12. Major Freeway Incident Ramp Diversion

Figure 12 illustrates a major incident necessitating complete freeway closure. Officers arriving at the location protect the site and request other emergency support. Where continuous frontage roads exist, traffic may be diverted onto the nearest connecting exit ramp and routed around the incident. Officers may be needed at various positions, which are site specific, to safely and efficiently implement the diversion to minimize delay.

2.3 SPECIAL EVENTS

2.3.1 General

Special events, such as sporting events and parades, exhibit many of the traits of incidents in that they frequently result in traffic congestion and other operational problems. They differ from incidents in that they are characterized by higher-than-usual traffic demands and their occurrence is generally known in advance. Consequently, police and transportation agencies can prepare, in advance, for the operational and safety problems associated with special events.

Special events may be broadly classified as short- or long-term. The traffic impacts of short-term events (parades, funeral processions, motorcades) are typically of short duration and "localized" in nature. The effects of long term special events (fairs, conventions, special sports events) are typically of longer duration and may extend several miles from the actual site of the event. Thus, long-term events may require the development of an area-wide traffic control plan (advance signing, optional diversion routes). Short-term events, on the other hand, can typically be handled "on-site" and do not require extensive area-wide traffic control.

Police agency personnel are generally well-trained in traffic control techniques for short-term special events. Consequently, the guidelines presented here pertain primarily to long-term special events which require special planning and may involve representatives from several agencies.

Many of the basic techniques used in freeway incident management are also applicable to special events. However, since the occurrence of special events is generally known in advance, police officer manpower requirements may be reduced by using transportation agency personnel to implement much of the traffic control plan.

2.3.2 Objectives of Police Utilization

The objective of utilizing police officers in traffic control for special events is to help alleviate the safety and operational problems which frequently accompany the high traffic demands associated with long-term special events. Police agency personnel provide real-time, demand-responsive control which facilitates traffic flow in situations where the threat of citation is needed to insure driver compliance with safety regulations. The patrolman, by his authority reinforces the existing or specially placed traffic control devices to serve increased traffic demands associated with the event.

Transportation agency personnel are responsible for the overall traffic control plan in response to the special event. This includes placement of all necessary traffic control devices and supervision of flagmen used for manual control of traffic in those situations where threat of citation is not required to be effective.

2.3.3 Requirements for Implementation

Requirements for traffic control for long-term special events are comparable to those for off-freeway diversion procedures used for major freeway incidents, except such diversion routes are typically of an optional nature. Manpower needs include transportation agency personnel to place signs to identify alternate routes to reduce delay in the vicinity of the special event, and police officers or flagmen for manual traffic control at intersections along the diversion route(s). Generally, five to ten individuals will be required, depending on the length and complexity of the diversion routes.

The personnel requirements for special events differ from those of incidents in that uniformed patrolmen are typically not needed for on-freeway traffic control. However, uniformed police officers should be used for manual traffic control at high volume intersections in the immediate vicinity of the special event and along diversion routes.

2.3.4 Assessment of Effectiveness

The effectiveness of utilizing police officers in traffic control for special events should be measured in terms of how quickly operations in the vicinity of the event can be restored to normal. The delay experienced by event generated traffic, as well as the delay experienced by other motorists as a result of the special event, can be used to assess the overall effectiveness of various traffic control techniques with police agency support.

2.3.5 Examples of Application

Figures 13 and 14 illustrate typical set-ups for optional diversion routes used to facilitate traffic flow in the vicinity of a long-term special event. Officers are needed at all locations along the diversion route where real-time, demand responsive, manual traffic control is needed in place of stationary fixed time control (signs, signals, etc.). The traffic control plan for diversion routing associated with a special event would be very similar to the traffic control implemented resulting from a major incident. However, more opportunity exists for prior planning, rather than emergency reaction, such that the utilization of patrolmen can be minimized with sufficient support by other personnel (flagmen) and appropriate traffic control devices.

Each special event is unique. Therefore, traffic control should be jointly planned by all responsible agencies, including individuals representing the event sponsor, the area transportation agency, and the police agency with local jurisdiction. Considerations in this planning process should include route capacities, modifications to traffic control

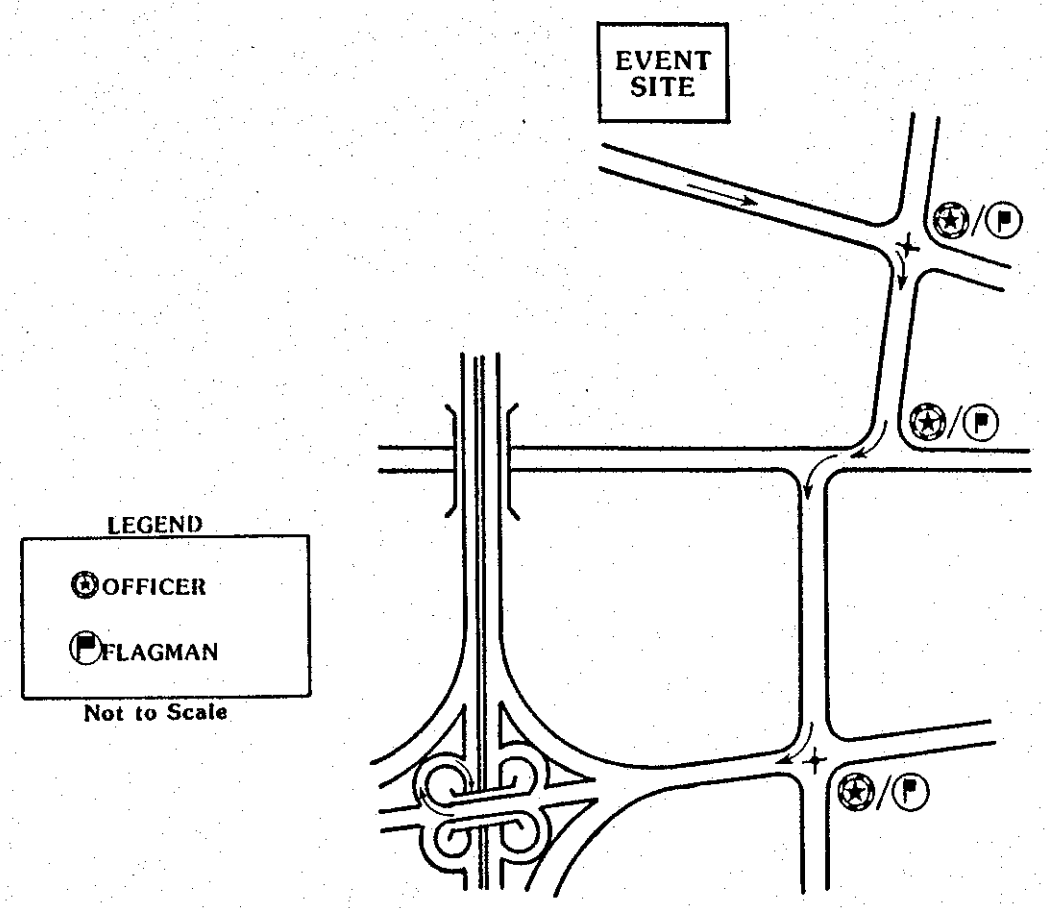


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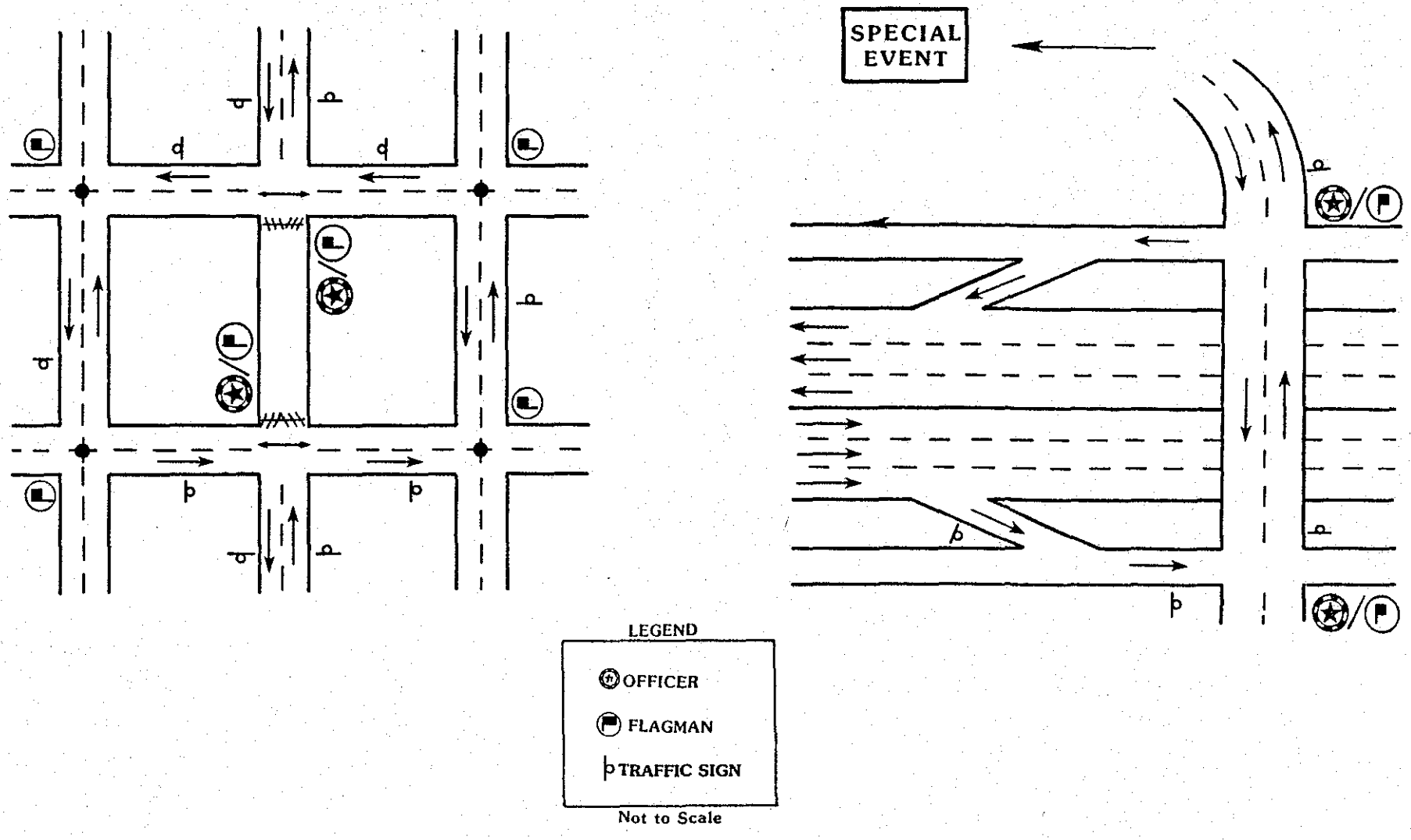
Figure 13. Special Event Diversion Routing



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2. The officer/flagman symbol indicates the possible location of either a flagman or a police officer (or both) depending upon specific event conditions and the judgement of the responsible agency.

Figure 14. Examples of Optional Diversion Route Set-Ups

devices, locations requiring real-time, manual control of traffic, and manpower requirements for police and other support.

2.4 SUMMARY

2.4.1 Construction and Maintenance Work Zones

Increasing levels of maintenance and construction activities on urban streets and freeways will necessitate a corresponding increase in the need for uniformed police personnel. Uniformed police personnel are needed to help insure the safety of the site and to maintain traffic flows through the site. Effective traffic control in maintenance and construction zones should not involve issuance of citations by police personnel involved in traffic control activities. However, where safety and movement of traffic through a construction or maintenance work zone is jeopardized by non-adherence to posted traffic warnings/regulations, then additional police personnel are required for enforcement. Each project is different by nature and should be monitored to determine if there is a problem with compliance which would necessitate the need for enforcement. The supervising engineer is responsible for this decision based on experience and field observations.

The requirements for traffic control in maintenance and construction zones will vary from site to site. Choice of the appropriate technique and manpower requirements will depend upon the type of work being performed, the length and duration of the work, and the time of day during which the work is being conducted. Figures 4-8 presented typical traffic control plans for a range of freeway maintenance and construction activities. These typical set-ups should be useful in developing traffic control plans for maintenance and construction activities likely to be undertaken by transportation agencies in Texas. Table 1 summarizes goals, objectives and measures of effectiveness for the traffic control strategies which may be used in conjunction with maintenance and construction activities.

2.4.2 Major Incident Response

A freeway incident is defined as an accident, mechanical breakdown, cargo spillage, or other traffic event that results in traffic congestion. This study presents general guidelines for use of uniformed police officers for traffic control at major freeway incident sites; where a major incident

Table 1. Goals, Objectives and Measures of Effectiveness for Urban Freeway Maintenance and Construction Traffic Control Strategies Utilizing Police Officers.

Goal	Objectives	Strategies	Measures of Effectiveness
Insure safety of the work zone	• Maximize safety	• Maximize visibility of site (traffic control personnel and workers) • Position police personnel and traffic control devices immediately adjacent to conflict points • Position police personnel and traffic control devices to provide advance warning of work zone	• Accidents (personal injury and property damage) • Accident rates • Conflicts
Maintain acceptable traffic flows through the work zone	• Minimize motorist delays	• Active traffic control by police personnel in cooperation with the supervising project engineer	• Travel times • Speeds • Length of queues

is defined as one that cannot be effectively managed by a single patrolman or patrol vehicle.

General guidelines for two general incident management strategies (techniques for increasing capacity and techniques for managing demand) were presented in Figures 9-14. Techniques for increasing capacity in the vicinity of an incident included: 1) Use of freeway shoulders; 2) Merging techniques, and 3) Contraflow operations. Demand management strategies included off-freeway diversion and advance warning signs.

Since the primary objective of incident management is to restore freeway traffic services are quickly and as safely as possible, the effectiveness of incident management techniques utilizing police officers should be measured in terms of: 1) How quickly the incident can be cleared and normal traffic services restored; and 2) How effective the techniques are in preventing or minimizing secondary incidents. Table 2 summarizes freeway incident management traffic control strategies in terms of goals, objectives and measures of effectiveness.

2.4.3 Special Events

Many of the basic techniques used in freeway incident management are also applicable to special events. However, since the occurrence of special events is generally known in advance, police officer manpower requirements may be reduced by using transportation agency personnel to implement much of the traffic control plan.

Requirements for traffic control for long-term special events are comparable to those for off-freeway diversion procedures used for major freeway incidents, except such diversion routes are typically of an optional nature. Figures 13 and 14 illustrated some typical diversion route set-ups for long-term special events.

The effectiveness of utilizing police officers and specially trained transportation agency traffic management personnel in traffic control for special events should be measured in terms of how quickly operations in the

Table 2. Goals, Objectives and Measures of Effectiveness for Major Freeway Incident Traffic Control Strategies Utilizing Police Officers.

Goal	Objectives	Strategies	Measures of Effectiveness
Protect the incident site	• Minimize secondary Incidents • Insure emergency vehicle access	• Maximize visibility of incident site • Position traffic control personnal and traffic control devices to provide advance warning	• Accidents • Accident rates • Emergency veh. response time
Maintain traffic flow and clear incident	• Minimize motorist delay • Maximize safety	• Use of shoulders • Manually-controlled merging • Contraflow diversion • Advance warning signs • Off-freeway diversion • Pre-planning regarding types and location of special equipment and traffic control personnel	• Travel times • Speeds • Accident rates • Emergency veh. response times • Time required to return to normal operations.

vicinity of the event can be restored to normal. The delay experienced by event generated traffic, as well as the delay experienced by other motorists as a result of the special event, can be used to assess the overall

effectiveness of various traffic control techniques with police agency support.

The general traffic flow goals, objectives and measured of effectiveness presented for freeway incident management strategies (Table 2) also apply to special event traffic control strategies.

3. ENFORCEMENT GUIDELINES

3.1 PRIORITY TREATMENT FACILITIES

3.1.1 General

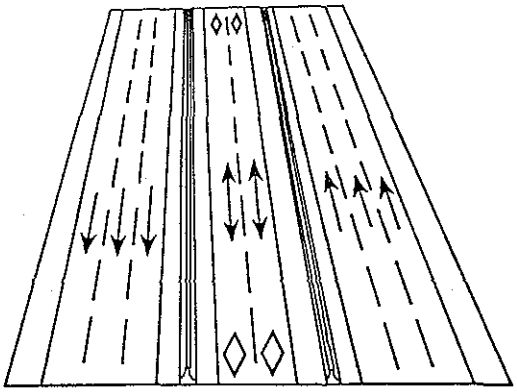
Priority treatment facilities are those areas of the freeway designated by design and/or operation to improve high-occupancy vehicle (HOV) travel speeds and, correspondingly, reduce travel time. Selected high-occupancy vehicles may be buses, vanpools, carpools, or any combination therefore, which are designated or authorized to use the priority treatment facility. These facilities have been shown to be an effective means of increasing the utilization of high-occupancy vehicles on freeways which, simultaneously, reduces congestion, energy consumption, downtown parking needs, and pollutants emitted.

With respect to enforcement application, four categories of priority treatment facilities are noteworthy. Figure 15 illustrates examples of each type of facility defined as follows:

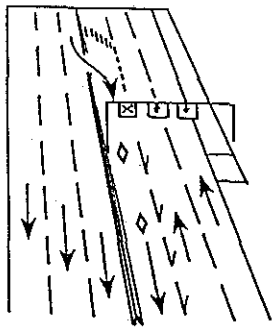
1. Separate Priority Treatment Facility. Lane or lanes that are physically separated from other freeway lanes and are designated for the exclusive, use of authorized high-occupancy vehicles. Referred to as transitways or authorized vehicle lanes.

2. Concurrent Flow Lane. A freeway lane in the peak direction of flow (commonly the inside lane), not physically separated from the other general traffic lanes, designated by traffic control devices for exclusive use by authorized high-occupancy vehicles.

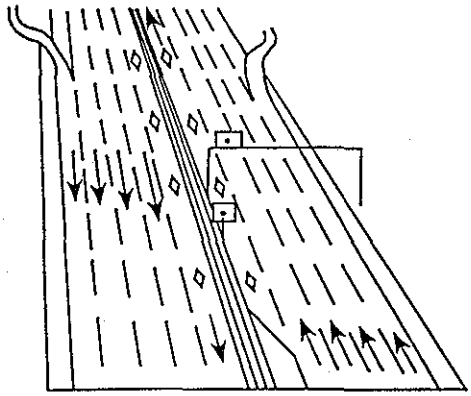
3. Contraflow Lane. A freeway lane (commonly the inside lane in the off-peak direction of travel) designated for exclusive use by authorized high-occupancy vehicles travelling in the peak direction. The lane is typically separated from the other off-peak direction travel lanes by plastic posts or other similar traffic control devices.



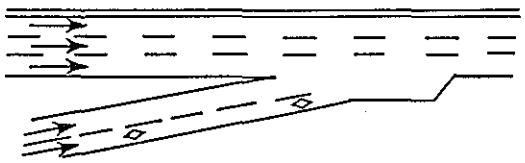
(a) Separate Priority Treatment



(b) Contraflow Lane



(c) Concurrent Flow Lane



(d) Priority Entry Ramp Treatment

Figure 15. Typical Freeway Priority Treatment Facilities

4. Priority Entry Treatment. Special ramp treatments designed for exclusive, use by authorized high-occupancy vehicles that allow those vehicles to bypass queues in entering the freeway. This treatment is commonly used in conjunction with freeway ramp metering.

3.1.2 Objectives of Enforcement

The primary objective of enforcement by police officers on priority treatment facilities is to maintain the design and operational integrity of the facility for those high occupancy vehicles designated or authorized to use it. In this regard, detection and apprehension of violators, issuance of citations to violators, and effective prosecution of violators is essential. Therefore, law enforcement personnel with full capability for citation issuance must be employed on priority treatment facilities.

A secondary objective of enforcement by police officers on these facilities is safe and efficient operations. Depending on the type of facility and priority users, the potential hazards imposed by vehicle breakdowns, wrong way movements, and/or other vehicle encroachments into the priority lane(s) pose critical considerations. Each of these potential hazards or conflicts will also adversely impact operations and must be a concern of the responsible enforcement authority. For those priority treatments which are not physically protected and involve daily, manual demarcation, protection of the field operational crews is also a responsibility of the police agency.

3.1.3 Requirements for Implementation

Depending on type of priority treatment facility and enforcement strategies, location of officers is extremely important. For priority entry bypass ramps, the officer should be located with a clear view of the ramp such that a determination of vehicle occupancy compliance may be made. The selection of location should be sufficient to allow adequate time and distance after identification of a violator for indication by signal of intended apprehension for citation. Adequate and safe refuge space for violator pullover should be provided.

Where access to a priority treatment facility is non-controlled and/or non-separated from adjacent freeway lanes, tandem (two officers) enforcement at strategic points may be most applicable. This technique locates an officer at an entry area to the HOV facility who detects the violation. Vehicle identification is communicated to a second officer located at a facility exit area. The second officer is responsible for apprehension and citation of the violator. This technique may require several officers to enforce facilities with multiple entry/exit locations.

Pursuit, apprehension and citation may also be employed at selected entry locations utilizing fewer enforcement personnel. This technique involves detection and pursuit of a violator on the facility with subsequent citation at a designated location off the facility. Application of this technique is very site specific and may only be implemented if the violator can be removed from the priority treatment facilities. The design requirements are:

1. A safe and easily accessible refuge area(s) bordering the priority lane in which to cite violators.

2. Existence of a vantage point(s) from which enforcement personnel can observe the priority lane.

3. A physical barrier between the priority lane and the general freeway traffic lane.

From the standpoint of citation for non-compliance, enforcement experience on priority treatment facilities (2) indicates the need for strict enforcement at the outset of a project. To allow the public time to become accustomed to the priority treatment, violators should be issued warnings for a short period.

Strict enforcement effort should continue for one to two months depending upon the type of priority treatment, the number of intermediate access points, the "innovativeness" of the priority treatment, and the degree to which standardized and frequent signing and marking is utilized.

Following the strict enforcement period, the enforcement effort can decrease to a more nominal level.

3.1.4 Assessment of Effectiveness

The effectiveness of enforcement on priority treatment facilities may be measured in terms of violation rates. Violation rate is defined as the percent of the total number of vehicles using the priority treatment facility which do not meet the occupancy authorization requirements. A wide range of violation rates have been observed--from 0 percent to over 90 percent (2). One intent of employing a certain level and type of enforcement is to achieve a violation rate that is acceptable to maintain the integrity of the priority treatment facility.

Various factors will affect violation rates on any particular priority treatment facility where enforcement is applied. These are as follows:

1. Priority signing and marking;
2. Type or combination of authorized vehicles;
3. Travel time incentive;
4. Probability of apprehension;
5. Penalty for violation;
6. Accessibility to priority facility;
7. Operating time period;
8. Level of occupancy authorization;
9. Visibility; and
10. Weather conditions.

Other areas relating to priority treatment enforcement may also be used to assess effectiveness. These include the following:

1. The relationship between the number of citations issued and the number of violations occurring.

2. The interrelationships between the violation rate, apprehension rate and the travel time savings of the priority lane.

3. The changes in the violation rate due to changes in the quantitative, qualitative or substantive aspects of the enforcement application.

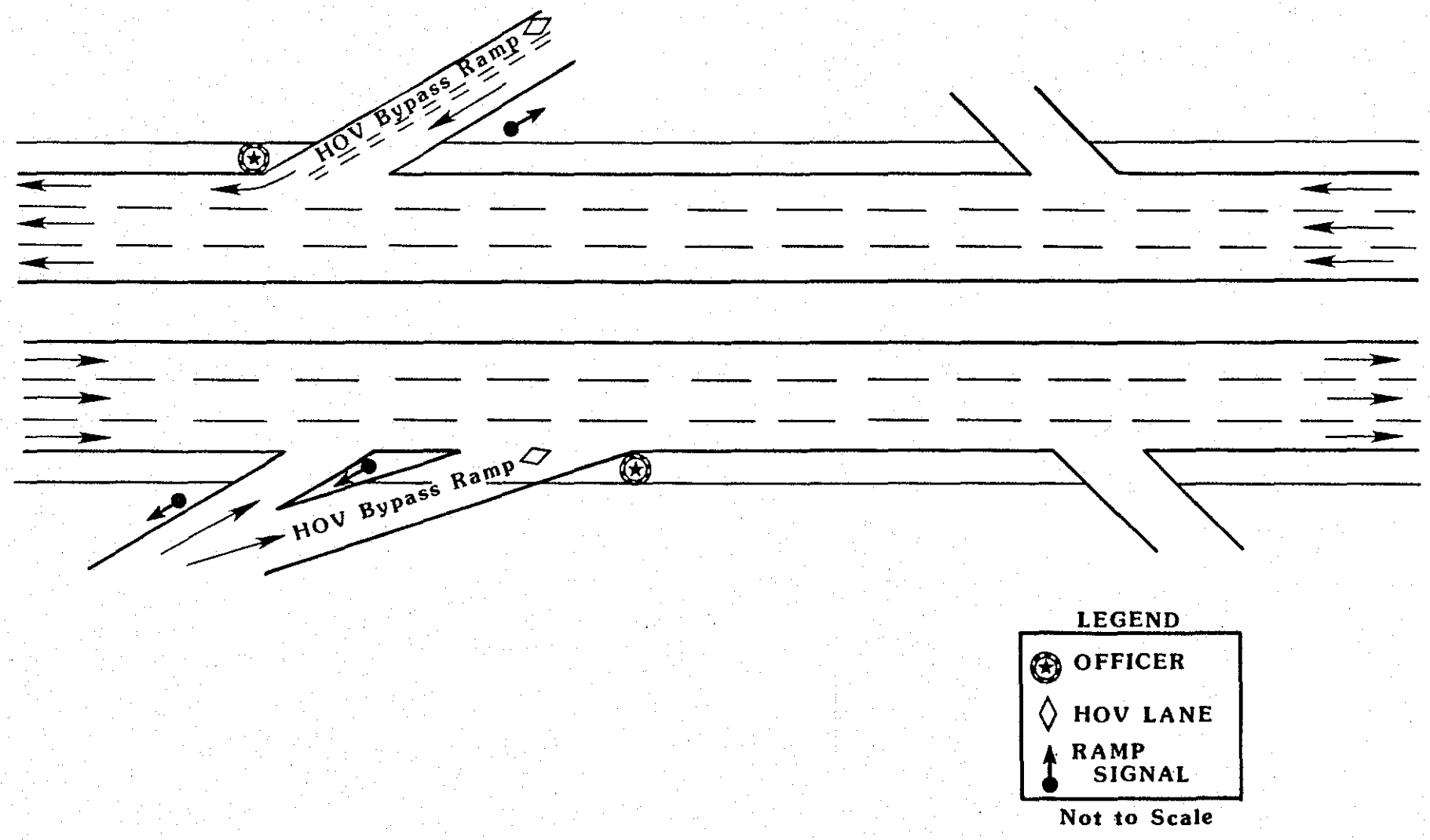
3.1.5 Examples of Application

Figures 16 to 18 illustrate several examples of enforcement on priority treatment facilities. Figure 16 indicates officer locations on two types of priority entry ramps. The patrolman must be in a position for good visibility on the ramp to assess priority restrictions with sufficient time to restrain violators. It's critical to have a refuge area adjacent to the priority ramp for this purpose and to issue citations.

Figure 17 presents possible enforcement strategies for either contraflow or concurrent flow lanes. Detection and apprehension of priority violators may utilize "catchment pairs" of patrolmen or routine line patrol procedures. Again, refuge areas for citation are essential.

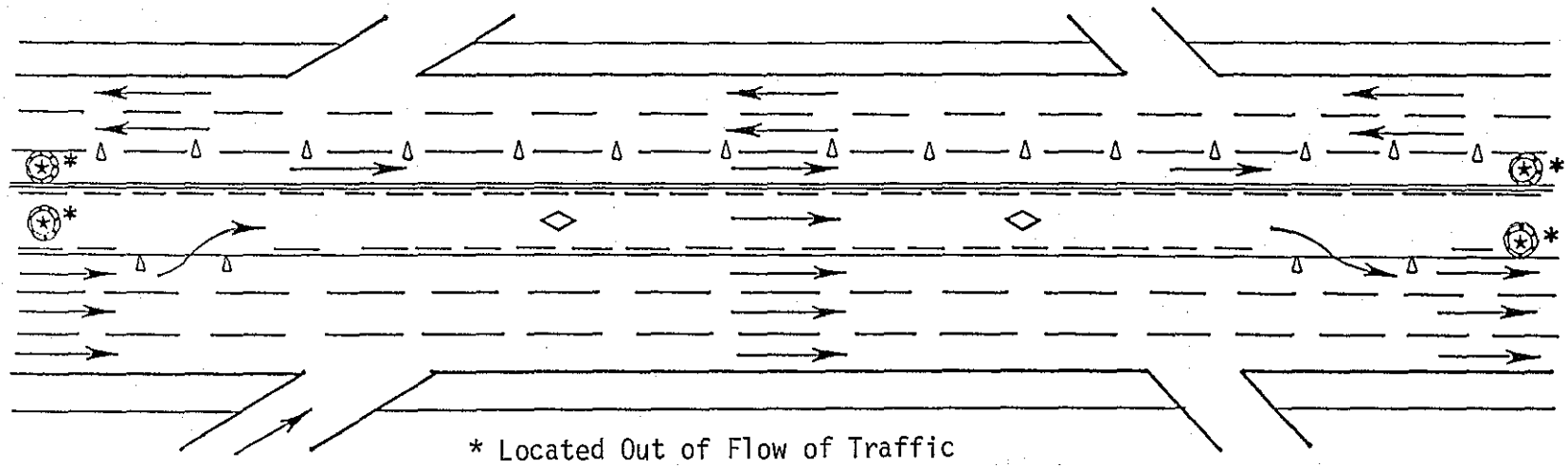
Figure 18 highlights the possible need for additional officers for enforcement on physically separated, controlled access, priority treatment facilities (transitways) with multiple entry/exit points. Violations must be controlled to maintain the priority authorization of the facility.

Enforcement on priority treatment facilities may come from local police agency personnel or it may be the responsibility of the operating transit authority. In this case, special transit police may enforce (detect, apprehend, cite) violations on these type of priority facilities. This insures, somewhat, consistency in enforcement due to more day-to-day facility operating experience by the transit police personnel.



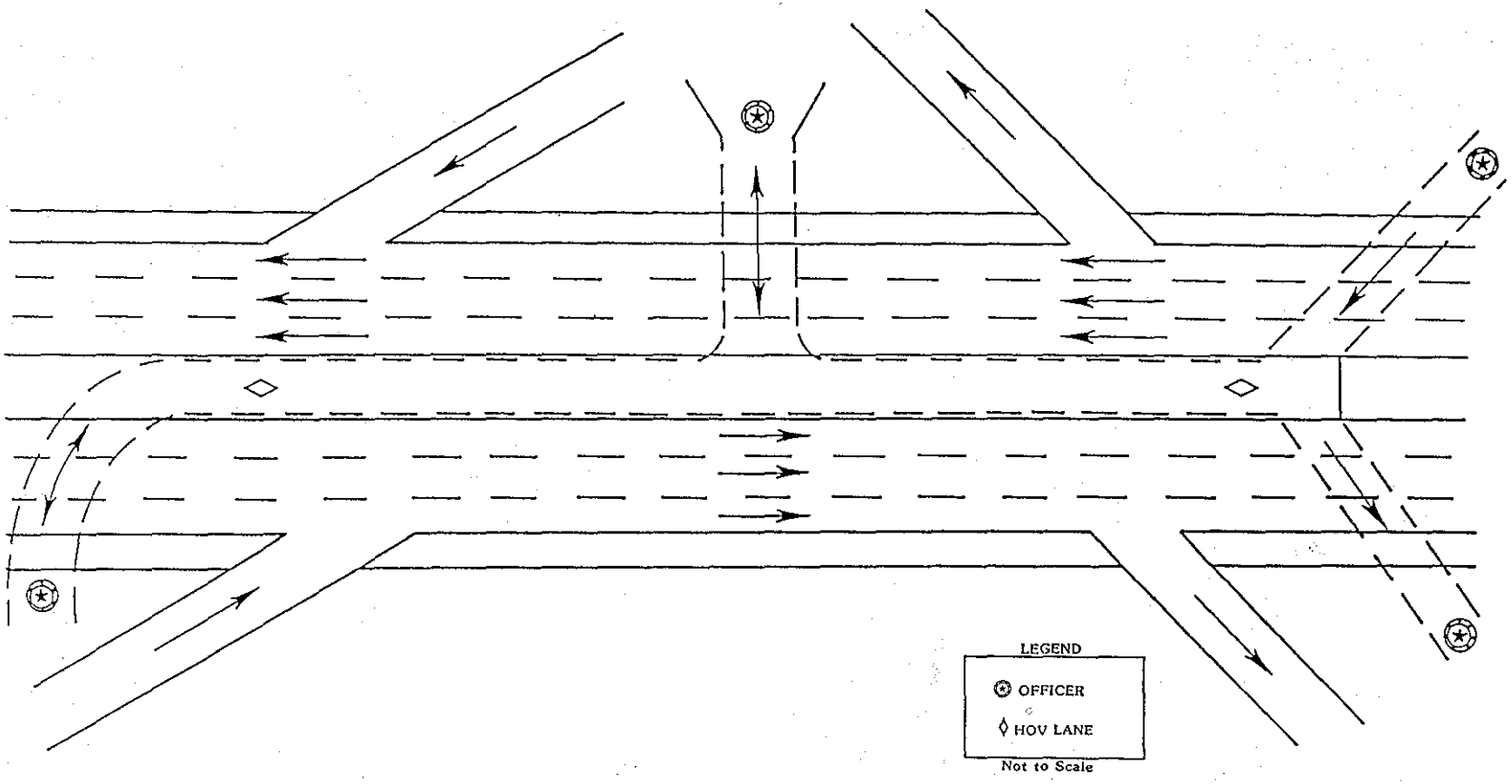
Note: Traffic control plan depicted is for illustration purposes only. It is not a standard or specification. In all cases, the MUTCD should be adhered to for location and placement of traffic control devices.

Figure 16. Priority Entry Ramps



Note: Traffic control plan depicted is for illustration purposes only. It is not a standard or specification. In all cases, the MUTCD should be adhered to for location and placement of traffic control devices.

Figure 17. Priority Contraflow/Concurrent Flow Lanes



Note: Traffic control plan depicted is for illustration purposes only. It is not a standard or specification. In all cases, the MUTCD should be adhered to for location and placement of traffic control devices.

Figure 18. Median Transitway

3.2 TRANSPORTATION SYSTEM MANAGEMENT OPERATIONS

3.2.1 General

As stated previously, increasing traffic demands are being imposed on urban freeway systems which are limited by both space and capacity. Transportation System Management (TSM) improvements concentrate on operational problems to improve the efficiency of the urban freeways. Enforcement of special regulations associated with TSM projects is essential for successful operations.

Several types of TSM operations that depend on enforcement are:

1. Ramp Meter Control. Technique of restraining the flow of freeway traffic at certain points to prevent congestion at more crucial locations. Accomplished by signalized metering of selective entrance ramp volumes.

2. Commercial Vehicle Routing. Technique of route direction for through trucks such that areas of intense congestion are bypassed. Also applicable for hazardous material movements for obvious safety considerations.

3. Speed Zoning. Technique involving reduction in posted speed for all vehicles on urban freeways and additional reduction in speed limits (differential) for large vehicles. Strict enforcement is essential to either.

4. Lane Restrictions. Technique designating a specific lane (extreme right or left) to be utilized by trucks to enhance both freeway safety and operations. Preliminary results as to effectiveness are inconclusive.

5. Shoulder Usage. Technique to increase freeway capacity by modifying the surface geometrics (reduction in mainlane widths and consumption of shoulder for additional travel lanes). May be operated either continuously (24-hour) or on a permissive (peak periods only) use basis.

The type of enforcement required on TSM projects is more "traditional", although the nature of the violations is somewhat unique. In most cases, active patrol and arrest activity are required to insure acceptable compliance with special TSM regulations necessary for successful and sustained operation. The lack of enforcement has been the overriding reason for the failure of many TSM efforts.

3.2.2 Strategies of Enforcement

There are three primary strategies employed for enforcement on TSM projects. These are given as follows:

1. Routine Enforcement - Which is conducted in concert with normal police officer's patrol duties;

2. Special Enforcement- Characterized by continuing, systematic manpower allocations and enforcement tactics specifically dedicated to enforce TSM operational violations. Involves reallocation of existing forces to the TSM effort or assigning additional manpower and equipment during TSM project operating hours (using existing police personnel on overtime basis or hiring additional patrol personnel);

3. Selective Enforcement - Special tactics applied periodically to specific problem area where violations of the TSM improvement have been observed. The application of selective enforcement can vary in terms of time, location and level of effort. Police personnel are generally made available by a reassignment of manpower from other duties.

Due to the special regulations necessary for TSM operations, increased enforcement manpower many times is required for initial implementation. This would be the case for ramp metering, truck routing, or various types of speed zoning. Over a period of time with effective compliance to the designated TSM restrictions, enforcement may be reduced to more routine levels. The amount of enforcement applied after the period of increased enforcement is dependent on the number of observed violations.

Other types of TSM projects, such as a special lane or shoulder usage, may require a continuing level of selective enforcement to adequately control violations. This may involve assignment of patrol manpower for certain times or locations; or randomly to extend the enforcement effect.

The selection of a particular strategy to be applied on a TSM project should be made by the supervising officer of the enforcement agency. As stated previously, this type of enforcement is traditional for special regulations.

3.2.3 Enforcement Procedures

There are several alternate procedures available for conducting TSM enforcement activities. These procedures cover various aspects of surveillance, detection, apprehension and citation of violators. With respect to surveillance and detection, a TSM enforcement program may include one or a combination of the following types of patrol:

1. Line patrol. Enforcement personnel travel by motor vehicles over a particular freeway section.

2. Zone patrol. Enforcement personnel travel by motor vehicle(s) over a zone in a particular area (not limited to a roadway section).

3. Stationary patrol. Enforcement personnel and motor vehicles are deployed in a fixed position at specific locations.

The TSM enforcement process may also include one or more of the following apprehension and citation procedures:

1. Standard. Involves the pursuit of a TSM violator followed by apprehension and issuance of a citation by a single patrol unit.

2. Stationary. Does not involve pursuit of the violator; involves directing the TSM violator to a refuge area for citation.

3. Signaling. Involves using appropriate physical gestures by the officer to the motorist in violation of the TSM regulation so that he is aware of infraction; may or may not involve apprehension or issuance of a citation.

Line and stationary patrols with standard or stationary apprehension and citation methods are the most commonly used enforcement procedures associated with TSM improvement projects.

3.2.4 Effectiveness of Enforcement

As with priority treatment facilities, the effectiveness of enforcement applied to transportation system management operations may be evaluated by compliance with posted restrictions and regulations. Studies (6) indicate that even low levels (i.e., one officer per week per month) of special enforcement will significantly reduce violations on most TSM projects. Moreover, the residual effects of active enforcement on TSM facilities have controlled the violation rates for 4-8 weeks after cessation.

Specifically, at ramp meter locations, enforcement appeared to be most effective where violation rates were previously high. On ramps where violation rates were already low (less than 4%), special enforcement seems to have less impact on reducing violations further, and violation rates returned to pre-enforcement conditions much faster. In the absence of enforcement, ramp violation rates can be expected to increase over time to the point at which meter effectiveness is minimized. (6)

For TSM projects involving special speed zoning, several studies (7, 8, 9) have shown the effectiveness of visible and active officer presence as measured by in-view hours and total stops. Speeding violations may be reduced by as much as 50% or more; and reductions in overall average speed and speed variability may be expected with enforcement presence. However, there is no consensus as to optimal or desired level of enforcement.

3.3 SUMMARY

3.3.1 Priority Treatment Facilities

The objectives of police enforcement on priority treatment facilities (transitways, concurrent flow lanes, contraflow lanes, HOV by-pass ramps) are to maintain the operational integrity and safety of the facilities. Consequently, a strict and active enforcement program is necessary. Detection and apprehension, issuance of citations, and effective prosecution of violators is essential.

For HOV by-pass ramps, the police officer should have a clear view of the ramp so that determination of vehicle occupancy can be made. A safe and accessible refuge area bordering the by-pass ramp should be provided for citation of violators.

For priority treatment facilities which do not have full access controls and/or are not physically separated from the general use freeway lanes, tandem enforcement at strategic locations along the facility may be applicable. In this technique, one officer detects violators and a second officer stationed downstream apprehends and cites violators. Figures 16-18 illustrated typical set-ups for priority treatment enforcement procedures.

Table 3 summarizes goals, objectives and measures of effectiveness for priority treatment enforcement techniques.

3.3.2 Transportation System Management Operations

Transportation system management strategies typically involve short-term improvements directed at making more efficient utilization of the existing transportation system. Basically, TSM methods are actions or groups of actions intended to produce shifts in the supply-demand equilibrium of the transportation system. Many of these strategies involve a rearrangement of physical facilities and/or operating practices, requiring users to face new situations and to learn new rules. Consequently, the success of many TSM strategies, such as ramp metering, commercial vehicle routing, speed zoning,

Table 3. Goals, Objectives and Measures of Effectiveness for Priority Treatment Enforcement Strategies.

Goal	Objectives	Strategies	Measures of Effectiveness
Maintain operational integrity	• Minimize travel times • Maximize vehicle occupancy levels • Minimize violation rates	• Strict enforcement of vehicle occupancy requirements • Clear communication of nature of facility • High visibility of enforcement officers • Swift, safe removal of violators	• Violations • Violation rates • Travel times
Maintain safe operations	• Minimize accidents • Minimize incident response and clearance times	• Strict enforcement of authorization requirements • Clear communication of nature of facility • Swift, safe removal of violators	• Accidents • Accident rates • Incident response and clearance times

lane restrictions, and shoulder usage, depends, in large part, on the effectiveness of the enforcement program which accompanies them.

There are three basic enforcement strategies which may be used in conjunction with TSM projects. These are: 1) Routine enforcement; 2)

Special enforcement; and 3) Selective enforcement. Specific enforcement procedures for TSM projects may include one or more of the following types of patrol: 1) Line patrol; 2) Zone patrol; and/or 3) Stationary patrol. In addition, the TSM enforcement process may include one or more of the following apprehension and citation procedures: 1) Standard; 2) Stationary; and/or 3) Signaling. Line and stationary patrols with standard or stationary apprehension and citation methods are the most commonly used enforcement procedures associated with TSM improvement projects.

As with priority treatment facilities, the effectiveness of TSM enforcement activities may be evaluated in terms of compliance with posted restrictions and regulations. Even low levels (i.e., one officer per week per month) of special enforcement may significantly reduce violations on most TSM projects. Moreover, the residual effects of active enforcement on TSM facilities have controlled the violation rates for 4-8 weeks after cessation of the special enforcement activities.

Table 4 summarizes goals, objectives and measures of effectiveness for selected TSM project enforcement strategies.

Table 4. Goals, Objectives and Measures of Effectiveness for Selected TSM Project Enforcement Strategies.

Goal	Objectives	Strategies	Measures of Effectiveness
Manage System Demand	• Meter freeway input (ramp metering)	• Strict enforcement of ramp metering	• Violations • Violation rates • Travel times
	• Reduce commercial vehicle congestion (commercial vehicle routing)	• Strict enforcement of truck/commercial vehicle route regulations	
	• Segregate vehicle types (Lane restrictions)	• Stringent enforcement of lane restrictions	
	• Reduce incidents and conflicts (e.g., speed zoning)	• Stringent enforcement of speed limits • High visibility of enforcement officers	
		• Institution of selective enforcement programs	
Increase system capacity	• Maximize capacity (Shoulder usage)	• Institution of selective enforcement programs	• Travel times • Accident rates
	• Minimize travel times		

4. IMPLEMENTATION ISSUES

4.1 GENERAL

The implementation of the guidelines presented in the previous sections requires first that some dissemination mechanism exist to place the guidelines in the appropriate hands. Second, there must be some means of training available to instruct police officers in the use of the guidelines. Finally, there must be some command or control structure to ensure that the guidelines are implemented.

The use of law enforcement officers to control traffic in work zones provides a built-in method of disseminating the guidelines. The contractor performing the work is responsible for the traffic control plan. Should this plan require enhancement, the contractor may hire law enforcement officers on a part-time basis. As these officers are hired, copies of the guidelines may be distributed and instruction in their use provided.

Dissemination of the guidelines poses a much greater problem in the cases of traffic control for major incidents and special events and for enforcement on priority facilities or TSM projects. These activities require a great deal of prior planning, training and rehearsal. It is possible for this planning to originate in the context of corridor management team meetings. However, at present, the level of involvement of most law enforcement agencies in these meetings is not sufficient to carry out an implementation program. Should the level of involvement increase, then detailed implementation procedures based on the guidelines would need to be developed by the law enforcement agencies participating.

Ideally, both dissemination of the guidelines and training in their use should become a part of the basic law enforcement certification course. Unfortunately, this curriculum is already overburdened and, unless the guidelines have proven their usefulness over time, it is unlikely that the Texas Commission on Law Enforcement Standards and Education (TCLOSE) would consider their inclusion.

Once the guidelines have been disseminated and law enforcement personnel trained in their application, the issue of command and control can be addressed. From a theoretical standpoint this is the most difficult obstacle confronting the implementation of the guidelines. Law enforcement officers in the field respond to the command authority of their supervisors in terms of assignments, responsibilities, and enforcement emphasis. However, they work as detached units and react to the dynamics of their environment. Often they must make field decisions that may remove them from their original assignments. Supervising officers must deal with competing demands for personnel and must establish priorities for assignments. Frequently these priorities are influenced by public or political pressure rather than actual need developed using objective criteria.

Realistically, if sufficient need can be demonstrated, or if funds can be provided to obtain additional manpower, the command structure of a law enforcement agency can generally arrange to dedicate personnel for a specific task. This is generally the approach taken for selective traffic enforcement projects (STEPs) where off-duty officers are paid with outside funds to address a specific problem. In such projects, only the most flagrant violations distract officers from their assignments.

In addition to the issues of dissemination, training and implementation, discussions with law enforcement officials, the review of the literature and the experience of the staff produced ancillary questions that might need to be resolved before the enforcement guidelines can be successfully implemented. These issues can be categorized as: 1) institutional, or those dealing with the internal and external orientation and relationships of law enforcement agencies, 2) legal, or those issues dealing with the responsibility to enforce and the legality of enforcement techniques, and 3) economics, or those issues related to manpower and funding.

Each of the two areas described in the guidelines has certain characteristics that are somewhat unique in the realm of traffic law enforcement. The control of traffic through work zones, for example, requires using officers in a non-enforcement oriented role. On the other

hand, traffic law enforcement on priority treatment facilities and TSM projects requires typical enforcement strategies and tactics.

Although in some instances the same implementation issues apply to both work zone traffic control and priority and TSM enforcement, the two areas are addressed separately in the following sections.

Again, these issues are not critical to the implementation of the enforcement guidelines. They simply represent problems that may arise. It is not the intent of the information presented to provide solutions to specific problems; rather they are intended to provide a basis for discussion during implementation planning sessions in order that they may be addressed and resolved by participating agencies.

4.2 TRAFFIC CONTROL ISSUES

4.2.1 Institutional

Law enforcement personnel, by virtue of their training are oriented toward apprehending people who violate laws. They are much more familiar with this aspect of their responsibility than they are with preventing violation or using their authority to control behavior. Because of this orientation, it is not surprising that some officers, when asked to control traffic through work zones, resort to citing violators.

This form of institutional resistance is usually compounded by transportation personnel who are not sure of the role law enforcement officers are to play when they are assigned to work zones and to whom they are responsible.

This enforcement orientation is not as prevalent during the occurrence of major incidents because of the requirement to secure the scene from a safety standpoint and because these incidents are usually of short duration. However, the attention of responding officers is on resolving the incident rather than managing the traffic problems that develop. In some cases, the number of officers dispatched to the scene of a major incident is usually

insufficient to handle both the incident management and traffic control roles. During these incidents there may be many agencies that respond that have some area of responsibility which may result in confusion of control authority and conflicts of purpose.

Traffic management for special events is a function to which most officers have been assigned at one time or another. These events are usually of short duration and have been planned to some degree within the law enforcement agency. However, there may be a need to include wrecker crews, emergency medical services, and appropriate traffic engineering, and maintenance personnel.

4.2.2 Legal

The primary legal issue resulting from the use of law enforcement personnel to control traffic through work zones is the disparity between the job they are contracted to perform and their sworn duty to uphold the law. In order to effectively manage traffic, officers cannot divert attention to the time consuming activity of stopping and citing violators. However, officers are obligated and trained to take action against drivers committing infractions. This dilemma is further compounded by the restriction against using funds dedicated for construction and maintenance to pay for enforcement activities. These funds, however, can be used to pay for traffic control. In this regard, much like STEPs, the primary responsibility of the officer is to the specific task set by the contractor, other enforcement activities become secondary.

4.2.3 Economic

The main economic issue is that of allocation of scarce resources. Enforcement agencies are notoriously undermanned and are consequently reluctant to dedicate manpower to areas other than those of the highest priority. In most urban areas, crime prevention and criminal investigation take precedence over traffic law enforcement. Within the realm of traffic law enforcement, traffic control assumes a lower priority than active traffic law enforcement. Since this is the case, the probability of having manpower

consistently available for traffic control is small. Consequently, there is a need for funds to hire off-duty personnel on a supplemental basis. Since active enforcement is not desired and since a clear cut accident problem usually does not exist, selective traffic enforcement or STEP funds would not be appropriate. This suggests that funds set aside by contractors for traffic control may be the best source, provided the institutional and legal difficulties can be overcome.

4.3 PRIORITY TREATMENT AND TSM ENFORCEMENT ISSUES

4.3.1 Institutional

The basic institutional issues which should be addressed in assessing enforcement needs are those of "enforcement philosophy" and interagency cooperation. Most enforcement agencies consider traffic enforcement measures primarily as means to reduce accidents or improve the safety conditions of a specific facility. This basic philosophy needs to be expanded to encompass the effective use of enforcement strategies in achieving an efficient movement of traffic. Early involvement of the enforcement agency in project planning/or additional enforcement agency training programs may be needed to bring about this broadening of enforcement philosophy.

Enforcement agencies tend to be institutionally isolated from those agencies responsible for transportation planning. Typically, police officials are not members of, and do not attend, meetings of formal transportation groups. Police involvement in transportation planning is typically on a project-by-project basis.

A significant factor in achieving a successful enforcement program appears to be early involvement in the planning process by representatives of the enforcement agencies affected. Such early involvement will insure consideration of the following five key elements of a sound enforcement plan (10).

1. Good Enforcement Design. One of the most serious requirements of good enforcement requires not just a good enforcement design but also a good safety design. In project planning, enforcement officers, who possess a wealth of knowledge and practical experience in traffic regulation and enforcement and safety-related matters, can make an important contribution.

2. Promotion of Cooperative Relationships. Early involvement in the initial planning gives each agency a feeling of importance and proprietorship in the project and thereby provides each agency with an impetus for the development of a successful project.

3. Provision of Technical Advice. Because of the police officer's familiarity with motorists and pedestrian behavior, enforcement personnel can provide valuable advice on signing and striping schemes.

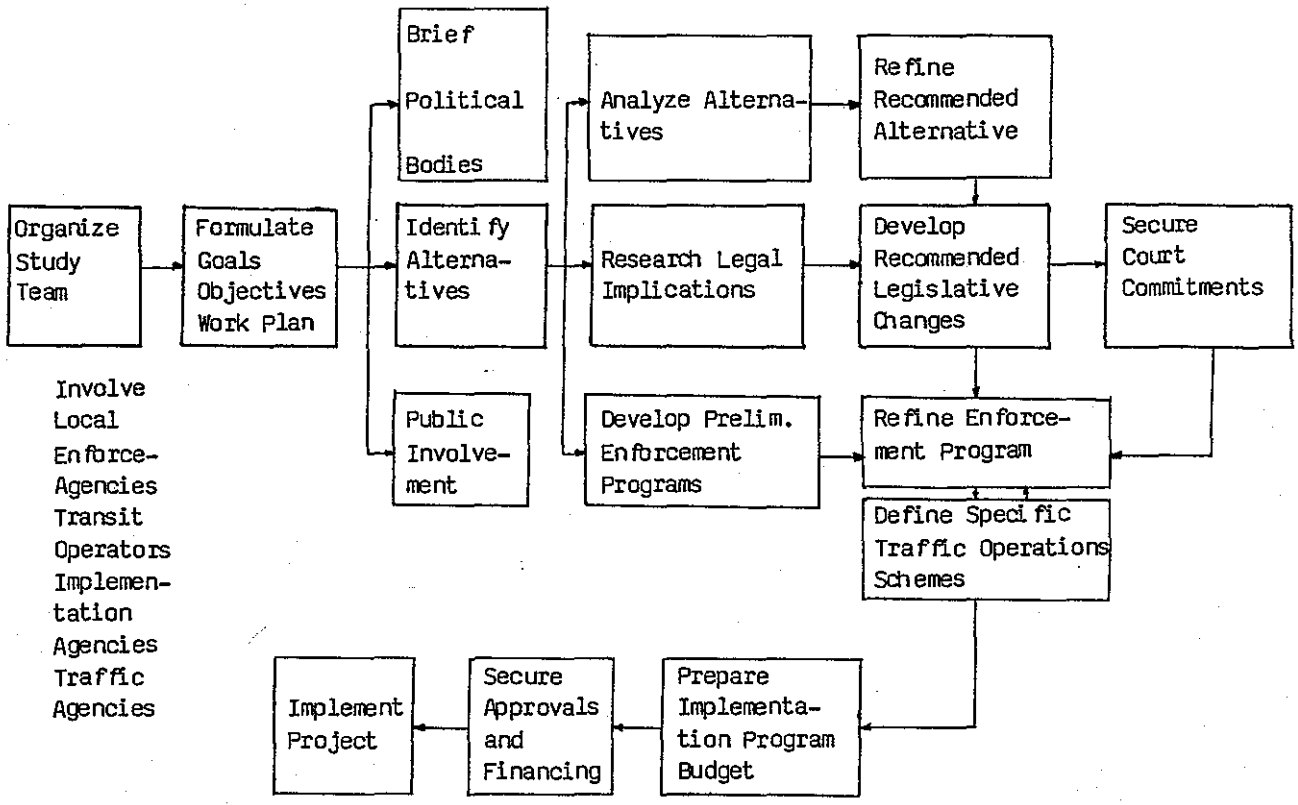
4. Personnel Planning. Since enforcement activities may require more manpower than is readily available, early involvement of the enforcement agency allows time for the recognition of this need in its budget proposals or in plans for the re-deployment of existing staff.

5. Investigation of Legal Restrictions. Police officers and local government attorneys are quite knowledgeable about possible judicial tendencies regarding various traffic operation schemes.

Figure 19 presents a general scheme for integrating the enforcement program into the overall planning process (11).

4.3.2 Legal

Legal issues which should be considered in assessing enforcement needs and procedures include not only the legality and enforceability of a particular strategy, but the responsibility for enforcement as well. In terms of the legality of the enforcement guidelines suggested in this study, the following specific legal issues should be researched with respect to state and local law.



Source: (11).

Figure 19. Enforcement Input to Overall Planning Process

1. HOV Priority Treatment Facilities. Lane restrictions for HOV facilities may be enforced by state, local, or special (e.g., transit authority) enforcement agencies. Local and/or state ordinances may need to be revised to clarify enforcement responsibilities for such facilities.

2. Work/Construction Zone Speed Restrictions. Work and construction zones typically have lower speed limits than those sections of the roadway on either end of the zones. However, given the current practice of allowing a 5-10 mph leeway in enforcing speed restrictions, the potential effectiveness of these speed restrictions may be diminished. Legislative changes may be necessary to clarify procedures for establishing speed limits and to permit more stringent enforcement of speed limits in construction work zones. Paradoxically, however, enforcement personnel must balance the need to enforce speed limits with the need to maintain efficient traffic movement in such zones.

3. Use of "Innovative" Enforcement Procedures. As stated previously, various alternatives to "standard" enforcement procedures have been suggested. A number of legal issues have been raised regarding the employment of some of this advanced technology, especially when it involves photography. Most of the concerns raised to date about the systems have been found not to present formidable legal barriers to their employment in the U.S. The major exception is the liability problem, which arises with photographic systems when only the vehicle owner can be identified (through the license plate), and not the driver (12).

Public opinion worldwide is generally opposed to speed laws, if they interfere with an individual's desire to drive at a speed he perceives to be reasonable. Thus, enforcement is viewed almost as a game between the individual and the law enforcement agency. Generally, therefore, public opinion does not become adverse as long as the game is fair. Automated equipment, while not necessarily liked because it enforces the law, is perceived to be fair because it is more likely to be uniform and consistent, and to apply equally to all persons as compared with options requiring officer judgement and discretion. However, if not used properly people may perceive the technology to be unfair or to present an infringement of

privacy. Use of hidden equipment (or officers) is considered unfair. Use of photographs showing the identity of the driver (and passengers) is viewed as an infringement of privacy, even though it may not be illegal (12).

A major consideration in the deployment of any automatic device is that it is likely to be too effective. Experience elsewhere in the world has repeatedly shown that the number of speeders detected is so great that it can quickly overwhelm all but the most carefully planned set of administrative procedures that process the arrests. It is not unusual for a half-day's field duty by an officer with one of the systems could tie him up for the rest of the week with paperwork unless the entire system is initially conceived so as to be able to handle the workload. Options such as part-time operation of the systems should be considered, with the anticipation that random periods of operation may provide sufficient deterrence value (12).

4.3.3 Economic

Many police agencies no longer have a special division for traffic. Consequently, traffic enforcement and any other transportation-related activities must compete with other responsibilities of the police agency. This means that either police enforcement for traffic management functions may not be available on a consistent basis, or that alternative means of enforcement and/or funding may be needed in many cases.

In the case of scheduled enforcement activities, such as construction/maintenance and HOV facility enforcement, enforcement costs could be included as a line item in the project budget. For non-scheduled enforcement activities (incident management, for example), additional funds will be needed if these activities are to be effectively managed. At this point, it is not clear what source(s) may be available to fund these enforcement activities.

5. RECOMMENDATIONS

The guidelines presented in Sections 2 and 3 provide a framework for assessing the needs for using uniformed police personnel for a large range of activities. It is the intention of the guidelines to supplement the required traffic control devices and traffic control plans with skilled persons who can command the attention of the motorists and receive the compliance to their directives to achieve acceptable levels of operations and safety.

For guidelines to be effective they must be implementable. Section 4 presents many of the issues and problems that must be resolved if wide scale application of the guidelines is to be achieved. The following recommendations are submitted for the purpose of achieving this goal.

1. Approval of Guidelines - The guidelines as presented in this report are necessarily broad and general to accommodate the large number of variables that must be considered. There is much work left to the "engineer" or "officer-in-charge" to make the guidelines site specific. However, the concepts that these guidelines represent need to be reviewed and approved by state and local agencies that will be responsible for their use.

It is the recommendation of this report that the guidelines as formulated be presented to designated state and local agencies for their review and approval.

2. Dissemination of Guidelines - The guidelines must be made available to those who will use them in a form that facilitates their use. There are at least three groups that should be considered; the police agencies, the transportation agencies and the construction and maintenance agencies. The guidelines should be restructured to address the specific requirements of these groups.

It is the recommendation of this report that the State prepare supplemental reports, training courses, informational case studies and other informational materials for use by the agencies responsible for implementation. Since the emphasis of the guidelines is on the police

agency, it is important to establish a forum for their presentation. Preliminary consultations indicate that the basic law enforcement certification course may not be available. Other training opportunities, therefore, must be investigated.

3. Implementation of Guidelines - A number of implementation issues were discussed in Section 4. Some of the issues are critical to implementation; others are not. It is the recommendation of this report that the State undertake the study of these issues with the purpose of achieving statewide acceptance of the guidelines. These issues are broadly described as institutional, legal and economic.

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