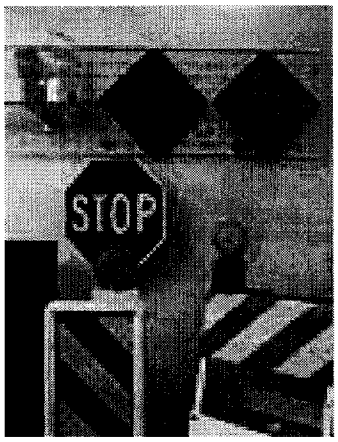
TRAFFIC BARRICADE DESIGN

Technical Design Manual #7



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I. INTRODUCTION AND PURPOSE OF BARRICADE MANUAL

This manual is produced to help provide safe conditions for motorists, pedestrians and workers on City streets, and to reduce congestion and confusion by providing uniform applications of standard traffic control devices in construction and maintenance areas. The provisions for public protection established herein are applicable to all persons, contractors, utilities and other agencies, including City forces, performing work in the City of Chandler public right-of-way, and for temporary traffic control during public activities such as parades and other special events that use the public right-of-way (1). Appeals of penalties may be directed to the Public Works Director or designee. When emergency conditions occur, immediate action shall be taken to protect the public. The requirements of this manual shall be implemented as soon as practical at each location.

The purpose of this manual is to establish basic uniform requirements for traffic control in construction and maintenance areas. This manual prescribes specific standards for the manufacture, application and maintenance of temporary traffic control devices. These requirements, standards and methods of application have been prepared to conform to the Manual on Uniform Traffic Control Devices (2). Minor deviations exist in some areas where field experience and engineering judgment has shown improved traffic operation will result. Typical applications of approved devices are illustrated herein. Application of these devices to other situations shall be handled consistent with the methods illustrated.

This manual supersedes all previous barricade manuals.

II. PURPOSE OF BARRICADING AND CHANNELIZATION

The purpose of barricading and channelization is to:

- Protect the motoring public
- Protect pedestrians and workmen
- Provide a safe, orderly flow of traffic
- Provide expedient and safe construction and maintenance
- Maintain good public relations

(1) Chandler City Code: Failure to comply with this manual is subject to penalties as provided in Section 1-8 of the Chandler City Code.

(2) USDOT, Federal Highway Administration, Manual On Uniform Traffic Control Devices for Streets and Highways, current edition, as adopted by the City of Chandler.

III. PERMISSION TO RESTRICT CITY STREETS AND SIDEWALKS

A. Requests for permission to close or restrict streets, sidewalks, or alleys can take place in one of three ways:

- For emergency restrictions during non-working hours, contact the Police Department at (480) 782-4130. During working hours, contact the Traffic Engineering Office at (480) 782-3454.

- For partial restrictions (lane closures), submit a Road Restrictions and Closures Permit to the Traffic Engineering office at 975 E. Armstrong Way, Building B; fax (480) 782-3472, for approval.

- For street closures, apply for a Road Restrictions and Closures Permit (form obtained from the Development Services customer service counter at 215 East Buffalo Street.)

B. A traffic control plan must be prepared and submitted for approval for all partial restrictions and street closures.

The purpose of a traffic control plan is to encourage forethought as to the time of day, sequence of construction, degree of restriction required, and traffic control needed. Traffic control plans may range in complexity from use of a typical illustration in this manual to a detailed site plan showing signing, barricading, detours, pedestrian walkways, construction fences, and project phasing. In all cases, the traffic control plan shall satisfactorily accommodate large or unusual projects or events, and advance consultation and review of the traffic control plan with City staff is encouraged.

C. One working day (24 hours) advance notice is required for partial restrictions on arterial and collector streets, and all restrictions or closures on local streets.

Ten working days advance notice is required for complete closure of any arterial or collector street. It shall be the responsibility of the applicant to prepare and submit a detailed traffic control plan, detour routing map, and a news release explaining the reason for the closure, its approximate duration and the alternate traffic routing plan. These materials must be submitted with a Road Restrictions and Closures Permit form.

D. All requests for alley restrictions or closures shall be discussed with the Solid Waste and Recycling office at (480) 782-3515 to determine an acceptable schedule for the closure, prior to submitting the Road Restrictions and Closures Permit form. Three working days (72 hours) advance notice is necessary to notify affected residents and to reschedule garbage and trash pickup.

E. The City reserves the right to deny or revoke any Road Restrictions and Closures Permit at any time when in their judgement the traffic restriction could or has resulted in intolerable congestion, major inconvenience, accident potential or hazard to workers.

F. The City's Traffic Engineering Inspector and Off-site Inspectors are responsible for monitoring that the work zone traffic controls are planned and implemented in accordance with this manual. The contractor in responsible charge of the work is responsible for the traffic control. The Traffic Engineering Inspector, in cooperation with Off-site Inspectors, is authorized to direct a contractor or supervisor of work in progress to take steps necessary for correction of deficiencies in work zone traffic controls. The restricted hours of work may be extended at the discretion of the City Transportation Engineer or his designee. Assistance with work zone traffic control for conditions not covered by this manual may be obtained from the Traffic Studies Manager at (480) 382-3450, or the City Transportation Engineer at (480) 782-3454.

G. The contractor shall provide construction signs identifying the name of the company performing the work, contractor name, general description of work, construction time frame, etc. as required by City Code 46-2.7E.

IV. GENERAL TRAFFIC REGULATIONS

The following are minimum traffic control requirements for all traffic restrictions, unless otherwise provided for in the approved street closure permit.

A. Traffic restrictions are not permitted at signalized intersections or on arterial streets during the peak traffic hours of 6:00 AM to 8:30 AM and 4:00 PM to 7:00 PM weekdays except as approved by the City Transportation Engineer. Traffic restriction hours may be extended at the discretion of the City Transportation Engineer or his designee. For six-lane roadways, one lane closure may be permitted in the non-peak direction based on peaking characteristics, as determined by the City Transportation Engineer.

B. Traffic restrictions are not permitted on accesses to major shopping centers during the hours of 9:00 AM to 10:00 PM on Saturdays. In rare instances, exceptions may be granted where the restrictions do not cause the intersection to exceed capacity or create any significant delays.

C. Left-turn lanes should be maintained at all times. If it can be demonstrated that closing the left-turn lane would result in improved traffic flow, or reduce delays, closure of the left-turn lane may be permitted.

D. During off-peak traffic hours, a maximum reduction of one through lane in each direction is permitted. Turn lanes may be restricted if approved by the City Transportation Engineer or his designate. Additional lane restrictions may be authorized during emergencies, nights and weekends. Weekends are defined as Friday at 9PM to 5AM on Monday. Nights are defined as 9PM to 5AM.

E. During off-peak traffic hours when traffic lanes are restricted at multiple lane signalized intersections with left-turn lanes, the left-turn lanes may be used with channelization and turn restrictions to provide a minimum of two lanes for each

direction, if approved by the City Transportation Engineer or his designate (see Figures 17, 22 and 23).

F. The contractor, utility or other agencies, (including City departments) shall provide uniformed off-duty City of Chandler police officers as necessary when barricades are restricting traffic during peak hours within 300 feet of signalized intersections. The City Transportation Engineer shall determine the number of police officers, if any, required by time of day. Exemptions may be waived at minor signalized intersections at the discretion of the City Transportation Engineer.

G. A traffic lane shall not be considered satisfactorily open to traffic unless it is paved with hot or cold mix asphalt if surrounded by, or adjacent to, existing pavement. Where all existing pavement has been removed, a traffic lane shall not be considered as satisfactorily open to traffic, unless graded reasonably smooth and maintained dust free as determined by the City Transportation Engineer. Small openings in the roadway surface may be bridged with steel plates level with the abutting pavement (pavement milled around edges of opening). Roadway depressions should not exceed 1" in 10'. All visible pushing/shoving of pavement shall be corrected. All temporary pavement shall be inspected daily, and above maintenance issues corrected within 24 hours.

H. With an approved permit, local streets may be closed except for local access when construction or maintenance requires.

I. Local access shall be maintained to all properties on all streets (arterial, collector and local) at all possible times. When local access cannot be maintained, the contractor, utility or other agency shall notify affected property owners, residents or tenants a minimum of 24 hours in advance and restore access as soon as possible.

J. Access to fire stations, police stations, hospitals, post offices and schools shall be maintained at all times. When access restrictions are necessary, the contractor, utility or other agency shall coordinate such access restrictions with the responsible person in charge of the affected fire station, hospital, police station, post office or school.

K. Coordination with special events or parades is necessary when construction and maintenance operations conflict with such events. Generally this requires repair, cleanup and preparation of conflicting areas by the contractor before the day of the event to provide clean, safe conditions during the event.

L. Construction and maintenance activities are restricted during the holiday season of November 15 through January 1, on streets adjacent to or serving as primary access to large shopping centers. Construction and maintenance activities that interfere with traffic flow near shopping areas and on high volume streets must be carefully evaluated and imposed only when absolutely necessary. In rare instances, exceptions may be granted where restrictions do not cause the intersection to exceed capacity or create any significant delays.

M. Devices placed for work zone traffic control (e.g., barricades, vertical panels, barrels, signs) must be removed from the street right-of-way at the time that work is

completed. Devices left in the right-of-way for more than 24 hours after stopping work will be removed by the City. Devices removed by the City may be reclaimed at the Public Works Operations Yard (249 East Chicago Street) after payment of fees covering City costs for removal and storage.

N. Set up of barricading and traffic control shall be undertaken by qualified and experienced personnel only. The City of Chandler requires that a contractor delegate the daily set up to a barricading company when working on arterial roads. Removal of barricading after completion of daily tasks may be undertaken by either the contractor or the barricading company.

O. On parallel arterials, lane closures (of more than one day in duration) are restricted, where detoured traffic from one closure could encounter restrictions at another closure. The separation of closures on parallel arterials must be more than two miles apart in radius.

P. Detours less than 3 days in duration shall use aggregate base course (ABC), AC millings, or temporary AC. Detours between 3 days to 2 weeks in duration shall us AC millings or temporary AC. Detours greater than 2 weeks shall use temporary AC. Temporary AC is defined as 2" EVAC A19 on 5" ABC, or as approved by a geotechnical engineer.

Q. When a difference in AC pavement elevation is created perpendicular to traffic flow, the Contractor shall provide at the end of the work day a temporary AC fillet over an 18" length. The Contractor is required to mill the fillet prior to final AC placement.

R. The Contractor is responsible to remain at the work site until all barricading is removed from the roadway by the barricade company. The Contractor may have the option to remove barricades. All barricading must be removed from the roadway within one hour of work completion. If barricades remain longer than one hour after work completion, the Contractor may be subject to penalties.

S. The Contractor shall contact Traffic Engineering prior to moving barricades at signalized intersections.

T. Failure to comply with a Street Closure Permit shall result in a $2,000 per day penalty. Failure to comply with the Traffic Control Plan shall result in a $500 per day penalty. Possible exceptions to penalties may include emergencies affecting public health and safety, or extreme weather conditions such as the 50 or 100-year storm. Exceptions would not be granted for typical rain delays or known adverse soil conditions. To obtain payment, the City may take actions such as withholding future Road Restrictions and Closures Permits or final acceptance of offsite improvements.

U. If traffic is being shifted between lanes at a signalized intersection, the contractor must notify the City 24-hours in advance and precisely at the time of the switchover. Please contact the City's Traffic Management Center at 480-782-3471.

V. EXISTING TRAFFIC CONTROL DEVICES

During construction and maintenance operations, it is important that existing traffic control devices be kept compatible with the traffic restrictions imposed. This includes signs, traffic signals, and pavement markings. Some devices will remain applicable to traffic and must be maintained while other devices must be covered, relocated or removed. Requirements for each group of devices are detailed in this section.

A. Traffic Signs

The contractor, utility or other agency shall maintain all existing STOP, YIELD and street name signs erect, clean and in full view of the intended traffic at all times. If these signs interfere with construction, the contractor, utility or other agency shall temporarily relocate the signs to permit construction, but the devices must be kept in full view of the intended traffic. The Traffic Engineering Inspector or the Off-site Inspector shall approve the temporary relocations of signs. Portable signs should be used to supplement these signs when maintained in other than normal locations.

Other applicable signs shall also be maintained erect, clean and in full view of the intended traffic by the contractor, utility or other agency at all times. Existing signs no longer applicable shall be removed by the contractor, utility or other agency without damage, and delivered to the sign shop at 249 East Chicago Street. The Off-site Inspector shall be notified of all sign removals, at the time of removal.

When construction is complete, the sign shop will reset all temporarily relocated signs to permanent locations. The contractor shall notify the sign shop (782-3454) prior to project completion for sign replacements.

B. Traffic Signals

The contractor, utility or other agency shall maintain that existing traffic signal equipment (except vehicle detector sensing devices and left turn arrows) are fully operational in the existing locations. They must also be in full view of the intended traffic at all times, unless otherwise specified in this manual or in the approved traffic control plan or street closure permit.

Vehicle detector sensing devices will be de-activated by the Traffic Signal Shop when necessary for construction. The contractor, utility, or other agency shall replace them when work is completed. Left turn arrows shall be de-activated by the Traffic Signal shop when left turn prohibitions are in effect. Twenty-four hours advance notice to the Traffic Signal Shop (782-3454) is required.

The contractor, utility or other agency shall notify the Traffic Signal Shop 24 hours prior to the start of any construction in the vicinity of signalized intersections.

The contractor, utility or other agency shall exercise due care to prevent damage to all existing traffic signal equipment. Should damage occur, the Traffic Signal Shop must be notified immediately to make the necessary temporary repairs to restore traffic signal operations.

All traffic signal equipment relocations and/or installations of temporary signal equipment shall be coordinated by the contractor, utility or other agency with the Traffic Signal Shop. Twenty-four hours advance notice is required. When temporary equipment or new equipment is installed to replace existing equipment, the temporary or new equipment shall be fully operational before the existing equipment is removed. The contractor, utility or other agency shall restore all signal control equipment to the original locations or new locations, if so specified, as soon as possible after all the work in the immediate areas is completed.

C. Pavement Markings

Existing pavement markings that conflict with the vehicle path indicated by barricades and channelization and cause driver confusion, shall be removed or obliterated by the contractor, utility or other agency, as directed by the Traffic Engineering office (480) 782-3454 or (480) 782-3425. Chandler requires use of portable traffic control devices that under normal conditions dominate pavement markings. Pavement marking obliteration will usually be required only on long-term construction projects or detours. However, removal or obliteration of existing pavement markings may be required at any location when visual inspection and/or accident history shows driver confusion exists due to pavement markings.

VI. TEMPORARY TRAFFIC CONTROL DEVICES

Temporary traffic control devices are used to delineate hazards, alert and guide motorists, and to protect pedestrians and workmen. They fall into six basic categories:

- Signs
- Barricades and channelizing devices
- High-level warning devices
- Pavement markings
- Police officers and flaggers
- Portable barriers

The contractor, utility or other agency shall provide and maintain all necessary temporary traffic control devices, including regulatory signs, to protect and guide vehicles and pedestrians, and to protect workers, during traffic restrictions.

Temporary traffic control devices shall be:

- Manufactured in a workmanlike manner to conform to the Manual on Uniform Traffic Control Devices. Stenciled signs are not allowed except during emergency conditions.
- Installed prior to the start of all restrictions

- Properly maintained and operated when restrictions exist
- Kept clean and fresh appearing at all times
- Kept in place only as long as needed and removed immediately thereafter

Where operations are performed in stages, only devices applicable to the restrictions present shall be in place. All signs that do not apply to the restricted conditions shall be removed, covered or turned away from traffic by the contractor, utility or other agency so as not to be readable by oncoming traffic. Portable signs should be turned away from traffic at a 45-degree angle because the sign edge is not visible when turned parallel to traffic and can be hazardous.

Channelization, including "KEEP RIGHT/LEFT" signs, shall be provided whenever traffic is moved across the street center line, the existing center line is obliterated, or opposing traffic is maintained in other than the normal traffic lanes.

Where existing or new signing and/or pavement markings must be installed or replaced, the necessary temporary traffic control devices shall be provided and maintained by the contractor, utility or other agency until such permanent work is completed.

All temporary traffic control devices shall be ballasted with sandbags or other approved ballast by the using contractor, utility, or other agency when necessary. Ballast shall be placed on lower parts of the frame or on the base and shall not be placed on top of any striped rail. The use of rocks, concrete or asphalt chunks, concrete blocks, etc., as ballast is prohibited.

A. Signs

Signs are a very important part of temporary traffic control. Signs are used to alert, advise and guide the motorist. Temporary traffic control signs are necessary in advance of traffic restrictions and whenever a motorist has to change his path of travel. It is especially important to use warning signs well in advance of traffic restrictions and place them so they will convey their intended message most effectively.

Temporary traffic control signs fall into the same three major categories as do other traffic signs, namely:

- Regulatory signs
- Warning signs
- Guide signs

Many signs normally used elsewhere also find application for signing construction and maintenance operations. Most of these signs are included in this manual, but other signs in the Manual on Uniform Traffic Control Devices may be used or required. Each sign shall be displayed only for the specific purpose described in the manual and indicated by the sign legend. Uniformity of signs and sign usage is necessary so that similar conditions will always be marked with he same type of sign whenever the condition occurs. In this

manner, the motorist becomes conditioned to the required action indicated by signs. The less variation in signs, the fewer responses the motorist must learn.

Temporary traffic control signs for construction and maintenance operations follow the basic standards for all traffic signs as to size, shape and color. Warning and guide signs in construction and maintenance areas, however, shall have a black legend on an orange background. Color for other signs shall follow the standards set by the Manual On Uniform Traffic Control Devices.

Standard minimum sign sizes, sign colors and sign shapes are shown in the illustrations of the individual signs rather than in detailed specifications in the text. The size and stroke of the legend or symbol shall be the largest possible permitted by the size and design of the sign consistent with good legibility and the Manual on Uniform Traffic Control Devices.

The dimensions of signs shown herein are for standard minimum sizes, which may be increased when necessary for greater legibility or emphasis. Deviations from standard sizes herein shall normally be in 6-inch increments. Signs mounted on posts along the side of the street (STREETSIDE SUPPORTS) shall be at least 6 inches larger per dimension unless otherwise indicated in the sign illustrations.

Two orange or fluorescent red-orange flags 16 inches square or larger shall be mounted on all streetside sign supports, and on all portable signs used for advance warning. They may also be mounted on other signs for added visibility.

All signs used during hour of darkness shall:

- Be reflectorized with smooth surface weather-proof reflectorized sheeting.
- Be equipped with operating Type A flashing barricade warning lights when mounted on portable supports used on City streets.
- Be equipped with operating Type B flashing warning lights when mounted on streetside supports for advance warning at arterial street construction projects.
- Have a minimum application of 150 square inches or orange weatherproof reflectorized sheeting on the back of signs exposed to opposing traffic. The reflectorized sheeting shall be placed in strips not less than 5 inches wide along each outer edge of the sign. Signs placed in two-way left turn lanes shall have at least one Type I barricade placed 10 feet behind the sign to alert opposing traffic.

All signs mounted on portable supports shall have minimum heights to the bottom of signs as listed below:

- Regulatory: 36 inches, except R 4-7a and 8a (KEEP RIGHT/ LEFT) and R11 - 7, 8 and 11 (SIDEWALK CLOSED/PEDESTRIANS) which shall be 18 inches
- Warning: 12 inches, except W1-6 (TARGET ARROW) which shall be 36 inches
- Guide: 24 inches

- Combination regulatory and/or warning: 12 inches

All signs mounted on streetside posts shall have a minimum height of 7 feet to the bottom of the signs.

Barricades, vertical panel channelizing devices and flag type high level warning devices are acceptable portable sign supports for City Streets. When flag type high level warning devices are used as sign supports, they shall be provided in addition to other flag type high level warning devices required by this manual. Ballast (sandbags) should be placed on the base of all portable signs that are unattended.

Metal and wood sign posts such as those commonly used to mount permanent traffic signs and steel street light poles are acceptable streetside supports. Signs shall not be mounted on wood power poles. Streetside signs should not normally be placed in sidewalks or walkways, but when necessary, care should be taken to minimize interference to pedestrians.

As a general rule, portable signs shall be located on the right side of the street when right lane traffic is restricted, and on the centerline or median when the left lane traffic is restricted. Streetside signs shall be located on the right side of the road and on protected medians. Where special emphasis is required, and where more than one lane of traffic is any one direction is effected, dual signs should be provided approximately opposite each other.

Portable supports should be used for short-term and moving operations. Streetside supports shall be used for construction speed limit and advance warning signs on long term fixed construction projects, such as arterial street construction.

For maximum mobility on certain types of construction and maintenance operations, signs may be mounted on a vehicle stationed in advance of the work, or moving along with it. This may be the working vehicle, as in the case of crack and chip sealing, or a vehicle provided expressly for this purpose.

Mobile sign displays such as electric changeable message signs and arrow panels, may be mounted on a trailer, may be provided with self-contained electric power units for flashers and lights, or may be mounted on a regular maintenance vehicle. Vehicles used specifically for mobile sign display should be equipped with an impact attenuating device to provide additional safety for workers and motorists.

1. Regulatory Signs

Regulatory signs impose legal obligations or restrictions on all traffic and are enforced by the Police Department. To be enforced, their use must be specified in the approved street closure permit. Special care must be used to insure proper use, maintenance, and removal of all regulatory signs in a timely fashion. Conflicting existing regulatory signs shall be covered or removed.

All regulatory signs are provided by the contractor, utility or other agency. Commonly used signs are illustrated in Figures 1 and 2.

Regulatory signs used in construction and maintenance areas shall be the shape and color required by the Manual on Uniform Traffic Control Devices. They shall be used as follows.

R1-1
30"x 30"

R1-2
30"x 30"x 30"

R5-1
24"x 24"

R8-8
12"x 18"

R3-2
24"x 24"
PANEL
4"x 24"

R3-1
24"x 24"

R3-7
(LEFT)(RIGHT)
24"x 24"

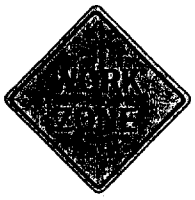
R3-8
(LEFT)(RIGHT)
24"x 24"

R3-5
(LEFT)(RIGHT)
18"x 24"

R6-2
(RIGHT)(LEFT)
18"x 24"

R6-1
(RIGHT)(LEFT)
36"x 12"

R2-5a
24"x 30"



W20-6
R2-1(25)

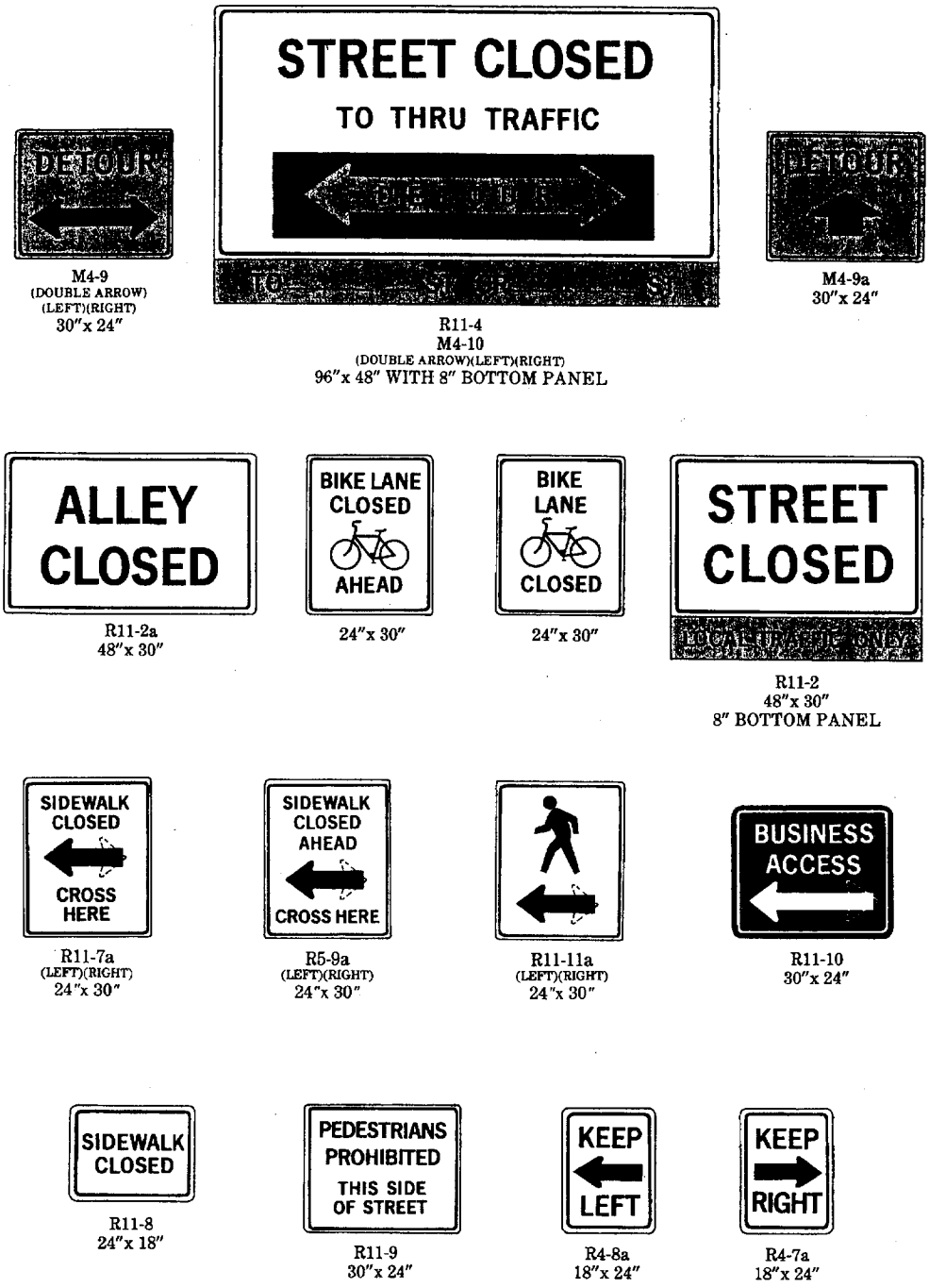
W20-6
R2-1(35)

W20-6
R2-1 (45)

SPEED LIMIT SIGN SIZES

Sign	City Street Post Mounted All Freeway & Expressway	City Street Portable
W20-6	36"x 36"	24"x 24"
R2-1	24"x 30"	18"x 24"

FIGURE 1 **REGULATORY SIGNS**



REGULATORY AND GUIDE SIGNS FIGURE 2

FIGURE 1 - REGULATORY SIGNS

Turn Restrictions

"NO LEFT/RIGHT TURN" signs are used whenever turns cause excessive congestion at intersections during restrictions. They shall be placed with a minimum of two (one on the near side and one on the far side of the intersection) for each direction of traffic affected. "EXCEPT BUSES" panels shall be attached at the bottom of each sign when turn restrictions affect transit routes to permit buses to turn left, when turns can be made in safety. A panel with hourly restrictions (e.g., 7:00 to 8:30 AM and 4:00 to 6:00 PM Mon-Fri) shall be attached when turn restrictions are required only during specific hours.

Mandatory turn signs are used to show motorists when they must turn right or left from a special turning lane separated from the through traffic lane. They shall be placed with a minimum of two (one in advance and one at the intersection) for each direction of traffic affected.

Speed Limits

"CONSTRUCTION ZONE"/"SPEED LIMIT" combination signs are used to indicate to drivers the reason for reduced speeds. They shall be placed with a minimum of one in advance of construction and a minimum of three signs per half mile on arterial and collector streets, for each direction of traffic affected.

"SPEED LIMIT" signs shall always be co-mounted with a "CONSTRUCTION ZONE" sign when reducing speed limits in construction areas. The large "CONSTRUCTION ZONE" and "SPEED LIMIT" signs on posts at the side of the street shall be used in all arterial street reconstruction areas. At other locations, the small signs on portable supports may be used. Existing conflicting "SPEED LIMIT" signs shall be covered or removed.

The "SPEED LIMIT 25" sign is used where the existing pavement has been removed, or traffic is being maintained on temporary detour roads, unpaved shoulders, or on traffic lanes that are severely restricted.

The "SPEED LIMIT 35" sign is used in advance of the "SPEED LIMIT 25" sign when reducing existing speed limits from 40 and 45 miles per hour. The "SPEED LIMIT 45" sign is used when reducing speeds from 50 and 55 miles per hour. Speed limits by State law shall not be reduced in increments greater than 10 miles per hour. The "SPEED LIMIT 35" sign is also used for interim speed reduction in construction areas until construction progress requires 25 miles per hour. The "SPEED LIMIT 35" is also used where traffic is being maintained on new asphalt paving projects and in most construction zones on improved streets where restricted traffic is maintained on a reduced number of lanes.

Street Closures

The "STREET CLOSED TO THRU TRAFFIC" sign shall be used for all complete closures of Major and Collector streets. When in use, the proper "DETOUR ARROW" and detour instructions shall be displayed. "STREET CLOSED AHEAD" and "DETOUR AHEAD" signs shall be used a minimum of 300 feet and 600 feet respectively, in

advance of all arterial and collector street closures (see Figure 14). Mandatory turn lanes approaching street closures shall be closed (see Figure 15).

The "STREET CLOSED LOCAL TRAFFIC ONLY" sign shall be used for all local street closures.

The "ALLEY CLOSED" sign shall be used for all alley closures.

The "DETOUR" sign with arrow shall be used to mark detour routes when required by the Traffic Engineering office.

The "OPEN TO LOCAL BUSINESSES" sign is optional where access on major and collector streets that are closed for construction becomes a problem. It is installed on a barricade adjacent to the "STREET CLOSED" sign when requested by the Traffic Engineering office.

Other Regulatory Signs

"KEEP RIGHT (LEFT)" signs shall be used at, or near the start of all channelization except where the "DOUBLE ARROW" warning sign is used. The "KEEP RIGHT" sign shall be used on both sides of all intersections where temporary centerline channelization is required.

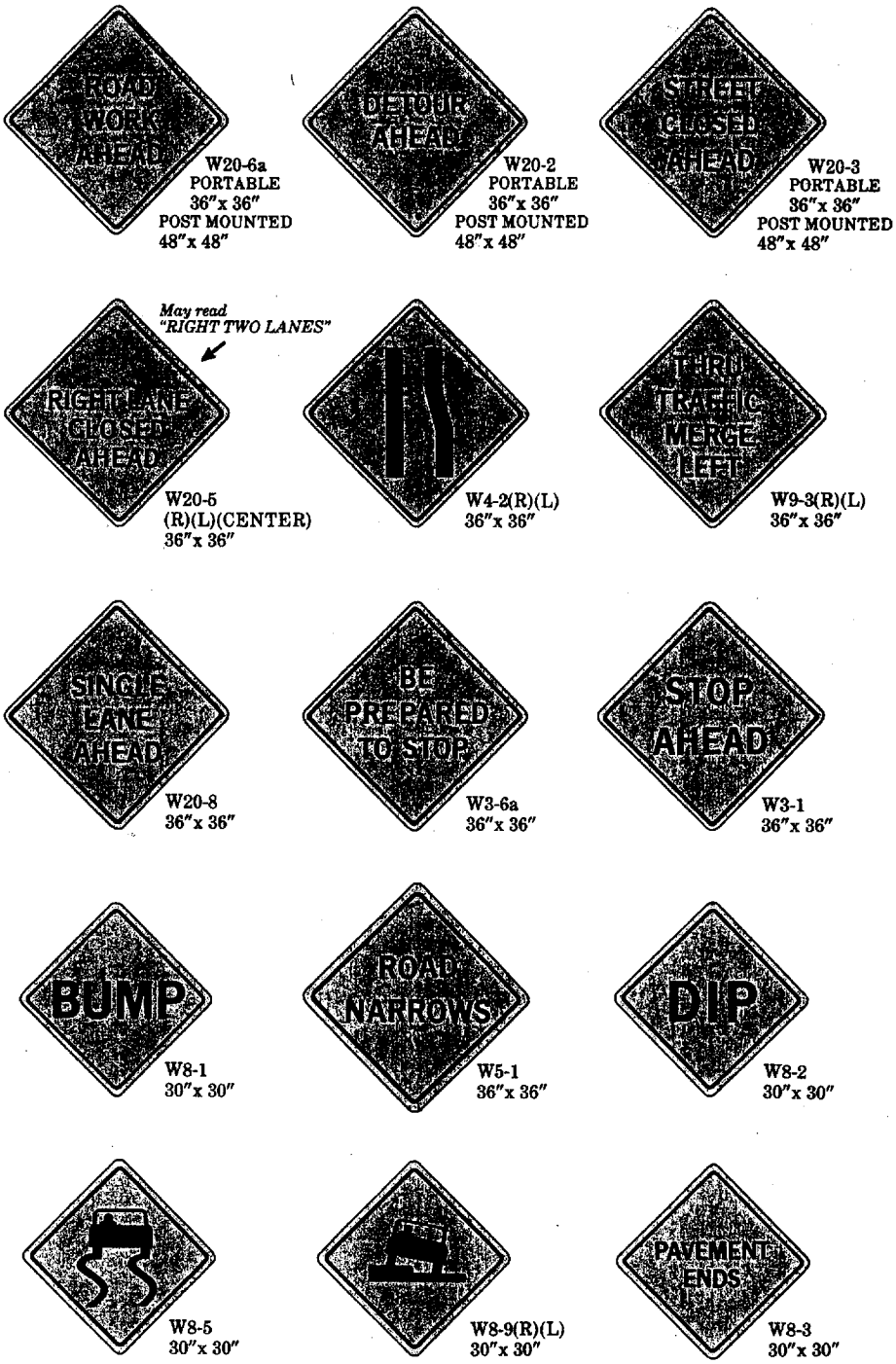
2. Warning Signs

Warning signs are used to notify motorists of specific hazards or restrictions in construction and maintenance areas. Within construction zones there may be a variety of temporary roadway conditions such as reduced width, open excavations or pavement removal. Motorists must be properly alerted well in advance to provide adequate time to react safely to the situation.

All warning signs are provided by the contractor, utility or other agency. Commonly used signs are illustrated in Figures 3 and 4.

Warning signs used in construction and maintenance areas shall be diamond shaped, except as otherwise shown in the warning sign illustrations. They shall have a black legend and/or symbol on an orange background. The warning signs illustrated shall be used for only those situations indicated by their legend or symbol. Distances such as 500 feet, 1,000 feet, ¼ mile, ½ mile, 1 mile or 2 miles, may be used in place of the word "AHEAD" on advance warning signs, and numerals may be used in place of words (e.g., 2 instead of TWO).

The "ROAD WORK AHEAD" sign shall be used in advance of all construction and maintenance areas in addition to other



WARNING SIGNS FIGURE 3

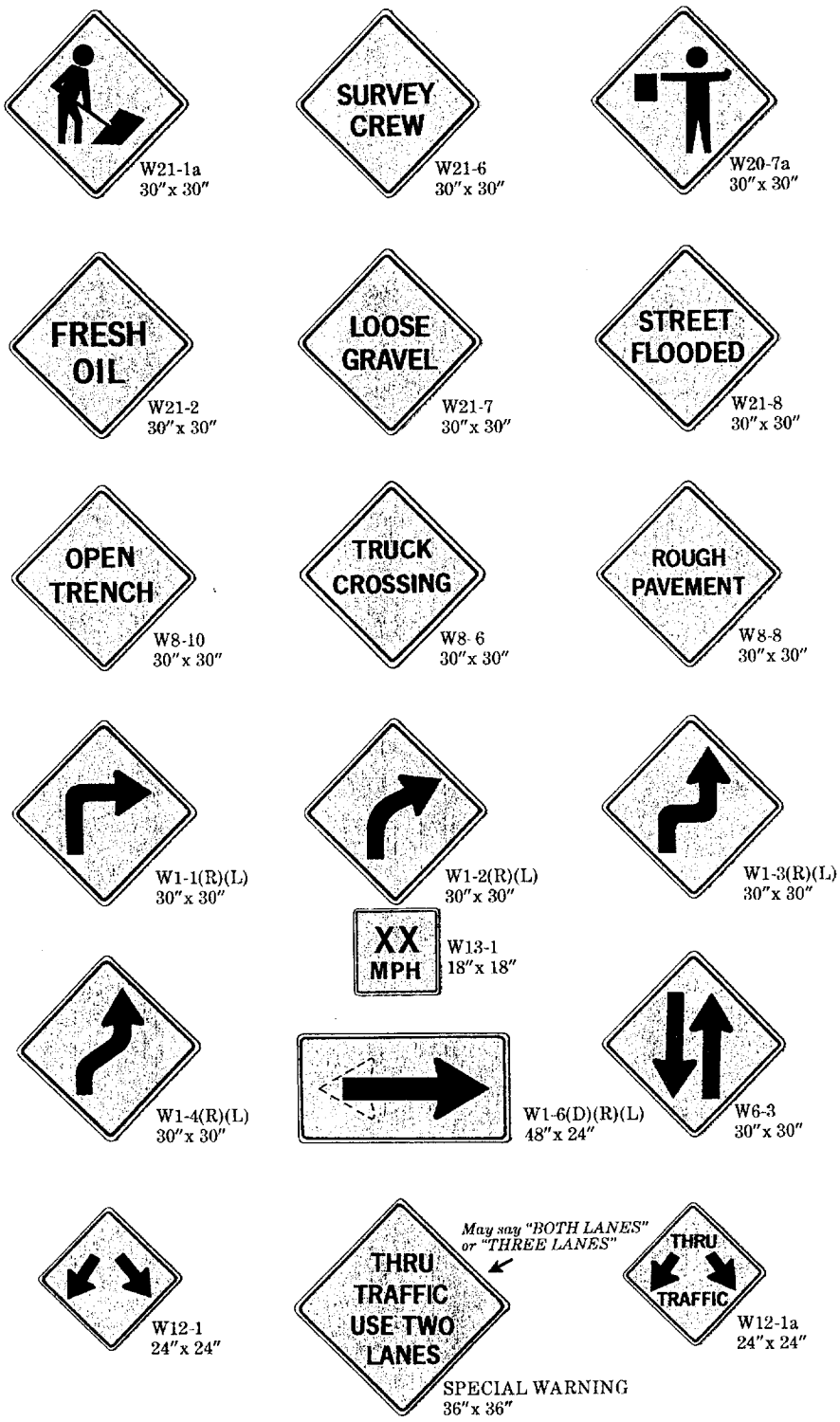


FIGURE 4

WARNING SIGNS

FORMULAS FOR TAPER LENGTH

Speed Limit	Formula
40 mph or under	$L = \frac{WS^2}{60}$
45 mph or over	$L = WS$

L = Taper Length W = Width of Lane
S = Posted Speed Limit

TAPER LENGTH AND DISTANCE BETWEEN DEVICES

Speed Limit (mph)	Taper Length (L) (feet)**			Maximum Distance Between Devices (feet)	Minimum Number of Devices Needed
	10′ Lane	11′ Lane	12′ Lane		
25	104	115	125	25*	6
30	150	165	185	30	7
35	204	225	245	35	8
40	267	293	320	40	9
45	450	495	540	45	13
50	500	550	600	50	13
55	550	605	660	55	13

* *Distance between **Traffic Cones** used for tapers should not exceed 25 feet regardless of speed.*
** *Advance warning signs should be placed a minimum of Distance (L) in advance of taper.*

FIGURE 5

applicable warning signs. Minimum spacing for advance warning signs in advance of channelization should be equal to the taper lengths shown in Figure 5.

3. Guide Signs

Guide signs are used to direct motorists on detour routes and provide information in advance of street closures.

All guide signs are provided by the contractor, utility or other agency.

Guide signs used in construction and maintenance areas are generally rectangular. They shall have a black legend on an orange background.

Guide signs most frequently used are the "DETOUR" signs and "ARROWS" shown with the "STREET CLOSED" signs in Figure 2. The "DETOUR" sign and detour instructions are incorporated into the design of the "STREET CLOSED TO THRU TRAFFIC" sign.

When required, the contractor, utility or other agency shall provide separate "DETOUR" signs, with the appropriate arrow, at locations along a specific detour route, as directed by the Traffic Engineering office. When required, detailed detour route instructions and/or State and Federal route symbols shall also be provided and attached to the detour signs.

B. Barricades and Channelizing Devices

Barricades and channelizing devices are the most important part of temporary traffic control in construction and maintenance areas. They are used to warn and alert motorists of temporary restrictions and to guide motorists and pedestrians through restricted areas. They are not intended to be physical barriers. Barricades and channelizing devices should always be used in groups to warn and guide traffic.

Rope, flagging and woven plastic tape may be used between barricades and channelizing devices in construction areas to provide additional guidance and security. In some major construction areas and in areas with substantial pedestrian traffic, the use of plastic or metal construction fencing may be necessary for maximum security.

Barricades and channelizing devices used to guide motorists must provide a smooth, gradual transition when moving traffic from one lane to another, onto a bypass detour, or when reducing the width of the street. This smooth, gradual transition is referred to as the "taper length". The minimum desirable taper length formulas, calculated taper lengths and spacing of devices for tapers are shown on Figure 5.

Minimum desirable taper lengths apply to streets of relatively flat grades and straight alignments. Adjustments may be desirable to provide adequate sight distance on the approach to channelization and to accommodate cross streets and adjacent driveways. Usually, better traffic operations will result by increasing taper lengths, provided additional cross streets and driveways are not adversely affected.

When more than one lane of traffic is diverted, a tangent length of channelization equal to twice the taper length should be used between the taper for each lane closed (see Figure 25). A tangent distance of one half the taper length should be used between tapers when diverting a single lane to an alternate alignment (see Figure 27). Spacing for devices used in tangent areas between tapers should be the same as the spacing for devices used in the adjacent tapers.

Barricades and channelizing devices are also used to protect workmen when working in the street, and to guide and protect pedestrians. They should be constructed in a substantial manner for protection. However, devices should be designed so as not to cause severe damage to vehicles if hit.

Barricades and channelizing devices shall be kept clean and fresh appearing at all times.

Typical uniform applications of barricades and channelizing devices are shown in the barricade illustrations included in this manual. Situations not illustrated shall be handled in conformance with the general methods set forth.

1. Barricades

Barricades used in Chandler shall be Type I, II or III (see Figure 6). Markings for all barricade panels shall be alternate orange and white stripes sloping down at a 45 degree angle to the side on which traffic is to pass. Both stripes (orange and white) shall be reflectorized with smooth surface weatherproof reflectorized sheeting.

All barricades shall be constructed of suitable materials in a professional workmanlike manner to the dimensions shown in Figure 6. Barricade supports shall be substantial and shall be galvanized or aluminum.

Type I and II barricades are intended for use where traffic is maintained through construction and maintenance areas. They are used to delineate hazards in or near the street or sidewalk, to close local and collector streets, to close sidewalks and alleys, and to channel traffic. When used to delineate hazards parallel to traffic, spacing should not exceed 75 feet. When used to close streets, sidewalks and alleys, spacing should not exceed 5 feet.

Type I and II barricades used to channel traffic, shall be placed on a taper to guide motorists past hazards. Taper lengths and barricade spacing should be as shown in Figure 5.

Type III barricades are used for complete street closures of arterial streets when they are under construction. They shall be placed with a minimum of one on each side of the "STREET CLOSED TO THRU TRAFFIC" sign, and one centered on the back of the sign. Additional Type III barricades shall be used as required to close the street to through traffic.

Barricades used in the right-of-way during hours of darkness shall have an approved barricade warning light attached and in operation. The warning light shall be mounted above the top panel on the end of the barricade closest to traffic. Type A flashing warning

lights shall be used to delineate hazards and close streets, sidewalks and alleys. Type C steady burn warning lights shall be used in a series to channel traffic, and guide traffic through construction areas.

Type I, II and III barricades shall have the using contractor, utility or other agency's name placed near the bottom of the lowest panel as illustrated in Figure 6. The letters shall be black on a white background and not less than 1 inch nor more than 2 inches in height.

2. Barricade Warning Lights

Barricade warning lights are alerting devices used with other traffic control devices for advanced warning of unexpected restrictions, and to guide motorists when entering and driving through restricted areas. They shall be mounted on all signs, barricades and channelizing devices, as specified in this manual, when used in the right-of-way during hours of darkness. Barricade warning lights shall be in operation during hours of darkness.

Barricade warning lights are portable, battery operated, lens directed enclosed lights, commonly referred to as either Type A low intensity flashing warning lights, Type B high intensity flashing warning lights or Type C steady burn warning lights. Warning lights shall have 7-inch diameter lenses that emit yellow light. They shall be in accordance with the current Institute of Transportation Engineers Purchase Specifications for Flashing and Steady-Burn Warning Lights, as required in the Manual on Uniform Traffic Control Devices.

Barricade warning lights must be maintained so that the light provides adequate advance warning to alert and guide motorists and pedestrians in restricted areas.

Type A low intensity flashing warning lights shall be used on all signs that are mounted on portable supports and on all barricades and vertical panel channelizing devices used to mark hazards and close streets. Type A warning lights shall not be used on devices intended to guide traffic.

Type B high intensity flashing warning lights shall be used on advance warning signs for major street construction when mounted on street-side supports and on all flag type high level warning devices when used at night. Type B warning lights mounted on portable supports and on flag type high level warning devices

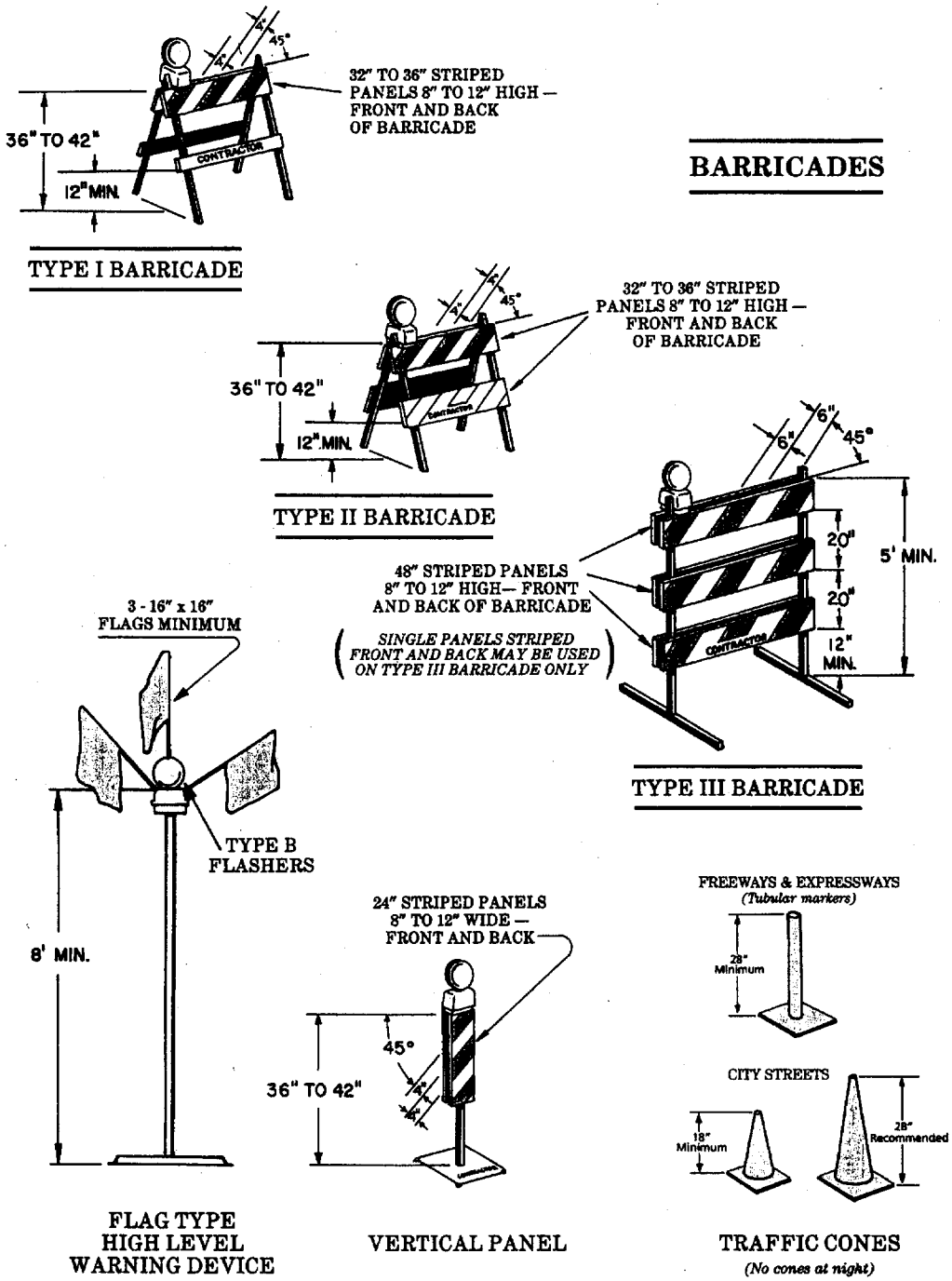


FIGURE 6

BARRICADES AND CHANNELIZING DEVICES

shall have the battery remotely mounted in the base at ground level to provide additional stability.

Type C steady burn warning lights shall be used on all barricades and vertical panel channelizing devices used to guide traffic, form tapers, and delineate center lines, lane lines, and the edge of the traveled way. Type C warning lights may be used on devices to mark hazards, but they are generally less effective than flashing lights for this purpose.

3. Channelizing Devices

Channelizing devices include traffic cones, vertical panel channelizing devices, drums, high level warning devices and pavement markings.

Traffic Cones

Traffic cones are effective for daytime channelization of traffic and to delineate minor maintenance areas. Traffic cones are versatile because they will not damage vehicles if hit, and can be set up and removed quickly. When traffic cones are used, it is necessary to check them often, as they are frequently disturbed (moved) by vehicles. Cones are not suitable for nighttime use.

Traffic cones may be conical or tubular devices, generally with square, weighted bases (see Figure 6). The predominant color of both devices shall be orange or fluorescent red-orange. For use on all streets, conical devices shall be a minimum of 18 inches high and tubular devices shall be a minimum of 28 inches high. On high volume arterial streets where additional traffic guidance is needed and the smaller devices are frequently disturbed by vehicles, conical devices shall be a minimum of 28 inches high, and tubular devices shall be a minimum of 42 inches high.

Traffic cones are used to channel traffic, divide opposing traffic lanes, divide traffic lanes when two or more lanes are open in the same direction, and delineate minor maintenance operations in the street. When traffic cones are used to divide traffic lanes or delineate minor maintenance operations, spacing should not exceed 50 feet.

When traffic cones are used to channel traffic, they shall be placed on a taper to guide motorists past hazards. Taper lengths should be as shown in Figure 5. Because cones are smaller and have less target value than barricades, spacing between cones used to channel traffic should not exceed 25 feet, regardless of speed.

Vertical Panel Channelizing Devices

Vertical panel channelizing devices are effective for 24 hour channelization. They are used in place of traffic cones for channelization during hours of darkness. They are versatile because they have much more target value than pavement markings, are portable, light weight and use less street width than barricades. Professional experience indicates that vertical panels properly placed dominate existing pavement markings, provide positive guidance, and permit existing pavement markings to remain on short term projects without driver confusion.

Markings for vertical panel channelizing devices shall be alternate orange and white stripes sloping down at a 45-degree angle to the side on which traffic must pass. When used to divide two traffic lanes in the same direction, the stripes shall slope down to the side on which traffic is being diverted (see Figure 26). Both stripes (orange and white) shall be reflectorized with smooth surface weatherproof reflectorized sheeting.

Vertical panel channelizing devices shall be constructed of suitable material in a professional workmanlike manner to the dimensions shown in Figure 6. The base and panel support should be substantial and designed to resist overturning. Because the base can be an obstacle to traffic when overturned, the base and support should be designed to minimize damage to a vehicle if hit.

Vertical panel channelizing devices are used to channel traffic, divide opposing lanes of traffic, divide traffic lanes when two or more lanes are maintained open in the same direction and in place of barricades, where space is limited. When vertical panels are used to channel traffic, they shall be placed on a taper to guide motorists past hazards. Taper lengths and vertical panel spacing should be as shown in Figure 5. When vertical panel channelizing devices are used in place of barricades to delineate hazards parallel to traffic, spacing should not exceed 50 feet. When used to divide opposing lanes of traffic or divide two or more lanes traveling in the same direction, spacing should not exceed 75 feet for short distances and 150 feet for extended distances.

Vertical panel channelizing devices used in the right-of-way during hours of darkness shall have an approved barricade warning light attached and in operation. The warning light shall be mounted above the marked panel. Type C steady burn warning lights shall be used in a series to channel traffic, to divide opposing traffic, separate traffic lanes and guide traffic through construction areas. Type A flashing warning lights shall be used to delineate hazards.

Drums

Drums are most commonly used to channelize or delineate traffic flow, but may also be used in groups to mark specific hazards. Drums are highly visible and have good target value, give the appearance of being formidable obstacles and therefore, command the respect of drivers. Their primary disadvantage is their size, which makes them difficult to use on City streets with narrow traffic lanes. Drum spacing used to delineate hazards, close streets and channel traffic, shall be the same as specified for Type I and Type II barricades. Drums are portable enough to be shifted from place to place in order to

accommodate changing conditions, but are generally used in situations where they will remain in place for a prolonged period of time. When drums are placed in the roadway, appropriate advance warning signs shall be used.

Drums used for traffic warning or channelization shall be approximately 36 inches in height and a minimum of 18 inches in diameter. Drums shall be made of plastic or other flexible material that will not cause serious damage if struck. Use of metal drums is prohibited. Markings on drums shall be horizontal, circumferential, orange and white alternating stripes 4 inches to 8 inches wide. Both stripes shall be reflectorized with smooth-surfaced weatherproof sheeting, which will display the same approximate size, shape and color day and night. There shall be at least two orange and two white stripes on each drum. If there are non-reflectorized spaces between the horizontal orange and white stripes, they shall be no more than 2 inches wide.

Drums should not be more than 20 percent filled with sand, water, or any material that would increase the obstacle nature of drums. Water shall not be used in periods susceptible to freezing. Open drums should have drain holes in the bottom so water will not collect. During hours of darkness, a flashing warning light shall be placed on each drum used to mark hazards and steady burn warning lights should be placed on drums used in a series for traffic channelization.

Arrow signs (WI-6) or vertical panels mounted above drums may be used to supplement drum delineation.

C. High Level Warning Devices

High level warning devices are used to alert the motorist of an obstruction in the street. Design of high level devices is such that they can be seen over the top of preceding vehicles. This height feature is particularly effective in diverting traffic around obstructions.

High level warning devices are required for all work in the street such as: new construction, pavement patching, manhole work, surveying, cranes, excavations, etc. High level warning devices may be attached to a vehicle located at, or placed in advance of, the obstruction. On fixed location projects, required high level warning devices should be positioned with or behind the channelization, and in the center of the area closed, except advance warning arrow panels. Arrow panels used on fixed location projects should be placed on the shoulder or in the parking lane at the beginning of the taper, when possible.

High level warning devices used in Chandler include advance warning arrow panels, flags, and rotating flashers or strobe lights.

1. Advance Warning Arrow Panels

Advance warning flashing or sequencing arrow panels, incorporating a number of sealed beam lamps designed to flash directional arrows or chevrons, should be used in lieu of other types of high level warning devices when possible. Arrow panels provide

additional advance warning and directional information to assist in diverting traffic, which is especially effective under high density traffic conditions and at night.

Advance warning arrow panels shall be legible to drivers at a distance of one-half mile on local or collector streets with a posted speed of 35 mph or less, and they shall be legible to drivers at a distance of three-fourths mile on arterial streets. Minimum legibility distances are those at which the arrow panel message can be comprehended by a driver on a sunny day or clear night.

The arrow panel should be positioned on the shoulder or in the parking lane at the beginning of the taper, when possible. When width is restricted, the arrow panel should be positioned behind the required channelization, near the start of the taper. The arrow panel must be in place throughout the restricted period.

Vehicles used to display arrow panels should be equipped with an impact-attenuating device whenever possible, to provide additional safety for works and motorists. While impact attenuators are optional, their use can help prevent serious damage to vehicles, equipment and workers at construction sites, which can make their use cost effective.

Generally, arrow panels should not be used for shoulder or roadside work activities, nor should they be used on two lane highways, because the panels can cause unnecessary lane changing.

Arrow panels provide additional advance warning and directional information when traffic must change lanes and should be used in lieu of other high level warning devices when possible.

2. Flag-Type High Level Warning Devices

Flag-type high level warning devices shall display three or more flags supported so that the lowest point of all three flags is 8 feet or more above the street (see Figure 6). The flags shall be orange or fluorescent red-orange in color, and 16 inches square or larger. The flag support and base shall be substantial to resist overturning by wind. The flag support and base shall be galvanized, aluminum or white in color.

During hours of darkness, each flag type high level warning devices must be equipped with a minimum of one Type B high intensity flashing warning light with lens mounted more than 8 feet above the street.

One flag-type, high level warning device is required for each direction traffic is affected. The devices shall be placed with or behind the required channelization in the center of the area closed. Additional flag type, high level warning devices may be used for sign supports. They shall be located at the location required by the sign legend.

3. Rotating Flashers and Strobe Lights

Electrically operated rotating sealed beam or halogen lamp flashers, or strobe light flashers, may be used in lieu of or in addition to flag-type, high level warning devices.

Rotating sealed beam flashers shall consist of one or more sealed beam units at lest 4 inches in diameter, rated at a minimum of 30,000 candlepower each. They shall emit a yellow light with a flash rate of 70 to 110 flashes per minute.

Halogen lamp flashers shall consist of one or more halogen lamps with a minimum rating of 50 watts generating 50,000 candlepower each, reflected in a rotating or alternating pattern by high quality parabolic reflectors. They shall emit a yellow light with a flash rate of 70 to 120 flashes per minute.

Strobe light flashers shall be rated at a minimum of 1,000,000 candlepower at the bulb. They shall emit a yellow light with a flash rate of 80 to 120 flashes per minute.

Rotating flashers or strobe lights, shall be mounted on a vehicle or other substantial support. When possible, they shall be mounted at a minimum height of 8 feet above the street.

The vehicle or other support, with flashers in operation, shall be positioned behind the required channelization and in the center of the area closed throughout the restricted period, except when used on a moving service vehicle.

Use of rotating flashers or strobe light type, high level warning devices is particularly desirable during hours of darkness, and they should be used in lieu of the flag type, high level warning device with the flasher attached, whenever possible.

D. Pavement Markings

Temporary markings may be used to guide traffic in construction and maintenance areas when clean, hard surfaced street or detour roadway surfaces exist. Temporary pavement markings must be kept clean at all times. Normally, they should be used in combination with signs, barricades and channelizing devices. Existing pavement markings that conflict with the vehicle path indicted by temporary markings shall be removed or obliterated as required in this manual. Temporary markings shall be removed and permanent markings replaced upon project completion.

Reflectorized paint lines, pavement marking tape or raised pavement markers may be used for temporary traffic control when approved by the Traffic Engineering office. They are generally used on paved detours, and on major street construction between completion of asphalt base and finish course. When used on major street construction, temporary painted left turn lanes shall be provided at all signalized intersections. Reflectorized paint lines shall be applied with a suitable paint striping machine using City of Chandler specification or equal traffic paint and reflective glass beads. Paint lines shall have a minimum wet film thickness of 15 mils with 6 pounds of glass beads applied per gallon of paint. Reflectorized pavement marking tape specifically manufactured for pavement

marking use may be used in place of paint lines. Pavement marking tape shall be durable and have the appearance and reflectively of paint lines. Application of short pieces of pavement marking tape to form dashed lines in lieu of pavement striping is not acceptable.

Centerline markings shall be two, 4-inch wide yellow lines with a 3-inch space between. Lane line markings shall be 4-inches wide, placed with 10 lineal feet of line and 30 lineal feet of space to form the lane line pattern. Other markings for barrier lines, edge lines, crosswalks and school zones, may be necessary to complete temporary marking installations. Edge lines shall be 4-inch wide continuous white lines. Barrier lines for mandatory turn lanes, pavement edge tapers and lane transition, shall be 8-inch wide white lines. Stop bars shall be 18-inch wide solid white lines. Crosswalk lines shall be 12-inch wide solid white lines.

Raised reflectorized pavement markers may be used in lieu of paint or tape markings. They should be used to supplement paint and tape pavement markings in unlighted areas, on lane changes and on detours. Centerline markers shall be yellow. Lane line and edge line markers shall be white. Spacing between markers used in lieu of paint or tape center and edge lines shall not exceed 10 lineal feet on straight alignments and 5 lineal feet on curves. Lane lines shall be groups of three markers spaced 5 lineal feet apart with a 15 lineal foot space between groups on straight alignments and a 10 lineal foot space between groups on curves. Spacing between markers used to supplement paint and tape center, lane and edge lines shall not exceed 40 lineal feet on straight alignments and 20 lineal feet on curves.

E. Police Officers and Flaggers

Police officers and flaggers perform a very important function as the human element in the temporary traffic control system. Other devices alter, advise and guide motorists and pedestrians, but cannot respond to the diverse traffic conditions that may occur during major restrictions. Police officers and flaggers can visually assess traffic conditions and respond accordingly. While flaggers are limited by the Manual on Uniform Traffic Control Devices to flagging operations that can be accomplished from the edge of the traveled way, police officers are authorized by City Code to direct traffic as required. They can operate traffic signals, control multiple lanes of traffic, and permit specialized lane movements. They can also assist pedestrians and enforce traffic restrictions. Police officers and flaggers that are alert, visible and accommodating can be a valuable public relations asset.

The use of police officers and flaggers is required at locations where equipment is intermittently blocking or crossing a traffic lane, or where only one traffic lane is available for two directions of traffic. Also at multiple-lane signalized intersections when traffic is restricted to one through traffic lane in any one direction. They may be required at other signalized intersections restricted to less than the normal lanes and where a large volume of trucks enter and leave construction sites.

Police officers are mandatory for manual control of traffic at signalized intersections and for flagging operations on multiple lane streets. One police officer at each signalized

intersection affected is generally adequate, but during flagging operations and when construction equipment creates vision restrictions, two or more officers may be required. Police officers or flaggers may be used for manual control of traffic at other locations. When only one traffic lane is available for two directions of traffic, two police officers or flaggers (one for each direction) are required, except when approved temporary traffic control signals are used.

Police officers or flaggers shall be provided for manual traffic control as specified in this manual and as required by the Police Department or Traffic Engineering office.

1. Police Officers

The use of on-duty police officers is limited to short-term assistance during emergency conditions. Contractors, utilities and other agencies shall employ off-duty City of Chandler police officers when police officers are required for traffic control.

Off-duty police officer use for traffic control during construction and maintenance operations is scheduled by the Police Department (782-4200), Monday through Friday from 8:00 AM to 5:00 PM. One working day (24 hours) advance notice is required.

2. Flaggers

Flaggers should be alert, courteous, neat and possess a sense of responsibility for the safety of the public and work crews. Flaggers shall wear an orange or fluorescent red-orange vest and hard hat and use a "STOP/SLOW" sign to control traffic. The "STOP/SLOW" sign shall be 24 inches in diameter with 6-inch series C letters. The "STOP" face shall have a red octagon background with white letters and border. The "SLOW" face shall have an orange diamond background with black letters and border. The sign shall be mounted on a suitable staff to support the sign 5 feet from the ground when in use.

The use of flags for controlling traffic is limited to emergency conditions only.

Flagging procedures are illustrated in Figure 7. Flaggers shall be stationed at a readily visible location on the shoulder or behind channelization in advance of the restriction. Flagger stations shall be marked with a high level warning device. "FLAGGER AHEAD" AND "BE PREPARED TO STOP" signs shall be used in advance of each station. At no time should a Flagger be allowed to stand in the traveled part of the roadway or cross a traffic lane to stop more than one lane of traffic.

During the hours of darkness, each Flagger station shall be illuminated. All traffic control devices including the STOP/SLOW sign and the flagger's vest shall be reflectorized. Signs, barricades and channelization in advance of each Flagger station shall have barricade warning lights attached and in operation.

F. Traffic Control Signals

A temporary traffic signal system may be used to control vehicular traffic movements at construction or maintenance work areas when a traffic engineering study indicates the desirability to do so. Each use shall be specifically approved by the Traffic Engineering office. All traffic signal control equipment shall meet the applicable standards and specifications prescribed in Parts IV and VI of the Manual on Uniform Traffic Control Devices.

Contractors, utilities or other agencies shall prepare a detailed traffic control plan showing the location, use, timing and hours of operation at each location for approval prior to implementation. Signal controller phasing and timing shall be pre-approved by the Traffic Engineering office. Only off-duty City of Chandler police officers may manually control temporary traffic signals unless otherwise approved by the Traffic Engineering office. "TRAFFIC SIGNAL AHEAD" (W3-3) signs shall be placed in advance of all approaches to temporary traffic control signals.

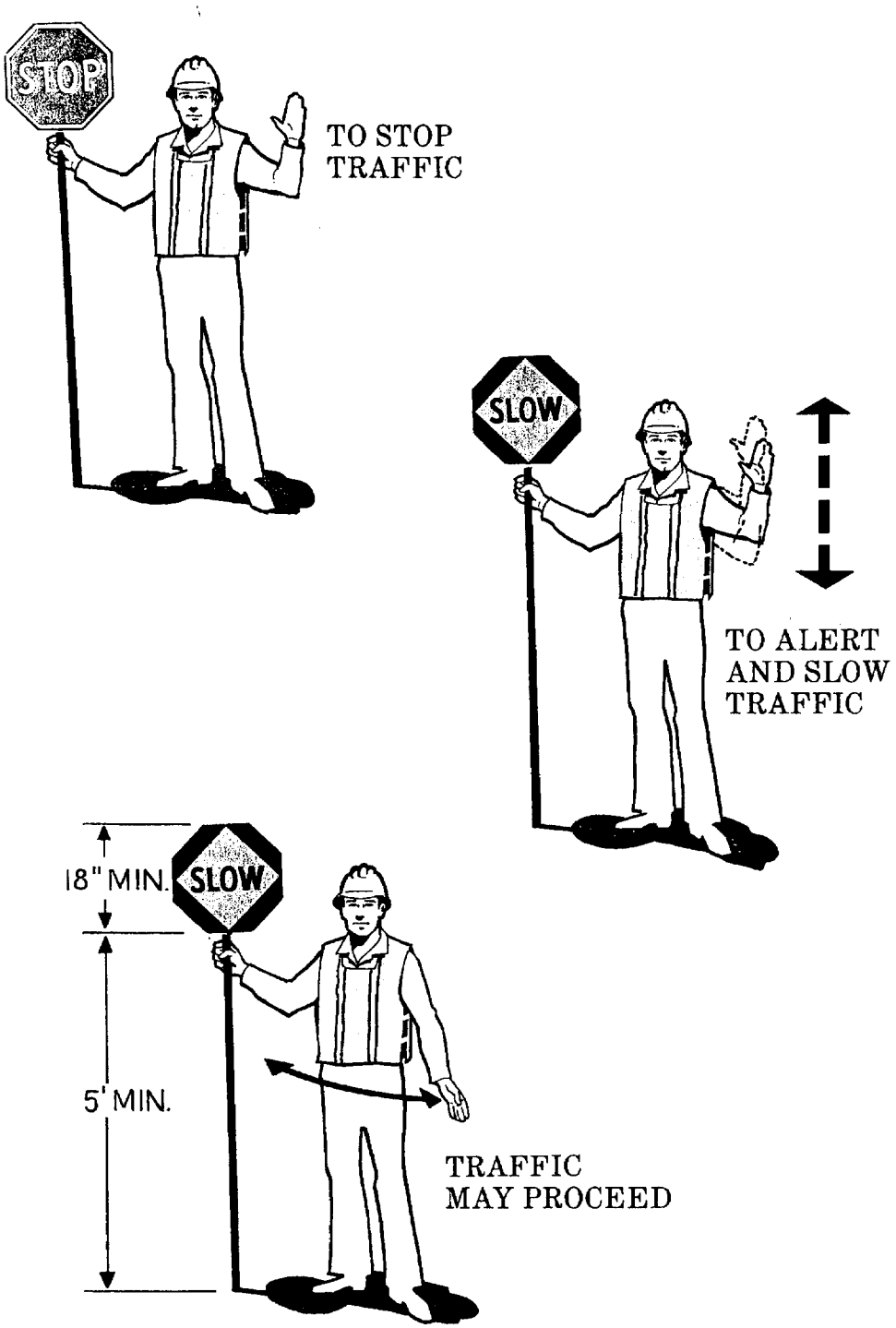


FIGURE 7 **FLAGGING PROCEDURES**

G. Portable Barriers

Portable barriers are usually heavy pre-cast reinforced concrete units commonly referred to as "Jersey barriers." These devices are approximately 36 inches high and taper from a wide base to a narrow top. They are designed to be physical barriers placed parallel to traffic lanes to prevent vehicles from leaving the traveled way, and to protect workers. They are generally used to guide traffic on curved detour alignments, replace bridge rails during reconstruction, and separate traffic from construction areas on long term, fixed location projects. They may also be used to separate opposing traffic lanes.

Portable barriers shall only be used in combination with the required signs, barricades and channelizing devices. Barriers may serve the additional function of channelizing traffic. When serving this function, barriers shall be light in color and equipped with vertical panel markings and barricade warning lights. The first two warning lights at the start of a continuous barrier shall be Type B flashing warning lights. All other warning lights shall be Type C steady burn warning lights. Spacing for barricade warning lights and vertical panel markings, shall be as required for vertical panel channelizing devices in this manual.

The traffic approach ends of all portable barriers shall be protected from vehicle impact by the use of impact-attenuators or flaring the ends away from the traveled way. When space permits, approach ends shall be flared at a 45-degree angle to a minimum of 10 feet from the traveled way. When space does not permit, barrier ends shall be protected with impact-attenuators as required in the Manual On Uniform Traffic Control Devices.

Water barriers may be used at the discretion of the City Transportation Engineer.

VII. PEDESTRIAN WALKWAYS AND CONSTRUCTION FENCES

Each and every crosswalk and pedestrian walking area, whether paved or earth, shall be maintained by the contractor, utility or other agency at all times, unless otherwise provided for in this manual or the approved street closure permit, or during emergency conditions.

Proper planning for pedestrians through and along construction areas is as important as roadway planning. Pedestrian consideration, including access to bus stop locations and crosswalks, must be an integral part of each project. When construction requires closing existing crosswalks and walkways, the contractor should provide temporary walkways and direct pedestrians to the safest, most convenient route possible. All walkways shall be clearly identified and wheelchair usable, protected from motor vehicle traffic, and free of pedestrian hazards (holes, debris, dust, mud, etc.). Pedestrian protection and temporary walkways may use any of the traffic control devices, including barricades, cones, signs, etc., approved herein (see Figure 8), unless a covered walkway or construction fence is required. All traffic control devices must be placed so as to leave at least a 36 inch accessible walkway past the sign. The only exception will be on the rare occasion when a walkway is totally closed to everyone for safety reasons (no open business beyond and all bus stops relocated beyond).

Temporary walkways, where possible, shall be maintained on part of the existing sidewalk, behind the existing sidewalk, or in the adjacent parking lane where available. The "PEDESTRIAN" sign with appropriate direction arrow shall be used to direct pedestrians to the alternate walkway when the walkway is maintained on the same side of the street.

Anybody requesting complete or partial walkway closures on one side of the street must first diligently try to accommodate pedestrians on accessible alternative paths on the same side of the street. If that cannot physically be done, and work procedures require that pedestrians be rerouted for protection, the contractor needs to make sure that the alternative path is fully accessible.

During approved complete sidewalk closures, "SIDEWALK CLOSED USE OTHER SIDE" signs shall be provided at the nearest crosswalk or intersection to each end of the closure. Where the closure occurs at the corner of an intersection, these signs shall be erected on the corners across the street from the closure.

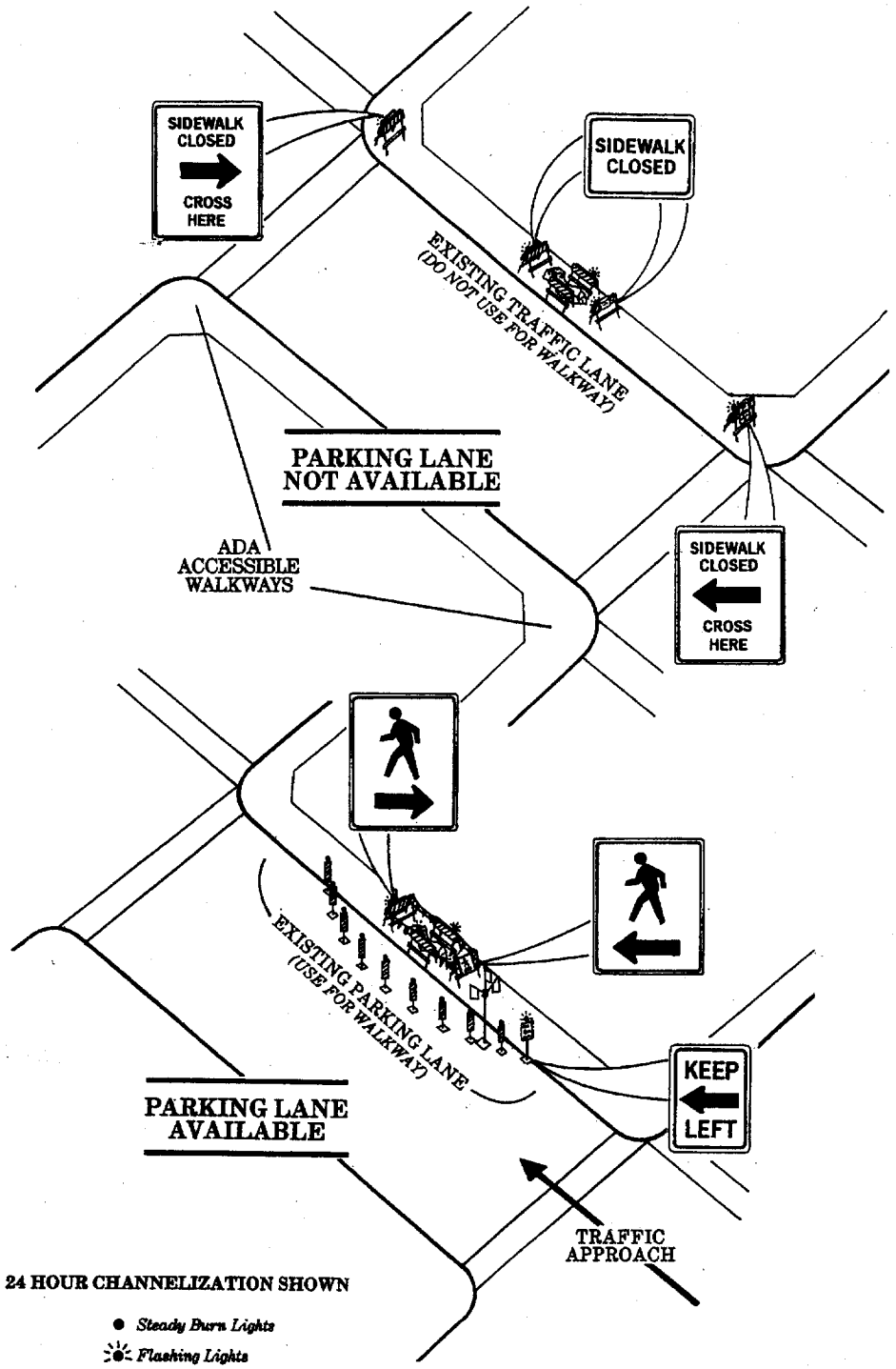
"SIDEWALK CLOSED" signs shall be used at the beginning of the actual sidewalk closure.

The "SIDEWALK CLOSED AHEAD" sign will be used to notify pedestrians that a walkway is closed ahead. Special care needs to be taken in sign placement to make sure that the sign is prominently visible to pedestrians, yet keeps open at least a 36 inch accessible path past the sign. Additionally, care needs to be taken to assure that adequate maneuvering room exists at the sign to enable disabled users to make an informed decision as to whether it is best to cross to the other side, or continue on the accessible path beyond the barricade to their destination.

During construction or demolition of buildings adjacent to sidewalks and other pedestrian walking areas, a covered walkway shall be provided for pedestrian protection when the walkway is less than one-half of the height of the exterior wall from the building. When the walkway is more than one-half of the height of the exterior wall from the building, a construction fence shall be provided. A fence is always required at all construction and demolition sites prior to any work.

The contractor shall submit a professionally prepared traffic control and walkway plan to the Traffic Engineering office for approval, before beginning building construction or demolition work that affects streets and sidewalks. All covered pedestrian walkways and construction fences shall be painted white or other approved light color except where hazard striping is required. They shall be maintained in good condition, clean and fresh appearing at all times. Damaged walkways and fences shall be repaired by the contractor immediately.

No loading or unloading of material, or staging or stopping of vehicles will be allowed on the street side of walkways and fences, without a street closure permit. Gates for access to the construction site shall not swing into the street or pedestrian walkways. Access to fire hydrants, traffic signal control boxes, manholes, and other utilities shall be provided at all times.



SIDEWALK CLOSURES

FIGURE 8

A. Covered Pedestrian Walkways

Covered walkways shall be substantially constructed of suitable material to support the loads to be imposed upon the structure. Minimum design requirements for the floor and roof shall be 100 pounds per square foot live load, uniformly loaded and 200 pounds per square foot concentrated load.

The clear walking area shall be at least 5 feet wide and 8 feet high. The walking surface shall be paved or covered with plywood or wood planking. Ramps shall be provided for wheel chair use.

The building side of the walkway shall be built of tight boards or plywood, except where chain link sign distance panels are required. The roof shall be tightly boarded. A 3-foot high enclosure and a 4-foot high railing shall be attached on the street side between walkway entrances. All interior surfaces of the walkway shall be smooth and free of protruding nails and splinters. The covered area of the walkway including entrances, shall be brightly illuminated during hours of darkness with 110 volt, 100 watt electric lamps in vandal resistant fixtures mounted on 30 foot centers, along the inside of the back wall near the roof line.

Each walkway shall be inspected daily and maintained clean and free of dirt, debris and hazard at all times. Covered walkways located in the street shall include the following traffic warning and pedestrian protection devices (see Figure 9).

1. **A high level warning board two feet high and width equal to that of the walkway mounted above the walkway on all traffic approaches.** The warning board shall be striped with 45-degree angle 12-inch orange and white hazard markings, sloping down toward the side on which traffic must pass. Two 110 volt, 75 watt flashing yellow lights in vandal resistant fixtures shall be mounted on the warning board, one on the lower right and one on the lower left corner.

2. **The traffic approach end of the walkway at mid-block locations shall have a fixed handrail extending from the curb to the traffic side of the walkway.** The area from rail to pavement shall be covered and striped with 45-degree angle 12 inch orange and white hazard markings sloping down toward the side on which traffic must pass. A minimum of three 100 volt, 75 watt steady burning yellow lights in vandal resistant fixtures shall be mounted equally spaced on the striped area at railing height.

3. **Steady burning 110 volt, 75 watt yellow clearance lights in vandal resistant fixtures mounted on 30 foot centers along the traffic side of the walkway, when the walkway is in the street, on the curb and within 18 inches of the back of the curb.** They shall be installed at railing height.

4. **A continuous bumper guard rail consisting of one, 2 inch by 16 inch board shall be mounted on the street side of the structure at a height of 10 inches from the pavement to the bottom of the rail.**

B. Construction Fences

Construction fences located adjacent to a required pedestrian walkway, separating pedestrians from construction or demolition work, shall be 8 feet high and substantially constructed of tight boards or plywood, except where chain link sight distance panels are required. Construction fences at locations where the walkway is more than the full height of the exterior wall from the building, or the adjacent walkway has been closed to pedestrians, may be constructed entirely of chain link fencing 8 feet high. Construction fences located in the street shall include the following traffic warning devices (see Figure 10):

1. **45-degree angle 3-inch orange and white hazard markings sloping down toward the side on which traffic must pass, at all traffic approaches. The marked area shall extend from the pavement to a minimum of 8 feet above the pavement, except as required for sight distance panels.**

2. **Two rows of 110-volt, 75-watt flashing yellow lights in vandal resistant fixtures (one row 3.5 feet from pavement and 1 to 8 feet minimum from pavement) with not less than two flashers per row mounted on 8-foot maximum centers along with the hazard markings, on all traffic approaches.**

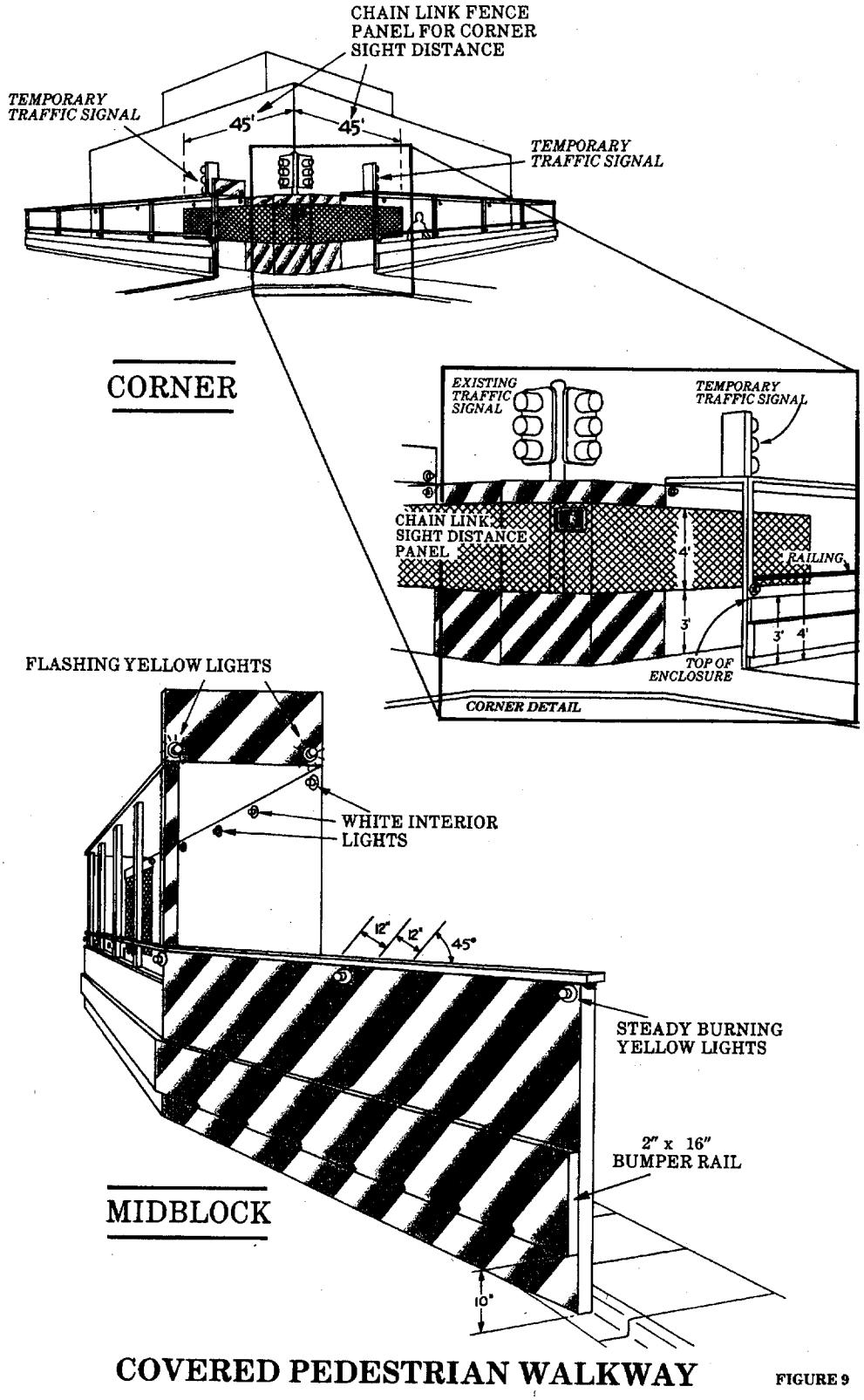
3. **Steady burning 110-volt, 75-watt yellow clearance lights in vandal resistant fixtures mounted on 30-foot centers along the traffic side of all fences in the street, on the curb, and within 18 inches of the back of the curb.** They shall be mounted 3.5 feet from the pavement.

4. **"PEDESTRIANS PROHIBITED THIS SIDE OF STREET", signs on the fence opposite all crosswalks, and at the end of all existing walkways, marked or unmarked, when the construction fence closes existing sidewalks or walkways.**

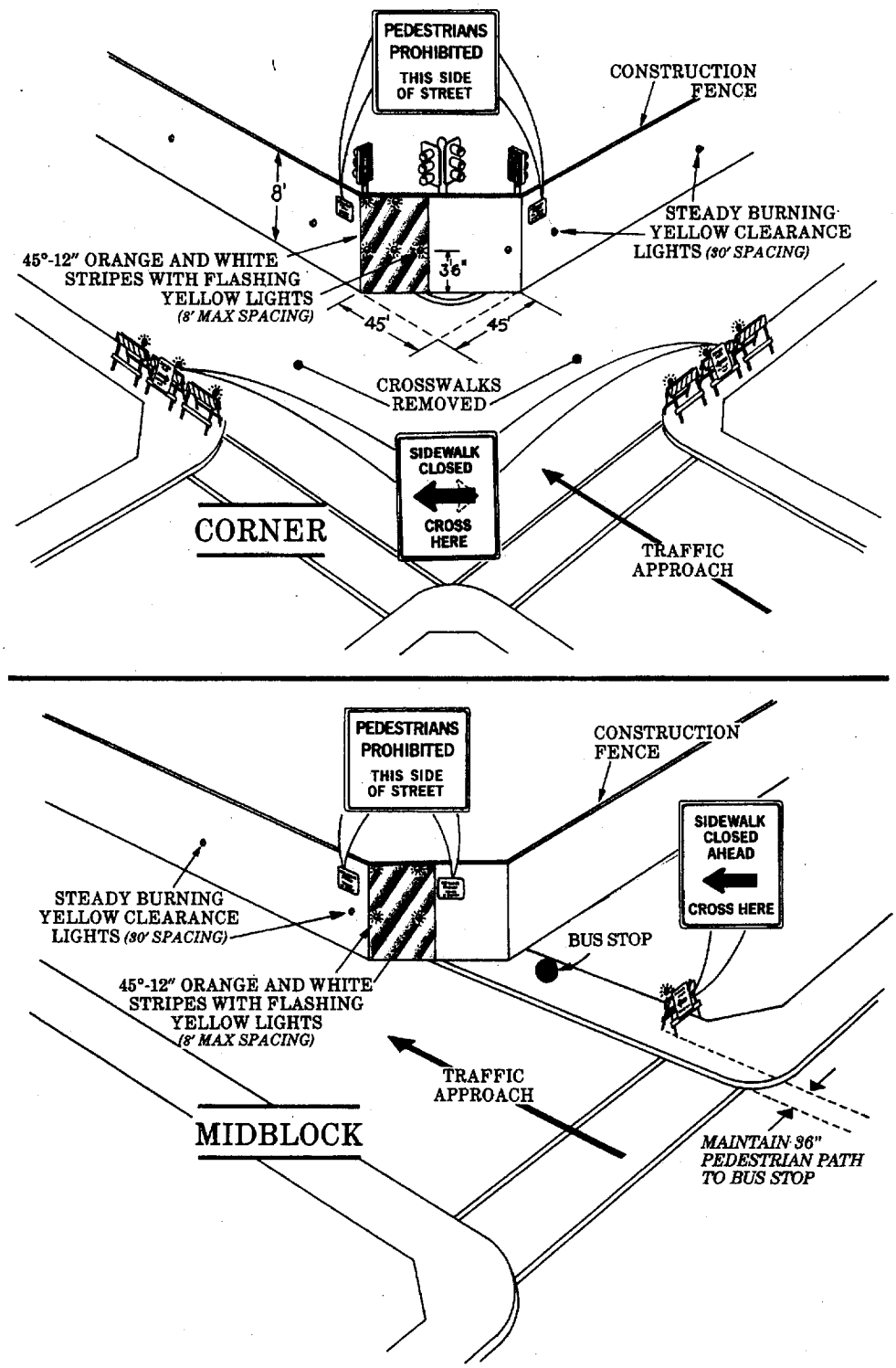
C. Sight Distance Requirements

Covered pedestrian walkways and construction fences installed at street intersections shall be constructed to provide a minimum 45 foot sight distance triangle when possible. If the walkway or fence cannot be constructed along the hypotenuse of the triangle, chain link fence panels shall be installed to provide the required sight distance. The chain link fence panels shall be a minimum of 4 feet high installed with the bottom 3 feet above the existing pavement. This sight distance shall be maintained clear of all temporary buildings, building materials, equipment, debris, and the like, at all times. Sight distance panels shall also be provided for 15 feet on each side of all vehicle access gates in construction fences adjacent to walkways and traffic lanes.

Where the above sight distance panels conflict with the required hazard markings on traffic approach ends of construction fences, the hazard markings and yellow flashing lights shall be provided above and below the panels. When covered pedestrian walkways or construction fences conflict with the normal operation and/or visibility of existing traffic signal equipment (pedestrian signals, traffic signal heads, controllers, etc.) and/or traffic signs, arrangements shall be made for relocation as provided for in Section V of this manual.



COVERED PEDESTRIAN WALKWAY FIGURE 9



CONSTRUCTION FENCES FIGURE 10

VIII. SURVEYORS

Pedestrian fatalities account for one of every three traffic fatalities. The nature of urban survey work is potentially hazardous. The surveyor, as a pedestrian in the street, may be obscured from the motorist's vision by the presence of a single car. The higher the traffic volume, the greater the chance of a mishap.

Surveying is not permitted on arterial or collector streets during the peak traffic hours, except when such work is in areas that are under construction and the contract special provisions permit restrictions, or with the prior approval of the Traffic Engineering office.

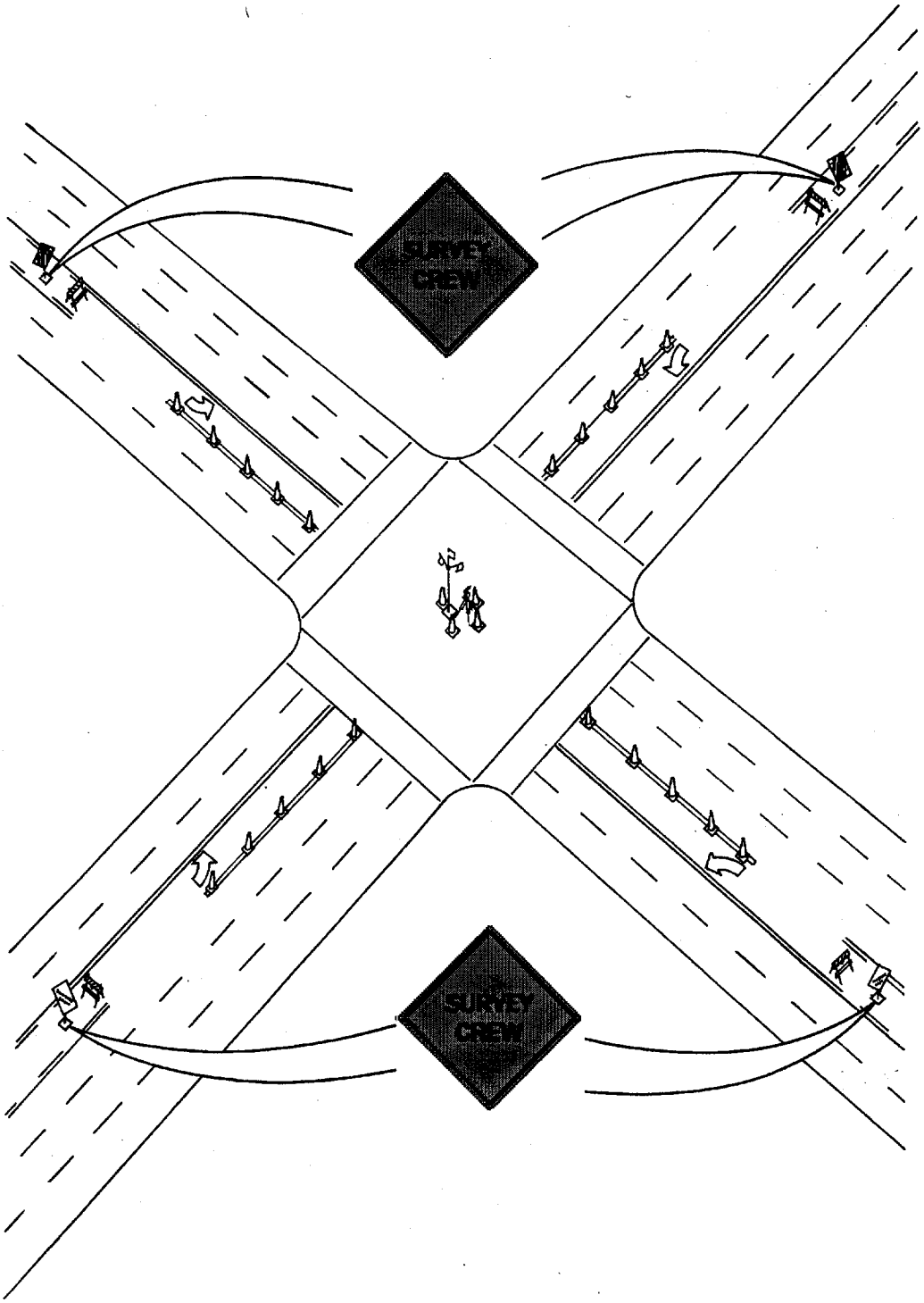
Street closure permits to restrict traffic for surveying on streets other than those under construction are requested as provided for in Section III of this manual. Traffic shall be controlled as provided for in Section IV of this manual. When surveyors are working in areas that are under construction, the traffic regulations applying to the contractor, utility or other agency shall also be applicable to the surveyor. All traffic restrictions in construction areas shall be coordinated with the contractor, utility or other agency.

Surveyors working in the street shall wear orange or fluorescent red-orange vests. Orange or fluorescent red-orange hats or caps should also be worn by surveyors when practical to help improve visibility for motorists.

Generally, the surveyor will be able to channel traffic easily with advance warning signs, high level warning devices and traffic cones. The surveyor's work in the street normally channels traffic to one side of a traffic lane rather than closing an entire lane. This channel may be made with cones or barricades using taper lengths and spacing as shown in Figure 5.

"SURVEY CREW" advance-warning signs placed in advance of the working area are valuable to alert motorists of the surveyor's movements in traffic. The flag type, high level warning device is extremely valuable for survey work as it may be seen over the top of preceding vehicles. Use of high level warning devices is mandatory. A high level warning device must be used any time an instrument is set up in the street and should be used when a range pole is placed in a signalized intersection. Typical daytime traffic control illustrations are shown in Figures 11 and 12.

When surveying work requires restricting a full traffic lane or when restricting traffic during hours of darkness, traffic control devices (signs, barricades, and channelization, etc.) shall be provided as required elsewhere in this manual for those conditions.



SURVEYING-INTERSECTION **FIGURE 11**

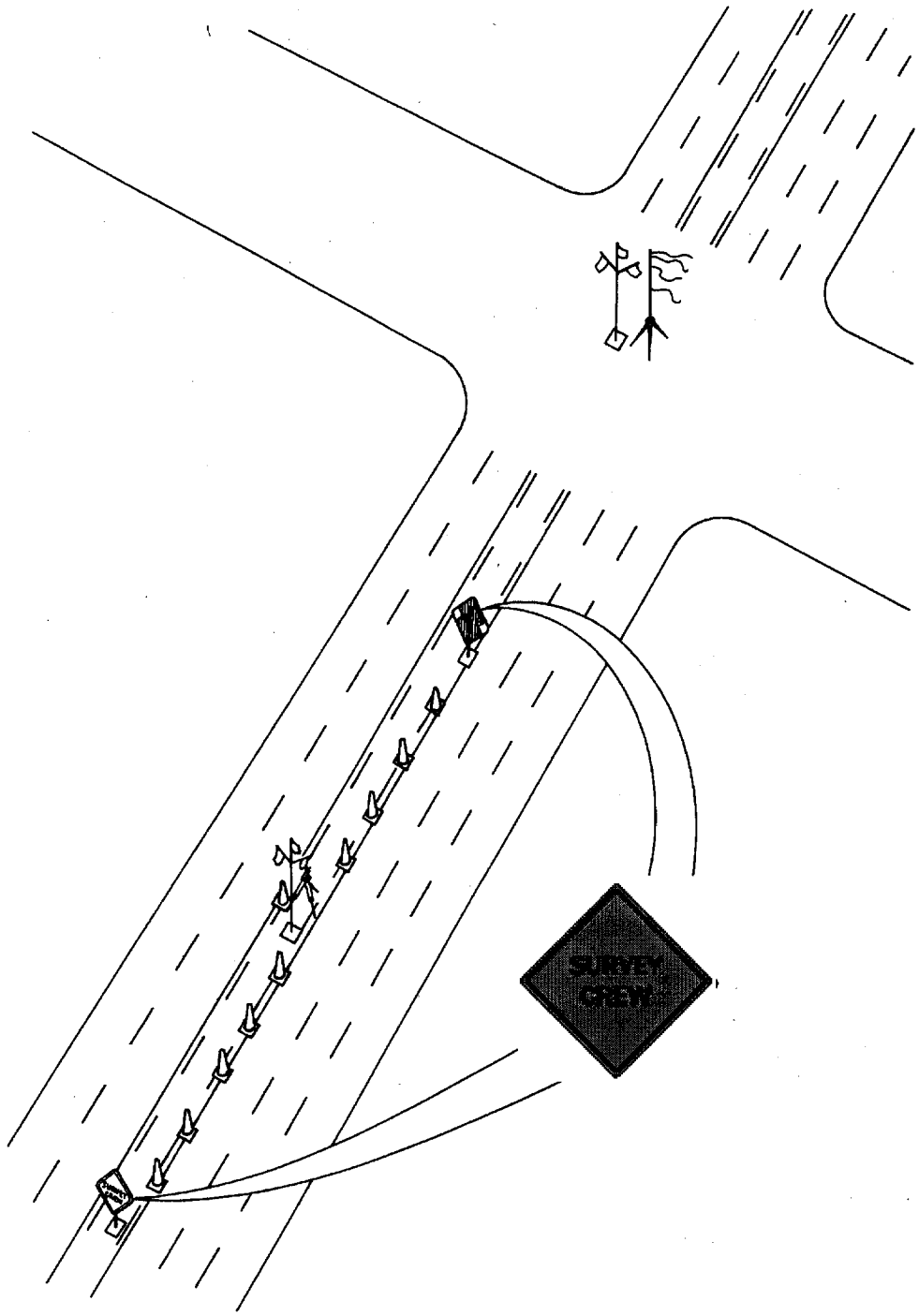


FIGURE 12 **SURVEYING-MIDBLOCK**

IX. SERVICE VEHICLES

Vehicles covered in this section are only those vehicles that are required by the nature of their work to travel slowly or stop for brief periods in City streets. Vehicles used for minor maintenance of street lights, traffic signals, traffic signs, street painting, sweeping, gas leak detection, sanitation pickup, minor pavement patching, and the like.

Service vehicles can impose a safety problem for workers, motorists and pedestrians. Service vehicle operations are prohibited on major and collector streets during peak traffic hours. During other times, the best and most desirable method for optimizing safety is for operators of service vehicles to plan their work to avoid stopping in the traveled portion of the street whenever possible, and when stopped, to reduce the time to a minimum.

When service vehicles must travel slowly or stop in City streets for brief periods, they shall display one of the following operating, high level warning light systems (see Figure 13).

- Two Rotating Flasher or Strobe Light, High Level Warning Light Devices. These devices must provide 360-degree visibility. They may be used in combination and incorporated into a "light bar" for added visibility.

- One Advance Warning Arrow Panel. Arrow panels shall be used in combination with rotating flashers or strobe lights to provide 360-degree visibility.

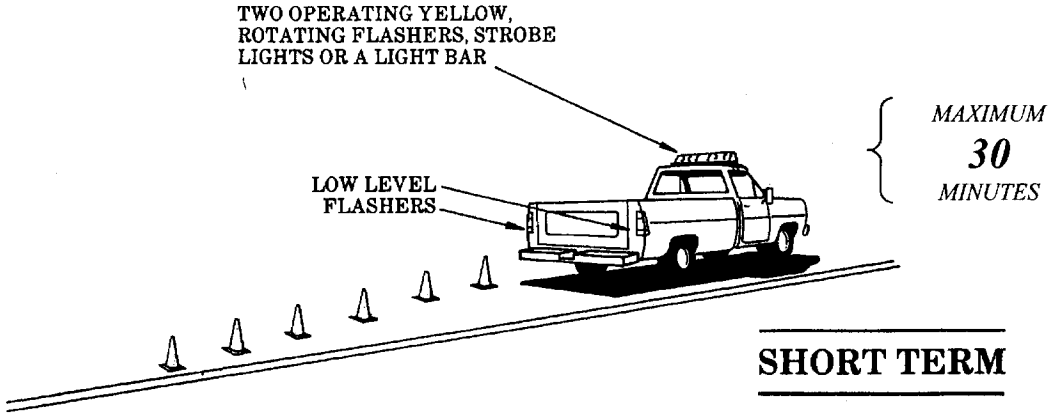
Flashing lights and arrow panels shall be located on service vehicles so that they remain in full view, front and rear, at all times and are not obscured by dump beds, mounted equipment or work activities. Minimum mounting height shall be 7 feet.

When service vehicles must stop in the street for brief periods, they shall also display the vehicle's four-way hazard warning flashers and at least two-traffic cones (each one 10 feet minimum to the rear of each rear corner). A short taper of cones (minimum 50 feet and 6 cones) at the rear of the vehicle may be used in high-density traffic areas to improve visibility. Flags on the upper rear corners of the vehicle may also be used to increase visibility.

Advance warning arrow panels provide additional advance warning and directional information when traffic must change lanes. Because they are more effective than flashing lights, vehicles equipped with an arrow panel are permitted extended times when stopped in City streets for service work. Maximum stopped time per service location is:

- 30 minutes for vehicles equipped with two rotating flashing or strobe light high level warning devices.

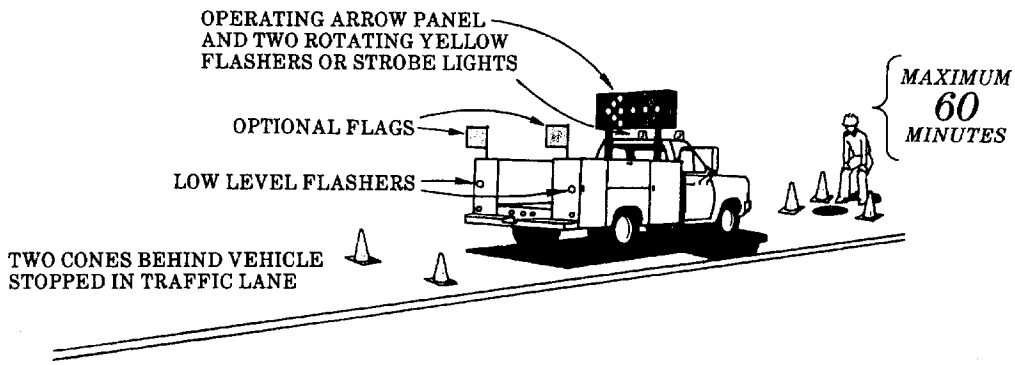
- 60 minutes for vehicles equipped with advance warning arrow panels.



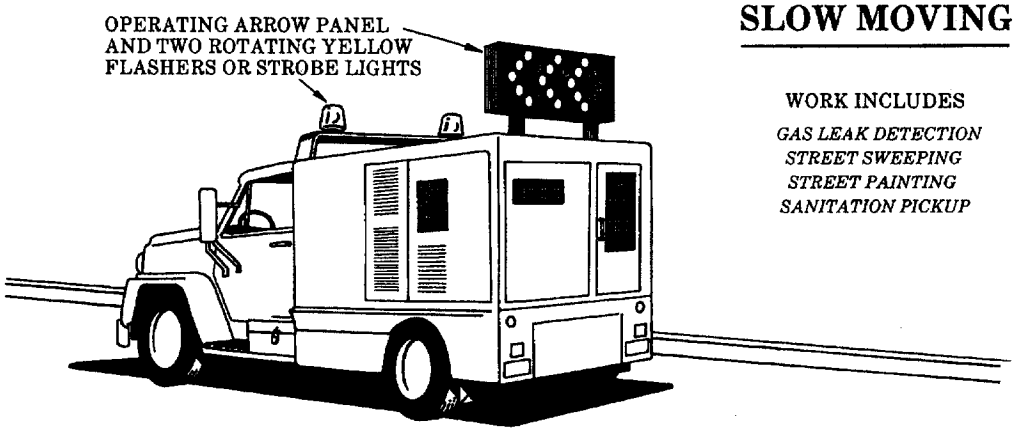
SHORT TERM

WORK INCLUDES

MANHOLE INSPECTION
CROSSWALK PAINTING
STREET LIGHT REPAIR
TRAFFIC SIGNAL REPAIR
PAVEMENT PATCHING



SLOW MOVING



WORK INCLUDES

GAS LEAK DETECTION
STREET SWEEPING
STREET PAINTING
SANITATION PICKUP

FIGURE 13

SERVICE VEHICLE FLASHER REQUIREMENTS

The more extensive signs, barricading and channelization, as required elsewhere in this Manual, are necessary for all service vehicles stopped in the street for more than 15 or 30 minutes, as applicable. Signs, barricades and channelizing devices are to be used for moving operations in relatively fixed areas such as pavement crack sealing and tree trimming, when on arterial and collector streets. Usually, these devices are set up in short sections and moved as the work progresses.

X. BARRICADING ILLUSTRATIONS

The traffic channelization and barricading illustrations on the following pages are presented to show typical applications of signs, barricades and channelizing devices. They illustrate the methods required for uniform application of standard traffic control devices as set forth in this manual. Specific situations not illustrated must be handled in conformance with the general methods and applications illustrated. The following illustrations are varied to show both daytime and 24 hour channelization as noted on the illustration where applicable.

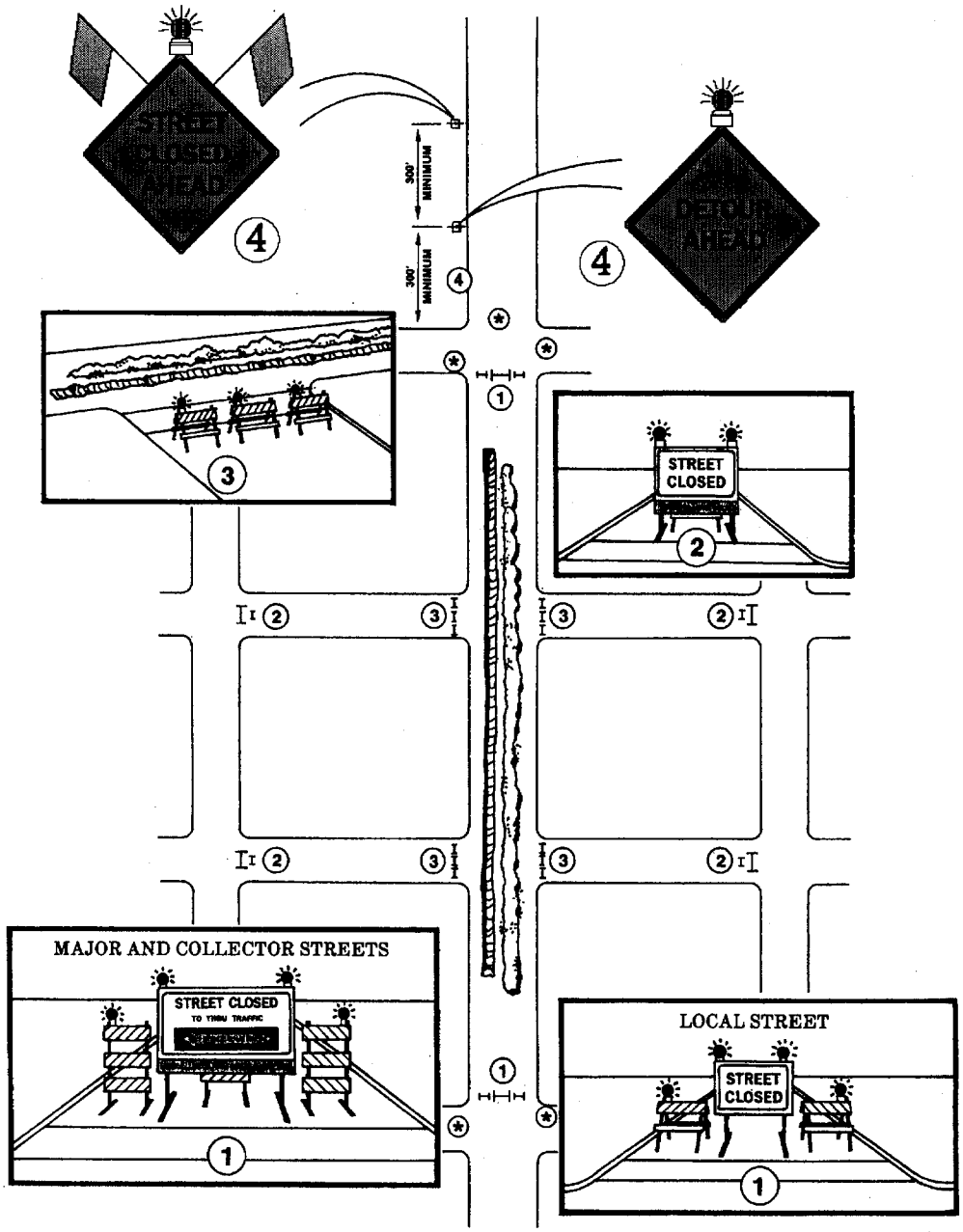
Specific elements shown in the illustrations are:

- The "ROAD WORK AHEAD" sign is used approaching all construction areas in addition to all other required advance warning signs.

- Barricades or vertical panel channelizing devices are used to mark hazards (excavations, holes, equipment, construction materials, piles of dirt, sand, etc.), closed streets, and to protect workmen and pedestrians in the public right-of-way.

- Channelization may include use of traffic cones during daylight hours but cones must be replaced with barricades and/or vertical panel channelizing devices during hours of darkness.

Traffic control devices used during hours of darkness must be reflectorized and equipped with barricade warning lights as specified. Only Type C steady burn warning lights shall be used on devices placed to form tapers, centerlines, lane lines, edge lines and other channelization to guide traffic. Type A or Type B flashing warning lights shall be used on all signs and flag-type high level warning devices as specified. Type A flashing, warning lights should also be used on all devices placed to mark hazards because they are more effective for this purpose than the Type C steady burn lights.



① STREET CLOSED. THE LARGE SIGN WITH THE DETOUR ARROW AND DETOUR DIRECTIONS SHALL BE USED FOR ALL MAJOR AND COLLECTOR STREET CLOSURES.

② STREET CLOSED SIGN, EXCEPT FOR LOCAL ACCESS, ON CENTER LINE OF STREET.

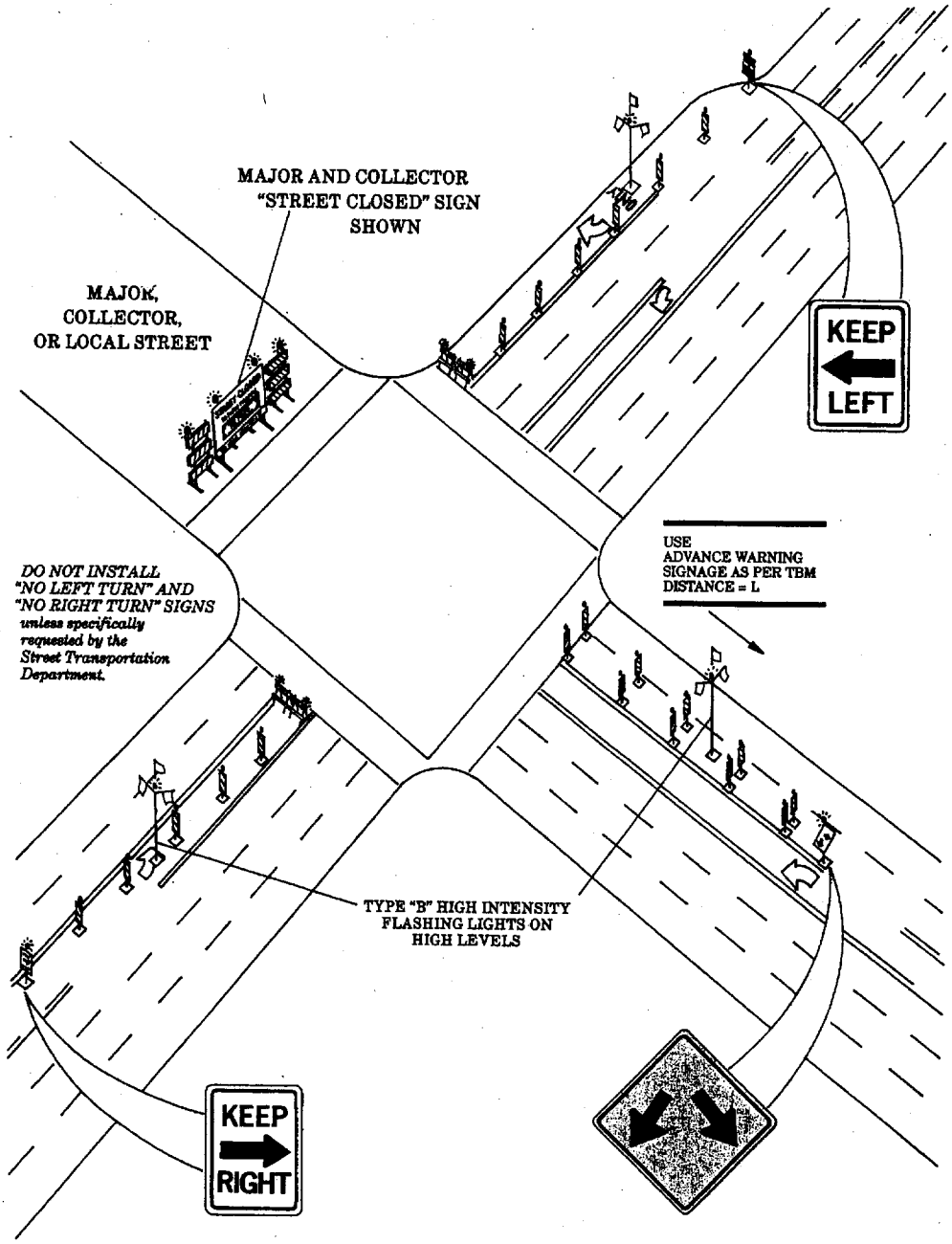
③ STREET BARRICADED AT CONSTRUCTION AREA.

④ ADVANCE WARNING SIGNS SHALL BE USED ON MAJOR AND COLLECTOR STREETS.

⊛ EXISTING MANDATORY TURN LANES APPROACHING CLOSURES SHALL BE CLOSED (SEE FIG. 15)

Flashing Lights

FIGURE 14 **COMPLETE STREET CLOSURES**



24 HOUR CHANNELIZATION SHOWN

• *Steady Burn Lights*

✻ *Flashing Lights*

MANDATORY TURN LANE CLOSURES

FIGURE 15

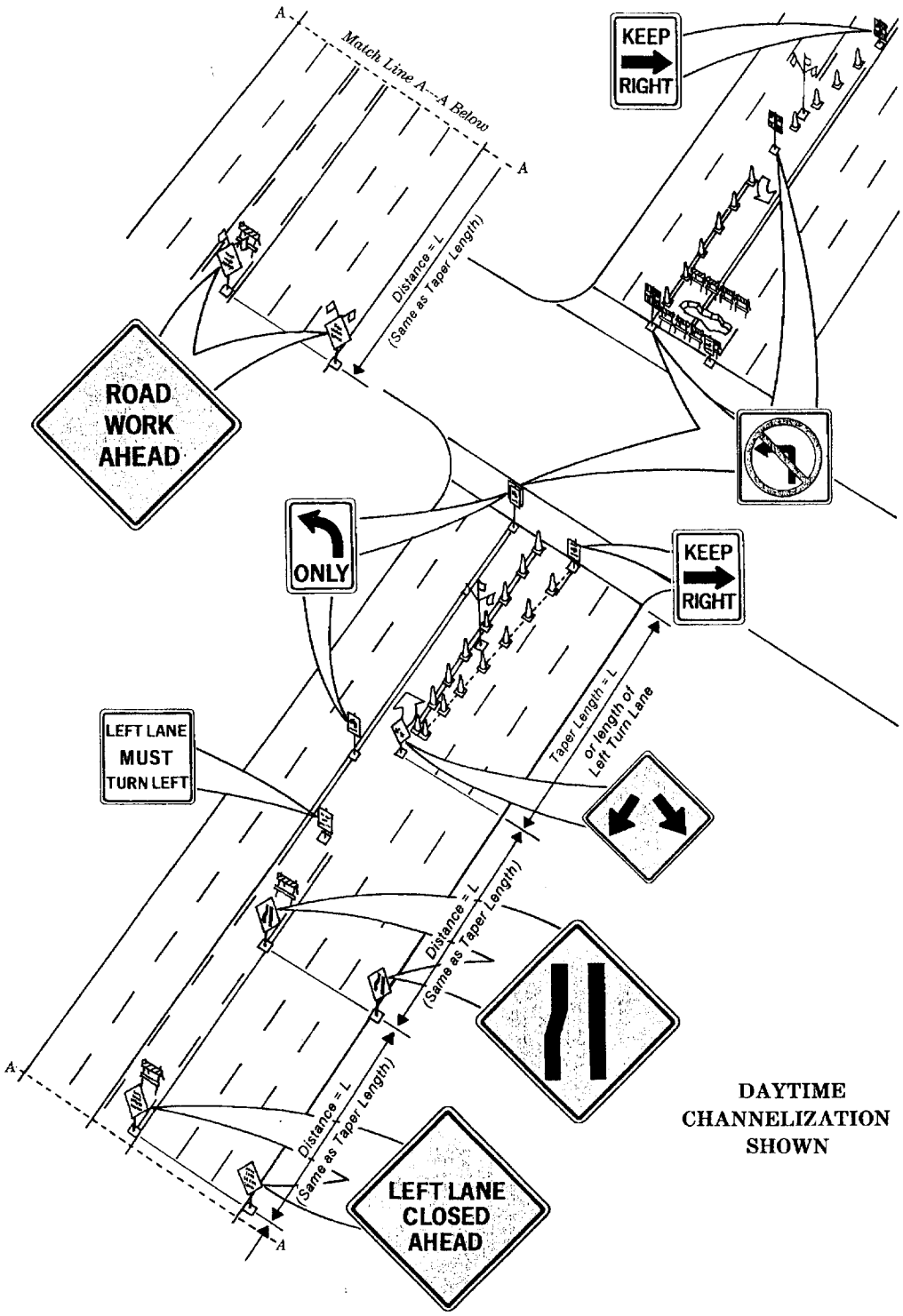
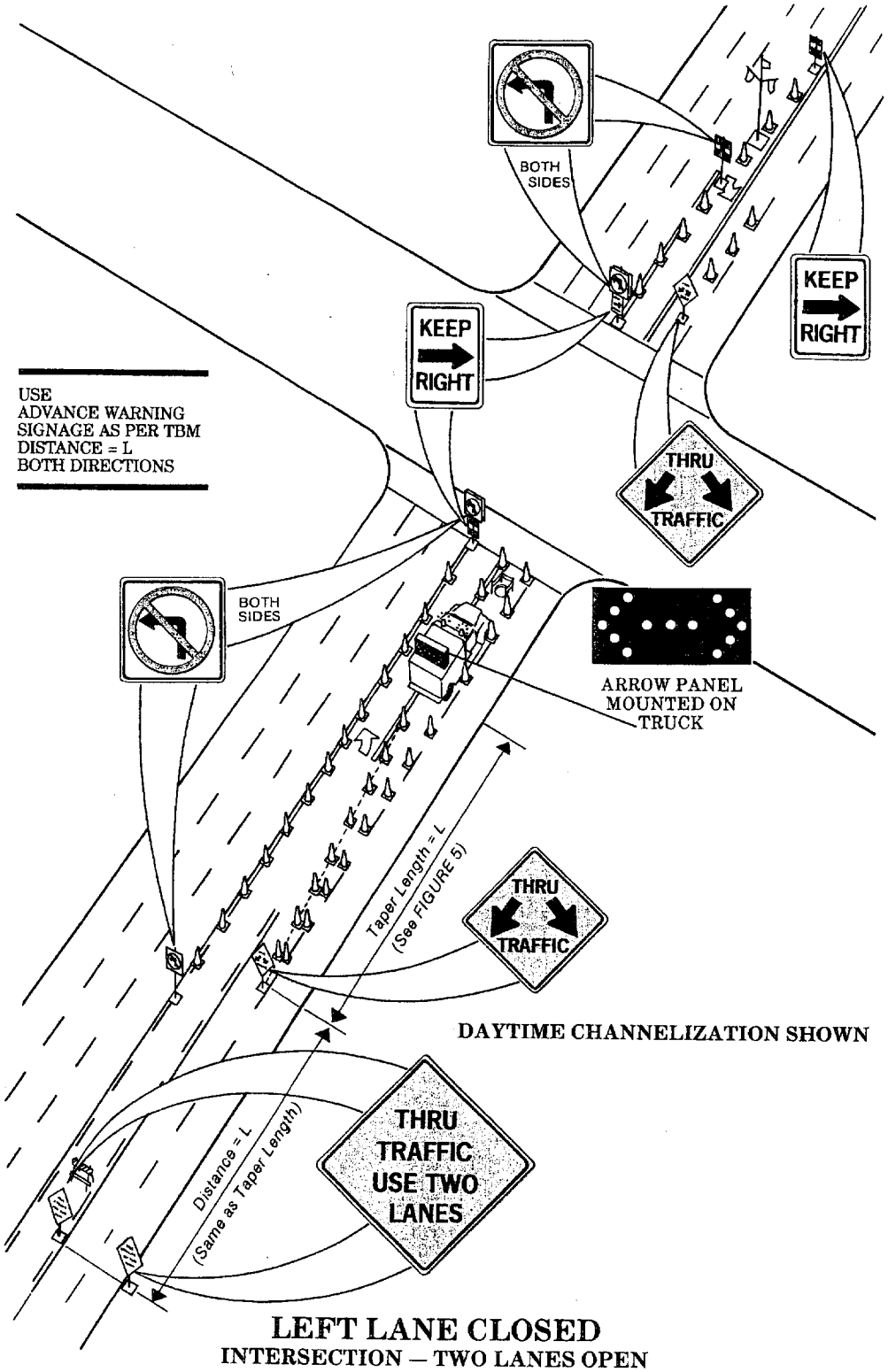


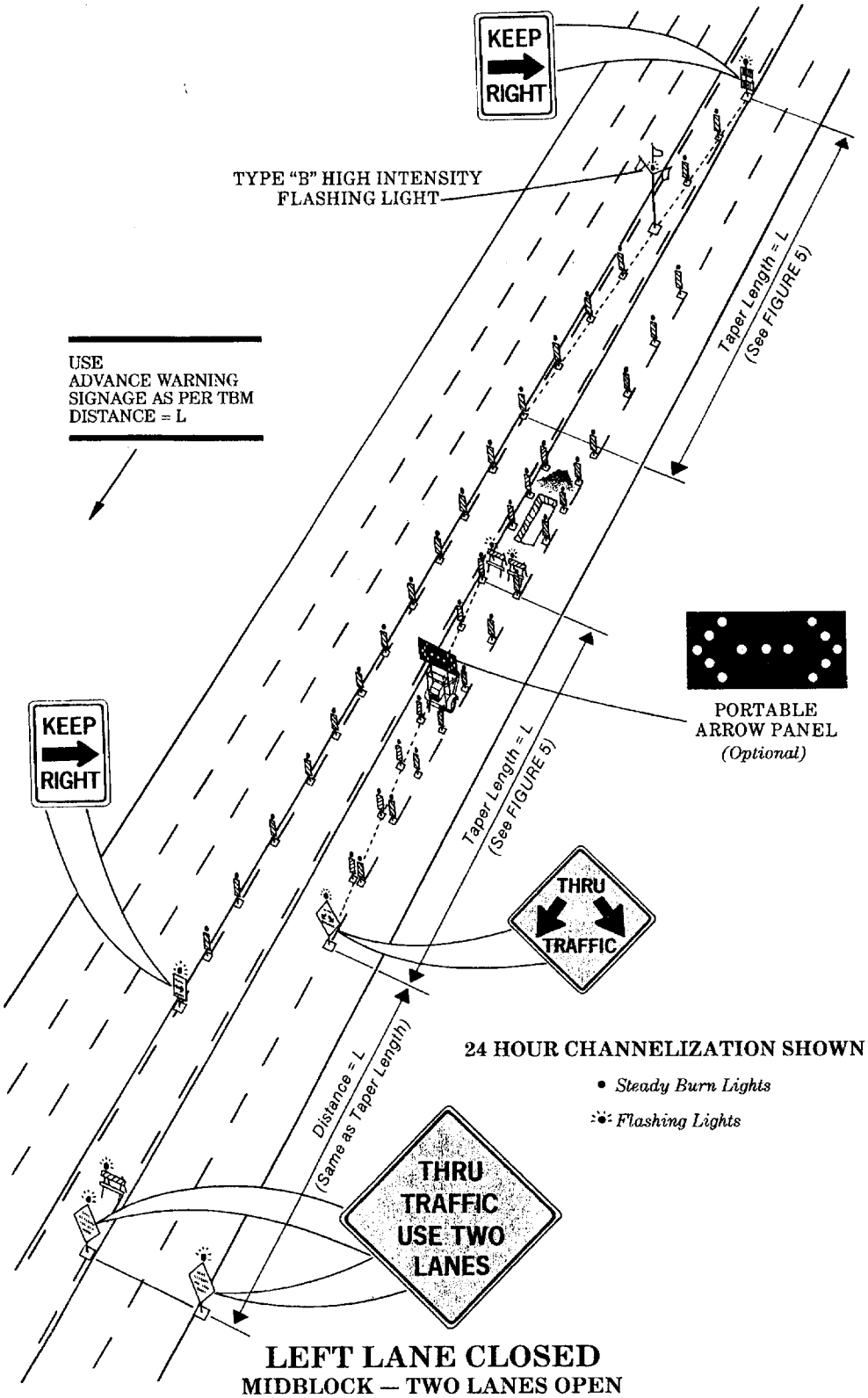
FIGURE 16

LEFT LANE CLOSED
INTERSECTION-LEFT TURN LANE OPEN



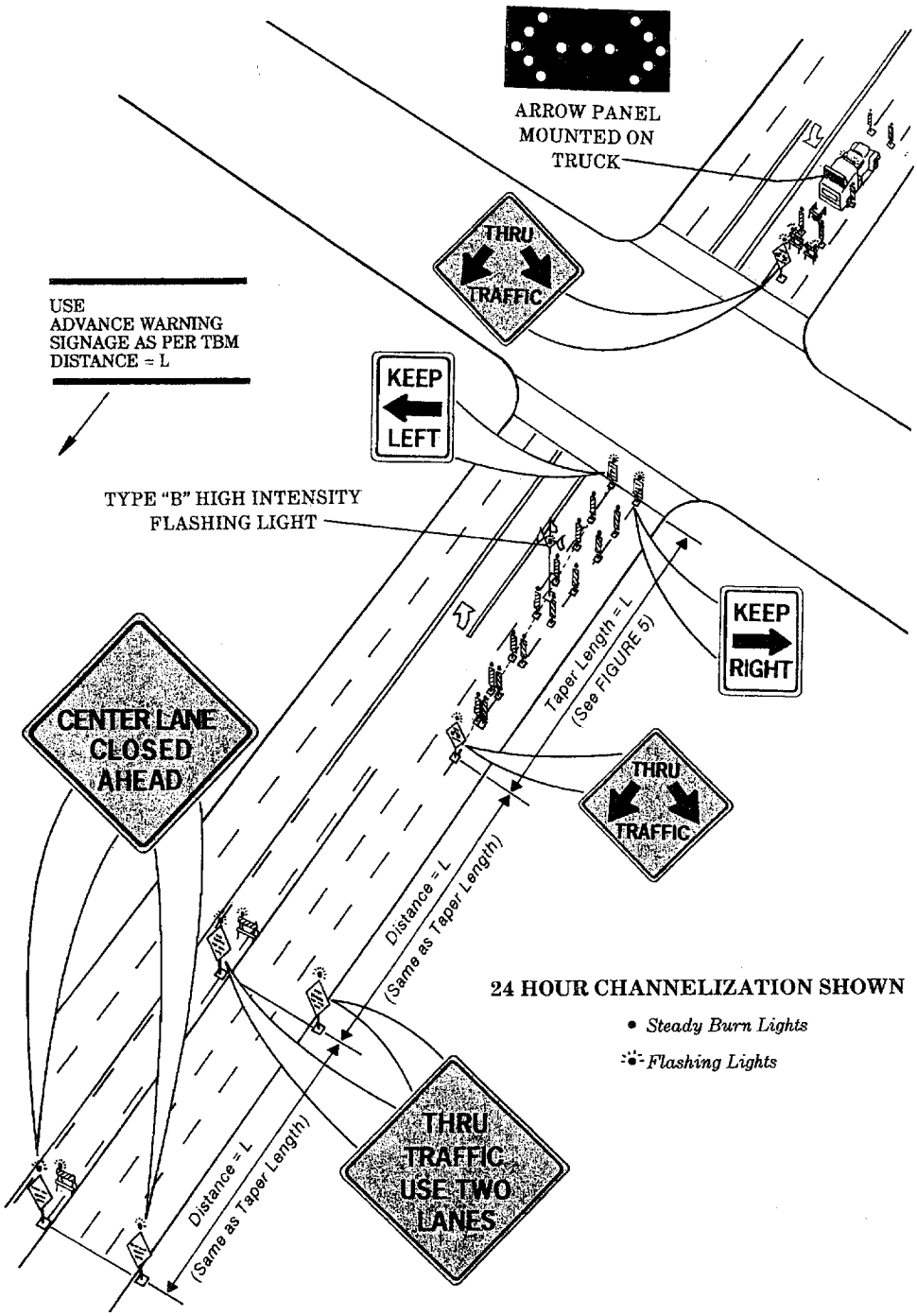
LEFT LANE CLOSED
INTERSECTION – TWO LANES OPEN
USING LEFT TURN LANE

FIGURE 17



LEFT LANE CLOSED
MIDBLOCK — TWO LANES OPEN
USING LEFT TURN LANE

FIGURE 18



CENTER LANE CLOSED
INTERSECTION — TWO LANES OPEN

FIGURE 19

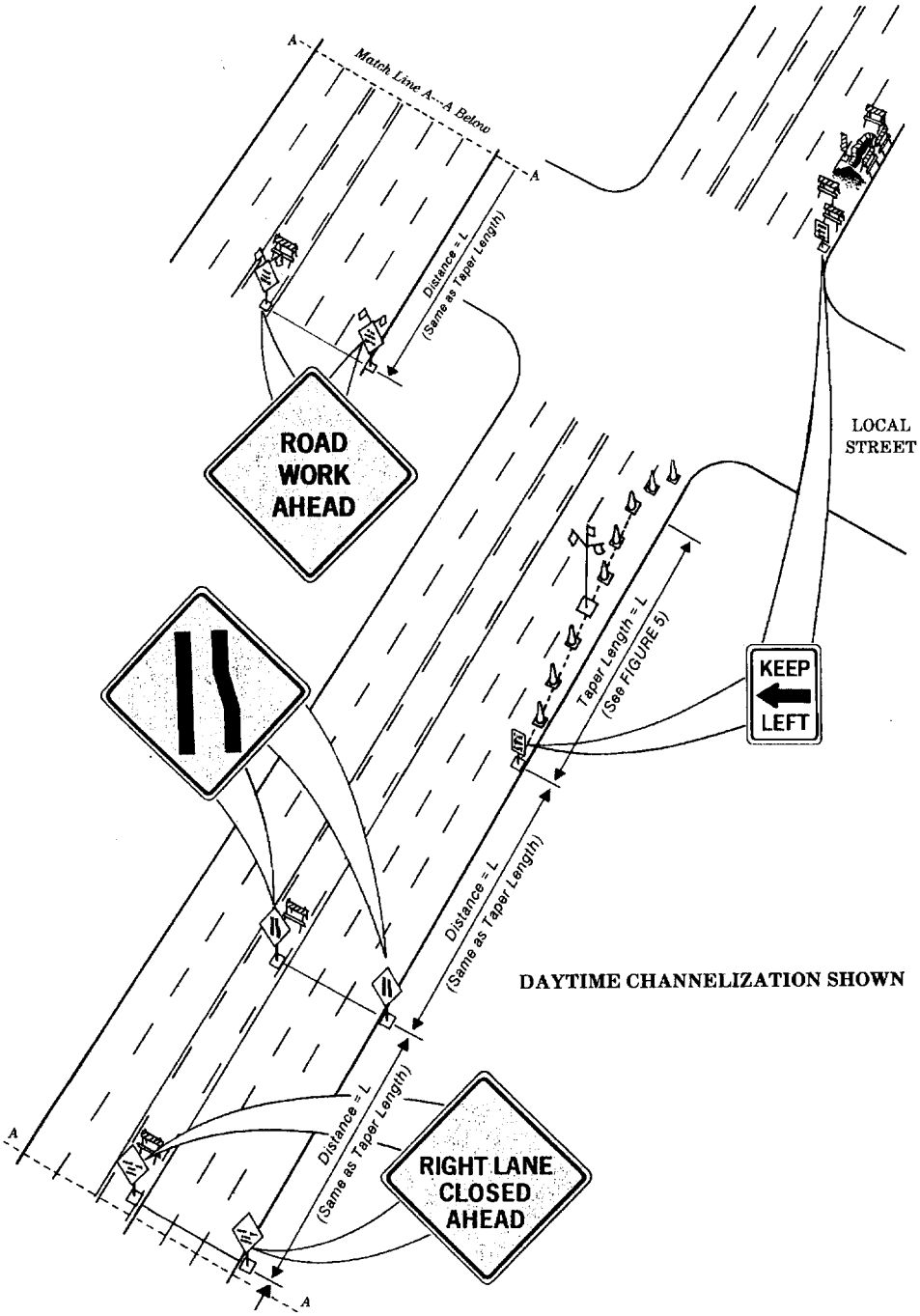
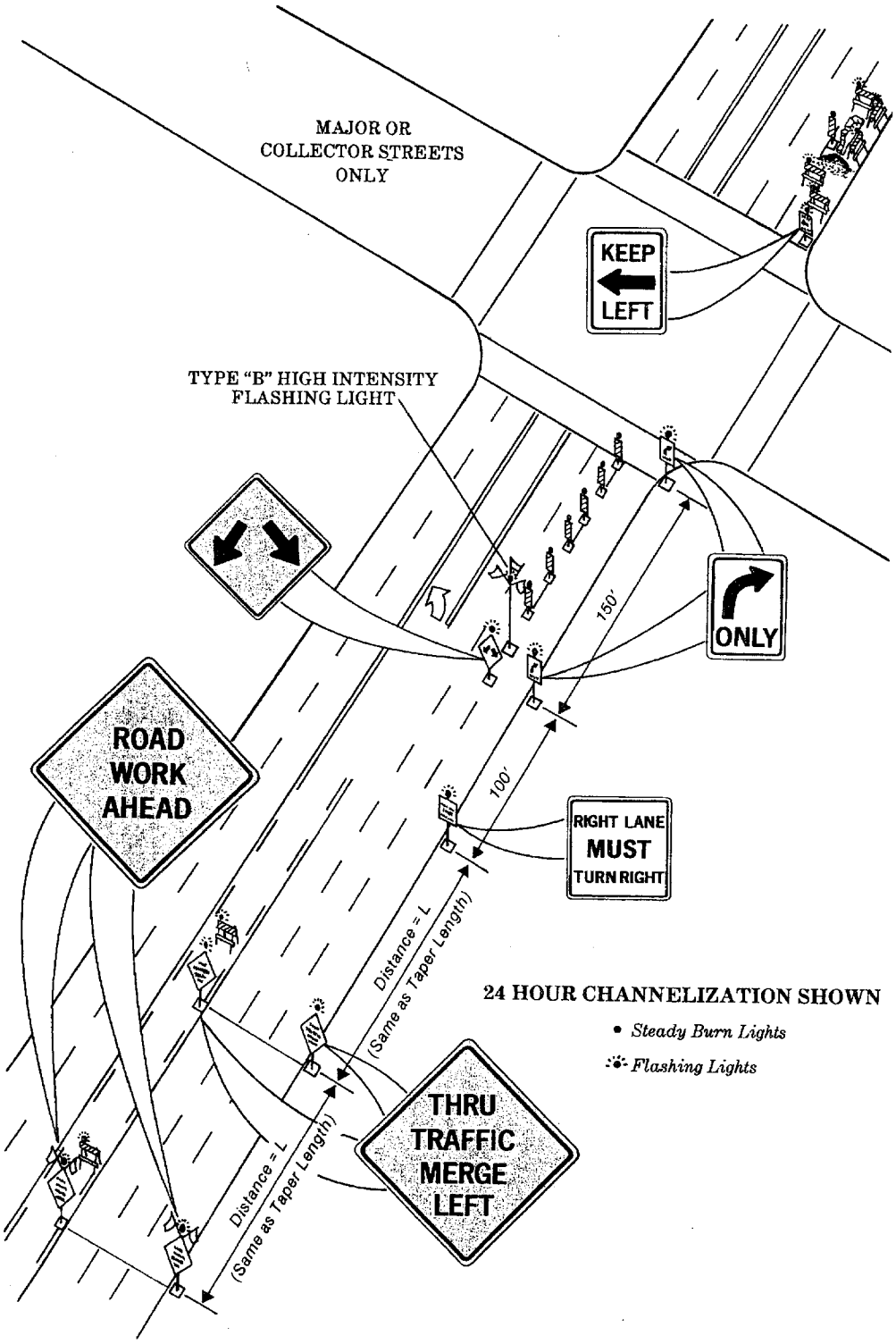


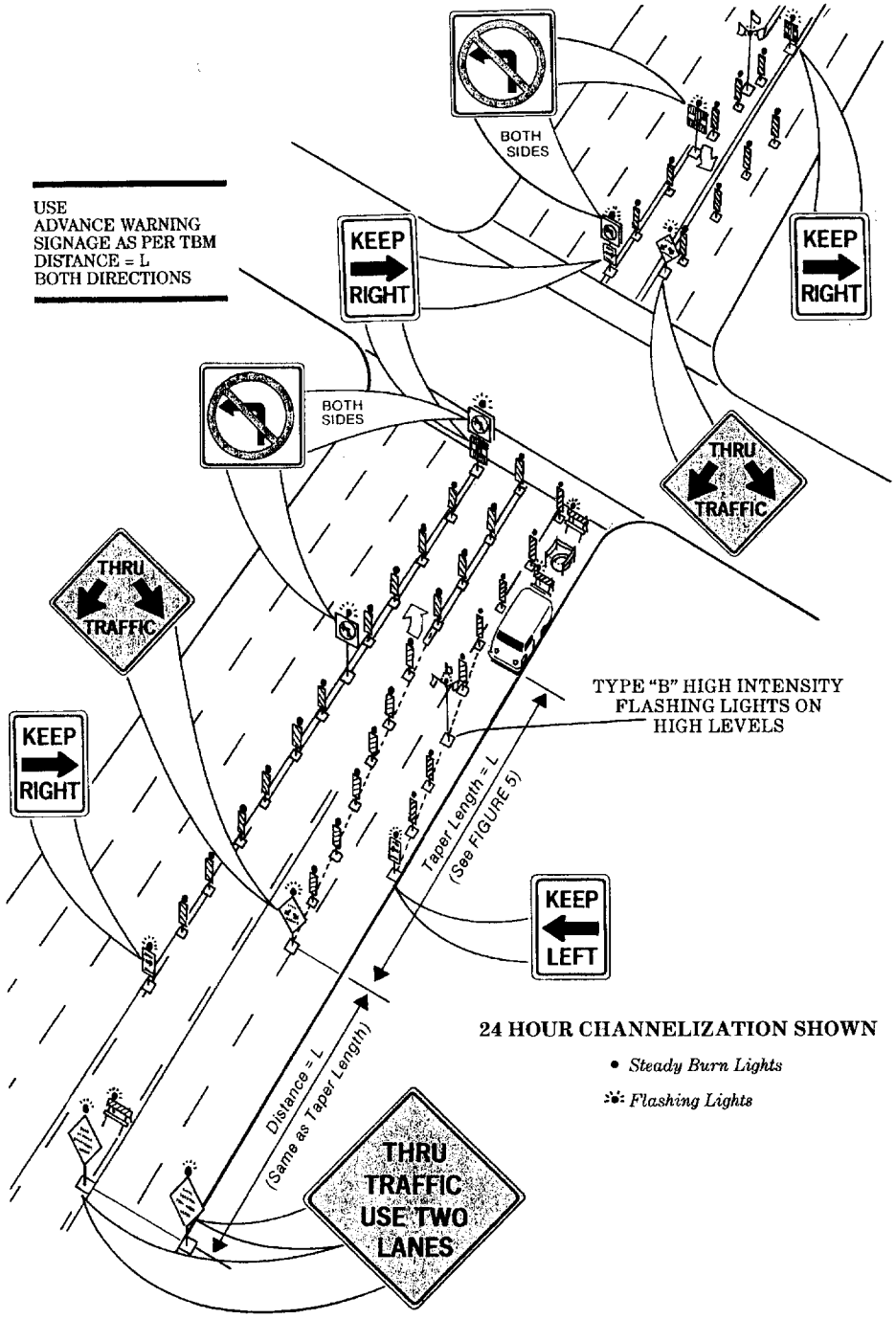
FIGURE 20

RIGHT LANE CLOSED
INTERSECTION — TWO LANES OPEN



RIGHT LANE CLOSED
INTERSECTION — RIGHT TURN LANE OPEN

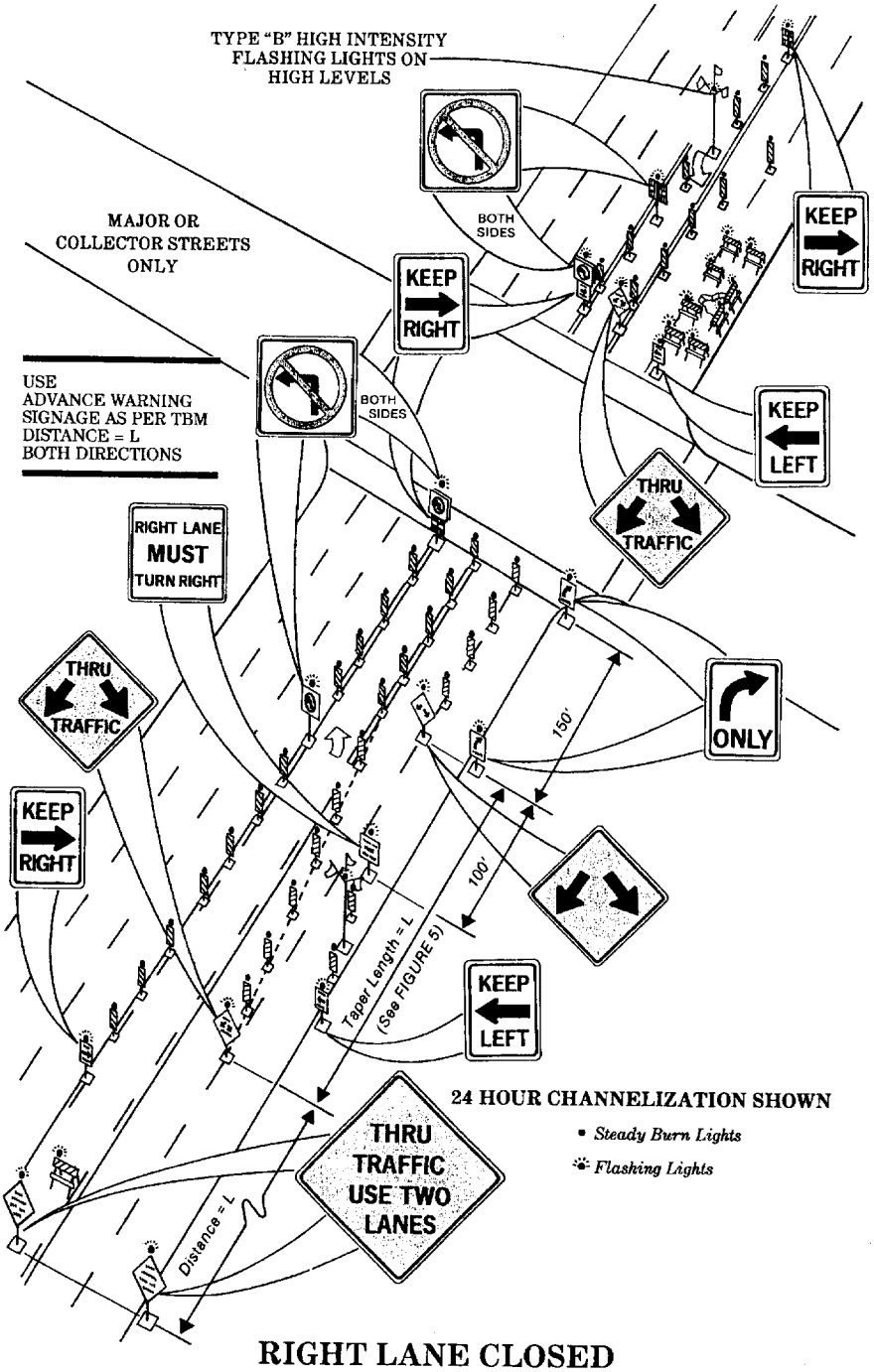
FIGURE 21



RIGHT LANE CLOSED

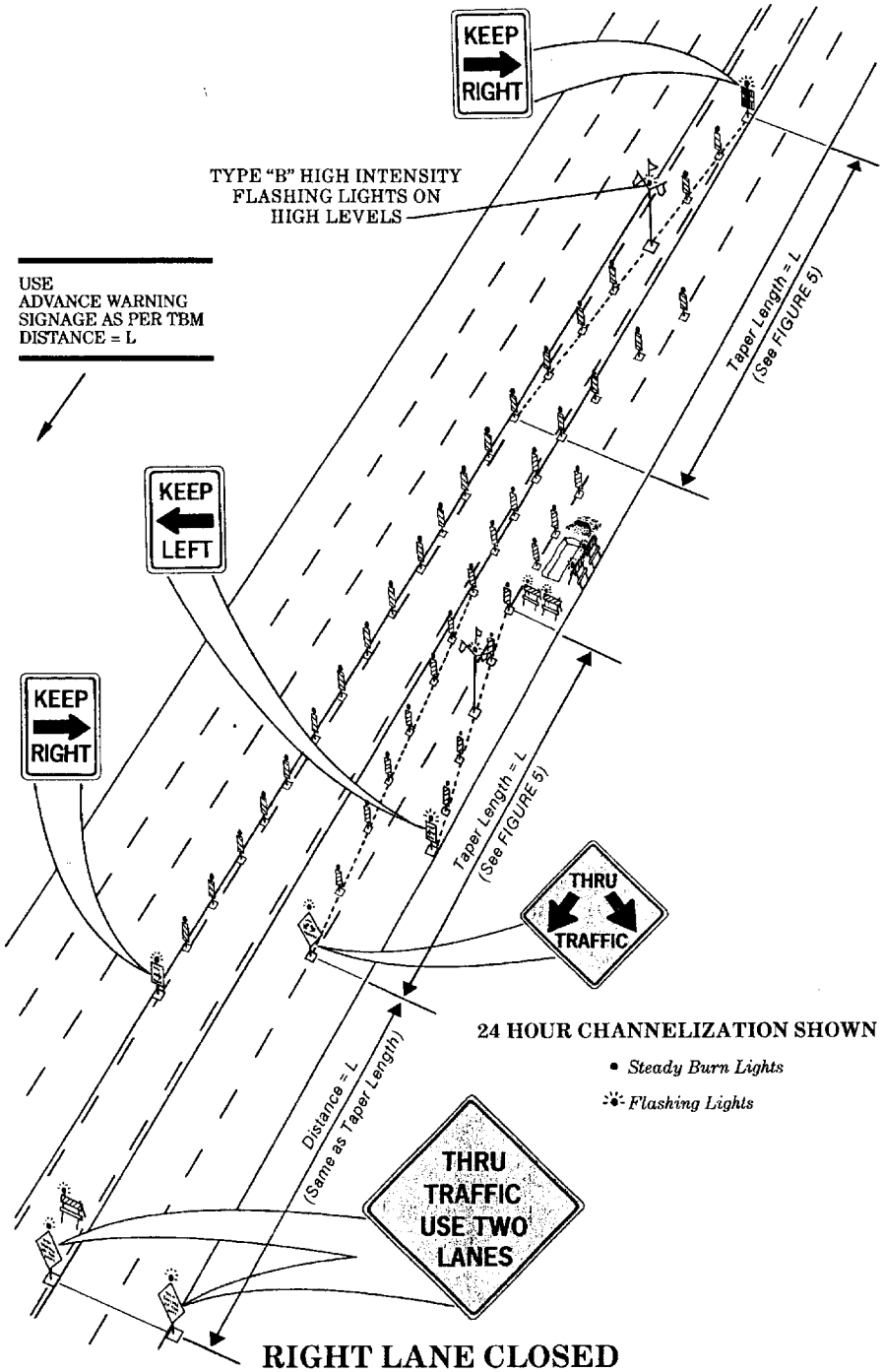
INTERSECTION — TWO LANES OPEN USING LEFT TURN LANE

FIGURE 22



RIGHT LANE CLOSED
INTERSECTION — TWO LANES OPEN
USING LEFT TURN LANE — RIGHT TURN LANE OPEN

FIGURE 23



RIGHT LANE CLOSED
MIDBLOCK — TWO LANES OPEN
USING LEFT TURN LANE

FIGURE 24

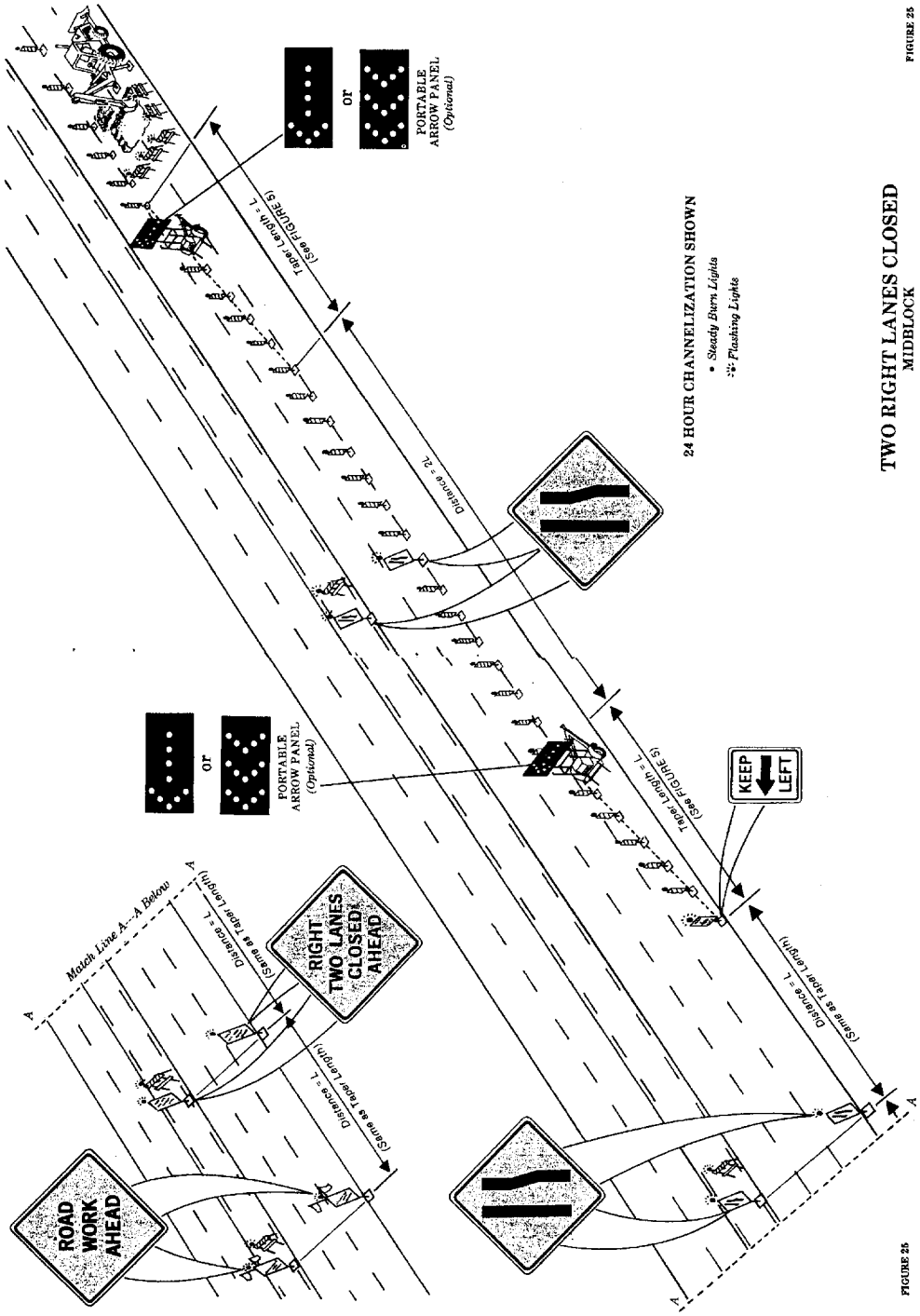
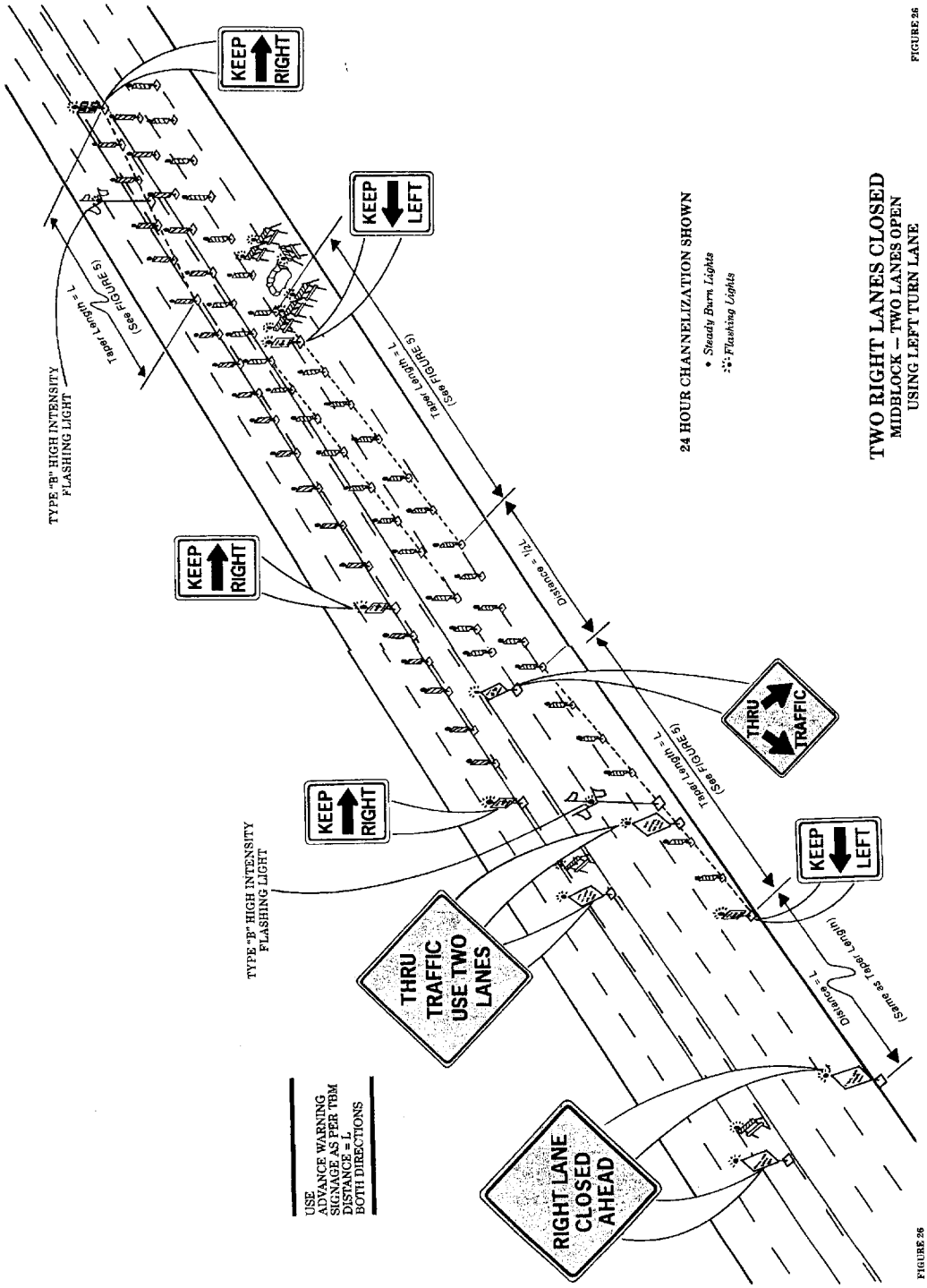
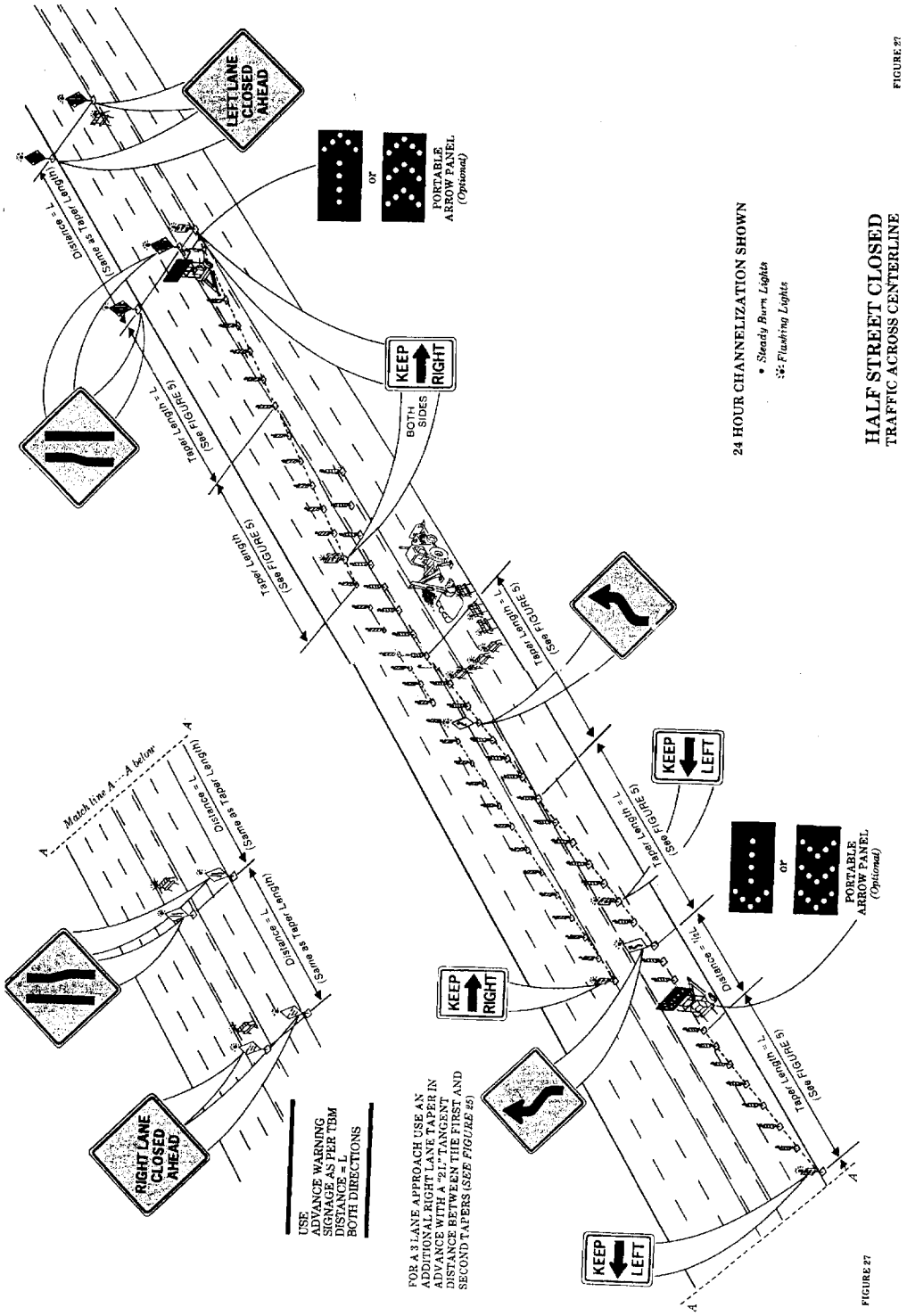
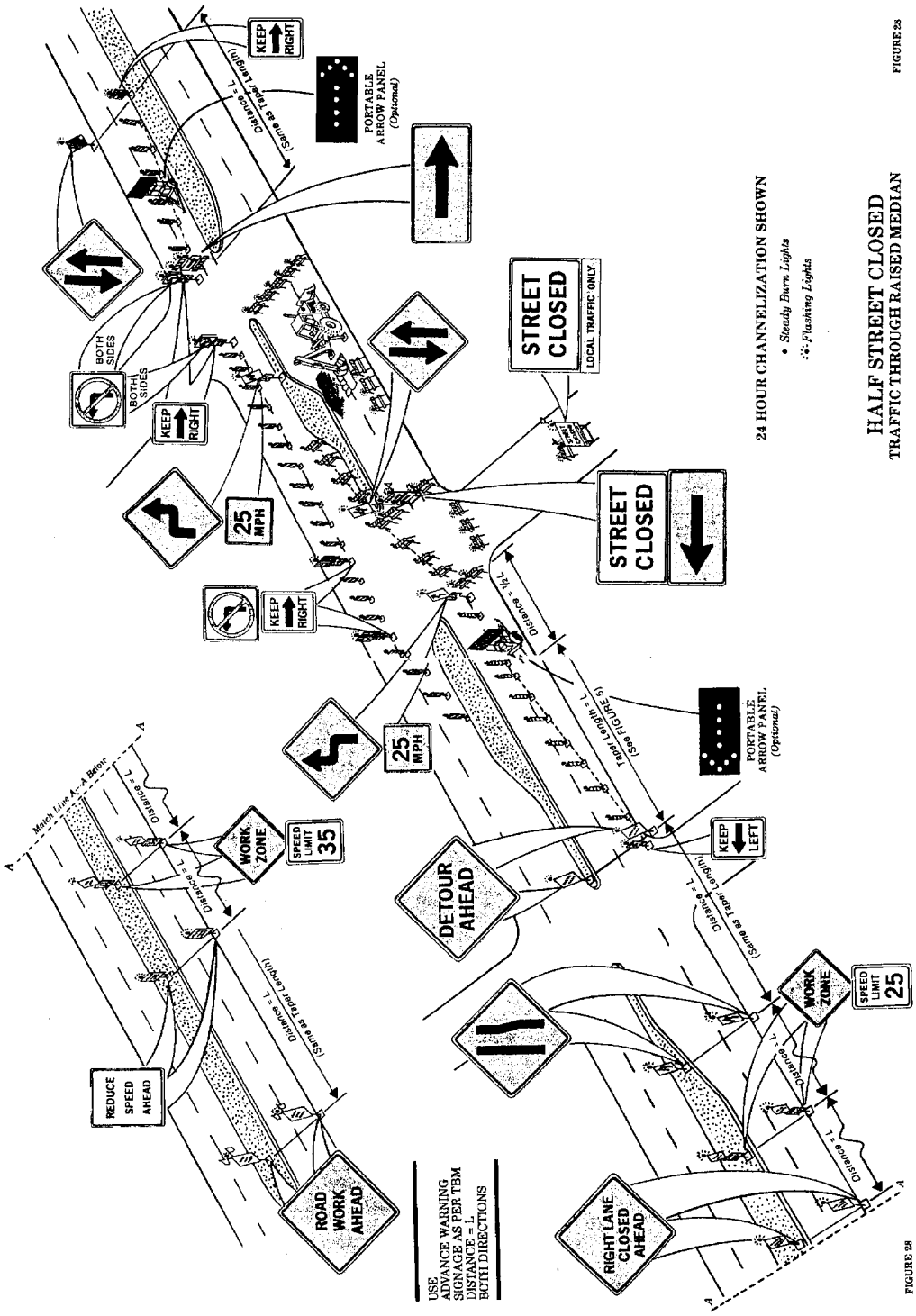
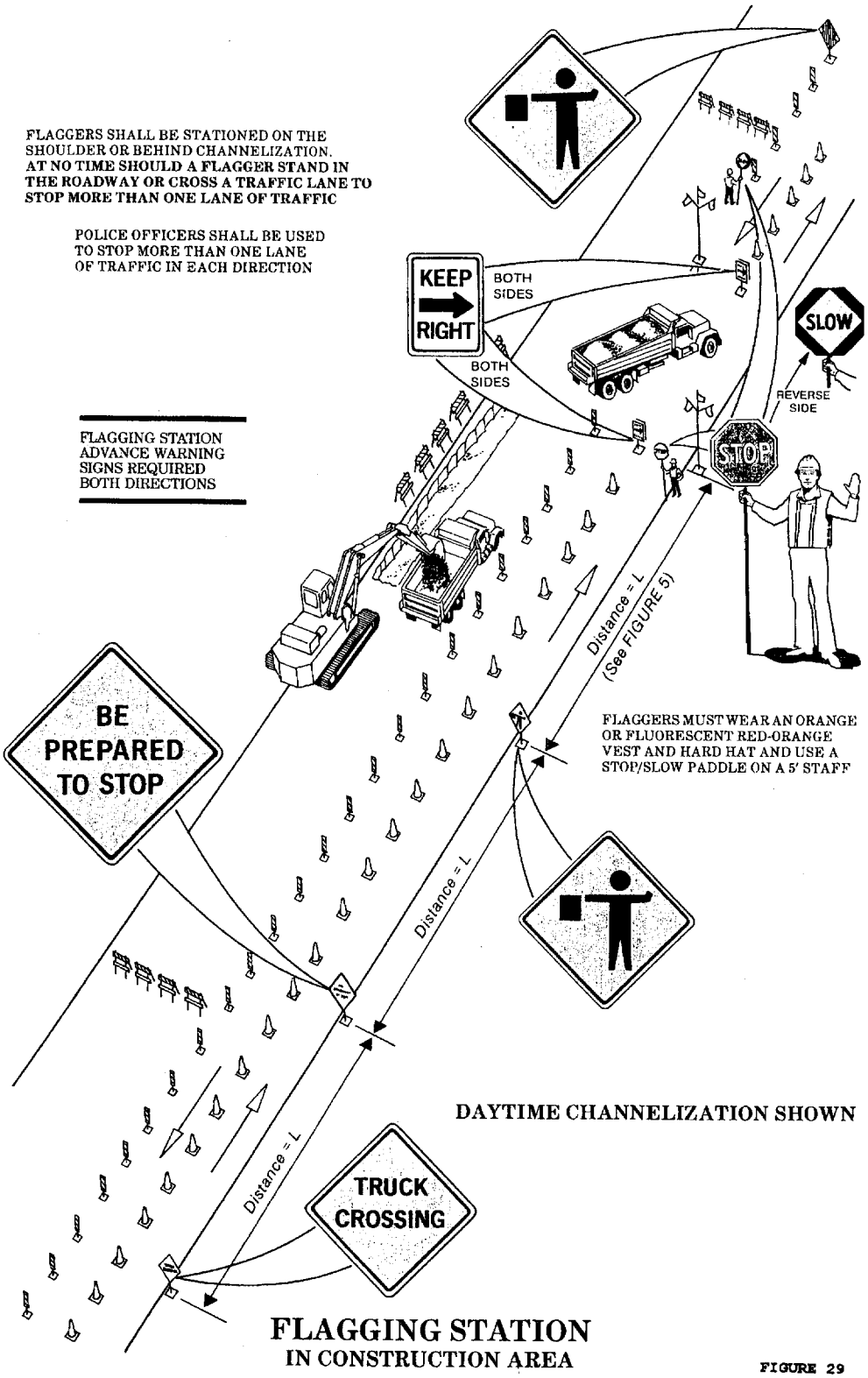

ROAD WORK AHEAD
RIGHT TWO LANES CLOSED AHEAD
Match Line A--A Below
A
Distance = L
(Same as Taper Length)
Distance = L
(Same as Taper Length)
PORTABLE ARROW PANEL (Optional)
OR
PORTABLE ARROW PANEL (Optional)
OR
Taper Length = L
(See FIGURE 5)
Taper Length = L
(See FIGURE 5)
Distance = 2L
KEEP LEFT
Distance = L
(Same as Taper Length)
24 HOUR CHANNELIZATION SHOWN
• Steady Burn Lights
Flashing Lights
TWO RIGHT LANES CLOSED
MIDBLOCK
FIGURE 25

FIGURE 25


KEEP RIGHT
KEEP LEFT
KEEP RIGHT
KEEP RIGHT
KEEP LEFT
THRU TRAFFIC
THRU TRAFFIC USE TWO LANES
RIGHT LANE CLOSED AHEAD
TYPE "B" HIGH INTENSITY FLASHING LIGHT
TYPE "B" HIGH INTENSITY FLASHING LIGHT
Taper Length = L (See FIGURE 5)
Taper Length = L (See FIGURE 5)
Taper Length = L (See FIGURE 5)
Distance = 1/2L
Distance = L (Same as Taper Length)
USE ADVANCE WARNING SIGNAGE AS PER TBM DISTANCE = L BOTH DIRECTIONS
24 HOUR CHANNELIZATION SHOWN
• Steady Burn Lights
Flashing Lights
TWO RIGHT LANES CLOSED
MIDBLOCK -- TWO LANES OPEN
USING LEFT TURN LANE
FIGURE 26


LEFT LANE CLOSED AHEAD
RIGHT LANE CLOSED AHEAD
KEEP RIGHT
KEEP LEFT
BOTH SIDES
PORTABLE ARROW PANEL (Optional)
or
Taper Length = L (See FIGURE 5)
Distance = L (Same as Taper Length)
Distance = 1/2L
Match line A—A below
A
24 HOUR CHANNELIZATION SHOWN
• Steady Burn Lights
✳ Flashing Lights
HALF STREET CLOSED
TRAFFIC ACROSS CENTERLINE
USE ADVANCE WARNING SIGNAGE AS PER TBM DISTANCE = L BOTH DIRECTIONS
FOR A 3 LANE APPROACH USE AN ADDITIONAL RIGHT LANE TAPER IN ADVANCE WITH A "2L" TANGENT DISTANCE BETWEEN THE FIRST AND SECOND TAPERS (SEE FIGURE 25)
FIGURE 27


KEEP RIGHT
PORTABLE ARROW PANEL (Optional)
Distance = L (Same as Taper Length)
BOTH SIDES
STREET CLOSED
LOCAL TRAFFIC ONLY
24 HOUR CHANNELIZATION SHOWN
• Steady Burn Lights
Flashing Lights
HALF STREET CLOSED
TRAFFIC THROUGH RAISED MEDIAN
FIGURE 28
25 MPH
Distance = 1/2L
Taper Length = L (See FIGURE 5)
KEEP LEFT
DETOUR AHEAD
Match Line A—A Below
WORK ZONE
SPEED LIMIT 35
SPEED LIMIT 25
REDUCE SPEED AHEAD
ROAD WORK AHEAD
RIGHT LANE CLOSED AHEAD
USE ADVANCE WARNING SIGNAGE AS PER TBM DISTANCE = L BOTH DIRECTIONS
FIGURE 28



FLAGGING STATION
IN CONSTRUCTION AREA

FIGURE 29

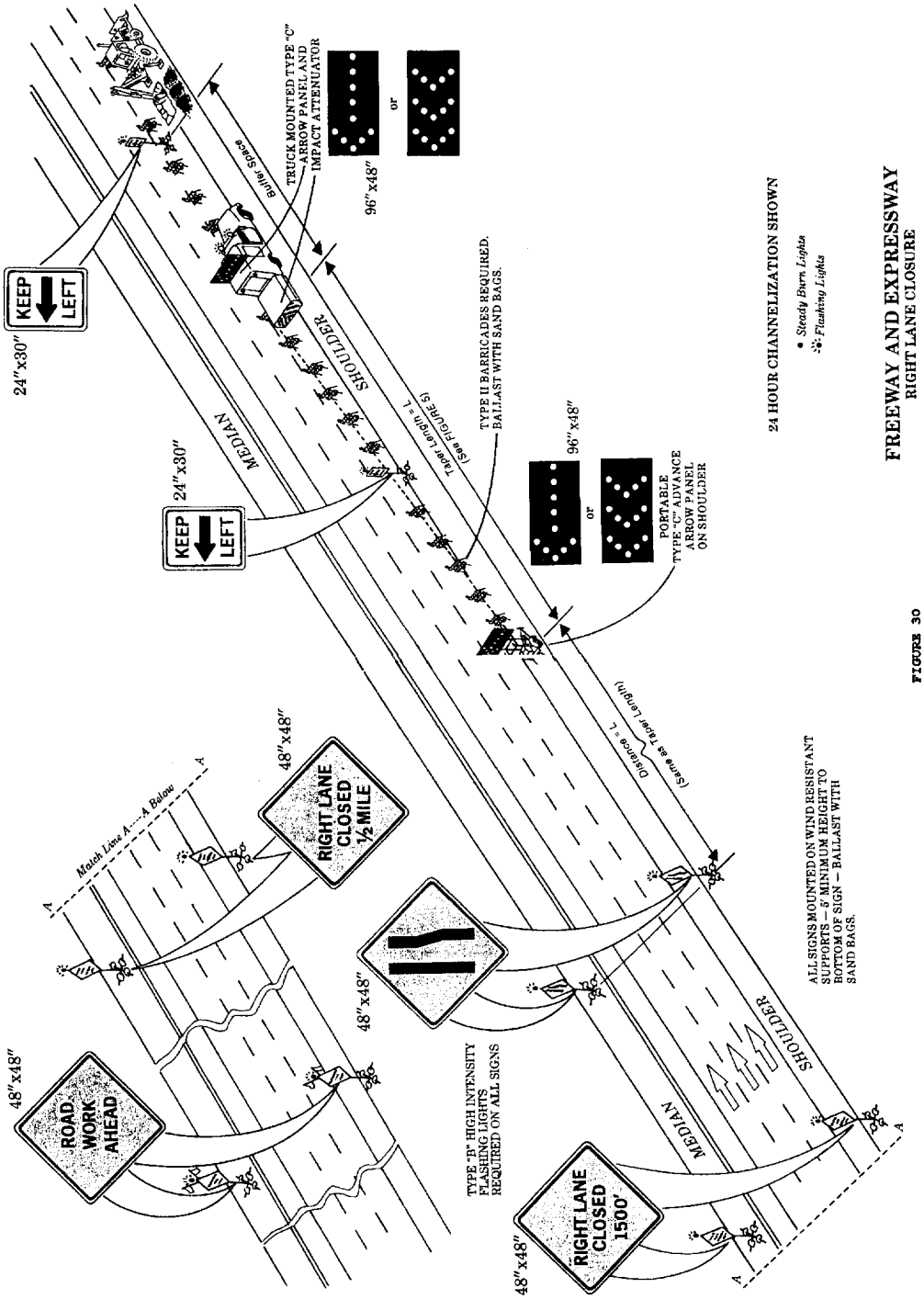

24"x30"
KEEP LEFT
Buffer Space
TRUCK MOUNTED TYPE "C" ARROW PANEL AND IMPACT ATTENUATOR
96" x48"
or
SHOULDER
MEDIAN
Taper Length = L
(See Figure 5)
TYPE II BARRICADES REQUIRED. BALLAST WITH SAND BAGS.
24"x30"
KEEP LEFT
96" x48"
or
PORTABLE TYPE "C" ADVANCE ARROW PANEL ON SHOULDER
24 HOUR CHANNELIZATION SHOWN
• Steady Burn Lights
Flashing Lights
FREEWAY AND EXPRESSWAY
RIGHT LANE CLOSURE
Distance = L
(Same as Taper Length)
Match Line A—A Below
A
48"x48"
RIGHT LANE CLOSED 1/2 MILE
48"x48"
ROAD WORK AHEAD
48"x48"
TYPE "B" HIGH INTENSITY FLASHING LIGHTS REQUIRED ON ALL SIGNS
ALL SIGNS MOUNTED ON WIND RESISTANT SUPPORTS – 5' MINIMUM HEIGHT TO BOTTOM OF SIGN – BALLAST WITH SAND BAGS.
MEDIAN
SHOULDER
48"x48"
RIGHT LANE CLOSED 1500'

FIGURE 30