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16. Abstract

This report summarizes findings of capacity studies conducted at urban freeway maintenance and construction work zones in Houston and Dallas. Studies were conducted on 5-, 4-, and 3-lane freeway sections. The results indicate that the per lane capacities are affected by the number of lanes open during the roadwork. For example, the average capacity on a 3-lane section with 2 lanes open was 1500 vphpl; while the average capacity with 1 lane open was only 1130 vphpl.

The report also illustrates how the data can be used to estimate the effects of the lane closures in terms of queue length, and thus can be applied to work scheduling.

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TRAFFIC CAPACITY THROUGH WORK ZONES ON URBAN FREEWAYS

by

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Research Report 228-6

Traffic Management During Urban Freeway
Maintenance Operations
Research Study 2-18-78-228

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College Station, Texas

April 1981

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The research direction was guided by a Technical Advisory Committee:

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The contributions of the Committee members are gratefully acknowledged.

CONTENTS

FREEWAY WORK ZONE CAPACITY

This section of the report summarizes findings of capacity studies conducted at 28 maintenance and construction work zones on freeways in Houston and Dallas. All of these studies were made at sites where one or more traffic lanes were closed. A total of 37 studies were conducted at work zones while the work crew was at the site; 4 studies were conducted while the work crew was either not at the site or not occupying a closed lane directly adjacent to one of the open lanes.

Capacity with Work Crew at Site

Figure 1 illustrates the range of volumes measured at several worksites while the work crew was at the site. All volumes were measured while queues were formed upstream from the lane closures, and thus, essentially represent either the capacities of the bottlenecks created by the lane closures or the effects of drivers gawkinq because of the work crew and machinery. Each point in the Figure represents the volume observed during one study; therefore, it is easy to view how the data cluster for each lane closure situation.

The designation (A,B) is used in this report to identify the various lane closure situations evaluated. "A" represents the number of lanes in one direction during normal operations; "B" is the number of lanes open in one direction through the work zone.

The average capacity for each closure situation studied is shown in Table 1. The data show that the average lane capacity for the (3,2) and (4,2) combinations was approximately 1500 vehicles per hour per lane (vphpl).

The studies conducted at worksites with (5,2) and (2,1) closure situations indicate significant reductions in capacity (compared to 1500 vphpl). The average capacity for these two situations was approximately 1350 vphpl.

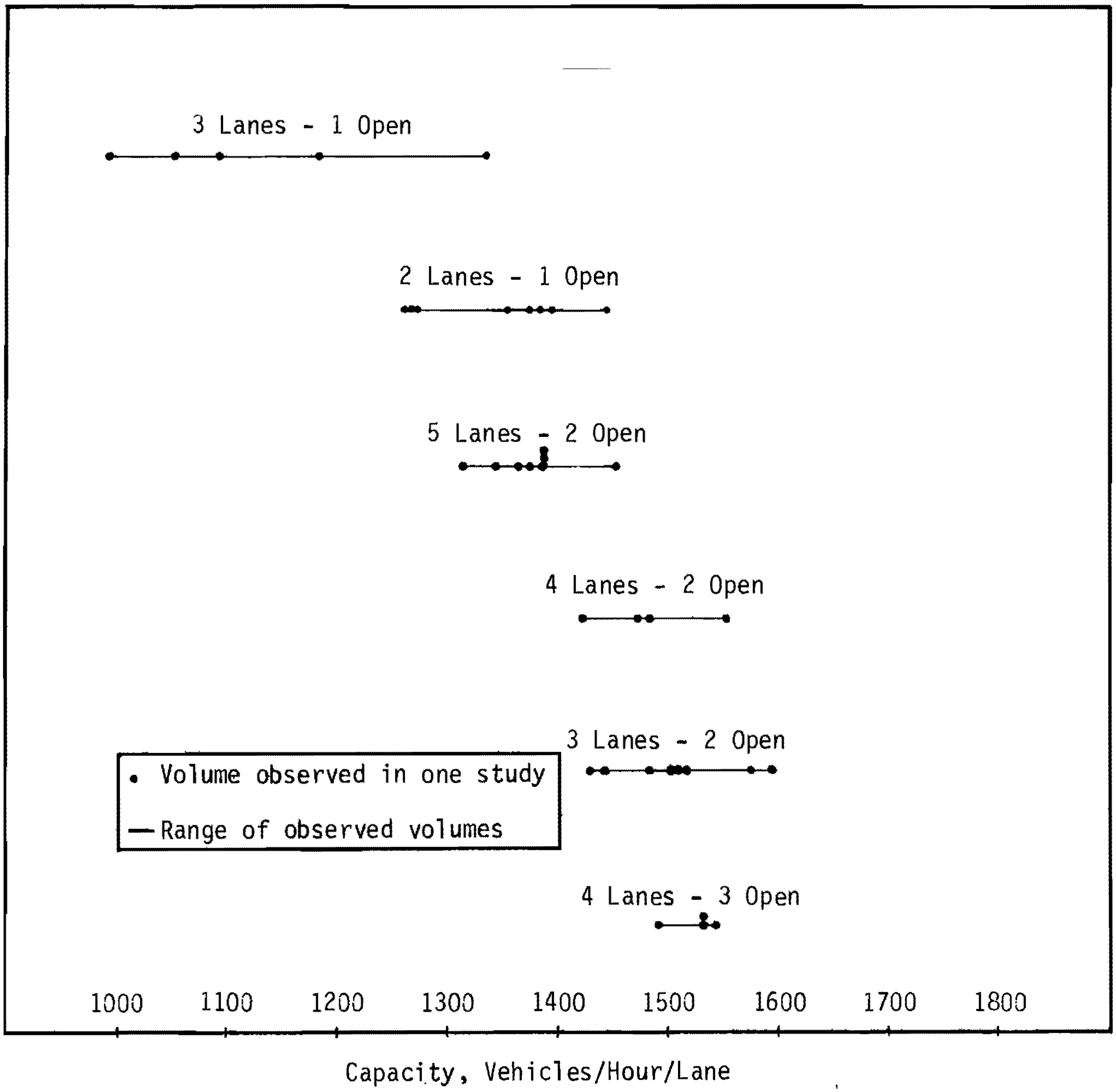


Figure 1. Range of Observed Work Zone Capacities for Each Lane Closure Situation Studied (Work Crew at Site)

TABLE 1. MEASURED WORK ZONE CAPACITY

Number of Lanes		Number of Studies	Average Capacity	
Normal	Open		vph	vphpl
3	1	5	1130	1130
2	1	8	1340	1340
5	2	8	2740	1370
4	2	4	2960	1480
3	2	8	3000	1500
4	3	4	4560	1520

Studies at (3,1) sites revealed even a greater reduction in capacity. The average capacity was found to be only 1130 vphpl.

Figure 2 shows the cumulative distributions of the observed work zone capacities. The function of the Figure is to assist the users in identifying risks in using certain capacity values for a given lane closure situation to estimate the effects of the lane closures (e.g., queue lengths).

For example, the 85th percentile for the (3,1) situation is 1020 vphpl. This means that 85% of the studies conducted on 3-lane freeway sections with 1 lane open through the work zone resulted in capacity flows equal to or greater than 1020 vphpl. The capacity flow was equal to or greater than 1330 vphpl in only 20% of the cases studied. Thus, to assume a capacity of 1500 vphpl for (3,1) work zones would tend to underestimate the length of queues caused by the lane reduction at the vast majority of these work zones.

Because of the limited amount of data, no attempt was made to statistically correlate capacity to the type of road work. However, results of individual studies summarized by type of work are presented in the Appendix. The material in the Appendix indicate that there are characteristics at each worksite that affect the flow through the work zone. Presence of on-ramps and off-ramps, grades, alinement, percentage of trucks, etc., also affect the flow. These factors were not evaluated in the studies performed as part of this research.

It is also interesting to note that, even at the same site, there were variations in maximum flow rate. Work activities (e.g., personnel adjacent to an open traffic lane, trucks moving into and out of the closed lanes, etc.) caused these variations.

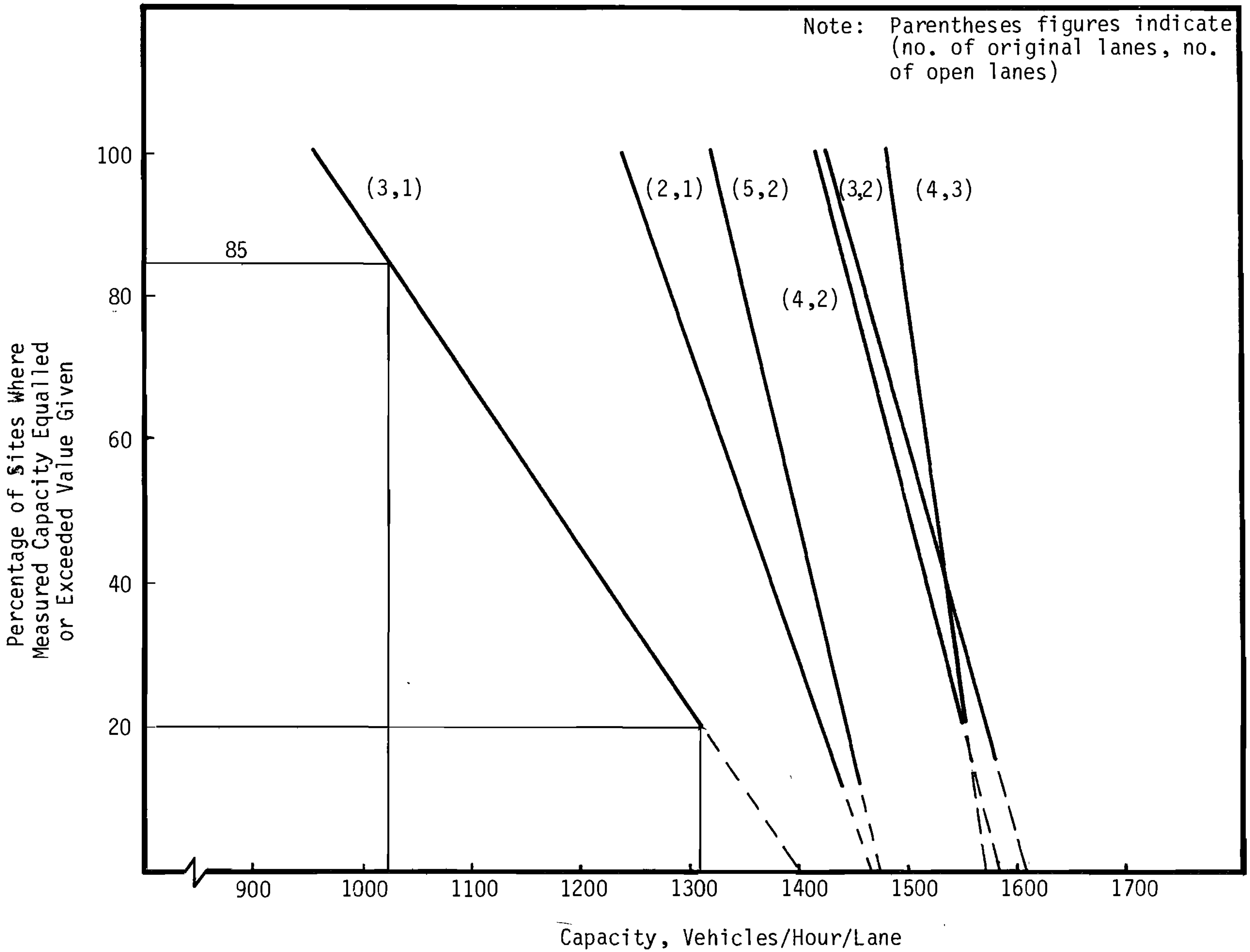


Figure 2. Cumulative Distribution of Observed Work Zone Capacities

Table 2 is an attempt to summarize typical capacities observed in California by Kermode and Myra (1) and those observed in Texas by TTI. The California data represent expanded hourly flow rates, whereas most of the Texas data are full hour counts. The reader is cautioned that the typical capacities by type of work zone shown in Table 2 for Texas freeways are based on limited data. A summary of these data is contained in the Appendix. The amount of data used to develop capacity rates for California was not indicated (1).

Capacity with No Work Activity at Site

Three studies were conducted at construction sites during the peak period while the work crew was not at the site. These studies were conducted in Houston on a 3-lane section of southbound I-45. Two lanes were open during the studies. The average capacity for this (3,2) lane closure situation was 1800 vphpl.

One study was conducted on the north I-610 Loop in Houston. The right two lanes of a 4-lane section were closed. There was no work activity in the closed lane immediately adjacent to traffic. A work crew and their machinery did occupy the shoulder lane, however, which was one lane removed from moving traffic. The volumes measured on the two open lanes over a period of 30 minutes were as follows: 926 vehicles in the lane adjacent to the closure and 730 vehicles in the median lane. These 30-minute volumes are equivalent to flow rates of 1850 vph and 1475 vph. It was apparent from field observations that the demand volumes were lower than the capacity of the two open lanes. Queues did not form upstream from the work activity or the cone taper. There was available capacity in the median lane. The work crew (one lane away from an open traffic lane) did not affect flow thru the work zone. It is estimated

TABLE 2. SUMMARY OF CAPACITY FOR SOME TYPICAL OPERATIONS*

Number of lanes one direction (Normal Operation)	3	2	5	3 or 4	4
Number of lanes open one direction (During Work)	1	1	2	2	3
Type of Work					
• Median barrier/guardrail repair or installation	N/A	1500 vph	N/A	3200 vph *2940 vph*	4800 vph *4570 vph*
• Pavement repair	*1050 vph*	1400 vph	N/A	3000 vph *2900 vph*	4500 vph
• Resurfacing, asphalt removal	*1050 vph*	1200 vph *1300 vph*	*2750 vph*	2600 vph *2900 vph*	4000 vph
• Striping, slide removal	N/A	1200 vph	N/A	2600 vph	4000 vph
• Pavement markers	N/A	1100 vph	N/A	2400 vph	3600 vph
• Bridge repair	*1350 vph*	*1350 vph*	N/A	2200 vph	3400 vph

* Volumes not italicized represent capacity rates observed in California (Reference 1)
Italicized volumes represent average capacities observed in Texas

N/A = Not Available

that the capacity of the two open lanes under the above-cited conditions was about 1800 vphpl. This volume could probably be sustained as long as queues do not form.

Shoulder Usage and Traffic Splitting on 3-Lane Section

Generally, when maintenance work is required on the middle lane of a 3-lane section, both the middle lane and one of the exterior lanes are closed. Table 2 indicates that the average capacity on the open lane may be between 1050 and 1350 vph depending on the type of road work. Results summarized in an earlier report (2) indicated that the capacity could be increased to 3000 vph by using a traffic control approach called "shifting" whereby drivers are encouraged to use the shoulder as an additional travel lane. In effect, two lanes are open to traffic.

The report also indicates that the capacity could be increased to approximately 3000 vph by using a traffic "splitting" approach. In this approach the middle lane is closed and traffic is allowed to travel on both sides of the work activity. It is important, however, that the lane closure technique recommended in Reference 2 be used to implement the "splitting" approach. Otherwise, considerable driver confusion could take place. The technique involves closing the left lane far upstream from the work area so that only two lanes of traffic enter the split area. Traffic is then "funneled" and split using cones--one lane to the left, and the other to the right.

APPLICATION TO WORK SCHEDULING AND TRAFFIC CONTROL

Maintenance work on urban freeways, even if performed during off-peak periods, can result in serious congestion and motorist delay. With increasing pressures from the motoring public to maintain acceptable levels of service on urban freeways, it is important to analyze the potential impacts of a lane closure in order to schedule the work during periods when the congestion would be minimized and/or select the most effective alternative traffic control techniques.

This portion of the report illustrates how the capacity study findings can be applied to assist the users in making decisions about scheduling freeway maintenance. It discusses the requirements and procedures for making estimates of traffic volumes and capacities.

Estimating Traffic Volumes

Work zone volumes are usually estimated from data routinely supplied by automatic traffic counters installed at permanent locations. It is important that current hourly volumes be used to estimate the potential impacts of a lane closure. Volume maps showing ADTs are not adequate for this purpose. Hourly traffic volumes recorded by the automatic counters during the previous two weeks on the same day of the week as the scheduled work will provide reasonable estimates of traffic demands.

Anticipated demand volumes at a work zone can also be estimated with good accuracy by making an on-site traffic count (manned or machine) one or two days prior to the work activity. The cost and time involved in conducting these type special counts, however, restrict the use of this approach to "special cases."

Hourly traffic volume data from permanent counters are readily available to most users; howevever, there are some limitations in using the data. One limitation is that the permanent count data may not provide an accurate estimate of work zone traffic volumes. Many freeway maintenance sites are a considerable distance from a permanent counter. The volumes recorded at the count stations can differ greatly from those at the worksite, especially when there are several ramps between the count station and work zone. Traffic volumes on a radial freeway, for example, may be much higher near the CBD compared to the outskirts of the city. If the permanent counter is located near the city limits, then the traffic volumes at a work zone near the CBD may be underestimated. In this case, the congestion may be somewhat more severe than estimated.

It should be apparent from this discussion that there may be significant problems and inaccuracies in using existing permanent counter data to estimate work zone volumes. However, until new urban freeway counting programs are developed and implemented, permanent counter data are probably the most practical.

The problem of estimating traffic demands at work zones is compounded by the phenomenon of natural diversion. When encountering unusual congestion on an urban freeway during the off-peak periods, many familiar drivers will leave the freeway and travel on the frontage road to bypass the congestion or seek alternate routes to their destinations (3,4). The extent of this natural diversion is difficult to predict.

Estimating Capacity

Previously, 1500 vphpl was a common value used by many traffic control planning analysts to estimate the flow through work zones. The capacity data presented in the preceding chapter, however, provide better insight into typical capacities at work zones on Texas freeways. For example, a review of Figure 2 suggests that using a work zone capacity of 1500 vphpl for a (4,3), (4,2), and (3,2) lane closure situation may not be too critical. However, this value seems too high for estimating the impacts of the (3,1), (2,1), and (5,2) closure situations.

As previously discussed, the cumulative distributions of observed work zone capacities shown in Figure 2 can be used to identify risks associated with using certain capacity values for a given lane closure situation to estimate the effects of the lane closures (e.g., queue lengths).

Estimating Queue Length and Delay

The delays associated with stop-and-go driving which occur at work zones involving a lane closure are the result of a lack of capacity. These work zones, which have insufficient capacity to handle demand, are analogous to a sand hourglass. The neck of the hourglass can handle only so much sand, and there is nothing the excess sand on top can do but wait. When traffic demand at a work zone exceeds the capacity of the work zone, vehicles begin to stack up at the lane closure taper to wait their turn to pass through the work area.

Figure 3 is a simple graphical procedure that can be used to roughly estimate queue length and delays at work zones. These estimates are obtained by plotting the cumulative demand volumes and the cumulative service volumes (capacity) versus time. As illustrated, the number of vehicles stored (or queued) and individual vehicle delay at any given time can be estimated.

The length of traffic backup or queue length can be roughly estimated using the following relationship:

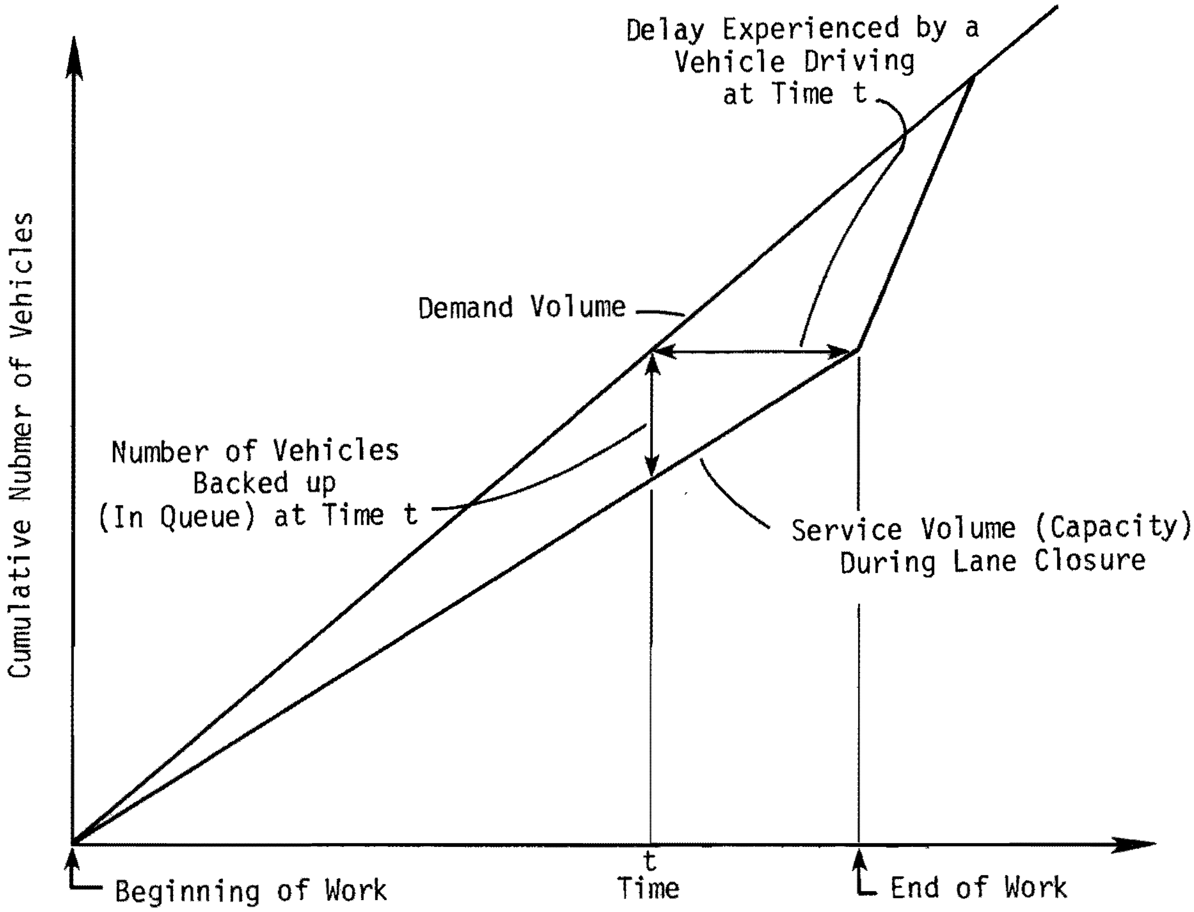


Figure 3. Graphical Procedure for Estimating Queue Length and Delays at Work Zones

$$L_t = \frac{Q_t \ell}{N}$$

Where: L_t = Estimated length of backup (queue length in feet) at time t

Q_t = Estimated number of vehicles in the queue at time t

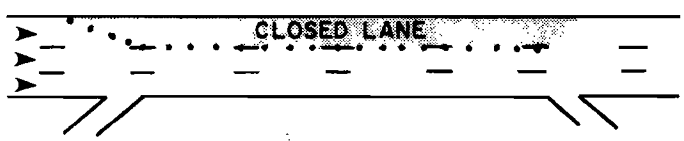
N = Number of open lanes upstream from lane closure

ℓ = Average space occupied by a vehicle in the queue (use ℓ = 40 ft.)

Example Problem

Figures 2 and 3 and Tables 1 and 2 present information to assist the users in making decisions related to scheduling maintenance. The following example demonstrates how the information may be used:

Assume maintenance work must occupy a 3-lane freeway section. The work will require that the median lane be closed as shown in the sketch below.



The work will require approximately four hours to complete. This includes the time required to install and remove traffic control devices. Data obtained from a nearby permanent counter during the previous two weeks was used to estimate the following demand volumes:

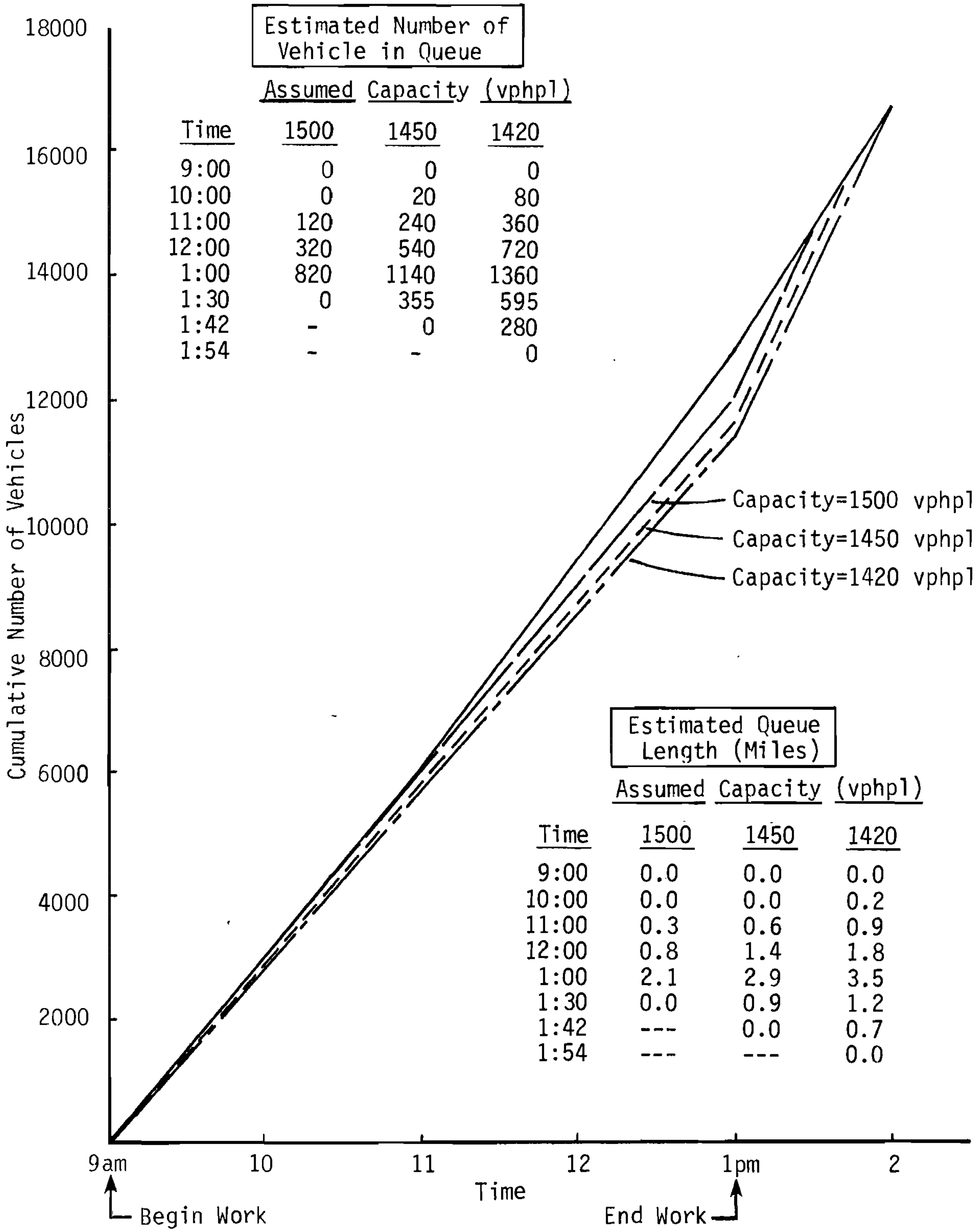
Time	Volume Anticipated (vph)
9-10 am	2920
10-11 am	3120
11-12 am	3200
12- 1 pm	3500
1- 2 pm	3830
2- 3 pm	3940
3- 4 pm	4620
4- 5 pm	5520

It should be noted at this point that any estimates of the queue length and vehicle delays, using the procedure shown in Figure 3, will be influenced by the accuracy of the demand volume data. The estimates are also greatly influenced by assumed work zone capacity. The consequences of using different capacity estimates are explored in this example problem.

Referring back to Table 1 and Figure 2, it is seen that the average capacity for the (3,2) lane closure situations studied was 1500 vphpl or 3000 vph. The 85th percentile was 1450 vphpl or 2900 vph; and the 100th percentile was 1420 vphpl or 2840 vph. Assuming these capacities (3000 vph, 2900 vph, 2840 vph), the graphical technique discussed earlier has been used to estimate the resulting queue lengths and delays (see Figure 4).

In Figure 4, the work is assumed to begin at 9 am. The estimated queue length at 1pm, after 4 hours of maintenance work and assuming a capacity of 3000 vph, is 2.1 miles. The estimate using 2900 vph is 2.9 miles, almost one mile longer; and the estimate using 2840 vph is 3.5 miles, about 1.5 miles longer. Therefore, the capacity value is a very sensitive parameter when queue length is estimated.

Figure 2 shows that the average capacity value of 3000 vph (1500 vphpl) is at the 60th percentile. This means that based on the data collected to date, there is a 40% chance that the actual capacity may be lower than 3000 vph and



Estimated Number of Vehicle in Queue

Time	Assumed Capacity (vphpl) 1500	1450	1420
9:00	0	0	0
10:00	0	20	80
11:00	120	240	360
12:00	320	540	720
1:00	820	1140	1360
1:30	0	355	595
1:42	-	0	280
1:54	-	-	0

Estimated Queue Length (Miles)

Time	Assumed Capacity (vphpl) 1500	1450	1420
9:00	0.0	0.0	0.0
10:00	0.0	0.0	0.2
11:00	0.3	0.6	0.9
12:00	0.8	1.4	1.8
1:00	2.1	2.9	3.5
1:30	0.0	0.9	1.2
1:42	---	0.0	0.7
1:54	---	---	0.0

Figure 4. Example Problem Solution

thus, the queue length longer than 2.1 miles. Likewise, there is only a 15% chance that the traffic will back up farther than 2.9 miles, assuming the maintenance work took 4 hours to complete. These estimates should be helpful in deciding where to place the advance signs for the work zone.

It should be apparent that stop-and-go traffic extending for 2.9 miles would be very undesirable. Thus, other options should be explored, for example the following:

1. Perform the work on a Saturday or Sunday when the volumes are lower.
2. Perform the work at night.
3. Reduce the work time or split the work into two shifts.
4. Implement additional traffic control strategies.

Curves similar to those shown in Figure 4 can be developed for weekend or nighttime work. It is not the intent of this report to discuss the merits or problems of performing road work during these times. However, it sufficies to say that the lower volumes associated with these time periods will result in reduced congestion.

A review of Figure 4 indicates that, if the work could be completed within 3 hours or less, the amount of congestion would be greatly reduced. Assuming a capacity of 3000 vph, the queue would extend an estimated 0.8 mile upstream from the lane closure, and with a capacity of 2900 vph (85th percentile), the queue would not extend more than 1.4 mile. If the work could be divided into two 2-hour periods from 9-11 am on two separate days, then the expected queue length would be greatly reduced to approximately 0.5 mile (assuming comparable volumes both days).

Another option would be to implement additional traffic control strategies. These might include entrance ramp closure and shoulder usage. Each of these strategies should be evaluated for their merits before implementation.

Closing entrance ramps at and upstream from a work zone may possibly reduce the traffic demands and greatly reduce queues such that work could be performed for four continuous hours. Decisions concerning entrance ramp closures including the time of closures should be based on the anticipated freeway and entrance ramp traffic demands and the available capacity on the alternate route (e.g., frontage road, arterial streets). Ramps should be closed when the combination of the freeway and ramp volumes exceeds the work zone capacity and there is available capacity on the alternate route. The ramps should remain open when the traffic demands are less than the work zone capacity. In the example problem, for example, the entrance ramps should not be closed until approximately 10 am even though the maintenance begins at 9 am. Closing ramps when available capacity still exists on the freeway promotes driver discontent and may create unnecessary operational problems on other facilities (e.g., frontage roads, arterial streets, etc.). Ramp closure techniques are discussed in Reference 5. Provisions should be made to achieve improved signal coordination on the frontage road whenever ramps are closed.

Allowing traffic to use the shoulder is another way to increase work zone capacity. Up to 1500 vph additional vehicles can be accommodated by using the shoulder. Traffic control details for shoulder usage are presented in Reference 2.

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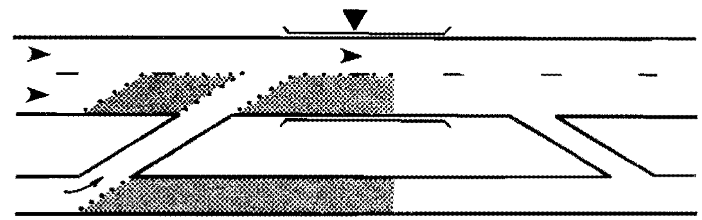
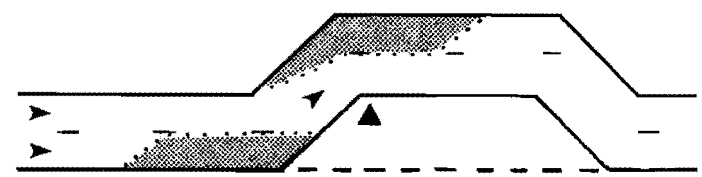
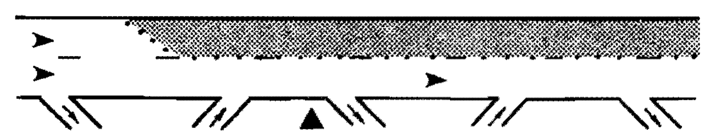
5. S. H. Richards and C. L. Dudek. Special Traffic Management Requirements for Maintenance Work Zones on Urban Freeways. Texas Transportation Institute. Report No. FHWA/TX-81/ 228-8. June 1981.

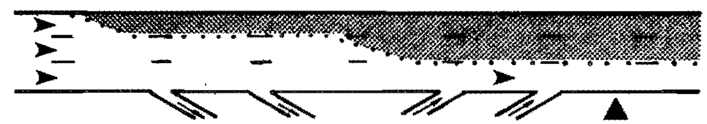
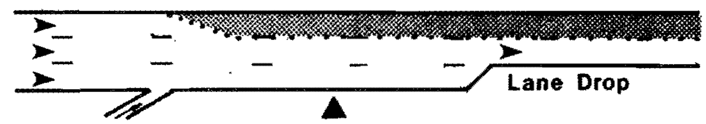
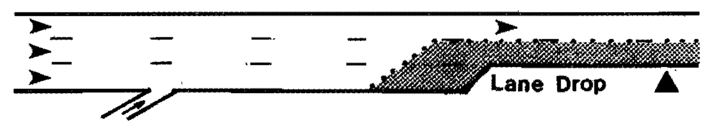
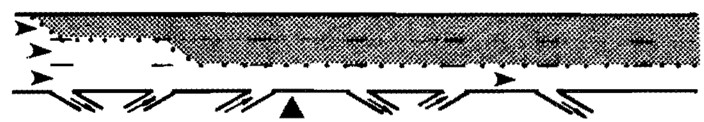
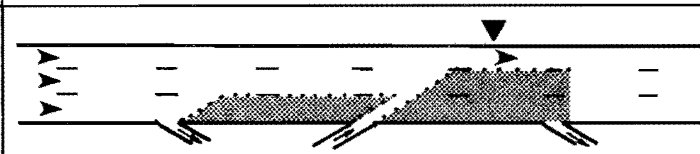
APPENDIX A
CAPACITY DATA

Number of Lanes - One Direction: 2 (Normal Operations) Number of Lanes Open - One Direction: 1						
Nature of Work	Side Closed	Site No.	Flow in Open Lanes		Study Period (min.)	Site Plan
			Total (vph)	Avg per Lane (vph)		
Bridge Repair	R	1	1390	1390	60	
	R	1	1260	1260	60	
	R	1	1265	1265	25	
Bridge Repair	R	2	1350	1350	25	
	R	2	1380	1380	60	
	R	2	1440	1440	60	
Asphalt Removal	L	3	1370	1370	60	
	L	3	1270	1270	45	

▲ Location of capacity study

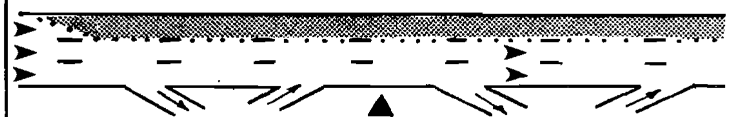
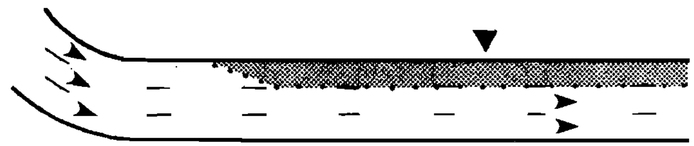
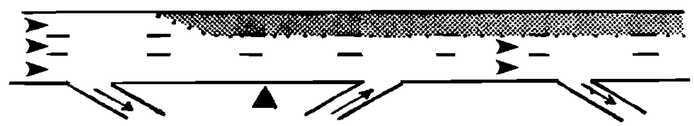
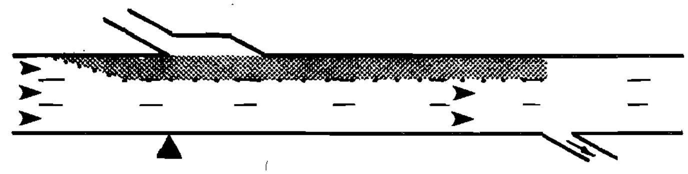
Number of Lanes - One Direction: 3
(Normal Operations)

Number of Lanes Open - One Direction: 1

Nature of Work	Side Closed	Site No.	Flow in Open Lanes: Total (vph)	Flow in Open Lanes: Avg per Lane (vph)	Study Period (min)	Site Plan
Patch Overlay and Resurfacing	L	4	1180	1180	75	
	L	5	1090	1090	60	
	R	6	990	990	90	
	L	7	1050	1050	35	
Bridge Repair	R	8	1330	1330	60	

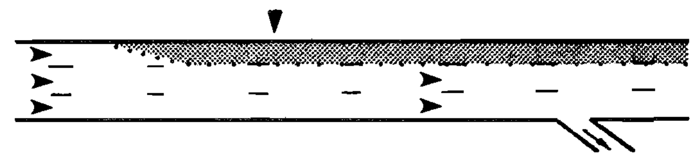
Number of Lanes - One Direction: 3
(Normal Operations)

Number of Lanes Open - One Direction: 2

Nature of Work	Side Closed	Site No.	Flow in Open Lanes		Study Period (min.)	Site Plan
			Total (vph)	Avg per Lane (vph)		
Patch and Overlay	L	9	3140	1570	90	
	L	10	3020	1510	115	
	L	11	3010	1505	60	
	L	11	2880	1440	60	
	L	12	2850	1425	60	
	R	13	3180	1590	35	

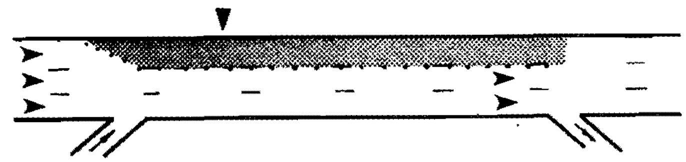
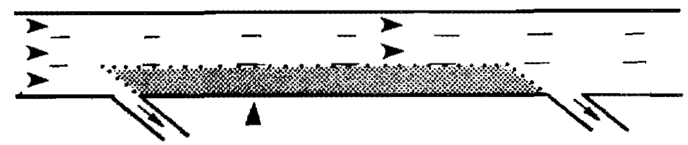
Number of Lanes - One Direction: 3
(Normal Operations)

Number of Lanes Open - One Direction: 2

Nature of Work	Side Closed	Site No.	Flow in Open Lanes		Study Period (min.)	Site Plan
			Total (vph)	Avg per Lane (vph)		
Shoulder Repair	L	14	2960	1480	100	
Freeway Widening	R	15	3000	1500	65	

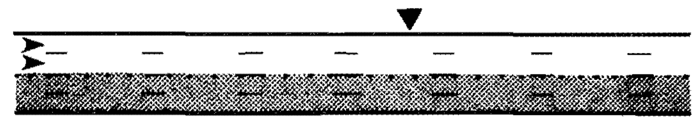
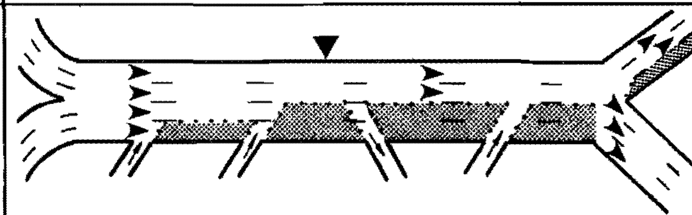
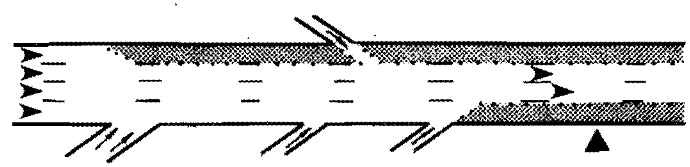
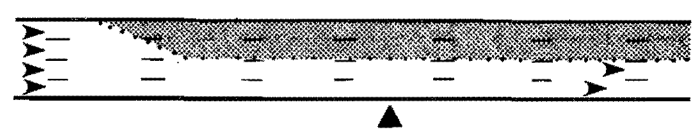
Number of Lanes - One Direction: 3
(Normal Operations)

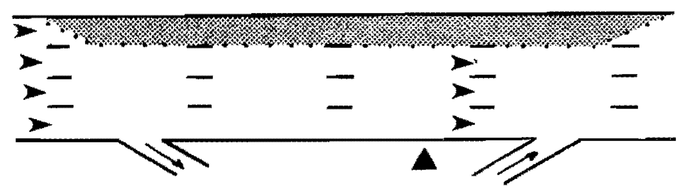
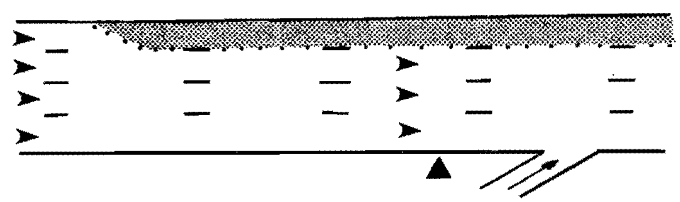
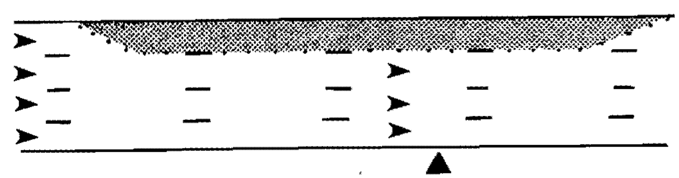
Number of Lanes Open - One Direction: 2

Nature of Work	Side Closed	Site No.	Flow in Open Lanes Total (vph)	Flow in Open Lanes Avg per Lane (vph)	Study Period (min.)	Site Plan
CAPACITY WITH NO WORK ACTIVITY AT SITE						
Pavement Repair	L	16	3560	1780	50	
Freeway Widening (Work Vehicles not in Adjacent Lane)	R	17	3640	1820	45	
	R	17	3660	1830	120	

Number of Lanes - One Direction: 4
(Normal Operations)

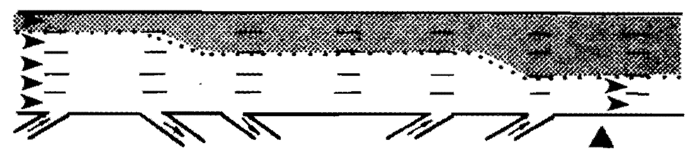
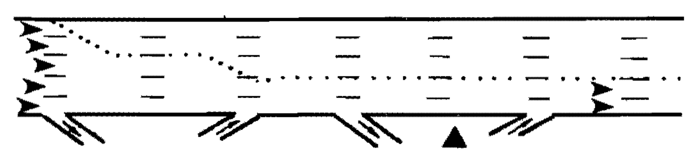
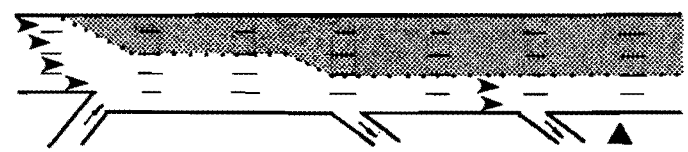
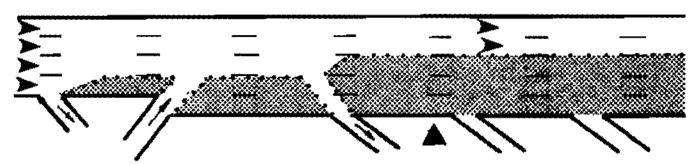
Number of Lanes Open - One Direction: 2

Nature of Work	Side Closed	Site No.	Flow in Open Lanes Total (vph)	Flow in Open Lanes Avg per Lane (vph)	Study Period (min.)	Site Plan
Pavement Repair	R	18	2840	1420	45	
Resurfacing	R	19	2960	1480	60	
Bridge Pylon Construction	L	20	3100	1550	60	
Concrete Median Barrier Installation	L	21	2940	1470	80	

Number of Lanes - One Direction: 4 (Normal Operations) Number of Lanes Open - One Direction: 3						
Nature of Work	Side Closed	Site No.	Flow in Open Lanes		Study Period (min.)	Site Plan
			Total (vph)	Avg per Lane (vph)		
Concrete Median Barrier Installation	L	22	4590	1530	45	
	L	23	4620	1540	60	
	L	24	4590	1530	75	
	L	24	4470	1490	75	

Number of Lanes - One Direction: 5
(Normal Operations)

Number of Lanes Open - One Direction: 2

Nature of Work	Side Closed	Site No.	Flow in Open Lanes		Study Period (min.)	Site Plan
			Total (vph)	Avg per Lane (vph)		
Asphalt Removal	L L L	25 25 25	2760 2680 2620	1380 1340 1310	60 60 60	
Asphalt Removal Resurfacing	L L	26 26	2740 2720	1370 1360	60 60	
Resurfacing	L	27	2760	1380	60	
Resurfacing	R R	28 28	2760 2900	1380 1450	60 50	

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

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

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

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F