SIXTH STREET FREEWAY TRAFFIC STUDY
PHASE II
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SUMMARY

During the summer of 1965, a comprehensive study of peak period traffic conditions was conducted on the Sixth Street Freeway. The purpose of that study was to isolate the causes of congestion and determine the extent of changes in the roadway system necessary for the alleviation of the congestion. The 1965 study resulted in a series of recommendations consisting of sign revisions, lane striping and ramp closures. A study of the feasibility of closing the Paseo off-ramp was also recommended.

The purpose of this report is to evaluate the effects of the implemented recommendations and to report on the feasibility of closing the Paseo off-ramp.

All recommendations were implemented during June and July. News releases, signing and the distribution of closure handbills preceded the ramp closings.

Before and after the implementation of each recommendation, speed and volume data were gathered at locations (shown in figure S1) where it was felt traffic operations would be most affected by the proposed change. Accident statistics are being compiled in order to study the impact of the recommendations upon the accident rate.

In addition to studies on the freeway, studies were made to determine the effect of displaced traffic on the city street system.

An overall decrease in operating speed was recorded at the Fourteenth Street interchange (Location 1). It was concluded that the changes in operating speed at this location were due to normal daily variation and the placement of traffic buttons had little or no effect upon operation at this location. It is recommended that the use of traffic buttons at this location be discontinued.

At Location 2, where the lanes from the west and north come together in the Sixth Street interchange, an overall increase in operating speed of 13 percent was recorded. All of this increase was recorded in the lanes from the Sixth Street Freeway. The average speed of traffic from the Paseo Bridge did not change when it was restricted to one lane. No significant change in volume occurred. It is recommended that traffic from the Paseo Bridge continue to be restricted to one lane at this location.

At the location east of the A.S.B. Bridge interchange (Location 3), no improvement in operation was noted after traffic destined for the Paseo Bridge was restricted to one lane. After Ramp 9 was closed, however, average peak hour operating speeds for all lanes increased by 26 percent. The movement of the overhead sign apparently had no noticeable effect on traffic; however, it should be left in its present location. It is recommended that the striping which restricts the Paseo Bridge traffic to one lane be discontinued but that Ramp 9 remain closed.
At the location where the Main Street on-ramp (Location 4) joins the freeway, the only change was the closure of the Main Street on-ramp (Ramp 5). An 11 percent increase in average peak hour operating speed, with a five percent increase in volume, was recorded at this location. Most of this increase took place in the lower ranges of speeds. It is recommended that Ramp 5 remain closed.

Average peak hour operating speeds for all lanes increased by 19 percent at the location near the Main Street off-ramp (Location 5). Traffic volume on Ramp 3 increased, primarily due to the closure of Ramps 5 and 9. It is recommended that Ramp 4 remain closed during the afternoon peak period.

At the only study location in the westbound lanes (Location 6), substantial increases in operating speed were recorded for all lanes. The speeds for all vehicles increased an average of 23 percent. Traffic volumes through this area dropped by approximately the same amount that had been carried by Ramp 10. Operating conditions on the alternate route to the A.S.B. Bridge did not appear to change due to the increased traffic. It is recommended that Ramp 10 remain closed.

Some increase in congestion on Broadway and Tenth Streets apparently resulted from the ramp closures. It was not felt that this increase was severe enough to warrant discontinuing any of the improvements.

The increase in volume on ramps serving as alternates to the closed ramps did not equal the volume of traffic which previously used the closed ramps. It was concluded that some traffic was probably diverted from the freeway system entirely.

No conclusion can be drawn on the impact of any of the improvements on the accident rate until sufficient time has elapsed to complete the accident study.

It was found that alternate routing was available for trips presently using the Paseo off-ramp, and in most cases, there would not be any substantial increase in travel time. It was concluded, however, that the benefits are not great enough to merit closure at this time. Closure of this ramp should be reconsidered after the south leg of the central business district loop is opened to traffic.
INTRODUCTION

The Sixth Street Freeway is that portion of Interstate Route 70 which forms the north leg of the central business district loop and occupies the approximate location of Sixth Street in Kansas City. In the years this freeway has been open to traffic, the volume and nature of peak hour traffic have changed drastically. Volumes larger than the original design volumes and numerous conflicting movements have resulted in congestion during peak periods of traffic flow.

While peak hour congestion can be found on much of the urban portion of Interstate Route 70, the most severe congestion is found on the north and east legs of the central business district loop, the section shown in black on Figure 1.

During the summer of 1965, a comprehensive study of peak period traffic conditions was conducted on the Sixth Street Freeway. Field studies consisting of an origin-destination survey of traffic using the Sixth Street ramps, volume-capacity studies at critical freeway locations and operating speed and travel-time studies were made.

The purpose of the study conducted in 1965 was to isolate the causes of congestion and determine the extent of changes in the roadway system necessary for the alleviation of peak hour congestion.

When studies were first begun, the overall plan was to determine the location of traffic bottlenecks and the optimum capacity for free flow conditions through these bottlenecks. By limiting access to the freeway through ramp control or closure, traffic volume would be kept below this level, creating free flow conditions on the freeway. As the study progressed, however, it became evident that some congestion existed under low volume conditions. It became evident that the best approach was to find methods of raising the capacity rather than lowering volumes. The fact that congestion existed under low volume conditions indicated that conflicts between the individual elements of the traffic stream existed. With this in mind, critical locations were analyzed to isolate the conflicting movements, and plans were developed to reduce friction in the traffic stream. This study resulted in a series of recommendations, a summary of which may be found in the appendix.

In general, the recommendations which were made in the report "Sixth Street Freeway Traffic Study - Kansas City, Missouri" consisted of sign revisions, lane striping and ramp closures. A study of the feasibility of closing an additional ramp was recommended.

The Phase II study has as its goal three main objectives, which are as follows:

(A) To assist other elements of the State Highway Department in implementing the recommendations of the Phase I report.
Figure 1. Central business district & freeway loop, Kansas City, Missouri.
(B) To measure and evaluate the effects of the traffic control measures initiated to improve traffic flow.

(C) To study the feasibility of closing (during the p.m. peak period) a ramp which is contributing to the congestion at a critical location on the freeway.

The purpose of this report is to present the findings of objectives (B) and (C) and to recommend the immediate disposition of the recommendations which were implemented.
IMPLEMENTATION OF RECOMMENDATIONS

The measures recommended to improve traffic flow fall into three categories: sign revisions, lane striping and ramp closures. With one exception, all of the sign revisions were incidental to ramp closures. Lane striping was recommended for two locations and traffic buttons were placed at a third location.

A total of six ramps, three on and three off, were closed; however, the Main Street off-ramp, Ramp 4 in Figure 1, was closed during the p.m. peak period only. The remaining ramps have not been re-opened since closure.

All recommendations were implemented during the months of June and July. The implementation of the recommendations was scheduled to fit the availability of manpower. In addition, sufficient time was allowed to provide adequate advance publicity and to allow for the collection of data before and after each phase.

All lane striping and ramp closures were preceded by advance publicity. This publicity took the form of news releases, signing and personal contact.

Included in the original news release was a map (Figure 2) showing the location of each improvement and the dates of each ramp closing.

Signing took the form of that shown in Figures 3 and 4. Personal contact consisted of handing leaflets to each motorist using the ramps during the morning and evening peak period of operation. These handbills (Figure 5) were distributed on Ramps 9, 10, 4 and 5, on two occasions during the week preceding ramp closure. Each contained a short message as to the reason for closure, the date of closure and a map on the reverse side which showed available alternate routes.

This advance publicity proved so successful that very few complaints were received when the ramps were closed.

Travel-time studies using the moving vehicle technique were used to measure the improvement in average overall peak hour operating speeds through the study area. Data were gathered on two different days on both the freeway and on runs made on alternate street routes.

Before and after the implementation of each recommendation, speed and volume data were gathered at a location where it was felt that traffic operations would be most affected by the proposed change. The speed and volume data were recorded on a 20-pen recorder during the peak period of operation.

In addition to the physical measurements, operation of each location was recorded on movie film for approximately 20 minutes of "before" and 20 minutes of "after" operation.
Dear Motorist:

As a user of the Sixth Street Freeway (I-70), you are aware that weekday traffic congestion on the freeway has risen steadily during morning and evening rush hours, from 6:30 a.m. to 8:30 a.m. and from 3:30 p.m. to 6 p.m.

In an effort to ease this condition, the Missouri State Highway Department, in cooperation with the City of Kansas City, conducted an intensive origin and destination traffic study of vehicles entering and leaving the freeway.

As a result of information gained by the study, a number of steps are being taken which are designed to improve traffic flow on the freeway without adding to congestion on city streets. They include revising and simplifying signs, changes in pavement markings and the closing of several ramps leading to or from the freeway.

This "on" ramp will be closed to traffic beginning Thursday, July 7, 1966.

It is believed that the closing of this ramp will help decrease congestion on the freeway by providing longer distances between ramps, thereby reducing the high amount of lane crossing by vehicles, weaving and other traffic conflicts which have existed.

After this ramp is closed, it will be necessary for you to take an alternate route to your destination.

To assist you in finding a new route, a detailed street map of the Central Business District is shown on the back of this leaflet.

You received this leaflet at "on" Ramp 9. Arrows on the map indicate alternate ramps which should serve you as well or better than Ramp 9, and at the same time, aid in decreasing congestion on the freeway.

Thank you for your patience and cooperation.

Sincerely,

[Signature]

M. J. Schmitz
Chief Engineer
Missouri State Highway Department
In addition to studies on the freeway, it was necessary to determine the effect of displaced traffic upon the city street system. Aerial photography was the primary method of obtaining this information. Photographs covering the central business district were taken during the p.m. peak hour before and after the recommendations were implemented. These photographs were taken for the purpose of determining traffic increases on the city streets. The before flights were made June 30th and after flights on August 3rd.

Traffic counts and turning movements were taken at critical ramps and street intersections which would be affected by the proposed changes.

In addition to the study of traffic operations, an accident study is being made. This study consists of a compilation of before and after accidents by type of accident. Due to changes in accident reporting, only statistics on accidents which occurred after January 1, 1966, are considered reliable. The before study includes accidents occurring from January 1 through June 30, 1966. These will be compared with accidents for a six-month after period.

The study of the paseo off-ramp traffic uses methods identical to those used in conducting the Sixth Street Freeway Ramp Traffic Study in 1965. Briefly, this procedure consisted of handing origin-destination questionnaires to all traffic using the ramp during the study period. The questionnaires were to be returned to the Highway Department in Jefferson City by means of postage paid envelopes. Returned questionnaires were coded and the results tabulated and analyzed.
EFFECTS OF RECOMMENDED CONTROLS ON FREEWAY TRAFFIC

Six study locations (Figure 6), five in the eastbound direction and one in the westbound direction, were selected to measure the effects of each recommendation on the operation of the freeway. Each site is a location where it was felt that the effect of a recommendation would be most noticeable.

Travel time studies were conducted on the portion of the eastbound lanes shown in Figure 6.

Since the primary concern is a comparison of before and after conditions, it was decided that the most direct method would be a simple comparison of average peak hour volumes and operating speeds.

For the sake of uniformity, it was decided to use the time period from 4 to 5 p.m. as the peak hour for the entire study section, since the actual peak hour may begin anywhere from 3:45 to 4:30, depending upon day and location. Some of the volumes shown may be slightly lower than the actual peak hour volume but, in most cases, this error is slight. This should in no way affect the validity of the comparison of the before and after conditions.

Fourteenth Street Interchange (Location 1)

The site designated as Location 1 (Figure 7) is situated in the eastbound lanes at the southeast corner of the central business district loop. Geometrically, the location is located on both a vertical and horizontal curve. The number of through lanes varies from two to four.

The Fourteenth Street interchange is the only location in the eastbound lanes where traffic volumes alone are sufficient to create poor operating conditions. The two lanes from the north and the ramp from Fourteenth Street carry volumes in excess of 1800 vehicles per lane during the peak hour.

The Fourteenth Street ramp joins the through lanes at a slight angle and continues as a third lane. Even though traffic does not have to merge at this point, there is a reduction in speed of traffic approaching this point. This problem is further aggravated by vehicles using the Paseo off-ramp approximately 1400 feet downstream of the merge point. Vehicles from the north attempting to weave right in order to use the Paseo off-ramp appear to be creating a slow-down in traffic flow.

Two recommendations, to provide more protection for the Fourteenth Street on-ramp and to study the feasibility of closing the Paseo off-ramp during the p.m. peak period, were made for this location. Only the recommendation to provide protection for the Fourteenth Street on-ramp would have any effect upon the measurements made at this time.
Figure 7. Location 1.

Figure 8. Comparison of peak hour operating conditions for Location 1.

Figure 9. Cumulative distributions of peak hour average minute speeds for Location 1.
The protection for the Fourteenth Street on-ramp was provided by means of traffic buttons placed as indicated in Figure 7.

A before and after comparisons of speeds and volumes at Location 1 is shown in Figure 8. This is the only location where there appeared to be a decrease in operating speed as a result of implemented recommendations. Most of this decrease occurred in Lane 3, Which is the lane least likely to be affected by placement of the traffic buttons. The lane protected by the buttons (Lane 1) showed only a slight increase in speed.

The accumulative distribution of average minute speeds (Figure 9) shows an almost uniform decrease in speeds over the entire speed range. This indicates a general slowing down of all vehicles through the area during the peak hour.

There appeared to be a slight drop in peak hour volume. It should be noted, however, that on one of the "before" days a volume that appeared to be somewhat higher than normal was recorded. This could have resulted in a biased comparison of before and after volumes.

The peak hour at this location begins at approximately 4:25 p.m. Actual peak hour volumes were somewhat higher than those shown in Figure 8. The total before and after peak hour volumes were 5587 and 5517, respectively. This means that average lane volumes are somewhere between 1840 and 1860 per hour.

There is insufficient evidence to say that the traffic buttons created the decrease in operating conditions at this location. Likewise, it cannot be shown that any improvement in conditions resulted from the placement of the traffic buttons. Perhaps if the Paseo off-ramp were closed, operations could be improved by providing more protection for the Fourteenth Street on-ramp traffic. For the present, however, it is recommended that the traffic buttons be removed.

Southbound Lanes - Sixth Street Interchange (Location 2)

At Location 2, where the two lanes from the Paseo Bridge merge with the two lanes from the Sixth Street Freeway, a merging conflict was found to exist. While more than two-thirds of the traffic through this junction comes from the Sixth Street Freeway, no priority was given to traffic from either direction (see Figure 10). In fact, the geometrics and the placement of a longitudinal construction joint appeared to give priority to traffic from the Paseo Bridge. The situation was such that traffic from the Sixth Street Freeway was queueing up at the merge point even under off-peak conditions.

The total peak hour volume from the Paseo Bridge is approximately 1000 vehicles. Since this volume should not exceed the capacity of one lane, it was recommended that the right lane from the Paseo Bridge be striped out as shown in Figure 11.
Figure 10. Location 2 before striping.

Figure 11. Location 2 after striping.

Figure 12. Comparison of peak hour operating conditions for Location 2.

Figure 13. Cumulative distributions of peak hour average minutes speeds for Location 2.
Average before and after peak hour speeds and volumes at this location are shown in Figure 12. An overall increase of 13 percent in the operating speed was achieved with almost no change in volume. Even though all the traffic from the Paseo Bridge was restricted to Lane 4, there was no decrease in average peak hour speed in this lane.

Figure 13 shows the accumulative distribution of average minute speeds through Location 2. Before any improvements were put into effect, the traffic averaged 35 mph or greater only 40 percent of the time. After all recommendations had been made, traffic averaged 35 mph or greater more than 65 percent of the time.

While traffic flow through this location has been improved considerably, there is a portion of the peak hour when back-up from downstream severely affects operation. This is indicated by that portion of the curve in Figure 13 to the left of the 25 mph line. During this period of time, which approximates 20 percent of the peak hour, no improvement in operations was found.

The peak hour back-up from Location 1 and vicinity needs further investigation. Completion of the central business district freeway loop may alleviate this problem for a while, but the anticipated growth in freeway traffic is expected to create a similar situation in the future. More must be known about the nature of this problem if future traffic operations in this area are to be maintained at a satisfactory level.

Since there has been a substantial improvement in operating conditions on the two lanes from the Sixth Street Freeway with no apparent decrease in operating conditions on the lane from the Paseo Bridge, it is recommended that the striping at this location remain in place.

Sixth Street Freeway - East of A.S.B. Bridge Interchange (Location 3)

Location 3, shown in Figure 14, is that portion of the eastbound lanes between the A.S.B. Bridge and the Sixth Street Interchange. This three-lane section lies on a vertical curve which carries the freeway over Charlotte Street. Just over the crest of the hill, located just beyond the sign truss in Figure 14, two lanes exit right to the Southeast Freeway and two lanes continue north to Independence Avenue and the Paseo Bridge. An on-ramp (Ramp 9) serves traffic from the South Service Road.

The location and geometrics of Ramp 9, the limited sight distance due to vertical curvature, and the geometrics of the Sixth Street interchange combine to create a weaving and merging problem at this location. Over 50 percent of the traffic using Ramp 9 was destined for the Paseo Bridge, which means that this traffic must cross Lanes 1 and 2. With no acceleration lane and short weaving distance, most vehicles waited for an opportunity to cross Lane 1, merging directly into Lane 2 or Lane 3, often under hazardous conditions.
Figure 14. Location 3 before closure of Ramp 9.

Figure 15. Ramp 9 barricaded.

Figure 16. Comparison of peak hour operating conditions for Location 3.

Figure 17. Cumulative distributions of peak hour average minute speeds for Location 3.
An additional weaving problem results from the limited sight distance and the manner in which the lanes to the Southeast Freeway break away to the right. In spite of the fact that most drivers are regular users of the freeway, approximately 1200 vehicles weave right from Lanes 2 and 3 to exit to the Southeast Freeway during the peak hour.

Recommendations at this location included striping out the right lane of the two lanes destined for the Paseo Bridge, revising the signing for the Sixth Street interchange and closure of Ramp 9.

The lane striping and sign revision constituted an attempt to channelize traffic so that traffic destined for the Paseo Bridge would use the median lane (Lane 3) and the traffic in the center lane destined for the Southeast Freeway would continue to use that lane rather than weave to the right. No revision in content was made; however, the signs were shifted to the left so that the sign directing Paseo Bridge traffic was directly over the lane adjacent to the median and the sign directing southbound traffic (Southeast Freeway) was centered over the two right lanes. At the time the picture in Figure 14 was taken the signs had already been moved.

Ramp 9 was closed by means of the barricade shown in Figure 15.

Before and after average peak hour speeds and volumes are shown in Figure 16. The "after" averages were computed from data gathered after all changes including closure of Ramp 9 had been made. Data gathered after the revisions in signing and the striping had been made showed no improvement in operation.

Traffic volumes through this section were very nearly as anticipated. A slight reduction in volume in the through lanes was due to the diversion of traffic when Ramp 5 (Main Street on-ramp) was closed upstream. Most of the decrease in total volume came from the closing of Ramp 9.

A substantial increase in operating speed was found in each lane. Average peak hour operating speeds for all lanes increased by 26 percent. The increase in operating speed through Location 3 is readily apparent in Figure 17. Using 35 mph as our desired operating speed, before any improvements were put into effect, vehicles were operating at a speed of 35 mph or greater only 10 percent of the time. After all improvements had been put into effect, this figure was increased to nearly 60 percent.

On occasion, Location 3 is also affected by the congestion which backs up from downstream of Location 2. While Location 3 is affected less frequently and less severely than Location 2, this back-up does sometimes interfere with traffic operations at this point.

* This was the only revision in signing other than those incidental to ramp closures.
There was no apparent improvement in operating conditions due to the striping out of the right lane to the Paseo Bridge. Many vehicles ignored this striping deliberately, or because they were trapped in the center lane. It is, therefore, recommended that this striping be discontinued.

It is further recommended that the signs be left in their present position, and that the closure of Ramp 9 be continued until such time as traffic conditions indicate the need for a reconsideration of this action.

Main Street On-Ramp (Location 4)

Location 4, shown in Figure 18, is located near the center of the Sixth Street Freeway. The grade is relatively flat and there is no horizontal curvature at this location.

At the point where traffic operations were measured, traffic approaches on a three-lane section; an on-ramp from Main Street (Ramp 5) enters the freeway, forming a short four-lane section: two lanes leave on a ramp which carries traffic destined for Oak Street Trafficway and the A.S.B. Bridge; and two through lanes continue downstream toward Location 3.

Traffic entering on Ramp 5 had to weave across a large volume leaving on Ramp 6-7 then merge into a section of freeway that has just narrowed to two lanes.

Ramp 5 was closed to eliminate the undesirable situation which resulted when approximately 900 vehicles were forced to weave in a distance of less than 350 feet. With Ramp 5 closed, all traffic has considerably more distance in which to merge into the proper lanes before arriving at this location.

Figure 19 shows the barricades at the entrance to Ramp 5 from the South Service Road.

Average peak hour speeds and volumes at Location 4 are shown in Figure 20.

Some increase in traffic volume was expected on the through lanes approaching the section due to traffic diverted to Ramp 3 (Broadway on-ramp) from Ramps 5 and 9. This increase, however, was not expected to equal the loss in traffic resulting from the closing of Ramp 5. On the two days of the study, however, the total traffic represented a 5 percent increase over total traffic before the ramp was closed. Since the increase in volume on Ramp 3 was about as expected, the additional volume must have come from the Intercity Viaduct.

Even with the increase in traffic volume, an increase in operating speed was registered for all lanes. The largest increase in average
Figure 18. Location 4 before closure of Ramp 5.

Figure 19. Ramp 5 barricaded.

Figure 20. Comparison of peak hour operating conditions for Location 4.

Figure 21. Cumulative distributions of peak hour average minute speeds for Location 4.
peak hour operating speed occurred in Lanes 1 and 2 expected. Overall speed increased 11 percent, which in light of the increased volumes is considered good.

The average minute speed distribution shown in Figure 21 indicates that the increases took place in the lower range of speeds where an improvement was most needed. There was no apparent increase in the amount of time that operation averaged above 45 mph.

It is recommended that Ramp 5 remain closed for the present.

Main Street Off-Ramp (Location 5)

Location 5, shown in Figure 22, is situated on a relatively flat grade with no horizontal curvature. The principal problem at this location is the short weaving distance, 420 feet, between the Broadway on-ramp (Ramp 3) and the Main Street off-ramp (Ramp 4).

Prior to any ramp closures, approximately 1050 vehicles weaved in the area between the ramp noses during the P.M. peak hour. It was felt that when additional traffic was diverted to Ramp 3 from Ramps 5 and 9, an intolerable weaving condition would develop. To eliminate this conflict, it was recommended that Ramp 4 be closed during the P.M. peak period only. It would have been desirable, and would have eliminated an accident hazard, to close Ramp 4 during all periods of operation; however, this ramp carries such a large volume during the A.M. peak hour that this was not feasible. To have done so would have diverted such a large volume of traffic to the west leg of the Broadway-South Service Road intersection that this intersection would have been overloaded.

At the present time Ramp 4 is closed by means of a swinging gate manually operated (see Figures 23 and 24). Traffic cones are used to channel traffic away from the closed ramp.

Signing was placed on the Intercity Viaduct directing downtown traffic to the Broadway exit and stating that the Main Street exit would be closed from 4 to 6 p.m. (see Figure 25).

Peak hour average speeds and volumes are shown in Figure 26.

Volumes measured in this area were very nearly as expected. A drop in volume was expected west of Ramp 3 due to traffic diverted from Ramp 4 to Ramp 2, the Broadway exit. As was anticipated, most of this decrease occurred in Lane 1. The increase in volume on Ramp 3 was due to traffic diverted from Ramps 5 and 9.

A substantial increase in operating speed was registered for all lanes. Average peak hour speeds for all lanes combined increased by 19 percent.
Figure 22. Location 5 before closure of Ramp 4.

Figure 23. Location 5 after closure of Ramp 4.

Figure 24. Ramp 4 gate and traffic cones.

Figure 25. Intercity-viaduct signing for Ramp 4.

Figure 26. Comparison of peak hour operating conditions for Location 5.

Figure 27. Cumulative distributions of peak hour average minute speeds for Location 5.
The average peak hour speed at this location is the highest of any encountered in the eastbound lanes of the Sixth Street Freeway. After all improvements had been made, traffic was operating at a speed greater than 35 mph for almost 90 percent of the peak hour (see Figure 27). Sustained periods of operation at speeds below 25 mph were all but eliminated.

For the present, it is recommended that Ramp 4 remain closed during the afternoon peak period.

Westbound Lanes-Sixth Street Interchange (Location 6)

This was the only westbound location studied and was the only location where operations during the morning peak period were the primary concern.

Location 6, shown in Figure 28, is situated near the Sixth Street interchange, where the lanes from the Paseo Bridge merge with the lanes from the Southeast Freeway and continue west. The geometries of the site do not favor high volume traffic operations. Horizontal and vertical curves and sight distance limitations tend to slow the movement of traffic through the area.

Traffic destined for the A.S.B. Bridge via Ramp 10 (see Figure 1) was thought to be a significant factor in the congestion daily observed in this area. This traffic would slow down and many times come to a halt in the right lane from the Southeast Freeway (Lane 2, Figure 29) awaiting an opportunity to merge with traffic in the shoulder lane from the Paseo Bridge. Very often, the resulting merge would be accomplished under extremely hazardous conditions.

Since virtually all of the traffic using Ramp 10 comes from the Southeast Freeway, and since an alternate route was readily available, it was decided to eliminate this movement on a trial basis by closing Ramp 10. This was accomplished by movable barricades placed across the ramp entrance.

In addition to closing Ramp 10, the Independence Avenue on-off ramps (Ramps 23 and 24) were closed. The freeway terminals of these ramps are visible in the lower right-hand corner of Figure 28. The traffic volumes on Ramps 23 and 24 were almost negligible and the geometrics of these ramps were such that any vehicle using them during the peak hour interfered with the freeway traffic stream.

Average peak hour speeds and volumes are shown in Figure 29. Since nearly all the traffic on Ramp 10 came from the Southeast Freeway, volumes from the Southeast Freeway had to decrease, if motorists followed the recommended alternate route.

The geometrics of Location 6 are not conducive to high speeds. Prior
Figure 28. Location 6 after closure of Ramps 10, 23 and 24.

Figure 29. Comparison of peak hour operating conditions for Location 6.

Figure 30. Cumulative distributions of peak hour average minute speeds for Location 6.
speed studies indicated that off-peak hour operating speeds through this area average less than 40 miles per hour. Nevertheless, substantial increases in operating speeds were registered in all lanes. Overall the speeds for all vehicles increased an average of 23 percent.

With existing geometrics, 30 miles per hour would have to be considered acceptable speed through this area. After Ramp 10 was closed, traffic through this area was able to maintain speeds of 30 miles per hour or greater for 60 percent of the time (Figure 30). Before Ramp 10 was closed this speed was maintained less than 15 percent of the time.

Since Ramp 10 was part of an interchange between an Interstate freeway and a major arterial route, it was necessary to provide an alternate route before it could be closed. (The ready availability of an alternate route was a factor in the decision to try closure of Ramp 10.)

The alternate routing and the freeway signing directing traffic onto the alternate route are shown in Figure 31. Signs placed by the city at the locations designated "a" and "b" give further direction to the motorist.

In order to determine some of the effects of routing Ramp 10 traffic over the suggested alternate route, travel time studies were conducted before and after the closure of Ramp 10. The results of these studies are shown in Table 1.

Traffic re-routed over Admiral Boulevard had to travel an additional two-tenths of a mile, with an average peak hour increase in travel time of approximately 1.7 minutes.

The additional traffic apparently did not increase overall travel time over the Admiral Boulevard route.

It is believed that the improvement in operating conditions is great enough to justify the increased travel time for the vehicles displaced from Ramp 10. It is recommended that Ramps 10, 23 and 24 remain closed for the present.

Travel Time Study

A limited travel time study was made in an effort to measure overall improvement in traffic operations throughout the entire study section. Upon analysis, it was found that insufficient data had been obtained for statistical accuracy and the analysis of overall travel times was discontinued.

The limited data obtained did indicate an overall improvement in travel time, especially during the period of 4-4:30 p.m. The data also reflected the effects of the congestion which continues to occur almost daily after 4:30 p.m. along the Southeast Freeway between the Fourteenth and Sixth Street Interchanges.
Figure 31. Freeway signing and alternate routing for ASB Bridge traffic.
<table>
<thead>
<tr>
<th>CHECK POINT</th>
<th>DISTANCE MILES</th>
<th>TRAVEL TIME - MINUTES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Via Admiral Boulevard)</td>
<td></td>
</tr>
<tr>
<td>10th Street</td>
<td>.09</td>
<td>.29</td>
</tr>
<tr>
<td>9th Street</td>
<td>.19</td>
<td>.66</td>
</tr>
<tr>
<td>Admiral</td>
<td>.18</td>
<td>.60</td>
</tr>
<tr>
<td>Charlotte</td>
<td>.19</td>
<td>.91</td>
</tr>
<tr>
<td>A.S.B. Ramp</td>
<td>.28</td>
<td>.60</td>
</tr>
<tr>
<td>5th Street</td>
<td>.11</td>
<td>.61</td>
</tr>
<tr>
<td>3rd Street</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>1.04</td>
<td>3.67</td>
</tr>
</tbody>
</table>

(Via Ramp 10)

<table>
<thead>
<tr>
<th>CHECK POINT</th>
<th>DISTANCE MILES</th>
<th>TRAVEL TIME - MINUTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th Street</td>
<td>.09</td>
<td>.23</td>
</tr>
<tr>
<td>9th Street</td>
<td>.16</td>
<td>.27</td>
</tr>
<tr>
<td>Admiral</td>
<td>.11</td>
<td>.22</td>
</tr>
<tr>
<td>Paseo Bridge Junction</td>
<td>.37</td>
<td>.78</td>
</tr>
<tr>
<td>5th Street</td>
<td>.11</td>
<td>.47</td>
</tr>
<tr>
<td>3rd Street</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>0.84</td>
<td>1.97</td>
</tr>
</tbody>
</table>
EFFECTS OF RECOMMENDED CONTROLS ON ADJACENT STREETS

Regardless of improvements made on traffic flow on the freeway, no improvement could be termed successful if it severely overloaded the adjacent street system. In order to determine the effect on the adjacent street system, critical streets, intersections, and ramps were studied.

Since the selected street system was extended over most of the central business district, and it was desired to study all streets during the same peak hour, aerial photography was employed as the study technique. Figure 32 is a mosaic of the central business district made up of aerial photographs from one flight. Each photograph covered approximately two-thirds of the study area; however, due to the angle of photography and the height of buildings, streets were visible on only a portion of each photograph. Complete coverage of peak hour was obtained for before and after periods of operation.

A series of photographs taken approximately 2.5 minutes apart were selected for each street to be studied. The number of vehicles within each section of street was counted and the average vehicle accumulation on each section of street determined.

Certain street and ramp intersections were felt to be directly affected by diverted traffic. At these locations manual turning movements and machine volume counts were made. Personnel requirements limited the manual turning movement counts to one peak period before and after. The machine counts covered a minimum of 48 hours.

A total of eight streets were selected for detailed study. These streets were felt to be those which would be most affected by the diverted traffic.

Vehicle accumulations during the peak hour for each street are shown in Figures 33 through 40. It should be emphasized that these figures represent actual number of vehicles and are not adjusted for length of section or number of lanes, therefore, the figures cannot be compared between adjacent sections. Only the before and after figures within each section are comparable.

Increases in vehicle accumulation were found on sections of Broadway, Charlotte, Tenth Street, Admiral Boulevard, and the South Service Road. The most significant increases in vehicle accumulation appeared to occur on Broadway and Tenth Street. The remaining sections showed less significant increases, and in some cases, such as Main Street, there is actually a decrease. (The decrease in Main Street was expected due to the closing of Ramps 4 and 5.)

The increase in traffic on northbound Broadway (Figure 33) was expected. Traffic was expected to be diverted to Ramp 3, using Broadway as a principal approach route. Observations of the aerial
Figure 33. Average vehicle accumulation on Broadway.

Figure 34. Average vehicle accumulation on Grand Avenue.

Figure 35. Average vehicle accumulation on Main Street.

Figure 36. Average vehicle accumulation on Oak Street.
Figure 37. Average vehicle accumulation on Charlotte Street.

Figure 38. Average vehicle accumulation on Admiral Boulevard.

Figure 39. Average vehicle accumulation on Tenth Street.

Figure 40. Average vehicle accumulation on South Service Road.
photographs indicated that the first three sections of Broadway from the South Service Road to Ninth Street were operating at capacity levels for a portion of the peak hour before any changes were made. This is indicated by the lack of any substantial increase in the maximum figures shown. The first section (between South Service Road and Seventh Street) shows no increase in the average number of vehicles in the section during the peak hour. This indicates that this section, or at least the intersection feeding it, was operating at near-capacity before anything was done and there was no room to store additional vehicles. The next four sections show an increase in the average number of vehicles during the peak hour indicating an increase in volume, or storage, on these streets. Apparently the section between Ninth and Tenth Streets was the first section which was not at one time or another filled to capacity during the "before" study. Traffic in this section was apparently increased significantly as a result of ramp closures. The increased usage of Broadway does not appear to extend south of Eleventh Street.

On Broadway, it appears that the duration, more than the severity, of congestion was increased. The maximum travel time has probably not increased too much during the periods of peak congestion; however it does appear that the peak period has been lengthened somewhat. For the motorists who have always used Broadway during the peak period, there would not be much change in travel time. For the motorists who were convenient to other ramps and are now using Broadway and Ramp 3, the increase could be significant.

Conditions on Tenth Street from Walnut to Grand (Figure 39) are very similar to those on Broadway. The congestion at this location appears to have been increased in duration with little increase in severity. This condition is due partly to the fact that some of the signalized intersections may already have been operating at capacity and would not pass additional traffic into the section. Again, a motorist who had ready access to one of the closed ramps would experience an increase in travel time if he were to use Tenth Street as an alternate route. The motorist who has always used Tenth Street during the peak period would probably notice little increase in travel time. The increase in vehicles on the last section (between Ramps 31 and 29) is probably due to an increased volume rather than an increase in congestion.

An apparent increase in congestion was found on Admiral Boulevard (Figure 40) west of the A.S.B. Bridge approach. This congestion is not believed to have been caused by any of the ramp closings. It may have resulted from some excavation being done in the traveled-way of Admiral during the period of the "after" study.

The eastern sections of the South Service Road (Figure 40) and the first sections of Charlotte (Figure 37) were expected to show increases. It was assumed that some drivers would attempt to use closed ramps and would be forced to use the South Service Road and Charlotte Street.
as a route to alternate ramps. The last section of the South Service Road shows an increase of two vehicles during maximum storage and an increase of approximately two vehicles for average peak hour conditions. This would indicate that the additional vehicles are arriving periodically and have not created an intolerable situation.

Traffic diverted to Charlotte Street would have either Admiral Boulevard or Tenth Street as a route of exit from the area. This is reflected in the increase between the South Service Road and Admiral and the drop in traffic between Admiral and Eighth Street and the build-up between Eight and Tenth Streets. Again, it is believed that this indicates an increase in traffic volume rather than an increase in congestion.

It was hoped that, once the ramps had been closed for a length of time, traffic would find alternate routes to their destination and never arrive at the closed ramps. Apparently, this has happened, since a slight drop in the average number of peak hour vehicles was recorded on most sections of the South Service Road. If traffic were arriving at the closed ramps and continuing on to an alternate ramp, there should be a slight increase in travel on the South Service Road.

The total vehicle accumulations for all of the selected streets is plotted chronologically in Figure 41.

Peak traffic build-up is reached at, or just after, 4:40 p.m. This undoubtedly reflects a 4:30 p.m. quitting time for a large number of workers in the downtown area. This is the same peak that reaches the freeway approximately five to ten minutes later.

Since it was expected that vehicles which were displaced from the closed ramps would travel a little further on the street system, a slight increase in total vehicle accumulation was expected. Analysis of the data on which Figure 41 is based indicates that this increase was slightly under four percent during the peak hour (4 to 5 p.m.).

It can be shown that average vehicle accumulation can also be estimated from the following formula:

\[
\text{Average accumulation} = \frac{\text{Total vehicle miles/ time period}}{(\text{Avg. No. of vehicles present})} = \text{Average overall vehicle speed}
\]

Since average vehicle accumulation on a fixed system over a given period of time (peak hour) is directly related to vehicle miles of travel and inversely related to average overall operating speed, and since

* See page 48, Appendix
Figure 41. Total vehicle accumulation on selected streets.
average vehicle accumulation increased by only four percent, it follows that the combined effect of an increase in vehicle miles or a decrease in average overall operating speed cannot exceed four percent. The maximum change in either vehicle miles or average operating speed is thus limited to four percent. Such changes in operating conditions are considered reasonable.

Before plans for any ramp closings were finalized, critical intersections and alternate ramps were studied to determine if there was sufficient capacity to handle the increased load.

Peak hour volumes and turning movements for the ramps and intersections studied are shown in Table 2.

The intersection approaches considered most critical were the west and south legs of the intersection of Broadway and the South Service Road. A large part of the traffic diverted from Ramps 4, 5, and 9 was expected to pass through this heavily used intersection. As indicated in Table 2, afternoon peak hour volume on the west leg increased approximately 198 vehicles. The total peak hour volume was thus increased to 1484 vehicles, well under the estimated capacity of 1620 vehicles per hour. Peak hour traffic on the south leg increased about 107 vehicles, to 1297 vehicles per hour, as compared to an estimated capacity of 1510 vehicles per hour.

A check of the effects of diverting Ramp 10 traffic was also made. Virtually all of this traffic was expected to use Ramp 27 (off-ramp to Admiral) and Admiral Boulevard, thereby increasing the south to west movement at the Ramp 27-Admiral intersection and the east to north movement at the Admiral-A.S.B. Bridge approach intersection. The increase in each of these turning movements during the morning peak hour was found to be very nearly equal to the 240 vehicles displaced by the closing of Ramp 10. At no time while these intersections were under observation did the added volume appear to cause congestion.

The total P.M. peak hour traffic diverted from Ramps 5 and 9 amounted to 700 vehicles. At the same time, a total increase of 596 vehicles was recorded at Ramps 3, 28, 29, and 31. As these counts were made shortly after the closing of the ramps, it is possible that some of the 100 or so vehicles which appear to have left the freeway system will return as drivers become more familiar with the new arrangements.

While there has been a small increase in congestion on the city street system, it is felt that this increase is not severe enough to warrant concern. The inconvenience to the few must be measured against the benefits to the many. A very good yardstick for this type of measurement is the number of complaints received, which so far have been few in number.
Table 2

PEAK HOUR TRAFFIC VOLUMES

and TURNING MOVEMENTS

4:00-5:00 PM
6:30-7:30 AM

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>PEAK HOUR</th>
<th>BEFORE</th>
<th>AFTER</th>
<th>CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Service Road and Broadway</td>
<td>PM</td>
<td>236</td>
<td>265</td>
<td>+ 29</td>
</tr>
<tr>
<td>West to North</td>
<td>PM</td>
<td>874</td>
<td>1042</td>
<td>+ 168</td>
</tr>
<tr>
<td>West to East</td>
<td>PM</td>
<td>176</td>
<td>177</td>
<td>+ 1</td>
</tr>
<tr>
<td>West to South</td>
<td>PM</td>
<td>1286</td>
<td>1484</td>
<td>+ 198</td>
</tr>
<tr>
<td>South to North</td>
<td>PM</td>
<td>866</td>
<td>928</td>
<td>+ 62</td>
</tr>
<tr>
<td>South to East</td>
<td>PM</td>
<td>324</td>
<td>369</td>
<td>+ 45</td>
</tr>
<tr>
<td>Ramp 3</td>
<td>PM</td>
<td>683</td>
<td>854</td>
<td>+ 171</td>
</tr>
<tr>
<td>Ramp 4</td>
<td>PM</td>
<td>266</td>
<td>0</td>
<td>- 266</td>
</tr>
<tr>
<td>Ramp 5</td>
<td>PM</td>
<td>328</td>
<td>0</td>
<td>- 328</td>
</tr>
<tr>
<td>Ramp 7</td>
<td>PM</td>
<td>152</td>
<td>189</td>
<td>+ 37</td>
</tr>
<tr>
<td>Ramp 9</td>
<td>PM</td>
<td>372</td>
<td>0</td>
<td>- 372</td>
</tr>
<tr>
<td>Ramp 10</td>
<td>AM</td>
<td>240</td>
<td>0</td>
<td>- 240</td>
</tr>
<tr>
<td>Ramp 14</td>
<td>AM</td>
<td>407</td>
<td>372</td>
<td>- 35</td>
</tr>
<tr>
<td>Ramp 27</td>
<td>AM</td>
<td>288</td>
<td>593</td>
<td>+ 305</td>
</tr>
<tr>
<td>South to West</td>
<td>AM</td>
<td>209</td>
<td>444</td>
<td>+ 235</td>
</tr>
<tr>
<td>Admiral to ASB Br.</td>
<td>AM</td>
<td>306</td>
<td>540</td>
<td>+ 234</td>
</tr>
<tr>
<td>East to North</td>
<td>AM</td>
<td>306</td>
<td>540</td>
<td>+ 234</td>
</tr>
<tr>
<td>Ramp 28</td>
<td>PM</td>
<td>266</td>
<td>426</td>
<td>+ 160</td>
</tr>
<tr>
<td>Ramp 29</td>
<td>PM</td>
<td>493</td>
<td>652</td>
<td>+ 159</td>
</tr>
<tr>
<td>Ramp 31</td>
<td>PM</td>
<td>466</td>
<td>572</td>
<td>+ 106</td>
</tr>
<tr>
<td>Total Diverted - Ramps 5 and 9</td>
<td></td>
<td></td>
<td></td>
<td>700</td>
</tr>
<tr>
<td>Total Increase - Ramps 3, 28, 29 and 31</td>
<td></td>
<td></td>
<td></td>
<td>596</td>
</tr>
</tbody>
</table>
It must be assumed that most of the displaced motorists have found routes which are at least satisfactory, if not as good, as previous routes.
ACCIDENT STUDY

While improvement of the level of operation of the freeway is the major goal of this study, an equally important goal is the reduction of accidents through the elimination of hazardous maneuvers. Even if the level of service through a critical area was not improved, a major reduction of accidents could be considered justification for the improvement measures remaining in effect.

The source of data for the accident study is a file of accident reports furnished the Highway Department by the City of Kansas City. Due to changes in the method of accident reporting, it was decided to use only those accidents occurring after January 1, 1966.

The base period for the before accident study is from January 1, to June 30, 1966. Figures 42 and 43 show the location and type of all accidents which occurred during this six-month period. A summary of these accidents is shown in Table 3.

Table 3
ACCIDENT STATISTICS

<table>
<thead>
<tr>
<th>Type Accident</th>
<th>Eastbound</th>
<th></th>
<th>Westbound</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Property Damage</td>
<td>Personal Injury</td>
<td>Total</td>
</tr>
<tr>
<td>Rear End</td>
<td>41</td>
<td>10</td>
<td>51</td>
</tr>
<tr>
<td>Side Swipe</td>
<td>18</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>Single Car</td>
<td>12</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>71</td>
<td>12</td>
<td>83</td>
</tr>
</tbody>
</table>

Grand Total = 147 Accidents

Of the total of 147 accidents, 83 occurred in the eastbound lanes and 64 in the westbound lanes. In both directions slightly over 14 percent of the accidents involved personal injury.

Rear-end collisions accounted for 61 percent of the accidents in the eastbound lanes and 66 percent of the accidents in the westbound lanes.

Most of the accidents appear to be clustered in the vicinity of the on-ramps, or at the Sixth Street and 14th Street interchanges. The lanes carrying the south to west movement at the Sixth Street interchange and the north to east movement at the 14th Street interchange seem to be especially prone to single car accidents. Rear-end collisions quite naturally occur at locations where at times movement of traffic is slowed or halted.
Figure 42. Accident spot map for Sixth Street Freeway.
Figure 43. Accident spot map for Southeast Freeway.
Accidents occurring in the vicinity of Ramps 3, 5 and 9 in the eastbound lanes and the areas identified as Locations 2 and 6 are of special interest since these areas should be directly affected by some of the improvements.

At the present time the accident map is included primarily as a matter of interest since no comparison can be made until enough time has elapsed to provide a base for the after studies. It is hoped that as soon as the final accident reports are received for 1966 the after comparisons can be made. A final analysis of accidents will be issued in memo form.
ANALYSIS OF EASTBOUND PASEO OFF-RAMP TRAFFIC

A study of the feasibility of closing the Paseo off-ramp was made as part of the attempt to improve operating conditions in the vicinity of the 14th Street Interchange. The closing of this ramp during the afternoon peak period would eliminate the problem of vehicles from the north attempting to weave right in order to use this ramp.

A tabulation of data obtained in the Paseo off-ramp origin-destination study is shown in Table 4. Routes of entrance and destinations are shown on the flow map in Figure 44.

Fifty-three per cent of the traffic on this ramp came from the Intercity Viaduct or the Paseo Bridge. Somewhat surprising was the 158 vehicles (17 percent) which came from the 14th Street on-ramp.

Nearly half of the traffic using the Paseo off-ramp is destined for the corridor between Troost and Prospect.

Of the total volume of 920 vehicles using this ramp between 3:30-6:00 p.m., 536 (58%) had destinations south of 43rd Street, a distance greater than three miles.

In order to estimate what would happen to the 920 vehicles using this ramp if it were closed, the following alternates were considered:

A. Paseo Bridge traffic could proceed straight down the Paseo.
B. Traffic could exit to Eleventh Street and continue down Charlotte, Troost or the Paseo.
C. Traffic could continue on to Prospect Avenue and go south on Prospect.
D. Some traffic would not enter the freeway at all, or exit on one of the Sixth Street ramps.

Travel times for the alternate routes were determined using peak hour speed-delay runs made for another study. Travel times from the Sixth Street interchange area to 39th Street along the various alternate routes were compared. These times varied from 9.8 minutes over Prospect Avenue to 11.2 minutes over the Paseo. Travel time over the present route (Southeast Freeway and the Paseo) was found to be 9.4 minutes.

The distances over which travel times were computed averaged about three miles, which means travel times average greater than three minutes per mile.

Travel time prior to entering or after leaving the alternate routes proved to be a greater factor than the difference in travel time between
Table 4

DATA SUMMARY
THE PASEO OFF-RAMP STUDY

May 18, 1966
3:30 - 6:00 PM

ROUTE OF ENTRY

<table>
<thead>
<tr>
<th>Entrance via</th>
<th>Expanded Volume</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercity Viaduct</td>
<td>212</td>
<td>23</td>
</tr>
<tr>
<td>Ramp 3</td>
<td>50</td>
<td>6</td>
</tr>
<tr>
<td>Ramp 5</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Ramp 8 (ASB Br.)</td>
<td>100</td>
<td>11</td>
</tr>
<tr>
<td>Ramp 9</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Paseo Bridge</td>
<td>279</td>
<td>30</td>
</tr>
<tr>
<td>Ramp 25</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Ramp 28</td>
<td>34</td>
<td>4</td>
</tr>
<tr>
<td>Ramp 31</td>
<td>67</td>
<td>7</td>
</tr>
<tr>
<td>14th Street Ramp</td>
<td>158</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>924</td>
<td>100</td>
</tr>
</tbody>
</table>

Questionnaire Returns

<table>
<thead>
<tr>
<th>No. Dist. - 923</th>
<th>No. Ret. - 245</th>
<th>% Ret. - 27</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Use of Ramp

<table>
<thead>
<tr>
<th>No. times Used Weekly</th>
<th>Number</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seldom or No answer</td>
<td>52</td>
<td>21</td>
</tr>
<tr>
<td>17</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>134</td>
<td>134</td>
<td>55</td>
</tr>
</tbody>
</table>

-43-
Figure 44. Traffic flow map for the Paseo off-ramp.
alternates. Therefore, the selection of alternate routes depended heavily on the location of the origins and destinations.

The following assumptions were made:

1. Traffic from the Paseo Bridge and destined for the corridor between Troost and Prospect would continue down the Paseo.

2. Traffic with destinations north of Truman Road would either leave on Sixth Street Freeway exits or never enter the freeway.

3. Traffic destined for areas south of Truman Road and west of Troost would use the Eleventh Street exit.

4. Traffic destined for east of Prospect and south of Truman Road would use the Prospect exit.

5. Of the traffic in the corridor between Troost and Prospect, 50 per cent would use the Eleventh Street exit and 50 per cent the Prospect exit.

These assumptions gave the following distributions, of the 920 vehicles presently using the Paseo off-ramp from 3:30 - 6:00 p.m.:

124 vehicles from the Paseo Bridge would continue straight down the Paseo,

247 vehicles would use the Eleventh Street exit,

317 vehicles would exit at Prospect Avenue, and

232 vehicles would leave the system on Sixth Street Freeway exits, or never enter the system.

Approximately one-half of the additional traffic assigned to the Eleventh Street and Prospect Avenue off-ramps would normally arrive between 4-5 p.m. Peak hour traffic on the Eleventh Street ramp would thus be increased about 124 vehicles, to 421 vehicles. Traffic on the Prospect Avenue ramp would be increased 159 vehicles, to 489 vehicles, during the peak hour. Both predicted volumes are within the capacities of the ramps.

The trip to the furthermost point on Prospect Avenue should take approximately four-tenths of a minute longer by this route than by the present route. The same trip using Charlotte or Troost should take about 1.2 minutes longer. The additional volume is not large enough to present a capacity problem either on the ramps or the streets.
Therefore, it is considered feasible to close the Paseo off-ramp.

At the present time, however, the inconvenience to the motoring public is felt to outweigh the anticipated improvement in traffic flow. Therefore, although it is feasible, peak period closure of the Paseo off-ramp is not recommended at this time.

This location should be kept under observation, as the need for closure may increase when the Cross-Town Freeway is opened.
SUMMARY OF RECOMMENDATIONS

1. Revise and simplify signing on the Sixth Street Freeway and make minor revisions in the signing on the adjacent section of the Southeast Freeway.

2. Stripe out the right lane of the eastbound lanes to the Paseo Bridge and Independence Avenue at the Sixth Street Interchange.

3. Stripe out the right lane of the southbound lanes from the Paseo Bridge at the Sixth Street Interchange.

4. Provide more protection for the eastbound on-ramp traffic from the Fourteenth Street on-ramp.

5. Close the westbound off-ramp to ASB Bridge (Ramp 10).

6. Close the eastbound on-ramp at the east end of the South Service Road (Ramp 9).

7. Close the eastbound on-ramp from Main Street (Ramp 5).

8. Close the eastbound off-ramp to Main Street (Ramp 4) during P.M. peak hour only.

9. Study the feasibility of closing the eastbound off-ramp to the Paseo during the P.M. peak hour.

10. Close the Independence Avenue eastbound on and off ramps (Ramps 23 and 24).
A FORMULA FOR COMPUTING AVERAGE VEHICLE ACCUMULATION ON A GIVEN SECTION OF A ROAD SYSTEM

Average vehicle accumulation equals the average number of vehicles present on a given section during a given time interval.

Thus, for the peak hour on a given section or system:

Avg. Accumulation = Density x Distance

\[
= \frac{\text{Volume (veh./hr.)} \times \text{Distance (miles)}}{\text{Average Speed (miles/hr.)}}
\]

which simplified to:

Avg. Accumulation = \frac{\text{Veh./hr.} \times \text{miles}}{\text{miles/hour}}

\[
= \frac{\text{Vehicles-miles/hour}}{\text{miles/hour}}
\]

\[
= \frac{\text{Vehicle-miles/hour}}{\text{Speed}}
\]