

# **A MEDIAN STUDY IN BAYTOWN, TEXAS**

By

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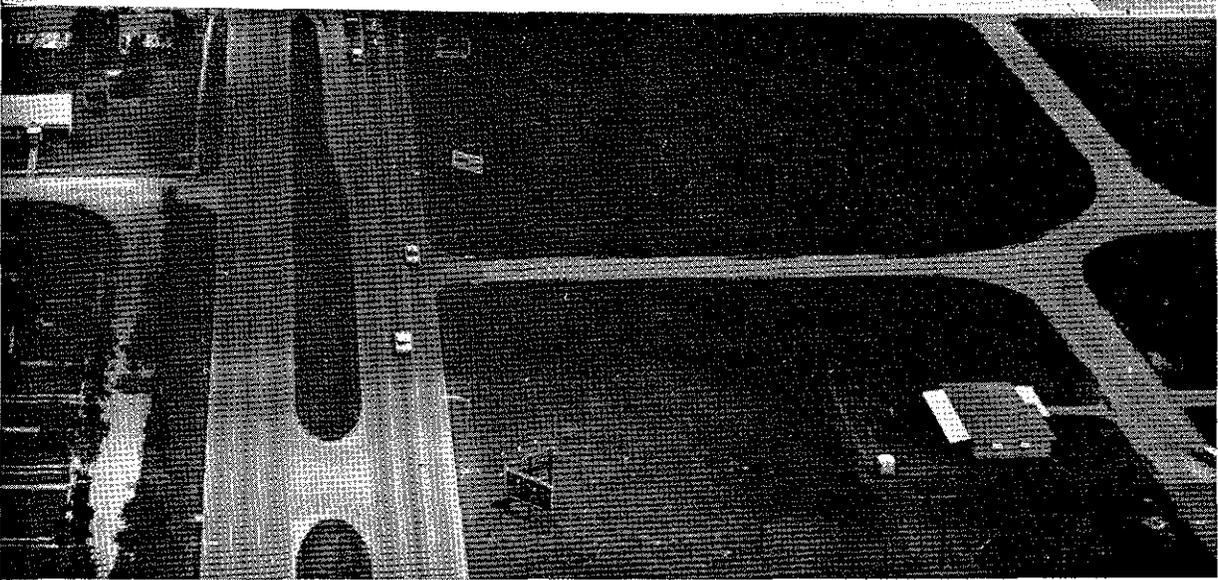
## FOREWORD

In September, 1958, a committee composed of members of the Texas Highway Department and the Texas Municipal League was formed to investigate and make recommendations on city-state median practices.

It was the intent of this committee to develop information on the effect that the addition of the median would have on a facility's ability to handle traffic more efficiently and safely and the effect that it would have on the local businesses. This information could then be used as a basis for evaluating future potential median sites to determine if a median-type facility should be installed.

The Texas Transportation Institute, as the official research agency of the Texas Highway Department, was asked to conduct the actual research program for the Committee. Three study sites, involving a heavily traveled route in a large city (San Antonio), a moderately traveled route in a medium sized city (Baytown), and a lightly traveled route in a small town (Pleasanton), were selected for the analysis.

Because of the variations in the conditions under observation, findings of these three studies are being released as separate reports. However, a statement of general conclusions concerning all three areas is included in each of the reports. For more detailed information, the other reports should be obtained.



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# General Conclusions of Over-all Study Pleasanton—Baytown—San Antonio

Although there were wide differences in the size, traffic density and community orientation of the three areas included in this study, certain conclusions concerning the effect of medians can be drawn. These conclusions point up both similarities and differences that were observed under the different sets of conditions.

## *ECONOMIC*

From an economic standpoint, the stimulus to new growth was perhaps the most significant effect of the median program. The street improvement program created attractive and desirable commercial sites in each of the three areas. The desirability of these sites is attested by the rapid influx of new businesses which began immediately after construction was completed.

In general, the construction process itself provided the most severe shock to the economic system of the community. This shock was most severe in Baytown, the middle-sized city, where some businesses were completely isolated from traffic for varying lengths of time due to both the contractor's scheduling and inclement weather conditions. It was less severe in Pleasanton, the smallest city, where local customers had few alternative firms in which to shop. In San Antonio, the largest city, the effect was less uniform. Certain classes of firms such as service stations were severely affected but from the standpoint of the area as a whole, their losses were made up by gains in the nontraffic serving businesses. On the basis of these three experiences, then, it may be concluded that the effect of the construction process on a firm will depend upon:

1. The provisions in plans and specifications and the care exercised by the contractor to prevent firm isolation for extended periods.
2. The availability of alternative firms near the area under construction.
3. The character of the firm itself. That is, whether it is oriented toward a large number of low volume sales (such as a service station or coffee shop) or a smaller number of high volume sales (such as a furniture store or automobile dealer).

After the new facility was completed business as a whole began to rapidly recover the sales lost during construction. After a full year of operation with the median, total business volume was above the pre-construction level in both San Antonio and Baytown. Of course, some of this gain was due to the establishment of new businesses along the facility, and many old firms were still below their base volumes. In general the businesses operating in older, less modern, less well kept buildings were most severely affected and were not able to regain their lost sales volumes. More modern firms with vigorous, progressive management often increased their sales well above their base levels.

The assumptions that losses in left-turn customer traffic into businesses would be offset by increases in

right turn traffic was not completely borne out. Customer turns appear to be inversely related to city size and traffic volume. In both of the smaller cities there was a noticeable increase in right turn customer traffic after the median was built. In San Antonio, however, where traffic volume was very heavy and speeds high, there was an actual reduction in right turns. This indicates that customer turns may be dependent upon both convenience and firm loyalty which is more pronounced in the smaller cities. In the three cities as a whole, the reduction in total customer traffic averaged about 10 percent after the median was installed.

## *TRAFFIC*

Traffic studies were conducted at each of the three study locations to investigate the effect of introducing a median on the character of traffic operation and safety. In general, there were four types of traffic studies conducted in each of the study locations. These studies were:

1. Traffic volume studies.
2. Accident studies.
3. Operational studies.
4. Travel time studies.

Although the purpose of the studies was to determine the effect of the median on traffic operation and safety, it was generally difficult to relate changes in traffic operation to specific roadway elements. In general, improved traffic operation was attributable to the overall upgrading of the highway facility; however, there were cases where the effects of the median could be specifically evaluated. Brief results of the separate traffic studies are indicated in the following sections.

### *Traffic Volume Studies*

Traffic volume studies conducted at each of the study locations indicated fairly static traffic volume conditions throughout the entire study period. In Baytown there was actually a slight decrease in traffic volume on S.H. 146 due to diversion to a new parallel facility. Cross street traffic in Baytown experienced normal increases as did S.H. 281 in the Pleasanton study. Traffic volumes in the study section in San Antonio, a section of Southwest Military Drive, remained static at approximately 20,000 vehicles per day.

### *Accident Studies*

Accident studies conducted at each of the study locations indicated reductions in certain types of accidents and increases in other types. There was a significant reduction in rear-end collisions involving vehicles waiting or slowing to make left turns. Head-on collisions involving the opposing streams of traffic were also eliminated. These reductions were attributable to the installation of a median.

Increases were observed, however, in other types of accidents. In the Baytown study, right-angle collisions

increased due to an inefficient signal system, but later were reduced by re-design of the system. Also, there were increases observed in accidents involving vehicles making improper lane changes. In some instances fixed-object type accidents increased when medians were installed.

### ***Operational Studies***

Operational studies conducted at the study locations indicated a large number of irregular maneuvers before medians were installed. These irregular maneuvers were virtually eliminated by the installation of the median, but a great many U-turns were created at the median openings. Normally, the U-turn maneuver is not too hazardous under low traffic volume conditions; however, in some cases the median was not wide enough to make a legal U-turn.

### ***Travel Time Studies***

Travel time studies conducted in Baytown and San Antonio indicated a great deal of congestion and delay during the "before" period. Travel time studies for the "after" period indicated an increase in traffic speeds due to the improvement of the facility. Some of this increase can be attributed to the median since it provided separates left-turn lanes and eliminated delay due to vehicles waiting to make left turns. The increase is also attributable to the fact that congestion was relieved by the construction of additional traffic lanes. In Pleasonton, the travel time studies indicated a fairly high level of service in both the "before" and "after" conditions. Only minor delays were experienced in the "before" study and the majority of these were due to traffic signals rather than traffic congestion and vehicles waiting to make left turns.

# A Median Study in Baytown, Texas

## Introduction

The Texas Highway Department and the various cities and towns of Texas have long been concerned with the necessity for and problems involved in improving highway routes along city streets. These routes are usually major traffic arteries in the larger cities and often serve as the Main Street in the smaller towns. As such they are usually heavily developed with commercial businesses throughout their length.

These combination highway routes and city streets are charged with fulfilling two diametrically opposed functions. In the smaller towns they must move the transient traffic through the town as quickly, safely and efficiently as possible and still serve as service streets to the businesses located on the adjacent land. In the larger cities they must perform these same functions and in addition carry the traffic moving between major sections of the city or between the suburban and central downtown areas. The difficulty in performing these functions concurrently has long been recognized.

Several procedures have been tried in an attempt to increase the efficiency with which this dual-purpose facility can be made to perform its functions. Among the more successful have been: speed zoning and signalization to regulate traffic flow; street widening or the creation of additional traffic lanes to increase the physical size of the facility; the creation of bypasses or alternate routes to remove through traffic; and finally the addition of a median barrier to increase traffic speed and decrease the number of accident exposure points. Median barriers are, of course, usually operated in conjunction with some type of traffic signalization and control.

With the advent of the median barrier, however, have come additional problems. Businesses which had been accessible to the total traffic flow from each direction were now directly accessible from only one direction. Motorists wishing to patronize businesses on the left side of the street were forced to go to the next median opening, turn around and return to the merchant. Merchants were naturally skeptical about the proportion of their customers who would go to the additional trouble of crossing the median to trade at their firms.

As a consequence, both the Texas Highway Department and the local city governments were frequently petitioned for the alteration or abolition of existing median improvements, and planned street improvement programs which included medians in their design were frequently resisted with vigor.

Since the Texas Highway Department was jointly concerned with the city each time a median was built, it was anxious to develop a solid foundation of facts from which the question of median installation and operation could be evaluated. It is not surprising, then, that in September, 1958, a joint City-Highway Department committee was formed to investigate and make recommendations on city-state median practices.

As the Committee reviewed the history of median operations, it found that medians have long been justified in the minds of their builders on the basis of their effectiveness in providing more efficient traffic movement and improving safety conditions. They have been opposed primarily on economic grounds. Local merchants feel that medians reduce their exposure to passing traffic and reduce their total sales volumes.

The committee felt, then, that its primary job was to determine through scientifically controlled research procedures just how the medians measured up to what was generally expected of them. That is, how much, if any, they increased traffic flow, eliminated delays, and increased safety, and how much, if any, they affected the retail sales volumes of adjacent businesses.

To do this, it was decided to select for study, areas which were operating under nonmedian conditions but upon which medians were scheduled to be constructed in the immediate future. Each of these areas would then be subjected to a detailed analysis concerning both its record of traffic operation and the economic condition of its attendant businesses. The field work for this type of analysis would need to be initiated in time for a complete record of traffic and economic conditions to be developed prior to the beginning of construction. Additional analyses, covering the same type of data, would then be made at periodic intervals after the new median had been built.

The research procedure is commonly known as the "Before and After" approach. Quite simply, its aim is to develop a complete picture of an area under its original set of operating conditions, let the operating conditions be changed, and then develop another picture. The research techniques carried on under this program are merely the mechanical workings of the researcher's analogous camera.

After the research approach was decided upon and the problems of financing solved, the first step was to select the appropriate areas for study. Funds and personnel were available to handle three separate study sites. These were selected on the basis of the size of the city, the scheduling of median construction, the density of traffic, the type of commercial and residential development and the availability of the needed traffic and economic information.

The first area selected and the one covered in this report was in Baytown, Texas, a city of some 28,000 population located about 30 miles East of Houston. The study site itself was a section approximately two miles in length along State Highway 146 to the South of the Central Business District. This route was originally constructed several years ago to bypass the business district of Baytown, but as frequently happens, the town soon grew out to include the bypass section as one of its busiest streets. Over a period of years a large number of commercial establishments had been located along the

route to serve both the local residents and the motoring public.

Traffic had increased to the point that approximately 10,000 vehicles used the facility each day and traffic congestion at peak hours had become an irritating problem. As a consequence the City of Baytown and the Texas Highway Department decided upon a street improvement program incorporating a median in the design of the new facility.

The median construction program in Baytown was scheduled to begin in December, 1958, and was expected to be completed by November 1 of the following year. The period November 1, 1957, through October 31, 1958,

was selected as the "before" period to represent a time of normal operations under non-median conditions. The period November 1, 1958-October 31, 1959, represented the "construction" or "during" period and November 1, 1959 to October 31, 1960, the first year of normal operation with a median, the "after" period. Field work was begun in November, 1958, and was carried out in the November-May period in each year.

The research program was conducted in two phases: the economic phase and the traffic phase. The field work on these two phases was often conducted concurrently. However, they were treated separately in the analyses and are reported in individual segments in the report.

## Concluding Observations—Baytown

### ECONOMIC SUMMARY

Some general observations concerning the effect of the construction of the median on businesses within the study area may be briefly stated as follows:

1. Adjacent businesses, both individually and as a group, were definitely hurt during the construction period. Many businesses were completely isolated for varying periods of time while the facility was being built with resulting severe losses in sales. Both business failures and decisions to relocate appear to stem directly from experiences during the construction process.

2. Some of this loss was recovered during the first year of operation, but most old firms were still operating with a slightly lower level of sales than in the "before" period.

3. Of the four firms that went out of business during the entire study period, only one could actually be considered as an economic casualty. Of the remainder, one burned down and was replaced by a business of a different type, one lost the use of right-of-way parking that it had been using and was relocated just to the north of the study area but still along the median-type roadway of S.H. 146, and the other built a new building just to the north of the study area and  $\frac{1}{2}$  block off the facility.

4. The improvement of S.H. 146 appears to have created a number of attractive commercial sites within the study area. Several new businesses have already moved into the area and other businesses are known to be considering these locations.

5. Total sales of all firms in the area were increased considerably above the base period. This was due largely to the establishment of new firms during the first year of operation under median conditions.

6. The monthly trend of sales for all firms in the last year was up even sharper than was reflected in annual sales.

7. No significant relationship was found to indicate that firms located at median openings fared better under median conditions than those without such openings. In fact, for this study, the opposite relationship was indicated.

8. Business operating under median conditions experienced a 10 percent decrease in total customer traffic. This was largely due to the reduction of left turns which

constituted almost half of the total turns in the "before" period, but constituted only about 25 percent of the total turns after the median was constructed.

9. The failure of gains in right turn customer traffic to completely offset losses due to restrictions in left turns, indicates an absolute reduction in the frequency of shopping trips within the area.

10. In general there was a positive relationship between changes in customer traffic and sales volumes. However, other factors associated with management appear to be of considerable importance in determining individual business success.

### TRAFFIC SUMMARY

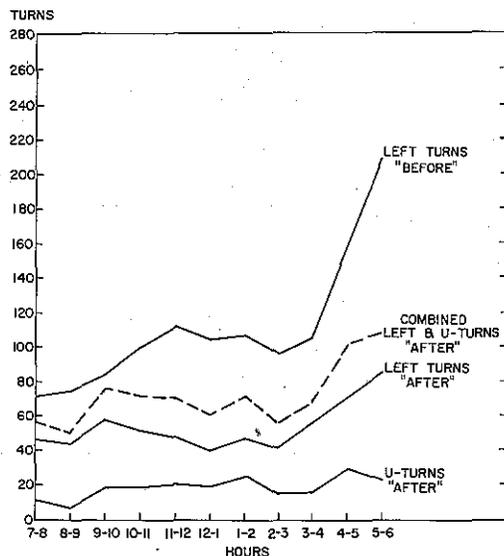
As a result of the "before" and "after" traffic studies in Baytown, Texas, the following conclusions were drawn:

#### Volume Studies

Traffic volume studies at the Baytown location indicated fairly static traffic volume conditions throughout the entire study period. In fact, there was a slight decrease in traffic volume on S.H. 146, the facility under study, but normal increases in traffic volumes were observed in the cross street traffic. The decreases in traffic volume were attributable to diversion of traffic to a new facility, I.H. 10, opened during the construction period.

#### Accident Studies

The accident study covering a period of one year before and three years after reconstruction of the facility indicated reductions in certain types of accidents and increases in other types. Rear-end collisions involving vehicles waiting or slowing to make left turns were significantly reduced, and head-on collisions involving the opposing streams of traffic were eliminated. These reductions were attributable to the installation of a median. A sizable increase was observed, however, in right-angle accidents during the first year of study after the new facility was opened. This increase was attributable mainly to the poorly timed and inefficient signal system in existence at that time. Also some of this increase can be attributed to the greater amount of exposure involved in vehicles crossing a multilane facility. There was a large increase in accidents involving vehicles making improper maneuvers such as turning from the wrong lane



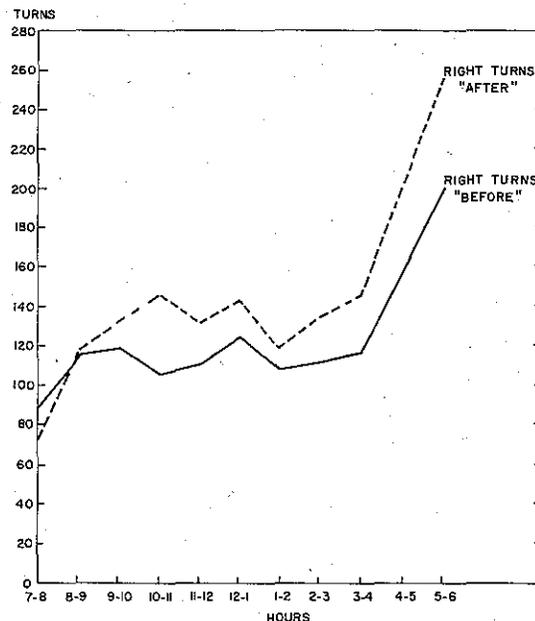
INFLUENCE OF A MEDIAN ON LEFT TURNS INTO BUSINESS FIRMS ALONG HIGHWAY 146, BAYTOWN, TEXAS

Figure 13.

in the shopping traffic stream. Before the median was built 47 percent of the total turns into businesses and 50 percent of the turns out were left turns which crossed the opposing traffic stream. Construction of the median reduced this to 25 and 26 respectively.

This was not all a net gain in the reduction of crossing traffic, however, since a number of shoppers who had previously entered those businesses by making left turns now made U-turns at one of the median openings. These U-turns, comprising 8 percent of the entering traffic and 15 percent of that leaving area firms, still cross the traffic stream, but do so now at regulated openings. The traffic implications of this development are covered in the traffic section of this report.

The hourly changes in the character of turns into and out of study area firms is shown graphically in Figures 13, 14, 15 and 16. Here again is shown the sharp reduction in left turns and the corresponding increase in right turns. This is a more detailed break-



INFLUENCE OF A MEDIAN ON RIGHT TURNS INTO BUSINESS FIRMS ALONG HIGHWAY 146, BAYTOWN, TEXAS

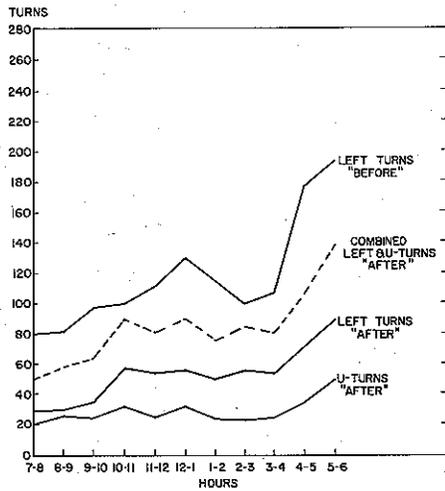
Figure 14.

down of the information shown in the preceding two tables. In addition, however, it shows the reduced level of combined left and U-turns after the median was built in comparison with the original level of left turns alone.

Since U-turns are created by the median, some additional attention was paid to determining their distribution within the area and their occurrence throughout the day. Figure 17 shows a rough outline of the study area with the businesses located in their proper relation to the median openings. It also shows the number of U-turns made at each opening (by direction), the number of those turns that were for shopping purposes within the immediate area, and the distribution of these turns between turns into and turns out of study area firms. The hourly breakdown of total U-turns at each median opening by direction of turn is also shown in Table 12 (in the traffic section).

Table 7  
THE INFLUENCE OF A MEDIAN ON TURNS OUT OF BUSINESS FIRMS ALONG S.H. 146, BAYTOWN, TEXAS

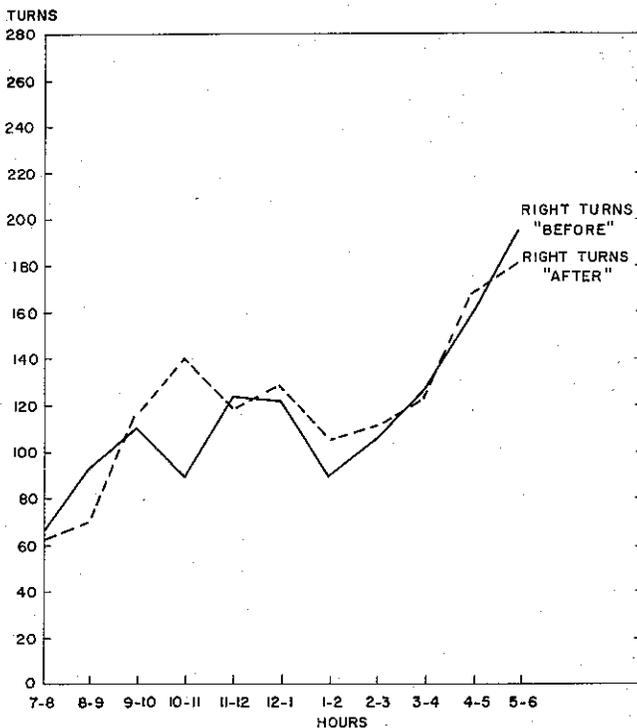
	Total Turn Outs (Number)	Right Turns		Left Turns		U Turns	
		Number (Number)	% of Totals (Percent)	Number (Number)	% of Totals (Percent)	Number (Number)	% of Totals (Percent)
<b>WEST SIDE BUSINESSES</b>							
Before	1,293	673	52	620	48		
After	995	539	54	371	37	85	9
<b>EAST SIDE BUSINESSES</b>							
Before	1,274	604	47	670	53		
After	1,244	781	63	221	18	242	19
<b>TOTALS</b>							
Before	2,567	1,277	50	1,290	50		
After	2,239	1,320	59	592	26	327	15



INFLUENCE OF A MEDIAN ON LEFT TURNS OUT OF BUSINESS FIRMS ALONG HIGHWAY 146, BAYTOWN, TEXAS

Figure 15.

By studying the character of the turns at each opening, the business generation of U-turn traffic can be better appreciated. At median opening #3 for example, the entire 95 shopping U-turns to the south were made by customers leaving businesses on the east side of the street. At the next opening, #4, the northbound shopping U-turns were all made by cars going to stores on the east side of the street. This is explained, of course, by the absence of any businesses on the west side of the street between these two median openings. At median opening #6, on the other hand, 72 of the shopping U-turns were made by vehicles which later entered



INFLUENCE OF A MEDIAN ON RIGHT TURNS OUT OF BUSINESS FIRMS ALONG HIGHWAY 146, BAYTOWN, TEXAS

Figure 16.

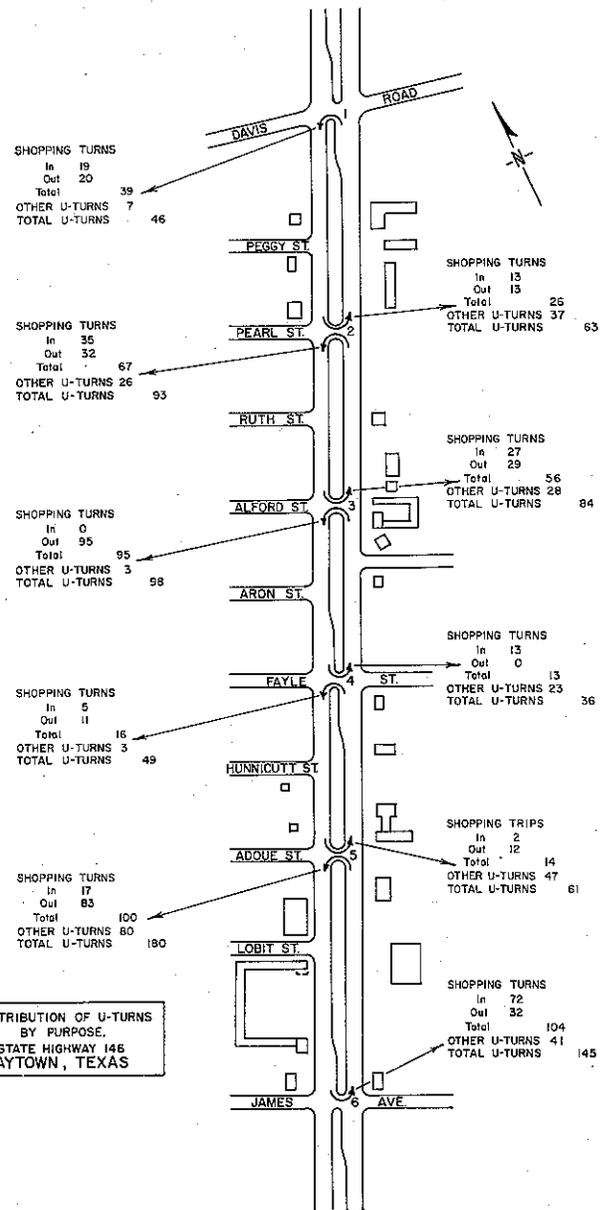


Figure 17.

one of the businesses on the east side of the highway while 32 were made by vehicles leaving one of the businesses on the west side of the street.

The relationships between business location and U-turns points up the importance of keeping both the present and potential business development in mind in designing a median type facility.

The last comparison that was made in this study was an attempt to relate changes in individual business volumes to changes in left-turn traffic entering the business. For this comparison all businesses for which records were available for both the "before" and "after" periods were arrayed in ascending order of positive changes in sales volumes. Changes in left-turn traffic were then determined for each business and compared to these data as shown in Table 8.

In a casual inspection of these data there appears to be little consistency between the percentage changes

Table 8  
COMPARISON OF CHANGES IN FIRM SALES WITH  
CHANGES IN CUSTOMER LEFT TURNS

Left Turns into Business Firms					
Firm Code	Business Orientation	Change in Sales	Before	After	Percent Change
		(Per- cent)	(Num- ber)	(Num- ber)	(Per- cent)
1	Traffic	- 44	18	9	-50
2	Traffic	- 38	131	46	-65
3	Traffic	- 28	23	5	-78
4	Traffic	- 26	16	2	-87
5	Traffic	- 16	51	12	-76
6	Nontraffic	- 12	38	19	-50
7	Traffic	- 9	49	9	-82
8	Nontraffic	- 9	311	203	-35
9	Traffic	- 4	33	34	3
Subtotal of Firms Losing in Sales		- 15	670	339	-49
10	Traffic	1	42	27	-15
11	Nontraffic	4	11	3	-73
12	Nontraffic	7	60	29	-52
13	Nontraffic	12	175	147	-16
14	Traffic	43	11	7	-36
15	Traffic	44	16	14	-13
16	Traffic	61	6	1	-83
17	Nontraffic	147	23	22	- 4
18	Nontraffic	382	17	19	12
Subtotal of Firms Gaining in Sales		35	361	269	- 5

in sales volumes and the percentage changes in the number of left turns into individual firms. In order to pursue this relationship further, however, a simple statistical test was made of the ranked data. In this test the businesses were first ranked in ascending order of positive percentage changes in sales as shown in Table 8. These firms were then assigned a second ranking in accordance with their ascending order of positive percentage changes in left turns. The extent to which these

rankings were correlated was then determined through use of the "rank correlation" formula

$$r_s = 1 - \frac{6(\sum d^2)}{n(n^2 - 1)}$$

The resulting  $r_s$  (measure of rank correlation) of 0.637 indicates that there is a positive correlation between rankings and that this relationship is significant at the 1 percent level.

In nonstatistical terms this means that in general the firms with the greatest percentage losses in sales also had the greatest percentage losses in left turns. It does not attempt to measure or estimate the extent of these losses.

Another statistical test, a linear correlation analysis, was then run in an attempt to determine the extent to which changes in sales were caused by changes in left turn traffic. This test, based upon actual changes in annual sales and actual changes in left turns, yielded a coefficient of determination of 0.049. This means that, in this case at least, only 5 percent of the change in sales could be explained by changes in left turn traffic.

If the firms are considered as groups the relationship between losses in sales and losses in left turns becomes more readily apparent. When all firms that lost sales were grouped together, their aggregate loss in left-turn traffic was 49 percent. Those that gained in sales lost only 26 percent of their left turn traffic.

This would seem to bear out the contention that there is some relationship, although not specific to every case, between the extent of losses in left turns and losses in business volumes. This relationship is not strong enough, however, to enable one to predict with any degree of accuracy the extent of the influence of a restriction in left-turn traffic on an individual firm's sales volumes. There are too many additional factors such as management, general location, extent of competition, etc. that are of equal or greater importance in determining this effect. Accessibility to traffic is, of course, a very important factor to most businesses. It is by no means always the most important one.

## Traffic Analysis

Traffic studies were conducted to investigate the character of traffic operation and to evaluate the level of service that existed on the study section in Baytown during both the "before" and "after" study periods.

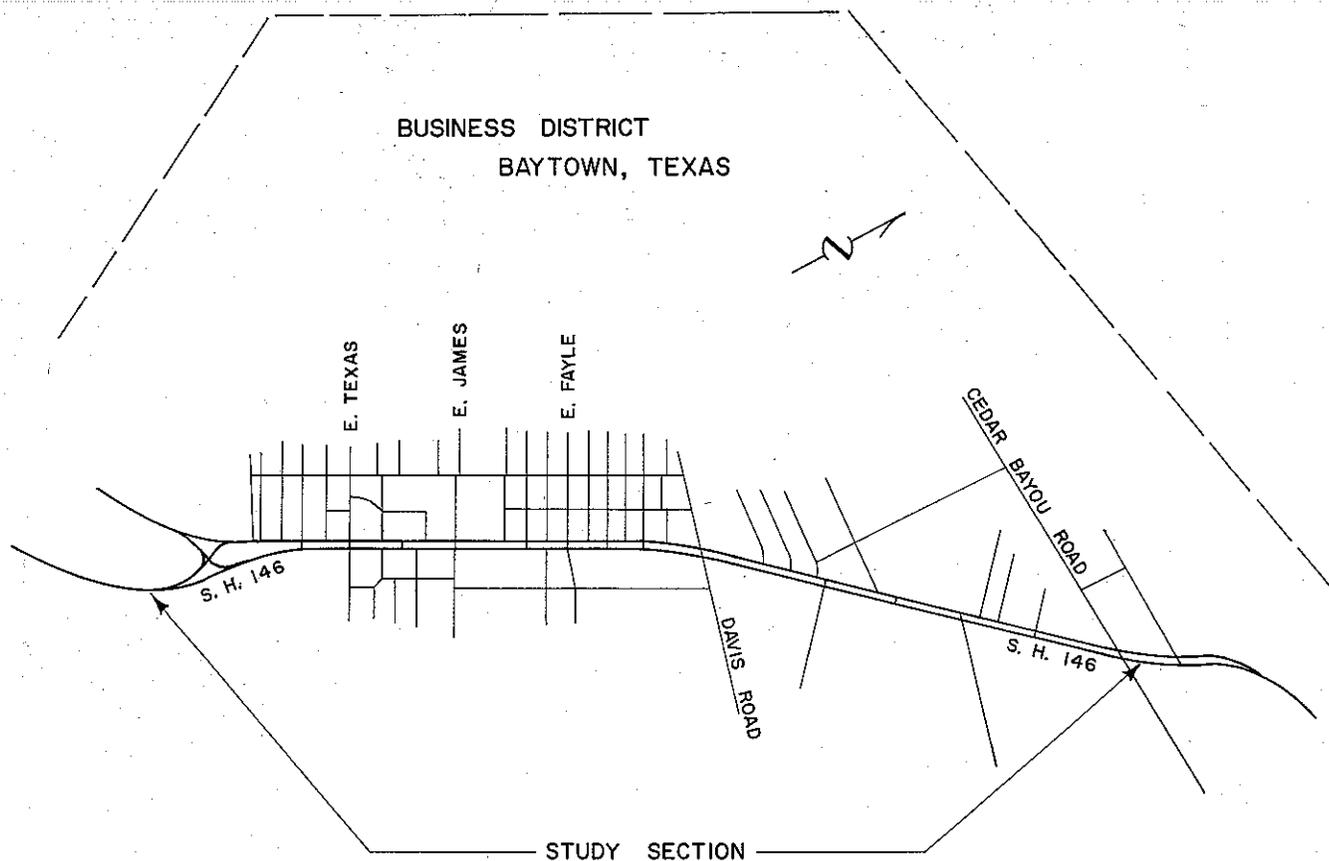
The study site, a section of S.H. 146, chosen for the traffic study is shown in Figure 18. This section extended from just south of Alexander Drive to a point immediately north of the intersection of Cedar Bayou Road, a section approximately two miles in length. During the "before" period, S.H. 146 consisted of a two-lane pavement, 20 feet in width with unsurfaced shoulders. Figure 19 illustrates a typical section during the "before" period. In 1959, S.H. 146 was widened to provide three traffic lanes in each direction and a 26-foot median with added left-turn lanes. Figure 20 shows a typical section after completion of the construction.

Four separate types of traffic studies were conducted to evaluate the "before" and "after" traffic conditions.

These were:

1. Traffic volume studies.
2. Accident studies.
3. Operational studies.
4. Travel time studies.

Although these studies were aimed at evaluating the effect of the median on traffic operation, it was generally difficult to relate changes in traffic operation to specific roadway elements. This was due to the fact that the facility under study was greatly improved through reconstruction and it was to be expected that other new elements of the facility would also produce an effect on traffic operation. Therefore, in general, the findings of the traffic studies reflect the effect of changing the entire highway facility; however, there were cases where the effects of the median could be specifically evaluated.



**STUDY SECTION  
STATE HIGHWAY 146  
BAYTOWN, TEXAS**

Figure 18.

**TRAFFIC VOLUME STUDIES**

The traffic volume studies consisted of manual and machine traffic counts conducted to establish 24-hour traffic volumes representative of the "before" and "after" study periods. Traffic counts were conducted at three locations on S.H. 146 and on each of the approaches of Texas Avenue, James Street, and Fayle Street in the proximity of S.H. 146.

Figure 21 provides a comparison of 24-hour traffic volumes for the "before" and "after" study periods. The counts for the "before" period were conducted during 1958 and the counts for the "after" period were made in 1960, after the facility was completed, and again in 1964.

Figure 22 shows the average daily traffic volumes for the entire period from 1958 to 1964 for two points within the study section and for several points on other roadways within the Baytown area.

**Analysis**

A comparison of the traffic volumes shown in Figure 21 indicates that the traffic on S.H. 146 within the study section did not change appreciably during the "before" and "after" periods; however, the traffic vol-

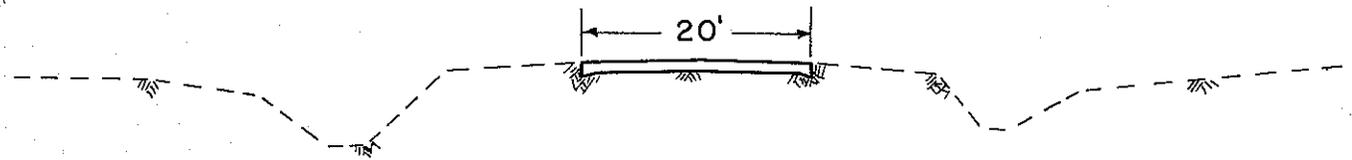
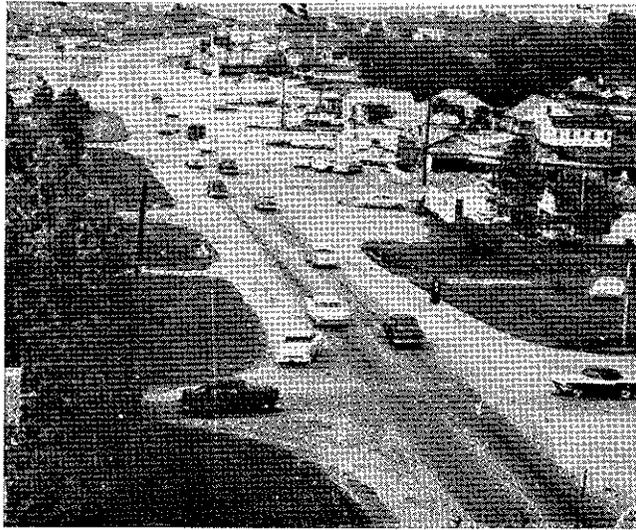
ume on the city streets increased appreciably during the "after" period. Since an increase in traffic on S.H. 146 would normally be expected, an investigation was conducted to determine why there was no increase.

This investigation showed that much of the through traffic formerly following a route along S.H. 146 through Baytown was diverted to Interstate 10 which passes to the north of Baytown. This facility was completed and opened to traffic in May, 1959, during the construction on S.H. 146. This is substantiated by volume data taken from recorder stations in the Baytown area and shown in Figure 22.

The results of the volume studies indicated that through traffic volumes on S.H. 146 were lower during the "after" study. The local traffic on S.H. 146 had increased, however, and a fairly static volume condition existed within the study section during the "before" and "after" periods.

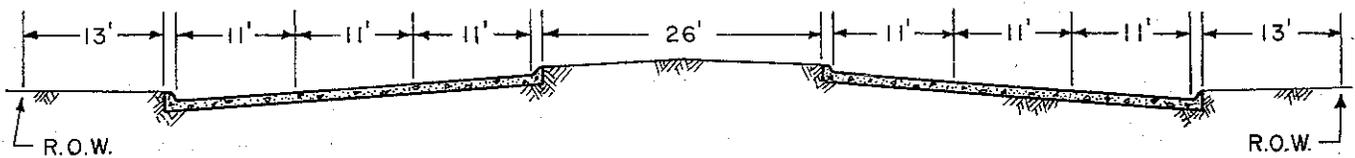
**ACCIDENT STUDIES**

The section of roadway selected for the accident studies was the same as that shown in Figure 18. Data on accidents occurring within the study section were obtained from the files of the Baytown Police Depart-



**TYPICAL SECTION BEFORE PERIOD**

*Figure 19.*



**TYPICAL SECTION AFTER PERIOD**

*Figure 20.*

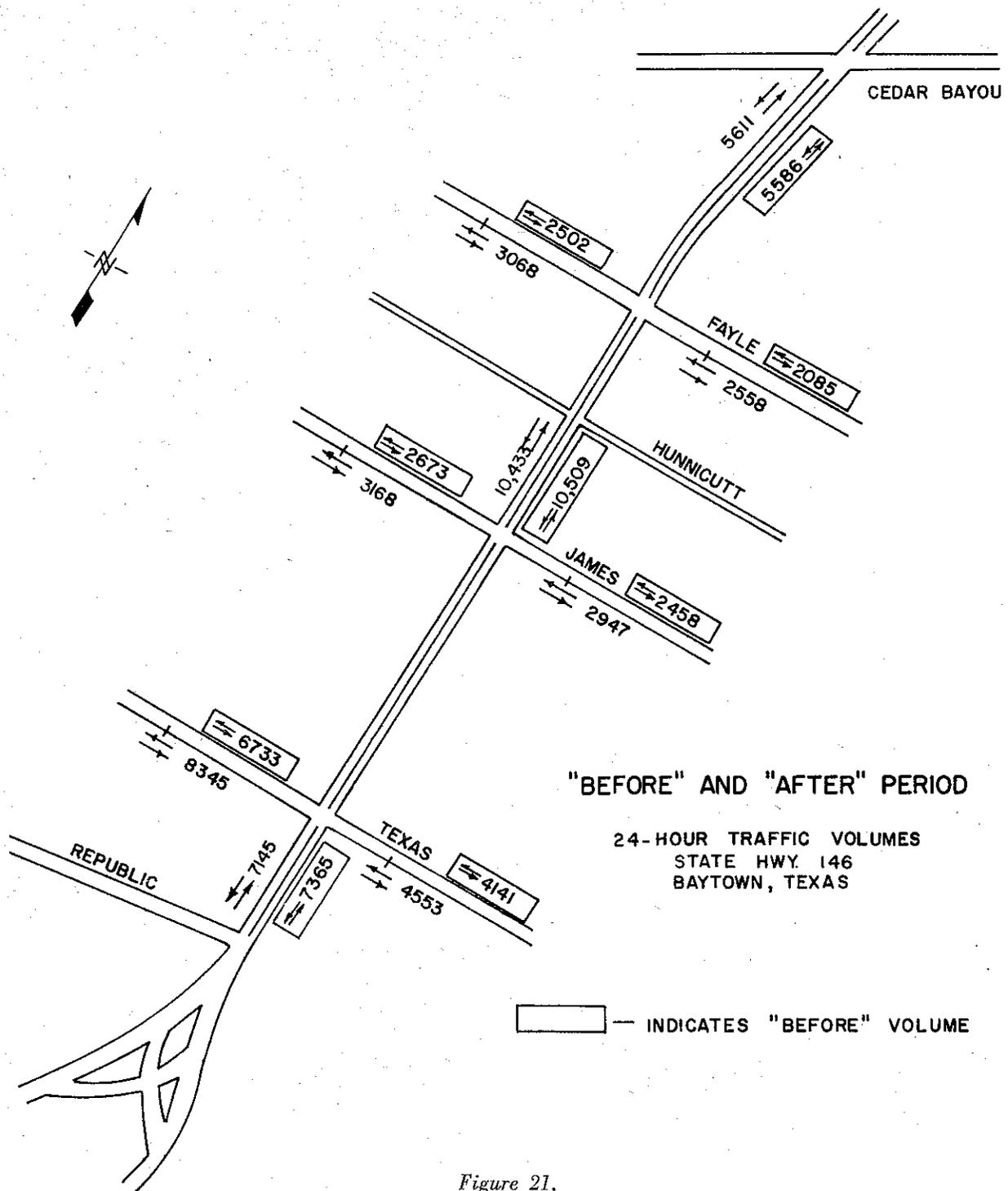
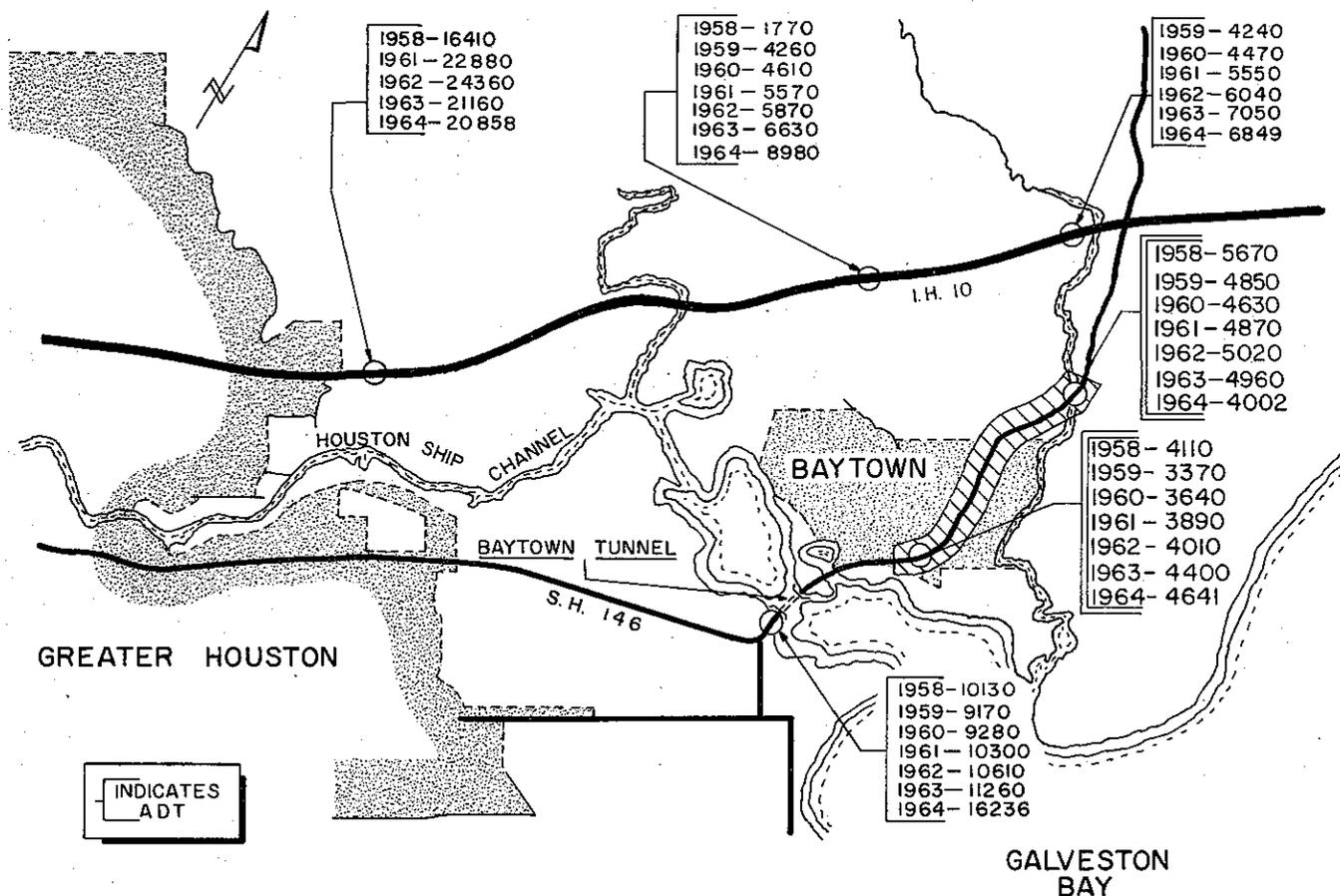


Figure 21.

ment. The "before" period was September 4, 1957, to August 31, 1958. Three "after" periods were selected for study to reflect the various changes in accident patterns due to changes in geometric design and signalization. The first "after" period was January 1, 1960, to December 31, 1960, which was a full year of normal operation following the reconstruction of the facility. During this first "after" period, signalization was unchanged from the "before" conditions. Uncoordinated and poorly timed signals remained in place at the intersection of James, Fayle, and Texas streets with S.H. 146.

The second "after" period was March 21, 1961, to March 20, 1962, which was the first full year of operation immediately following the installation of interconnected signals at the intersections of James, Fayle, and Texas streets. The third "after" phase was October 1, 1961 to September 30, 1962. This period provided one complete year of operation beginning 6 months after completion of the new signalization.

Only those accidents occurring within the confines of the right-of-way limits of S.H. 146 were considered in the study.



### BAYTOWN, STUDY 24-HOUR TRAFFIC VOLUME

Figure 22.

For each of the study periods, the accidents were classified according to the type or cause of collision. A comparison of the accidents by type and by total number for each of the study periods is provided in Table 9 and Table 10. Also included in this tabulation are estimated property damages and the number of personal injury accidents for each of the study periods. No fatalities were recorded in any of the periods.

#### Accident Analysis

It is difficult to draw firm conclusions from a comparison of the "before" and "after" accident data in this study. In making such an analysis, it must be taken into consideration that construction of the facility changed the entire character of traffic operation on the facility. Due to this difference in character, one might expect some types of accidents to be virtually eliminated while other types would become frequent in number. For this reason it was felt that the best means of analyzing the accident data was to examine the types and causes of accidents and to relate these to elements of the facility.

**Rear-end Collisions**—Rear-end collisions at intersections are generally of two types: (1) collisions involving vehicles waiting or slowing for a traffic signal, and (2) collisions involving vehicles waiting or slowing to

make a left or right turn. Table 9 shows a slight reduction in the number of accidents of the first type and a sizable reduction in rear-end collisions involving vehicles waiting or slowing to make left or right turns. The reduction of accidents of this type is directly attributable to the median which provides separate left turn lanes.

**Right-angle Collisions**—There were six right-angle collisions during the "before" phase as compared to 21 during the first "after" phase, and 15 and 9, respectively, in the second and third "after" phases. Eighteen of the 21 accidents in the first "after" phase were caused by vehicles "running the red light" at signalized intersections.

Studies of the signal operations at the signalized intersections of James, Fayle and Texas indicated an inefficient operation which no doubt contributed greatly to the right angle collisions. There was no coordination in the three signals, and as a result smooth progressive movement through the signal system was not possible.

A coordinated signal system was installed at the three intersections in question and put into operation in March, 1961. Table 9 shows some reduction in total accidents and a definite reduction in the right angle collisions in the two "after" study periods following the installation of the new signal system.

ACCIDENT TABULATION  
S.H. 146  
BAYTOWN, TEXAS

Table 9

TYPES OF ACCIDENTS	Before	After 1	After 2	After 3
1. Rear-end collision where one of the vehicles was either waiting or slowing for a signal or congestion.	11	4	9	6
2. Rear-end collision where one of the vehicles was slowing or waiting to make a left turn.	6	3	1	1
3. Rear-end collision where one of the vehicles was slowing to make a right turn.	1	0	1	1
4. Right-angle collision where one of the vehicles failed to yield the right-of-way.	6	21	15	9
5. Right-angle collision where a left turning vehicle from S.H. 146 collided with an opposing vehicle.	3	7	2	2
6. Right-angle collision where a left turning vehicle from cross street collided with an opposing vehicle.	2	0	2	3
7. Collision involving vehicles making improper maneuvers, including turns from wrong lane and side swipes.	2	14	14	13
8. Collision involving a vehicle out of control striking a fixed object.	3	2	4	1
9. Collision involving a vehicle crossing centerline or median and striking another vehicle.	3	0	0	0
10. Unclassified accidents involving irregular maneuvers and entries from private drives.	3	6	5	4
<b>TOTALS</b>	<b>40</b>	<b>57</b>	<b>53</b>	<b>40</b>
<b>NUMBER OF PERSONAL INJURY ACCIDENTS</b>	<b>5</b>	<b>3</b>		<b>6</b>
<b>TOTAL ESTIMATED PROPERTY DAMAGE</b>	<b>12,722</b>	<b>18,410</b>		<b>13,225</b>
<b>AVERAGE COST PER ACCIDENT</b>	<b>\$320</b>	<b>\$323</b>		<b>\$343</b>

The detailed comparison of accidents also shows that the number of accidents involving left turning vehicles in collision with opposing traffic was high during the first "after" study. This increase was primarily attributable to the existing signal system and the increased exposure of the left turning vehicles now being required to cross two lanes of opposing traffic.

*Improper Maneuvers*—The detailed comparison of accident data shows a sizable and consistent increase in this type of accident which includes side swipes resulting from improper lane changes and turns from the wrong lane, such as left and right turns from the inside through

lane. The increase was attributed primarily to the fact that the facility was changed from two-lane to four-lane operation. This increase does not reflect upon the median, but it does cast some reflection on the ability of people in the local area to properly use a multilane facility.

*Fixed Object Accidents*—As Table 9 shows, there was no significant change in the number of fixed object accidents.

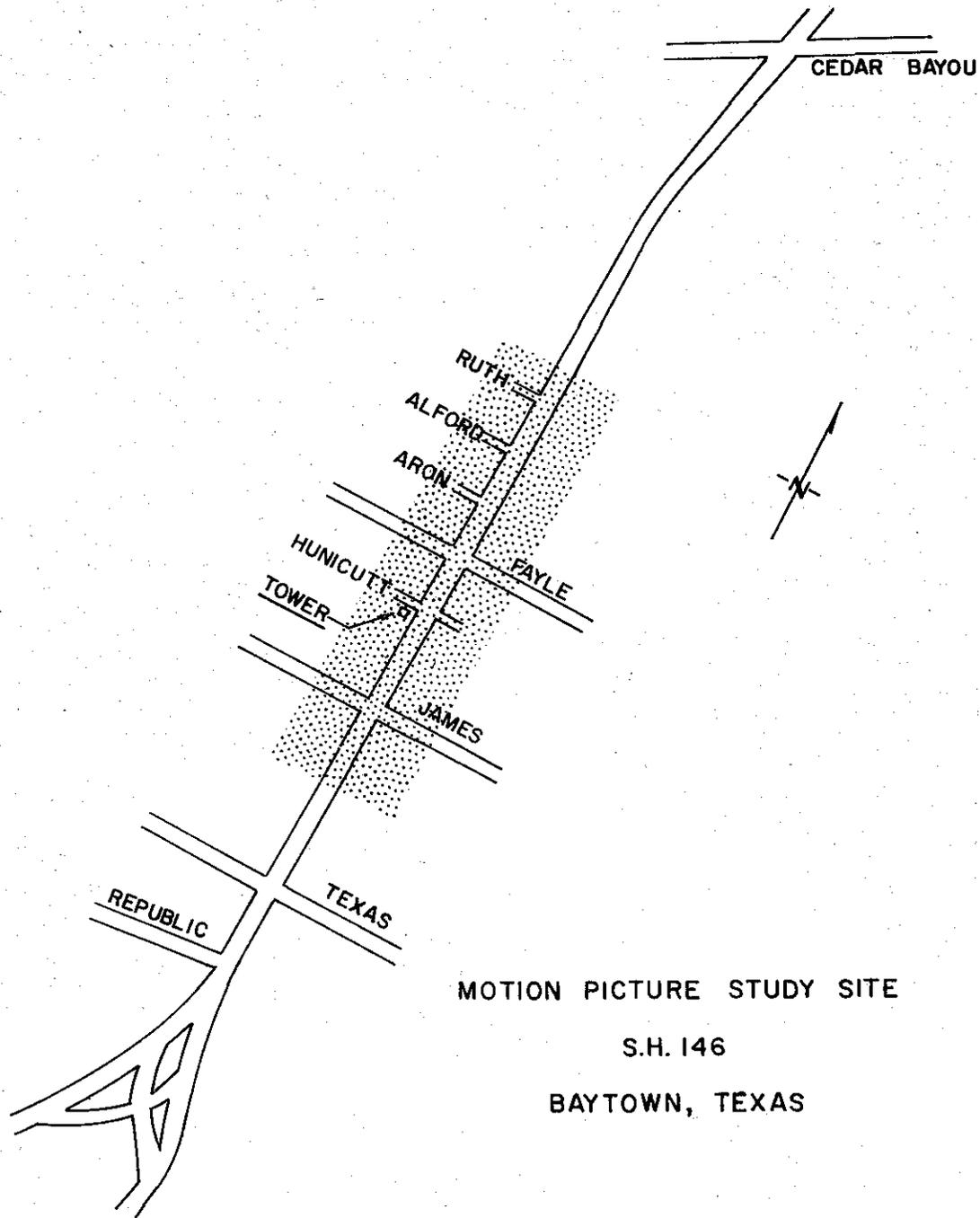
*Head-on Accidents*—During the "before" period, there were three "head-on" type accidents caused by vehicles crossing the center line and colliding with vehicles traveling in the opposite direction. This type of accident was completely eliminated in the "after" period and the reduction is directly attributable to the installation of the median.

ACCIDENT TABULATION  
S.H. 146  
BAYTOWN, TEXAS  
Table 10

	Before 9-4-57 to 8-31-58	After 1 1-1-60 to 12-31-60	After 2 3-21-61 to 3-20-62	After 3 10-1-61 to 9-30-62
Intersection Accidents	28	47	37	32
Nonintersection Accidents	12	10	16	8
<b>TOTAL</b>	<b>40</b>	<b>57</b>	<b>53</b>	<b>40</b>

### OPERATIONAL STUDIES

Motion picture studies of selected areas on S.H. 146 were conducted to investigate the extent to which improper maneuvers were occurring during the "before" period and to see if these maneuvers were reduced or eliminated during the "after" period. A section of S.H. 146 with the most business activity was selected for this study. The area studied is shown in Figure 23 and the schedule for filming operations is shown in Table 11.



MOTION PICTURE STUDY SITE

S.H. 146

BAYTOWN, TEXAS

Figure 23.

**“Before” Study**

An analysis of the motion pictures made during the “before” study indicated a total of 153 irregular maneuvers occurring during the three hours and 34 minutes of study time. These maneuvers are shown in Figure 24.

While this study is a relatively small sample of the daily operation on the facility, it does serve to show some of the irregular and potentially dangerous maneuvers that occur on a facility without a median.

**“After” Study**

The results of the “after” studies indicated that the median had virtually eliminated all of the irregular move-

ments observed during the “before” study and that traffic flow was smooth and efficient. The maneuvers observed during the “after” study are shown in Figure 25. The only maneuver which was considered to be irregular and potentially dangerous was the one in which vehicles were traveling a considerable distance opposing traffic on the wrong side of the street. The U-turns shown were not classified as irregular but were presented to indicate the amount of U-turning which has been created by the median.

The U-turn maneuver is created by the motorist’s desire to enter property on the opposite side of the roadway. It replaces the direct crossing in front of opposing

Table 11  
BEFORE STUDY

Study	Area Photographed	Time
1	North Area	7:05- 7:40 a.m.
2	North Area	9:30-10:00 a.m.
3	North Area	2:45- 3:15 p.m.
4	North Area	4:30- 5:19 p.m.
5	South Area	7:40- 8:20 a.m.
6	South Area	10:00-10:30 a.m.

AFTER STUDY

Study	Area Photographed	Time
1	North Area	7:05- 7:25 a.m.
2	South Area	7:40- 8:00 a.m.
3	North Area	9:30- 9:50 a.m.
4	South Area	10:00-10:20 a.m.
5	North Area	2:45- 3:05 p.m.
6	North Area	4:30- 4:50 p.m.

traffic which was so prevalent in the "before" study. The U-turn maneuver, however, does create a frictional movement in the traffic stream which may account for some of the left-turn accidents observed during the after study.

In connection with the economic studies, a tabulation of U-turn maneuvers was made at selected intersections during an 11-hour manual count. This tabulation is presented in Table 12 to indicate the magnitude of the U-turn movement during a typical day. The section in which these turns were observed is shown in Figure 17.

TRAVEL TIME STUDIES

Travel time studies were conducted in order to obtain a measure of the level of service provided by the facility both during the "before" and "after" periods. Travel time data were obtained by the "average-car method" in which a vehicle was driven through the study section at the average speed of traffic. Data were obtained on speeds through various sections of the facility and the delays were recorded. Travel time runs for both the "before" and "after" studies were conducted during the two periods, 11 to 12 a.m. and 3:30 to 5 p.m.

Table 13  
TRAVEL SPEEDS  
11 A.M. TO 12 NOON

Section	N - S		S - N	
	Before	After	Before	After
South - #1	23.2	34.8	17.5	29.4
#1 - #2	18.0	32.1	15.8	31.1
#2 - #3	30.0	37.5	25.5	33.9
#3 - #4	39.6	40.2	36.2	37.7
#4 - North End	37.2	35.8	38.0	36.6

3:00 P.M. TO 5:00 P.M.

Section	N - S		S - N	
	Before	After	Before	After
South - #1	21.5	31.4	20.2	28.6
#1 - #2	20.2	31.9	22.7	30.2
#2 - #3	27.0	35.0	29.4	29.7
#3 - #4	33.0	39.8	36.1	38.0
#4 - North	27.6	35.6	32.0	35.6

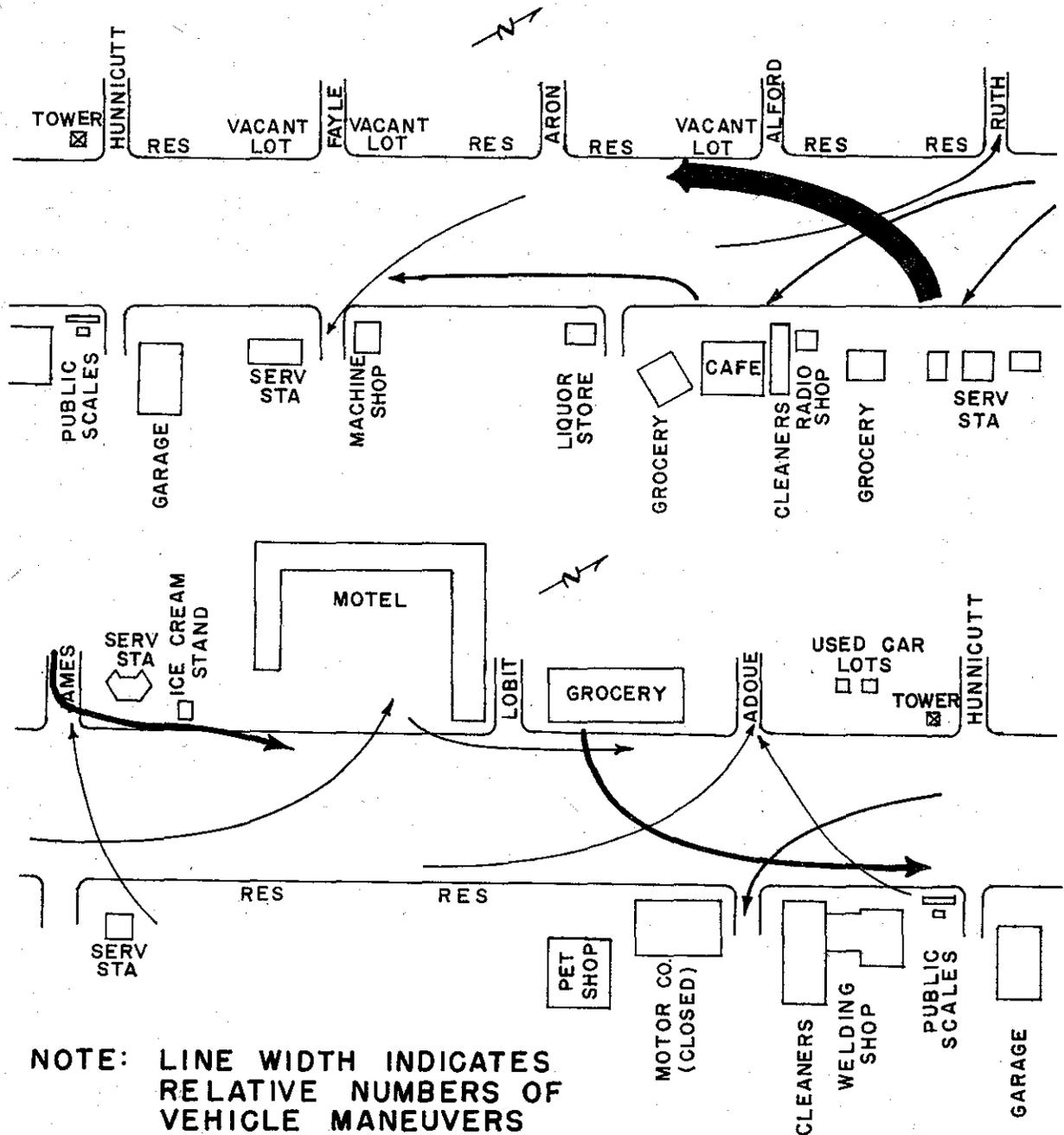
Figure 26 shows a plot of the "before" and "after" travel speeds for both directions of travel. Sections S-1, 1-2, and 2-3 include the signalized intersections of Texas, James and Fayle streets and contain most of the developed business area. This accounts for the slower speeds evident in these sections. Table 13 presents a tabulation of the average speed in each section for both the "before" and "after" studies.

During the "before" studies, a considerable amount of congestion was observed in sections S-1, 1-2, 2-3 which contributed to a reduced travel speed through these sections. Also left-turning movements off of S.H. 146 contribute to delay of through traffic.

The improved geometrics of the facility improved the travel speeds through the study section during the "after" period but the level of service for the facility was impaired by the traffic signal operation. The three signals at Texas, Fayle and James streets, while almost ideally spaced, were not coordinated and introduced much unnecessary stopping and inherent delay to the traffic stream.

Table 12  
MEDIAN STUDY—BAYTOWN  
TOTAL U-TURNS BY ONE-HOUR PERIODS  
7:00 A.M. — 6:30 P.M.

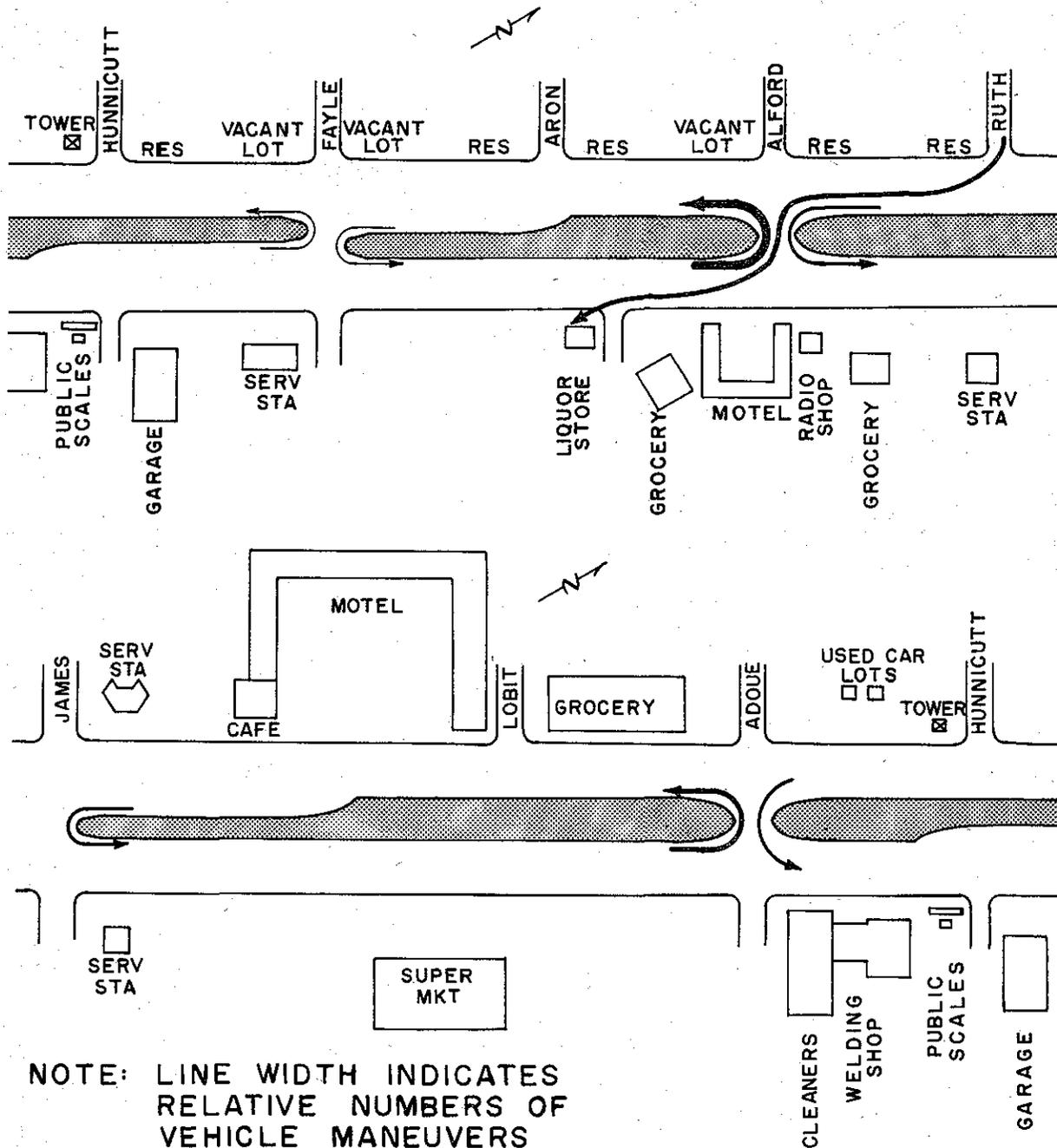
Hour	Opening No. 1		Opening No. 2		Opening No. 3		Opening No. 4		Opening No. 5		Opening No. 6		Totals	
	N-S	S-N	N-S	All										
7 - 8	8	2	4	5	8	1	6	5	7	6	19	33	52	
8 - 9	2	2	3	5	6	2	1	1	8	8	18	20	38	
9 - 10	4	3	12	9	8	5	6	7	13	13	37	43	80	
10 - 11	5	7	14	8	10	2	5	4	20	9	34	54	84	
11 - 12	4	9	4	5	3	2	3	5	20	13	34	34	68	
12 - 1	7	6	11	7	8	6	7	14	15	14	47	48	95	
1 - 2	5	2	8	9	6	3	5	8	19	15	37	43	80	
2 - 3	3	2	2	6	11	4	4	2	22	18	32	42	74	
3 - 4		8	4	8	8	4	4	6	17	15	41	33	74	
4 - 5	3	10	10	14	11	3	4	5	20	13	45	48	93	
5 - 6	5	12	21	8	19	4	4	4	19	21	49	68	117	
Totals	46	63	93	84	98	36	49	61	180	145	389	466	855	



NOTE: LINE WIDTH INDICATES  
 RELATIVE NUMBERS OF  
 VEHICLE MANEUVERS  
 SCALE: 1" = 300 veh

**VEHICLE MANEUVERS  
 BEFORE PERIOD  
 S.H. 146  
 BAYTOWN, TEXAS**

Figure 24.



NOTE: LINE WIDTH INDICATES  
 RELATIVE NUMBERS OF  
 VEHICLE MANEUVERS  
 SCALE: 1" = 300 veh

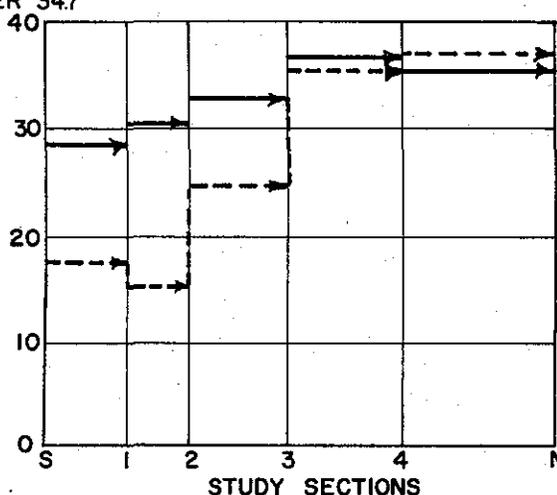
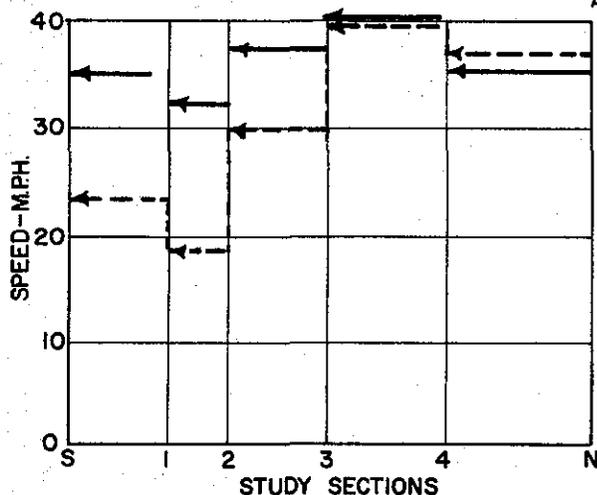
VEHICLE MANEUVERS  
 AFTER PERIOD  
 S.H. 146  
 BAYTOWN, TEXAS

Figure 25.

## NOON 11:00-12:15

BEFORE ---- AFTER ——  
AVERAGE SPEEDS BOTH DIRECTIONS

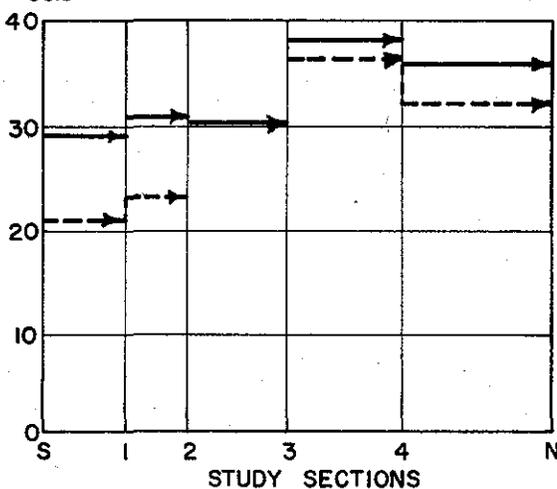
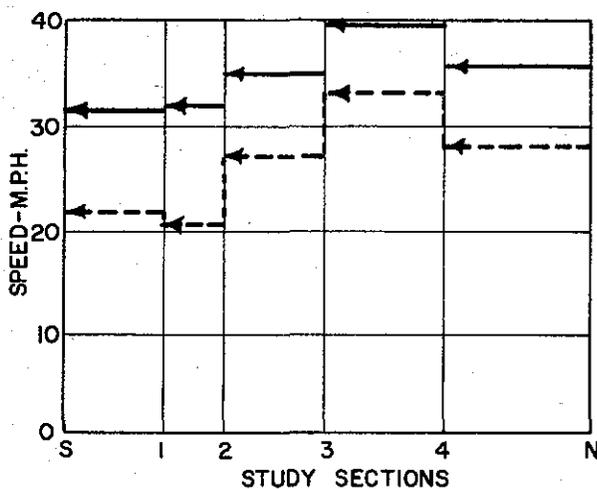
BEFORE 279  
AFTER 34.7



## AFTERNOON 3:30 - 5:15

BEFORE ---- AFTER ——  
AVERAGE SPEEDS BOTH DIRECTIONS

BEFORE 33.8  
AFTER 36.9



## TRAVEL SPEEDS BEFORE AND AFTER PERIODS S. H. 146 BAYTOWN, TEXAS

*Figure 26.*

## SUMMARY OF RESULTS

The results of the "before" and "after" traffic studies in Baytown, Texas, can be summarized as follows:

*Traffic Volumes*—Traffic volumes on S.H. 146 within the study section were approximately the same during the "before" and "after" periods. This static condition was the result of decreased volumes on S.H. 146 due to through traffic diversion to I.H. 10.

*Accidents*—The analysis of accident data for one year before and three years after reconstruction of the facility indicated reductions in certain types of accidents and increases in other types. Rear-end collisions involving vehicles waiting or slowing to make left turns were significantly reduced, and head-on collisions involving the opposing streams of traffic were eliminated. These reductions were attributable to the installation of a median.

There was a sizable increase in right-angle accidents during the first years of study after the new facility was opened. This increase was attributable mainly to the poorly timed and inefficient signal system in existence at that time. Some of this increase can be accounted for by the greater amount of exposure involved in vehicles crossing a multilane facility.

There was a large increase in accidents involving vehicles making improper maneuvers such as turning from the wrong lane and making improper lane changes. This type of accident is inherent in operation on multilane facilities, and is a general indication of the ability and experience of local people in driving on multilane facilities. The increase is not a detrimental reflection on the median.

*Irregular Movements*—The "before" motion picture study indicated that numerous irregular movements were occurring which were detrimental to safe, efficient traffic flow. These maneuvers were eliminated by the median installation. It was also observed that a large number

of U-turn movements were created as a result of the median installation.

*Travel Speeds*—Travel time studies indicated a great deal of congestion and delay on S.H. 146 during the "before" period. When the facility was improved, there was a very definite improvement in travel speeds, but the level of service was still somewhat impaired by inefficient and inadequate signalization. Shortly following the "after" study, the signal system was revised to provide more efficient operation.

Although the median has made significant contributions in the improvement of safety and efficiency of operation, the transformation of the facility from a narrow two lane facility to a multilane facility probably had the greatest effect on the operational characteristics.

## RECOMMENDATIONS

On the basis of the "before" and "after" studies of traffic operation on S.H. 146 in Baytown, the following recommendations are made regarding high-type urban highway facilities.

1. The traffic studies indicated that drivers in small urban areas are not educated to the proper use of high-type multilane facilities. A public relations program introduced through local news media would appear to be extremely valuable during the construction and precompletion period of urban highways in areas where this type of facility is not too common.
2. The medians on high-type urban facilities are successful in regulating traffic into an orderly, efficient flow pattern; however, the studies indicated that a very high U-turn movement was created in sections with considerable business activity. It should be realized that this movement will develop and perhaps some consideration should be given to this movement through design and control measures.

and making improper lane changes. This type of accident is inherent in traffic operation in multi-lane facilities, and the frequency of this type of accident is generally a good indication of the ability and experience of local people in driving on multilane facilities. The increase is not a detrimental reflection on the median.

### **Operational Studies**

Operational studies by motion pictures indicated that numerous irregular movements which were detrimental to safe, efficient traffic flow were occurring before reconstruction of the facility. These maneuvers were

eliminated by the median installation. It was also observed that a large number of U-turn movements were created as a result of a median installation.

### **Travel Speeds**

Travel time studies indicated a great deal of congestion and delay on S.H. 146 during the "before" period. The improved facilities increased the level of service provided to through traffic, but this level of service was still somewhat impaired by inefficient and inadequate signalization. Since the "after" study was conducted, the signal system has been revised to provide more efficient operation on S.H. 146

## **Economic Analysis**

The economic phase of the study was concerned with determining the influence of the median on local businesses. In this study only those businesses which fronted on the facility were considered as being in the influence zone of the median. The steps that were taken to insure that an accurate picture of their operation was obtained are as follows:

### **1. Initial Preparation**

As a first step, a complete inventory was made of the study area. The name and address of each business were recorded and its location was plotted on a large scale map of the section. Each retail businessman was then written a personal letter explaining the study in detail and asking for his cooperation. He was also told that a member of the research staff would be by on a certain date to obtain specific sales information from him.

At the same time press releases were issued to the local newspaper, television and radio stations. Their cooperation was also sought later in publicizing the study through spot announcements and follow up feature stories. Civic leaders, such as the mayor, manager of the Chamber of Commerce, the presidents of local service clubs, and the chief of police, were also asked to help publicize the study and inform the local residents of its purposes.

### **2. Selection of Controls**

In order to minimize the influence of external factors, such as an area wide boom or recession that would affect all businesses in the area, a group of control firms was selected to compare with the study firms. These external control firms were selected on a "one for one" basis and each control business was selected for its similarity to the business it was to control. It was also selected from a section of town that was judged to be least affected by the construction program. A service station, for example, would have as its companion control another service station handling the same brand of gasoline. This station would be of approximately the same size and would observe the same general operating procedures but would be located in another section of Baytown. The distribution of controls is shown in Figure 1.

After a control business had been selected, it was subjected to the same treatment as the study businesses. Its owner was contacted and his cooperation solicited. In cases where he would not cooperate or records were not available, a preselected alternate firm was chosen.

### **3. Business Interviews**

Each study and control area business owner or manager was personally interviewed by a member of the research staff. Considerable information concerning the business' operating history, its management practices, and the condition of its physical plant was obtained in these interviews. The main objective, however, was to get an accurate record of monthly retail sales volumes for the preceding 12-month period.

Since Texas had no system of sales taxes or State receipt taxes at the time this study was made, there was no way of determining gross business revenues from published records. Consequently, sales records were available from only one source — the business itself. This, of course, made it very necessary to get good cooperation from the firms that were interviewed. Fortunately, this was possible in Baytown as only two of the study area firms refused to cooperate in the study.

As the businesses were interviewed, they were classed into homogeneous groups. These groupings were developed to fit this study but were based on the Standard Industrial Classification Index of retail firms. Service stations, for example, were classed in a group by themselves as were motels and restaurants. For the purpose of this report these small groups were further combined, where necessary, to form six major classes of businesses. This was done in order that a comparative business analysis could be shown.

## **BUSINESS ANALYSIS**

A listing of all the firms located within the area that were selected for study, along with a record of their participation in this study is shown in Table 1. At the time the study was initiated, there were a total of 23 retail businesses located along S.H. 146 between James Avenue and Davis Road. All but two of these firms cooperated in the study by furnishing a record of their monthly gross sales volumes for the "before" period.

After construction was begun, however, one of the businesses was moved out of the area, one was destroyed by fire and one went out of business. Consequently, only 18 of the original firms were able to supply monthly sales data for the construction period. One additional firm moved out of the area during the "after" period to reduce the number of original firms supplying information to 17. During this same time, however, 5 new firms were established in the area. Four of these were in op-

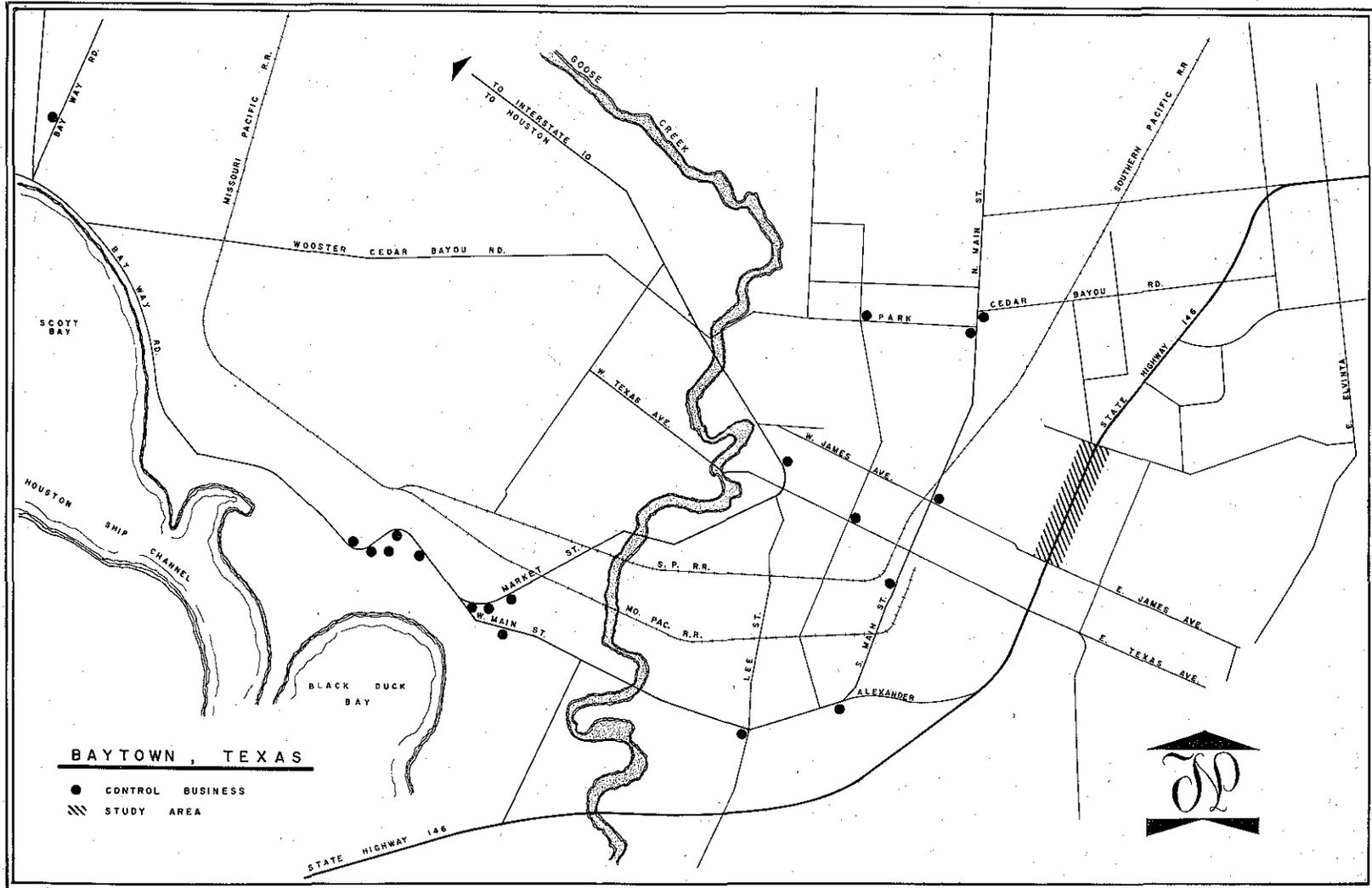


Figure 1. Major streets of Baytown with location of study and control area firms.



*Relocated to North 1/2 block off S.H. 146.*



*Relocated North of study area on S.H. 146.*



*Moved out of area—building now occupied by cleaners.*



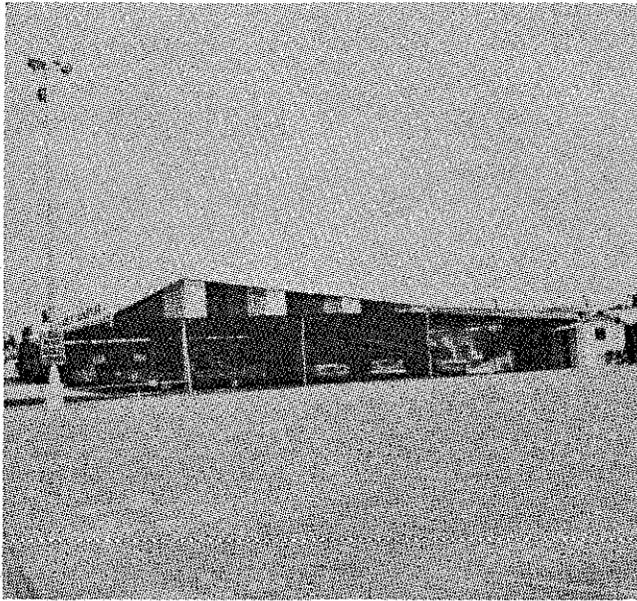
*Burned down—replaced by new motel.*

*Figure 2. These four firms went out of business during the study.*

eration for a long enough period to furnish some monthly data for the "after" period.

Because of the changes in the number of firms operating in the study area during the 3 years of observation, it was very difficult to show an accurate picture of the influence of the median on their volumes through the use of a single method of sales comparisons. The effect on individual firms or groups could be quite different from that reflected by the area as a whole, and losses or gains in the number of businesses could have an effect on the over-all volume of business by the entire group. For this reason the analysis was conducted and the comparisons are presented here in 3 different ways.

Table 2 shows what happened to the original group of businesses that were in the study area before construction of the median. This includes the sales of all those firms which went out of business during the 3 years but does not include sales of any of the new firms. It represents, then, only the sales records of the original 21 firms shown as a group. As such, it naturally shows the most severe decline in sales of any of the comparisons made. This decline was 16.5 percent between the "before" and "during" periods and 13.5 percent when extended to the "after" period. It should be remembered, however, that these comparisons include only 18 firms in the construction period and 17 firms in the "after" period.



*Motor company.*



*Grocery store.*



*Motor company.*



*Motel.*

*Figure 3. Four of the new businesses that have been established since the median was built.*

Using the same method of comparison, the control businesses were considerably less affected during the study. Of the original 21 firms only 2 went out of business during the period; both early in the construction phase. Consequently, the sales of these firms were reduced by only 3 percent and 5 percent respectively in the two later periods.

Another way of comparing the business volumes of firms in the influence area is shown in Table 3. Here the comparison is made of only those firms which were operating in the area at both the beginning and the end of the study. The fact that they continued to operate throughout the period would indicate that they were probably the better established firms from the standpoint

of both financing and management. This observation is borne out by the much smaller losses in sales experienced by these firms. During the construction period these firms lost less than 10 percent of their sales, and in the 12 months after the facility was completed their losses were reduced to 6.6 percent of the base period sales.

In a similar treatment of control area firms, losses amounted to 3.6 percent in the "during" period and 4 percent in the final year. This smaller loss was the result of the elimination from consideration of 2 firms which went out of business during the study.

The third method of comparison is shown in Table 4. Here the sales of all firms in operation within the

Table 1  
BUSINESSES BY TYPE AND RECORD OF PARTICIPATION IN THE BAYTOWN STUDY

Business Number	Type Business	Period of Participation		
		Before	During	After
1	Motel	x	x	x
2	Food	x	x	x
3	Miscellaneous	x		
4	Service Station	x	x	x
5	Food	x	x	x
6	Personal Service	x		x
7	Miscellaneous	x	x	x
8	Food	x		
9	Food			
10	Miscellaneous			
11	Service Station	x	x	x
12	Automotive	x	x	x
13	Automotive	x	x	x
14	Personal Service	x	x	x
15	Automotive			x
16	Food			x
17	Service Station	x	x	x
18	Service Station	x	x	x
19	Food	x		
20	Food			
21	Motel	x	x	x
22	Food	x	x	x
23	Automotive	x	x	x
24	Automotive		x	x
25	Service Station	x	x	x
26	Food	x	x	x
27	Food	x	x	x
28	Motel			x
29	Food			x

- <sup>1</sup>Changed owners in "before" period.
- <sup>2</sup>Closed at end of "before" period—did not reopen.
- <sup>3</sup>Station changed brands of product in "during" period.
- <sup>4</sup>One firm moved—another firm of same type opened up in "after" period.
- <sup>5</sup>Burned down in "during" period.
- <sup>6</sup>Would not cooperate.
- <sup>7</sup>Changed management in "during" period.
- <sup>8</sup>Opened up as new business in "after" period.
- <sup>9</sup>Opened as new business in "after" period (only in operation last 4 months).
- <sup>10</sup>Moved from area at end of "before" period.
- <sup>11</sup>Opened as new business last month of "after" period.
- <sup>12</sup>Opened as new business in "during" period.
- <sup>13</sup>Changed owners and name at end of "before" period.
- <sup>14</sup>Opened as new business at end of "after" period (sales not included in study).

study area are shown for each time period. This is probably the most logical comparison that can be made for the area as a whole. It is concerned with the annual retail sales within the study area rather than with either the "original" or "surviving" firms as specific groups. These are the figures that reflect gross incomes for tax bases for the area as a whole. As such, they should be most useful to governmental taxing and planning agencies.

This comparison shows that sales were down sharply in the construction period. This is, of course, influenced to some extent by the loss of 3 firms in that period. However, it is also a legitimate reflection of general business conditions while construction was underway. During the construction period the highway serving these businesses was torn up for a considerable period of time and several of the businesses were completely isolated for short periods. Consequently, total sales throughout the study area were off rather sharply while construction was underway.

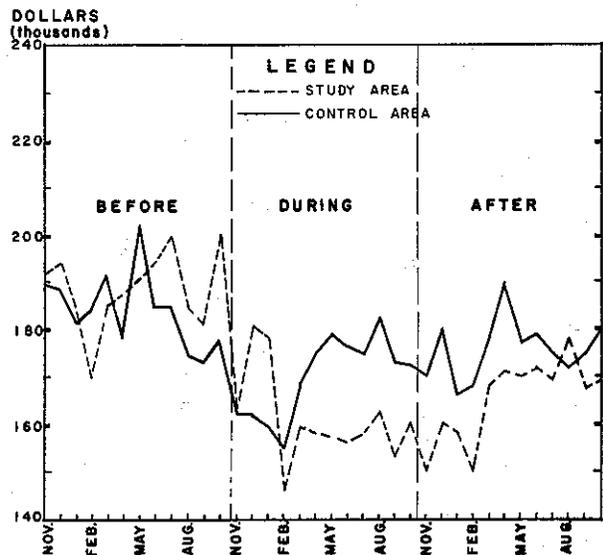
After the construction was completed the recovery in total study area sales was quite rapid. Total study area sales increased from about \$1.9 million in the construction period to over \$2.6 million in the first full year of operation. Here again, however, the cause of the increase was divided between generally small increases in the sales of established firms (as shown in Table 3) and the more impressive gains caused by the new firms that located in the area after the improvements were completed. Together they caused the gross sales in the final period to show a 15.7 percent increase over that recorded prior to construction.

The effect of the construction program on monthly sales is shown graphically in Figures 4, 5, and 6. These figures show on a monthly basis the same information for all businesses that is presented by years for the different classes of business in Tables 2, 3, and 4.

The first two charts show the same general picture; that is, monthly sales of study area firms fluctuating in the same general area as the control firms in the "before" period with the sales of both in a general downward trend. Then, early in the construction period, the relatively greater losses in sales by the study area firms begins to become evident. By the time the construction was completed the monthly sales of firms in the study area were well below those in the controls.

After the construction was completed, monthly sales of study area firms began to recover some of the sales they had lost while construction was underway. By the end of the first full year of operation with a median, study and control firms were again operating at about the same general level. However, sales for the year as a whole were still below their base period levels.

When the new firms were included in the analysis, as shown in Figure 6, the picture was changed considerably in the "after" period. As each new firm opened, its sales volume was added to those firms already in operation. This caused total sales to increase at an increasing



MONTHLY SALES OF ALL STUDY AND CONTROL AREA FIRMS THAT WERE IN BUSINESS AT THE BEGINNING OF THE STUDY PERIOD.

Figure 4.

Table 2  
TOTAL SALES OF ALL FIRMS THAT WERE IN OPERATION AT THE BEGINNING OF THE STUDY<sup>1</sup>  
STUDY AREA

Types of Business	Before Period (Base) Sales (Dollars)	During Period			After Period		
		Sales (Dollars)	Change From Base (Dollars)	Percent Change (Percent)	Sales (Dollars)	Change From Base (Dollars)	Percent Change (Percent)
Service Station	\$ 511,630	\$ 411,932	\$- 99,698	-19.5%	\$ 458,691	\$- 52,939	-10.3%
Food Stores	1,408,044	1,224,145	-183,899	-13.1	1,216,574	-191,470	-13.6
Automotive	153,403	133,258	- 20,145	-13.1	150,844	- 2,559	- 1.7
Personal Services	54,562	52,163	- 2,399	- 4.4	69,433	+ 14,871	+27.2
Motels	77,754	76,894	- 860	- 1.1	70,654	- 7,100	- 9.1
Misc. Retail	71,540	2,400	- 69,140	-96.6	2,500	- 69,040	-96.5
Totals	\$2,276,933	\$1,900,792	\$-376,141	-16.5	\$1,968,696	\$ 308,237	-13.5%
CONTROL AREA							
Service Station	\$ 527,784	\$ 493,875	\$- 33,909	- 6.4%	\$ 507,419	\$- 20,365	3.9%
Food Stores	1,359,181	1,236,356	-122,825	- 9.0	1,271,589	- 87,592	- 6.4
Automotive	150,384	138,938	- 11,446	- 7.6	139,553	- 10,831	- 7.2
Personal Services	85,775	76,546	- 9,229	-10.8	81,803	- 3,972	- 4.6
Motels	18,020	17,370	- 650	- 3.6	17,830	- 190	- 1.1
Misc. Retail	71,350	75,656	+ 306	+ .4	82,961	+ 11,611	+16.3
Totals	\$2,212,494	\$2,034,741	\$-177,753	- 8.0%	\$2,101,155	\$-111,339	- 5.0%

<sup>1</sup>Includes firms that went out of business during the study but does not include sales of the new firms that located in the area after construction was completed.

rate throughout most of the final year. As a consequence, average monthly sales of all study area firms in the last 3 months of the "after" period were approximately 50 percent higher than for the same months in the "before" period. This would seem to indicate that if the study were extended for an additional year the increase in gross study area sales would be considerably greater than the 15.7 percent shown in Table 4.

The general decline of both study and control area sales throughout the "before" period may be at least partially explained by the general economic conditions affecting Baytown during that time. Business activity dropped off sharply in early 1958 all over the United States. The business decline in Baytown was probably aggravated by the reduction in activity by the petroleum

industry. Baytown's economy is rather closely geared to the oil-petro chemical industries and a cut-back in their operations is rapidly reflected in the economic activity of Baytown businesses.

An indication of the general level of economic activity in the Baytown area is shown in Figures 7 and 8. Figure 7 is concerned with employment (and unemployment) in the Baytown area and Figure 8 is a record of month-end bank deposits. The general upward trend of total employment, which is revealed in the first chart is the condition that would be normally expected in an expanding area such as the Gulf Coast. The fact that this growth was interrupted in the late summer and fall of 1958, and that total employment was actually reduced by a significant amount for a few months, is an indication

Table 3  
TOTAL SALES OF ALL FIRMS THAT WERE IN OPERATION AT BOTH THE BEGINNING AND ENDING OF  
STUDY PERIOD<sup>1</sup>  
STUDY AREA

Types of Business	Before Period (Base) Sales (Dollars)	During Period			After Period		
		Sales (Dollars)	Change From Base (Dollars)	Percent Change (Percent)	Sales (Dollars)	Change From Base (Dollars)	Percent Change (Percent)
Service Stations	\$ 511,630	\$ 411,932	\$- 99,698	-19.5%	\$ 458,691	\$- 52,939	-10.3%
Food Stores	1,308,780	1,224,145	- 84,635	- 6.5	1,216,574	- 92,206	- 7.0
Automotive	153,403	133,258	- 20,145	-13.1	150,844	- 2,559	- 1.7
Personal Services	54,562	52,163	- 2,399	- 4.4	69,433	+ 14,871	+27.3
Motels	77,754	76,894	- 860	- 1.1	70,654	- 7,100	- 9.1
Misc. Retail	2,400	2,400	-	-	2,500	+ 100	+ 4.2
Totals	\$2,108,529	\$1,900,792	\$-207,737	- 9.9%	\$1,968,696	\$-139,833	- 6.6%
CONTROL AREA							
Service Stations	\$ 527,784	\$ 493,875	\$- 33,909	- 6.4%	\$ 507,419	\$- 20,365	- 3.9%
Food Stores	1,257,133	1,236,366	- 20,767	- 1.6	1,271,589	+ 14,456	+ 1.1
Automotive	150,384	138,938	- 11,443	- 7.6	139,553	- 10,831	- 7.2
Personal Services	85,775	76,546	- 9,229	-10.8	81,803	- 3,972	- 4.6
Motels	18,020	17,370	- 650	- 3.6	17,830	- 190	- 1.1
Misc. Retail	71,350	71,656	+ 306	+ .4	82,961	+ 11,611	+16.3
Totals	\$2,110,446	\$2,034,751	\$- 75,695	- 3.6%	\$2,101,155	\$- 9,291	- 0.4%

<sup>1</sup>Does not include either firms that went out of business or new firms that located in the area after construction was completed.

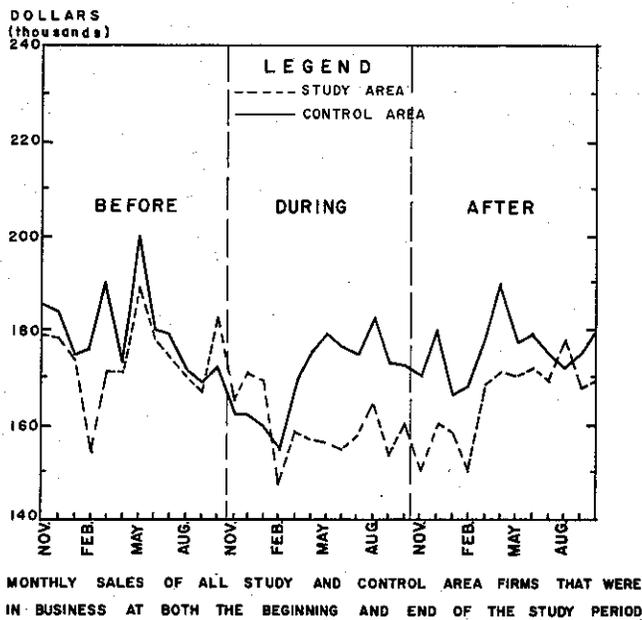


Figure 5.

of the severity of the economic decline. This is substantiated by the high and increasing percentage of unemployment in 1958 which was subsequently reduced to more "normal" levels in late 1959 and 1960.

Bank deposits, which are considered as a somewhat less reliable indicator of economic activity, declined sharply in early 1958 as a result of less income and continued spending. They built up again during the year as people postponed spending in the face of the recession that was then being recognized. Then, as confidence was restored by the increased hirings of area firms and the general economic recovery of the nation as a whole, spending again reduced bank deposits by the fall of 1959. It is perhaps not unreasonable to speculate that the decline in retail sales by both study and control firms in the "during" period was accentuated by the hesitancy of

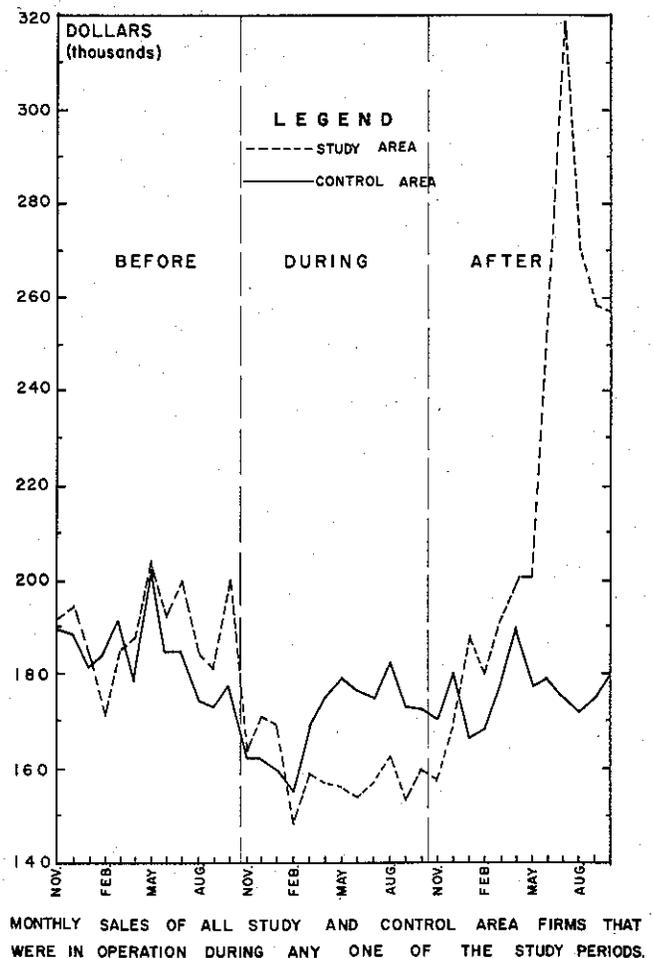


Figure 6.

Baytown residents to spend money during the latter phase of the 1958 recession and the early stage of the subsequent recovery.

Table 4  
TOTAL SALES OF ALL FIRMS THAT WERE IN OPERATION DURING ANY ONE OF THE THREE STUDY PERIODS<sup>1</sup>  
STUDY AREA

Types of Business	Before Period (Base Sales (Dollars))	During Period			After Period		
		Sales (Dollars)	Change From Base (Dollars)	Percent Change (Percent)	Sales (Dollars)	Change From Base (Dollars)	Percent Change (Percent)
Service Stations	\$ 511,630	\$ 411,932	\$ - 99,698	-19.5%	\$ 458,691	\$ - 52,939	- 10.3%
Food Stores	1,408,044	1,224,145	-183,899	-13.1	1,471,869	+ 63,825	+ 4.5
Automotive	153,403	133,258	- 20,145	-13.1	556,057	+402,654	+262.5
Personal Services	54,562	52,163	- 2,399	- 4.4	69,433	+ 14,871	+ 27.3
Motels	77,754	76,894	- 860	- 1.1	76,256	- 1,498	- 1.9
Misc. Retail	71,540	2,400	- 69,140	-96.6	2,500	- 69,040	- 96.5
Totals	\$2,276,933	\$1,900,792	\$ -376,141	-16.5	\$2,634,806	\$ +357,873	+ 15.7%
CONTROL AREA							
Service Stations	\$ 527,784	\$ 493,875	\$ - 33,909	- 6.4%	\$ 507,419	\$ - 20,365	- 3.9%
Food Stores	1,359,181	1,236,356	-122,825	- 9.0	1,271,589	- 87,592	- 6.4
Automotive	150,384	138,938	- 11,446	- 7.6	139,553	- 10,831	- 7.2
Personal Services	85,775	76,546	- 9,229	-10.8	81,803	- 3,972	- 4.6
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Misc. Retail	71,350	71,656	+ 306	+ .4	82,961	+ 11,611	+ 16.3
Totals	\$2,212,494	\$2,034,741	\$ -177,753	- 8.0%	\$2,101,155	\$ -111,339	- 5.0%

<sup>1</sup>Includes sales of firms that went out of business and new firms that were established during the study period.

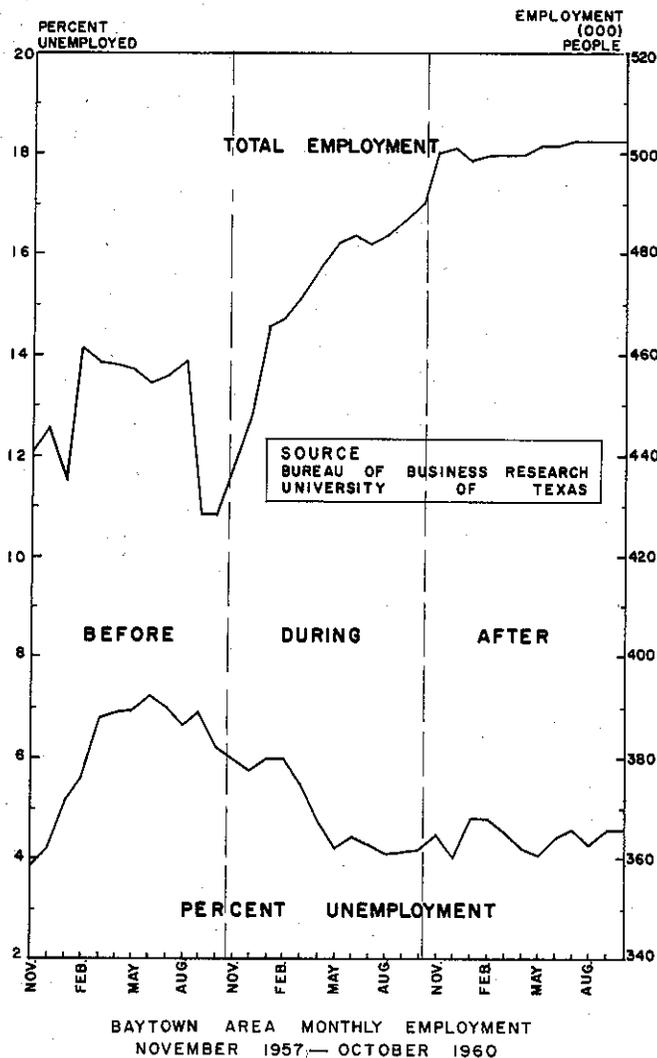


Figure 7.

### Relationship to Median Openings

One of the prime points of contention in the acceptance of a median-type design by adjacent businesses is the location of median openings with regard to each business. It is generally accepted by businessmen that a site at a median opening is much preferred over one without a median opening. The average businessman would like to have a median opening immediately in front of his business. He feels that this would give him a continued accessibility to opposite stream traffic and would reduce the adverse effect of the median on his sales volumes.

As a part of this study it was decided to test the validity of this belief in as far as the data would permit. Each firm was classified as being located either at or away from a median opening. All firms which could be approached by a legal left turn were considered as being located at a median opening. Those that could not be entered by a legal left turn were placed in the nonopening group.

The relatively small number of firms, included in this study prevented an analysis by individual classes of firms. However, the comparison for all firms as a

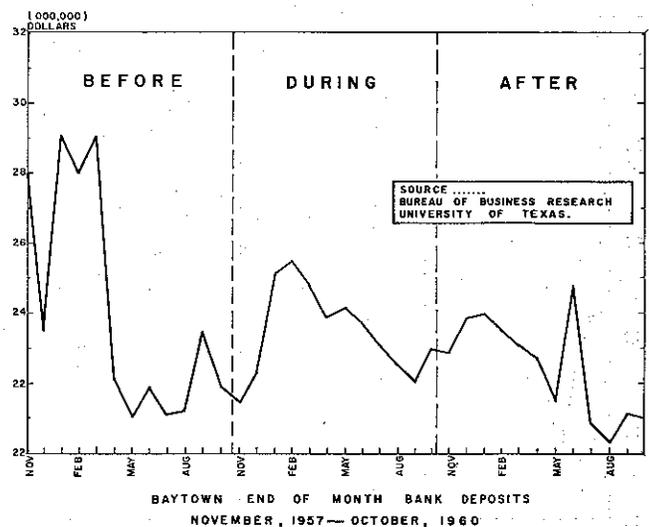


Figure 8.

group is shown in Table 5. Individual firm names or business types have been omitted in order to protect the identity of cooperating firms.

Of the 18 firms which were in operation at both the beginning and end of the study period, 10 were located at median openings and eight were located away from the median crossing. This is admittedly a very small number from which to draw concrete conclusions. It is interesting, however, to compare the different effects on the two groups of firms. Of the two groups, those located at the median openings fared no better than those without openings. In fact their sales were ten percent below their base levels after a full year's operation with a median. The other group, those located away from the median openings, managed to show

Table 5  
THE EFFECT OF FIRM LOCATION WITH RESPECT TO MEDIAN OPENINGS ON SALES VOLUMES AS SHOWN BY INDEX NUMBERS (Nov. 1957—Oct. 1958=100)

GROUP I—FIRMS LOCATED AT MEDIAN OPENINGS				
Firm No.	Business Orientation	Before (Number)	During (Number)	After (Number)
1	Traffic	100	97	62
2	Nontraffic	100	168	482
3	Traffic	100	79	101
4	Nontraffic	100	133	143
5	Nontraffic	100	91	107
6	Traffic	100	79	91
7	Traffic	100	84	84
8	Nontraffic	100	91	91
9	Traffic	100	48	56
10	Nontraffic	100	99	111
TOTAL		100	89	90
GROUP II—FIRMS NOT LOCATED AT MEDIAN OPENINGS				
11	Traffic	100	149	144
12	Traffic	100	68	73
13	Traffic	100	83	74
14	Traffic	100	83	96
15	Nontraffic	100	82	88
16	Nontraffic	100	140	247
17	Nontraffic	100	135	161
18	Nontraffic	100	100	104
TOTAL		100	98	117

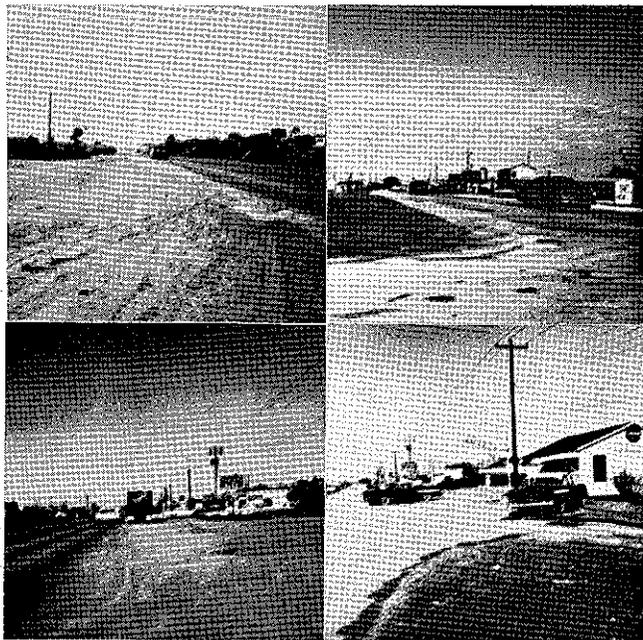


Figure 9. Views along S.H. 146 showing the complete lack of control of movements in and out of adjacent businesses before the median was built.

a 17 percent increase in sales over the same period of time. This difference is significant not because of what it shows, but because of what it fails to show. The anticipated better performance by firms at median openings failed to materialize.

This difference cannot be explained by the composition of the two groups since the different types and classes of businesses are fairly well distributed between them. Group I has five of its 10 firms classed in the "traffic serving" category while Group II has four of its eight firms in this grouping. There is also little difference in the proportion of firms that gained or lost business during the study period.

It would appear, then, that in this instance at least, there was no advantage to a firm to be located near a median opening. The variations in sales of firms both with and without median openings strongly supports the theory that individual management—and managements' reactions to changing conditions—exerts a much stronger influence on sales than does location.

### Median Influence on Customer Traffic

After the economic information had been obtained from each business, a concerted effort was made to determine the effect the median had on customer traffic entering and leaving study area firms. Since the commercial establishments had been built up alongside the highway, they were well distributed and each business furnished its own customer parking. Unlike a shopping center where complementary businesses furnish a joint parking lot and joint attractions to customers, it was unusual for a driver to park at one business and walk to others in the vicinity. That made it possible to relate turn-in traffic to motor-borne customers with a high degree of confidence. Consequently, it was decided that an analysis of business dependence on two-way or left-

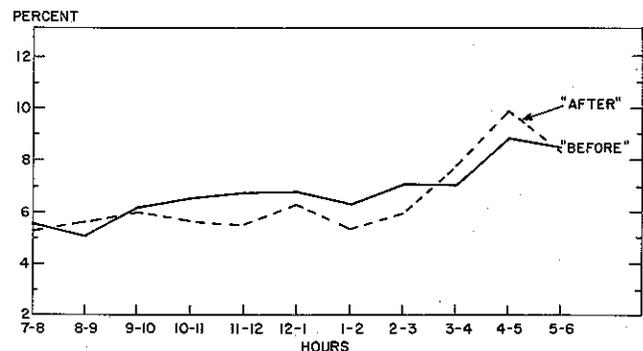
turn traffic would serve as further indication of the effect of the median on business.

Traffic entering or leaving a business from a street with no median has quite a bit of leeway in its movements. It can enter from the same side of the street by making a right turn or from the opposite side by making a left turn and crossing the opposing traffic stream. It can also leave in either direction. The addition of a median barrier restricts only this second—or left turn—movement. It is the loss of this left-turn traffic that the retailer fears will hurt him.

In this study an attempt was made to answer two questions about customer traffic: first, the extent to which a median would restrict it, and second, the influence that the change would have on the sales of the businesses concerned. To do this it was necessary to get a record of the customer traffic entering and leaving each business before the median was installed and then obtain the same information under median conditions. This was done by observing and recording the directional movement of customer traffic for a 12-hour period for each business before the median was established and then repeating the study after the median had been in operation for a year. Since few of the businesses opened before 7:00 a.m. and many closed by 6:00 p.m., only traffic moving during that 11 hour period was included in the study.

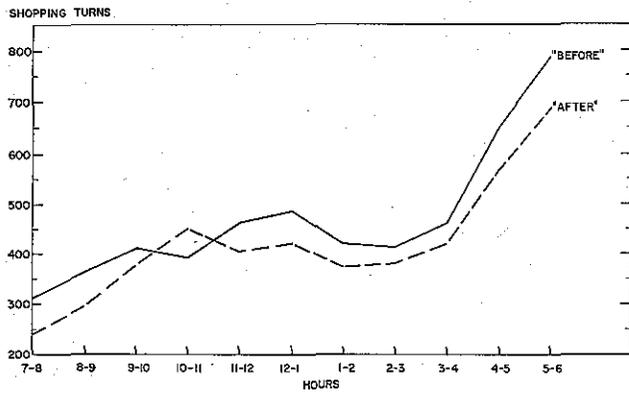
A discussion of the influence of the median on the level of traffic over S.H. 146 in Baytown is included in the traffic section of this report. It is sufficient to say here that the average daily traffic was little changed during the two study periods. The distribution of total traffic during the 11 hours of the customer count is shown in Figure 10. This shows that hourly traffic in the "after" period followed the same general pattern as in the original period throughout most of the 11 hours studied. It was, however, at a slightly lower level except in the final 3 hours.

Customer turns into study area firms were about 7 percent lower in the "after" period than they were before the median was installed. The hourly distribution of these turns during both periods is shown in Figure 11. In both cases shopping turns were lowest in the early morning hours, were fairly steady from mid-morning to mid-afternoon, and then increased sharply to their highest levels in the 5-6 p.m. period. This peak in customer



HOURLY TRAFFIC AS A PERCENTAGE OF ADJUSTED 24 HOUR TRAFFIC ALONG HIGHWAY 146, BAYTOWN, TEXAS

Figure 10.



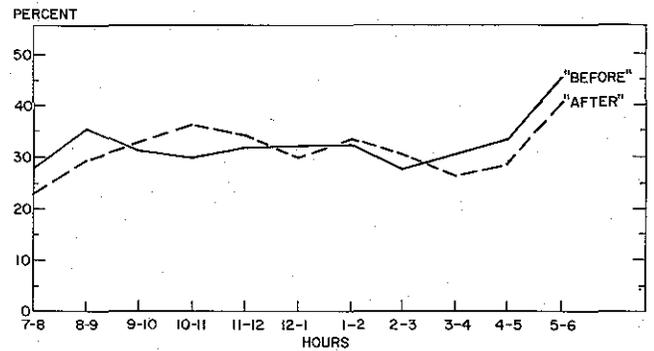
HOURLY SHOPPING TURNS INTO AND OUT OF BUSINESS FIRMS ALONG HIGHWAY 146, BAYTOWN, TEXAS

Figure 11.

traffic coincides with the return from work trips and is a normal occurrence in automotive shopping.

The lower level of shopping turns in the "after" period may have been caused by the increased difficulty of entering and leaving study area firms under median conditions. This could have caused potential customers to postpone the less essential trips or combine a week's shopping into fewer trips. If so, the lower level of customer exposure and its subsequent effect on "impulse buying" would be expected to lower total sales by a small amount. It is also possible, of course, (though not as certain as believed by most businessmen) that the median could have dissuaded certain through traffic from stopping at all. If so the loss of these stops would show up as a net loss in the sales volumes of all firms in the area.

During the daytime period of 7:00 a.m. to 6:00 p.m. about 32 percent of the total traffic passed through the study area before the median was built turned into one of the study area businesses. Even though there was a slightly lower level of customer traffic, this percentage remained at 31 percent after the median had been in operation for a year. The hourly distribution of customer traffic in relation to total traffic is shown in Figure 12.



TURNS INTO BUSINESSES AS A PERCENTAGE OF TOTAL HOURLY TRAFFIC ALONG HIGHWAY 146, BAYTOWN, TEXAS

Figure 12.

Here again the patterns are basically similar for the two periods. In the "after" period, however, there is a fairly pronounced peak in the late morning hours; also, the proportion of customer turns in both the early morning and late afternoon hours is considerably lower than under premedian conditions. This latter condition would seem to support the observation that fewer shopping trips are now being combined with work trips. That is, people driving through the area on their way to and from work may not be stopping as frequently at study area firms as they were before the median was built. Instead, a relatively larger number of special shopping trips may be made by housewives during the late morning hours.

If this observation is correct it should have a certain beneficial influence on traffic conditions. That is, it would remove some of the shopping turns from the traffic stream in the late afternoon hours when the volume of total movement is highest and add them to the less congested mid-day traffic stream.

Tables 6 and 7 show the influence of the median on shopping turns into and out of study area firms by direction of turns. Businesses on each side of the street are shown separately and total figures are shown for all businesses in the study. The most significant point brought out here is the very sharp reduction in both the absolute number and the relative proportion of left turns

Table 6  
THE INFLUENCE OF A MEDIAN ON TURNS INTO BUSINESS FIRMS ALONG S.H. 146, BAYTOWN, TEXAS

	Total Turn Ins (Number)	Right Turns		Left Turns		U Turns	
		Number (Number)	% of Totals (Percent)	Number (Number)	% of Totals (Percent)	Number (Number)	% of Totals (Percent)
<b>WEST SIDE BUSINESSES</b>							
Before	1,324	635	48	689	52		
After	1,081	637	59	372	34	72	7
<b>EAST SIDE BUSINESSES</b>							
Before	1,251	728	58	523	42		
After	1,314	965	74	225	17	124	9
<b>TOTALS</b>							
Before	2,575	1,363	53	1,212	47		
After	2,395	1,602	67	597	25	196	8