

AN EVALUATION OF INDUCED TRAFFIC
ON NEW HIGHWAY FACILITIES

by

Ronald W. Holder
Assistant Research Engineer

and

Vergil G. Stover
Study Supervisor

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ABSTRACT

This report presents the results of a study of induced traffic on various new highway facilities opened in Texas in recent years. A significant portion of the traffic occurring on some new facilities was identified as induced traffic. Not all locations studied, however, experienced induced traffic. Criteria are developed for evaluating the potential for induced traffic on planned facilities and a procedure is recommended for incorporating an estimate of induced traffic into existing traffic forecasting procedures.

Key Words: Induced Traffic, Travel Forecasting, Urban Transportation Studies, Transportation Planning, Traffic Assignment

SUMMARY

In several instances, forecasted traffic volumes on new facilities have been seriously underestimated using existing procedures. Future traffic on a new highway can be divided into the following six components for analysis and forecasting purposes: (1) diverted (2) converted (3) growth (4) developed (5) cultural, and (6) induced. Existing survey and forecasting techniques used by the Texas Highway Department account for the first five components but induced traffic is not included. Thus, this study was authorized to evaluate the significance of induced traffic and the need to incorporate an assessment of it in forecasting procedures.

Fifteen locations were considered for a study of induced traffic from which eight were selected for further analysis. Traffic volume data were analyzed and the "apparent induced traffic" was identified for each location. Efforts were made to evaluate the validity of the "apparent induced traffic" by identifying the presence or absence of complicating factors such as changes in land development adjacent to the facility.

Two of the eight locations studied showed no indications of induced traffic. The induced traffic component for other locations ranged in magnitude from 4000 to 35,000 vehicles/day constituting 5 to 21 percent of the total corridor volume. If all of the induced traffic is assumed to have occurred on the new facility, it represents from one-fourth to two-thirds of the traffic using the facility. The magnitude of the induced traffic component indicated by these studies is much larger than was expected.

Results of these analyses indicate that the following two conditions must exist before a substantial amount of induced traffic will occur on a new facility:

1. Major Change in Accessibility - The off-peak travel times within a corridor must be reduced significantly by the new facility.
2. Latent Demands Exceed Existing Capacity - Existing facilities have insufficient capacity so that they are acting as bottle-necks even during off-peak periods.

A Separation Index and a Congestion Index are developed to use in evaluating these two factors that influence induced traffic. Also, a macroscopic approach is presented that can be used to determine the amount of induced traffic that is likely to occur on a new facility.

IMPLEMENTATION STATEMENT

The results of this study indicate that significant induced traffic can occur on new facilities under certain conditions. In severe cases, the induced traffic component can double or even triple the amount of traffic using a new highway facility. Consequently, existing traffic forecasting techniques should be modified to include consideration of the induced traffic component.

The macroscopic approach developed in this study provides a means to evaluate induced traffic based on readily available data. Thus, it is recommended that this approach be incorporated in the traffic forecasting procedures.

Although the precision of the numerical values for induced traffic given in Figure 8 can be improved upon, the approach is believed to be valid and suitable for interim implementation. Additional data will need to be collected at numerous locations as specific opportunities occur in order to substantially improve the precision.

Incorporation of this step into existing traffic forecasting procedures should result in significantly better estimates of future traffic on those facilities that have the potential for induced traffic.

INTRODUCTION

There is growing discontent in America with highways and automobile traffic. One major factor contributing to this feeling of dissatisfaction is the rapidity with which many new highway facilities are filled to capacity. It is not unusual for the traffic volume on a new facility to grow so rapidly that within two or three years it exceeds the volumes forecasted for twenty years hence. Budgets may never permit the building of highways with sufficient capacity for long term future demands but we should at least be able to accurately forecast near term future traffic volumes on a new facility.

Future traffic on a new highway facility can be divided into the following six components for analysis and forecasting purposes:

1. Diverted Traffic - Trips currently being made on other streets and highways that will be diverted to the new, or improved, facility.
2. Converted Traffic - Trips currently being made on other modes of transportation that will be converted to the new facility.
3. Growth Traffic - Increased volumes of traffic due to population growth of the urban area - with the increased population exhibiting the same average trip generation rates.
4. Developed Traffic - Increased traffic volumes due to changes in the land use within the travel corridor served by the new facility. This is an element of growth traffic but it is of such a unique nature in relationship to the new facility that it merits specific identification.

5. Cultural Traffic - Changes in traffic resulting from a change in propensity for travel due to socio-economic characteristics of the population. This traffic is similar in nature to and is often included with growth traffic. Cultural traffic, however, results from changes in customs, cultural habits, and life styles which influence the number of trips made by each person.
6. Induced Traffic - New trips that are made because of the added convenience afforded by the new facility (increased accessibility).

Existing survey and forecasting techniques consider the first four components of future traffic. The Texas Highway Department considers the fifth (cultural traffic) through the forecasting of increased auto ownership and use. However, present techniques do not account for induced traffic on a new facility.

Recognizing the need to include induced traffic in travel forecasts, the Texas Highway Department approved a study of induced traffic as part of the Urban Travel Forecasting Project (Study No. 2-10-71-167) to be conducted by Texas Transportation Institute over a three-year period beginning in 1971. This evaluation of induced traffic will include a definition of the problem, analysis of available data, formulation of forecasting techniques, and incorporation of those techniques into the basic transportation planning process. This report summarizes the findings to date.

PROBLEM DEFINITION

SEVERITY OF PROBLEM

Transportation planners are responsible for predicting the need for new or improved traffic facilities within an urban area. These forecasts of future traffic demands are based upon measurements of traffic volumes and trip generation characteristics occurring under existing conditions (population, income, land use, traffic network, etc.). Projections are then made for future changes in population, trip generation rates, and land use in order to determine the need for new facilities and to predict the traffic volumes on the revised traffic network. However, when new facilities are opened that provide a significant improvement in accessibility (reduced travel time) within an area, the resulting traffic volumes are often seriously underestimated. The magnitude of this error is reflected in the example cases cited in Table I.

TABLE I - EXAMPLES OF TRAFFIC VOLUMES EXCEEDING FORECASTS

Location	<u>Projected Traffic</u>		<u>Measured Traffic</u>	
	Year	ADT	Year	ADT
Houston: I 610 across Buffalo Bayou	1980	100,500	1970	129,000
Dallas: I 20 across Downtown	1985	70,000	1970	79,000
Waco: FM 3051 across Bosque River	1970	1,660	1970	6,020
	1985	4,110		

Obviously, existing survey and forecasting techniques do not always adequately estimate the volume of traffic that will use a new facility - especially when a much higher level of service is made available by the new facility. It is suspected that much of this error lies in a failure to properly account for the induced traffic component. A better understanding of induced traffic is needed if procedures are to be developed that will avoid such underestimates in the future.

IDENTIFYING INDUCED TRAFFIC

Logically, the first step in analyzing this problem is to identify the induced traffic component on several relatively new facilities. Induced traffic is that portion of the traffic that is due to the increased accessibility provided by the new facility - trips that were not made before the facility was opened. In other words, individuals may have wanted to make the trips before but were discouraged because of the inconvenience of travel to certain locations. However, now that it is more convenient they will make more trips.

Induced traffic can be expected to occur within a few months after the facility is opened so that it can be easily separated from growth traffic or developed traffic. In other words, all traffic using the new facility in the first few months would be expected to either be diverted, converted, or induced traffic. However, construction of a freeway usually takes 3 to 5 years. During this time new shopping centers, office complexes, or apartment buildings may be constructed along the route and timed to open simultaneously with the freeway. Thus what appears to be "induced

traffic" that was developed prior to the opening of the facility. So efforts to identify the induced traffic component on a new facility should consider recent land developments in the area.

Another factor that complicates the identification of induced traffic is that some of it may occur on older facilities where the congestion has been relieved by the new facility. This can be accounted for by using traffic measurements taken in the entire travel corridor before and after the opening of the new facility.

Induced traffic could be more easily identified if entire new facilities were opened at once resulting in a sudden and dramatic change in the degree of accessibility for a large segment of an urban area. Examples of such major changes would include the opening of a complete beltway in an urban area where circumferential travel had been difficult or the simultaneous opening of a number of miles of diagonal freeways in a developed area with a gridiron arterial system. In Texas, however, such facilities usually are constructed and opened in relatively short sections that, by themselves, do not produce a drastic change in accessibility. Thus such induced traffic as does occur is difficult to identify and measure.

ANALYSIS OF DATA

PROCEDURE

Fifteen possible locations were considered for a study of induced traffic from which eight were selected for further analyses. These eight locations represent various types of facilities in several cities in Texas.

Total corridor traffic volumes were plotted for several years before and after the opening of the new facility.¹ The growth trend established prior to the opening of the facility was projected and compared to the actual traffic recorded in the total corridor after the facility was opened. The differences between the projected line of previous trends and the measured traffic was considered to be "apparent induced traffic". Efforts were then made to determine the presence or absence of complicating factors such as changes of land development adjacent to the facility during construction.

Results of studies for each of these eight locations are discussed briefly in the following paragraphs.

DATA FOR SPECIFIC LOCATIONS

Houston - IH 610 Across Buffalo Bayou

The opening of Interstate Highway 610, or the West Loop, across Buffalo Bayou in Houston produced a significant change in the accessibility across this natural barrier. Buffalo Bayou is also the screen line for Houston for

¹Traffic volumes were plotted on semi-log paper so that a straight line indicates a constant percentage increase each year.

which annual traffic counts are taken on each crossing. Therefore data for the entire corridor were readily available for several years prior to and following the opening of IH 610. The corridor included all points at which Buffalo Bayou could be crossed for approximately five miles either side of the new facility. The corridor analysis included: Fondren - Piney Point Road, Voss - Hillcroft, Post Oak Lane, Shepherd, Waugh, Studewood, and Sabine.

IH 610 was constructed in stages with the opening of the service roads in 1963 and the opening of the through lanes in 1967. The trend lines for the traffic within the corridor and on the facility are shown in Figure 1. There was a significant change in the slope of the curve with the opening of the service roads in 1963 and then a significant jump in the over-all traffic level with the opening of the through lanes in 1967. The "apparent induced traffic" indicated by the projection of the trend line was approximately 20,000 vehicles per day in the corridor. This constitutes approximately 12% of the total traffic in the corridor and approximately 27% of the traffic on the new facility.

Not all of the "apparent induced traffic" on this facility should be considered as true induced traffic. There was considerable construction of commercial facilities along the West Loop during the time that the freeway was being completed. The total traffic for the corridor without the freeway showed a significant up turn in trend lines about 1966 coinciding with the opening of some of these shopping centers. However, sufficient data are not available to determine the amount of this apparent induced traffic that should be identified as traffic developed prior to the opening of the freeway.

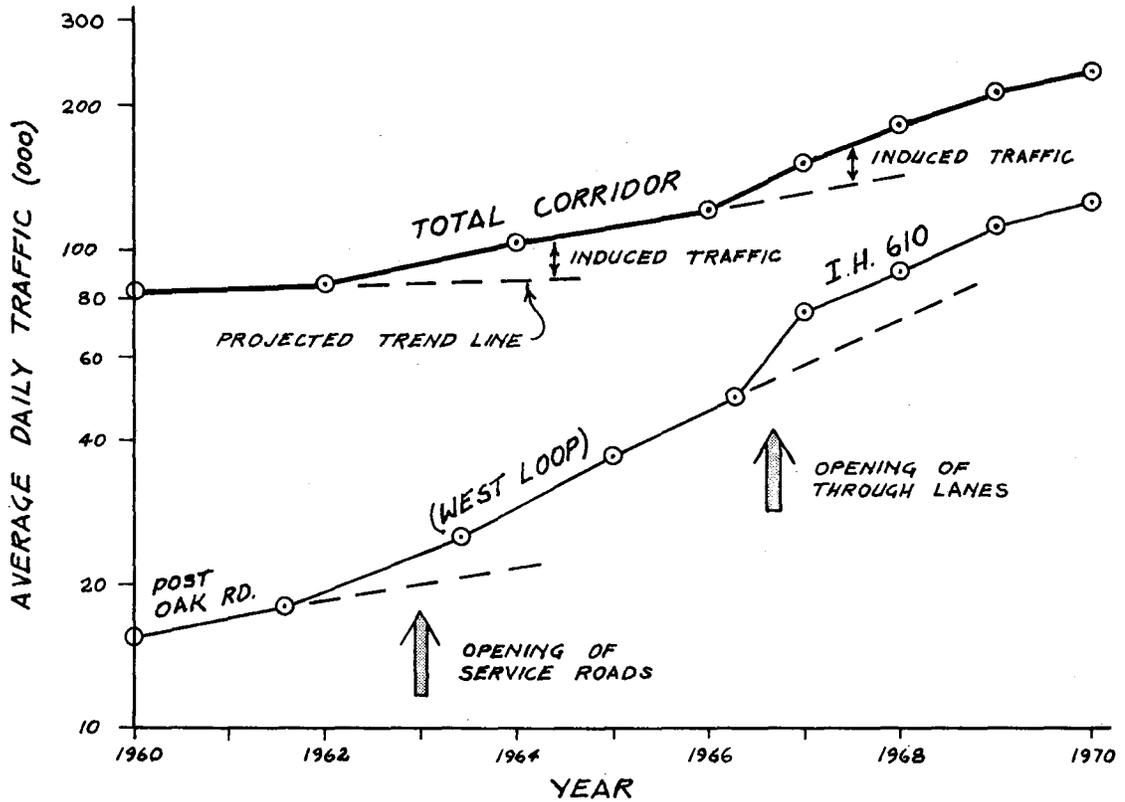
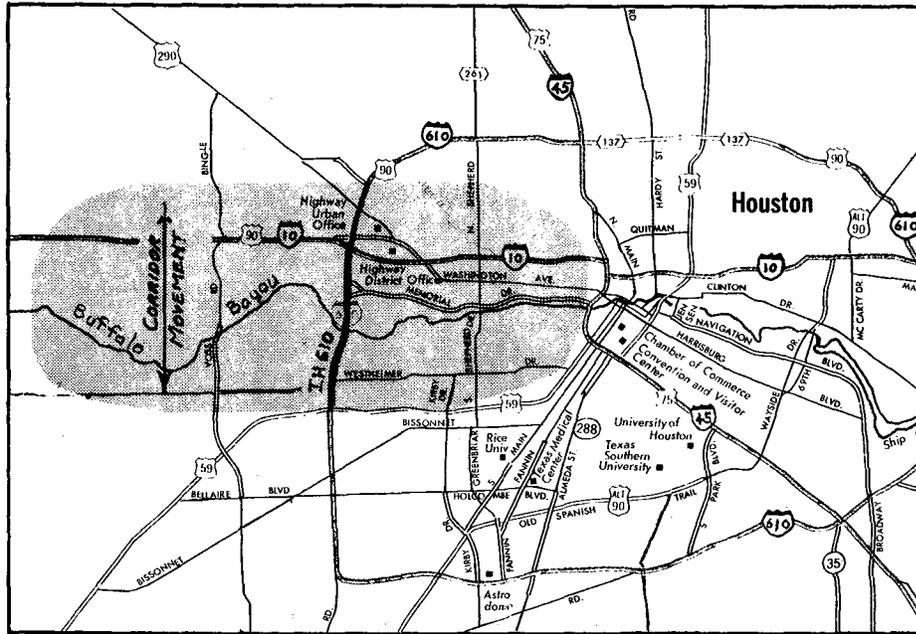


FIGURE 1 - TRAFFIC DATA FOR IH 610 IN HOUSTON

Houston - IH 10 Near Sheppard

The section of Interstate Highway 10 between the West Loop and downtown Houston was opened in early 1969. This facility roughly paralleled the Old Hempstead Highway and did not provide a new path across a significant barrier; however, it did provide significant increase in the capacity along the corridor. The following streets were considered to be part of the total corridor for IH 10: Calvacade (West 20th), 11th, Washington, Memorial, Allen Parkway, Gray, Westheimer, Alabama, and Richmond as well as the North Loop portion of IH 610 and the Southwest Freeway (U.S. 59).

The trend line for traffic along this corridor does not indicate the occurrence of induced traffic with the opening of IH 10 (see Figure 2). It does, however, indicate a diversion of some traffic from both the North Loop and the Southwest Freeway to the new IH 10. The traffic on these two freeways did not experience a sudden drop in volume with the opening of IH 10 (as did Washington, Memorial, Alabama, and 11th Streets) but it did show an abrupt leveling off from previous growth trends. It should be noted that the total corridor trend line parallels the average growth in traffic for the entire City of Houston. Therefore it was concluded that no induced traffic occurred on this section of IH 10.

Dallas - IH 20 Across Downtown

The completion of IH 20 Freeway across downtown Dallas significantly changed the East-West travel time across the downtown area. This location was evaluated not because it crossed a natural barrier but rather because

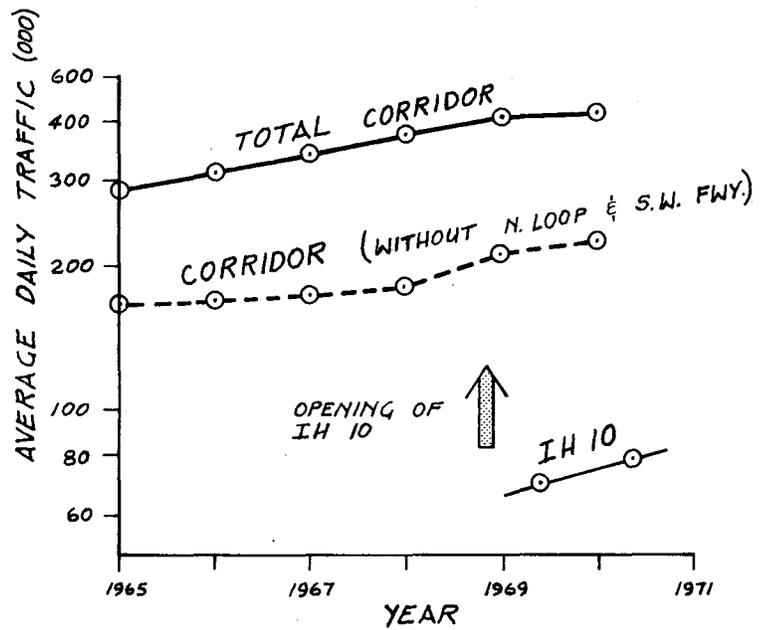
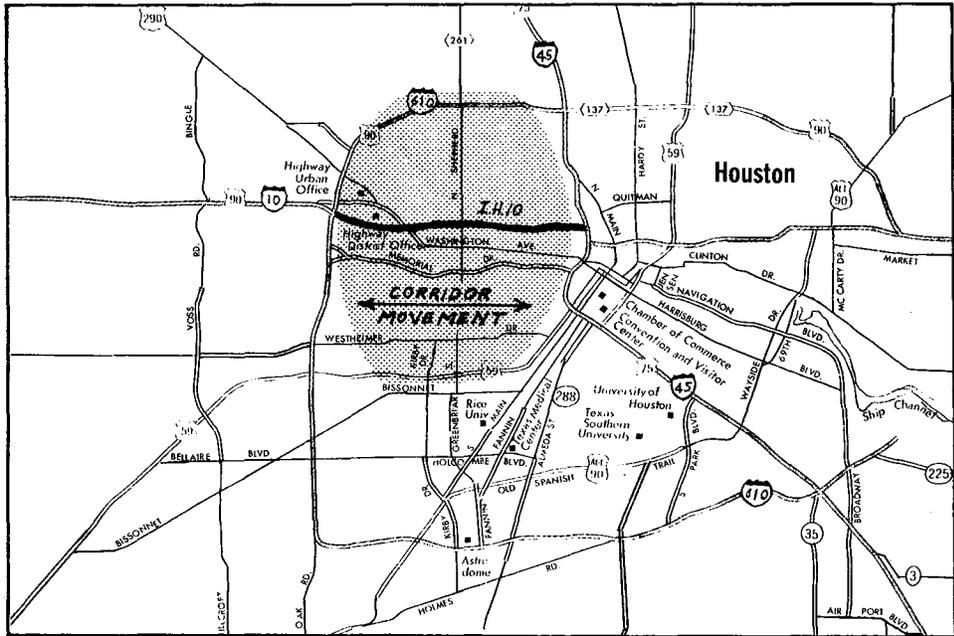


FIGURE 2 - TRAFFIC DATA FOR IH 10 IN HOUSTON

it crossed a congested traffic area. It was difficult to determine an appropriate corridor for evaluating these movements; however, the following streets were included in the corridor figures: Pacific, Elm, Main, Commerce, Jackson, Wood, Young, Canton, and Cadiz.

The opening of IH 20 in 1966 resulted in a sudden increase in traffic volumes crossing the downtown area East and West. The curve shown on Figure 3 indicates approximately 35,000 vehicles per day could be included as "apparent induced traffic". This constitutes approximately 21% of the traffic moving in the corridor and 49% of the traffic on the new facility. No significant indications were found of the land developments or changes in traffic trends within the City of Dallas that would discount this assessment of apparent induced traffic.

Fort Worth - Texas 121, Riverside to Beach

Texas State Highway 121, a freeway type facility, extends from downtown Fort Worth towards the Northeast roughly paralleling Belknap Street. The segment studied does not cross a natural barrier, but it does provide a significant increase in accessibility along this corridor. For this study, Belknap and East First Street were included in the corridor.

The traffic trend shown on Figure 4 reflects a sudden increase in total corridor traffic after the opening of the Texas 121 in 1963. However, the total traffic then began to decline for a period of four years (due primarily to a slump in economic activity in the area). Because of this subsequent decline of traffic volume, it is questionable if the earlier increase in traffic should be designated as induced traffic. However, no other designation

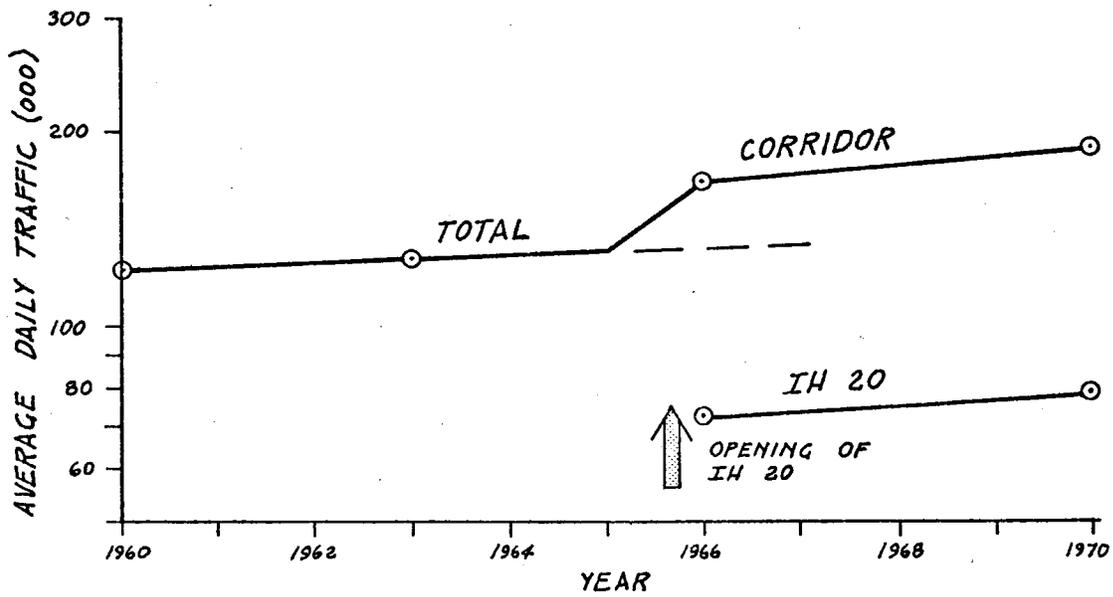
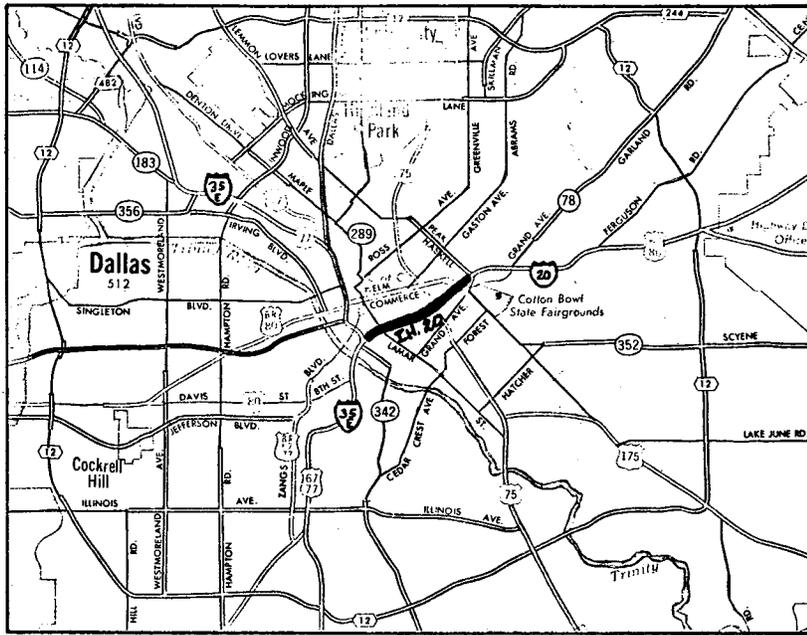


FIGURE 3 - TRAFFIC DATA FOR IH 20 IN DALLAS

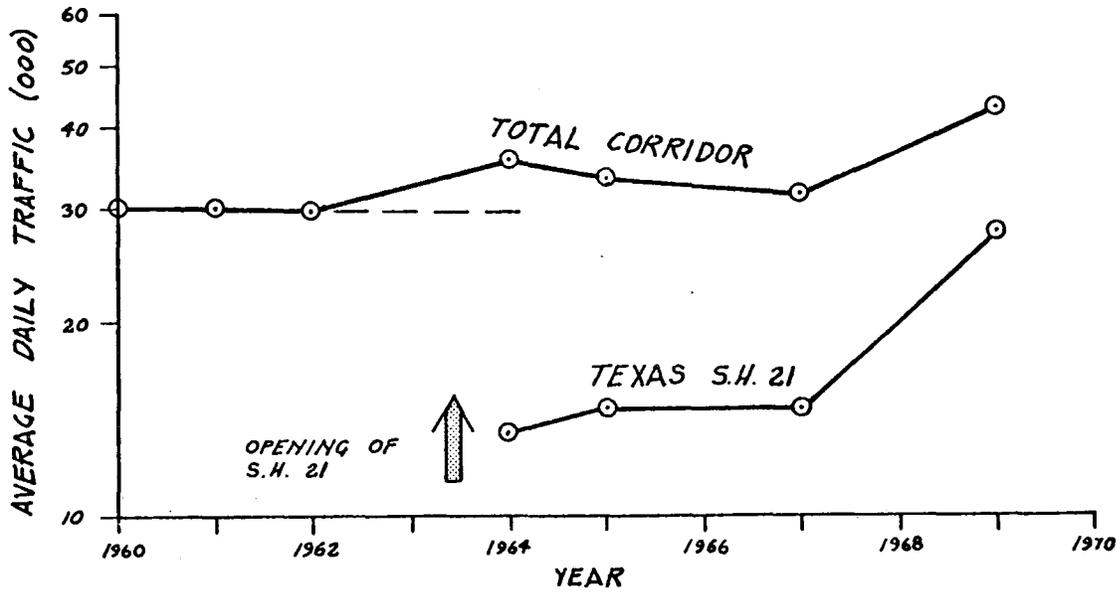
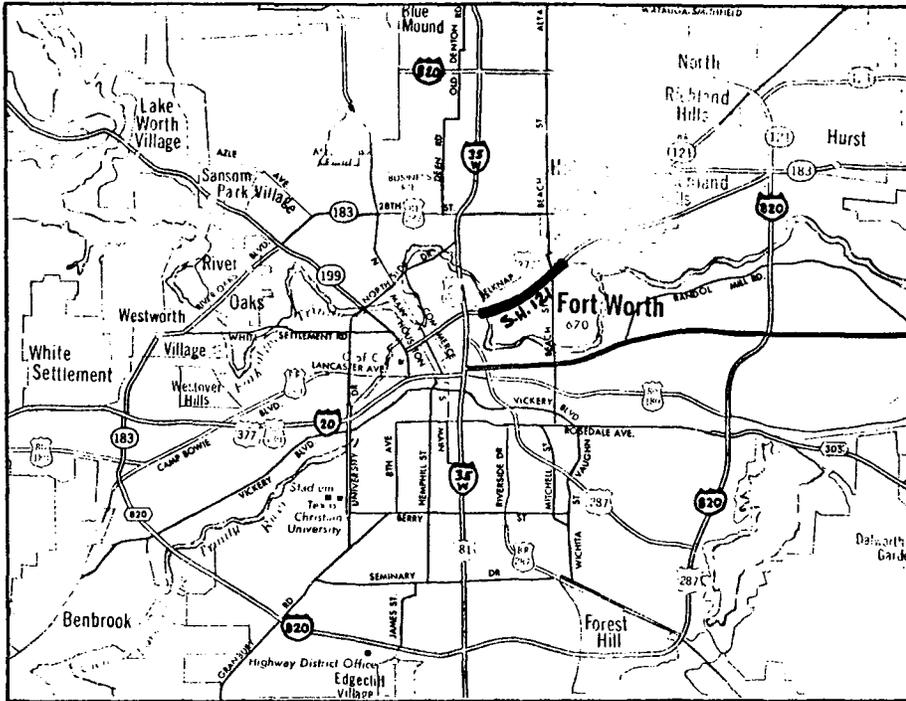


FIGURE 4 - TRAFFIC DATA FOR TEXAS 121 IN FT. WORTH

appears to be appropriate. A total increase in traffic of about 5,000 vehicles per day occurred in the corridor. This constitute 15% of the total corridor traffic and 37% of the traffic on the new facility.

Austin - Bridges Across Colorado River

Two bridges across the Colorado River were evaluated for induced traffic in Austin. The First Street Bridge was opened in 1954 and extensive traffic measurements were made on all river crossings before and after its opening. No net increase in corridor movement was noted, in fact there was a slight drop off in corridor movement after the bridge was opened to traffic.

Interstate Highway 35 was opened across the Colorado River in 1961. Only scant traffic counts are available during this time period but they indicate that some induced traffic did occur at this time. The traffic trend lines shown on Figure 5 indicate an increase in traffic volumes of approximately 10,000 vehicles per day occurring with the opening of IH 35 Bridge. This constitutes 10% of the total corridor movements across the river and about 45% of the traffic on IH 35 at this location.

Waco - FM 3051 Across Brazos River

The segment of FM 3051 across the Bosque and Brazos Rivers, a two-lane farm to market highway, was opened in 1970. It connected northwest Waco to the Dallas Highway and the Lacy Lakeview - Bellmead section of the Waco urbanized area. Although the opening of this facility did not produce a significant change in the total capacity across the Brazos River, it did

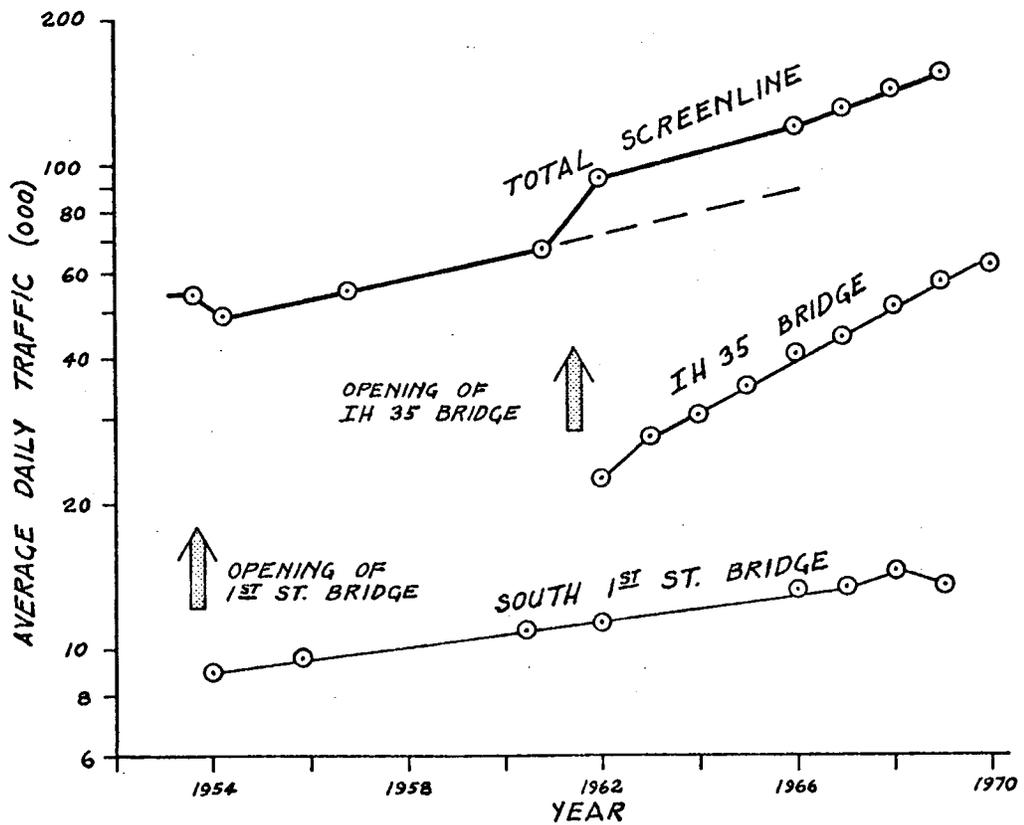
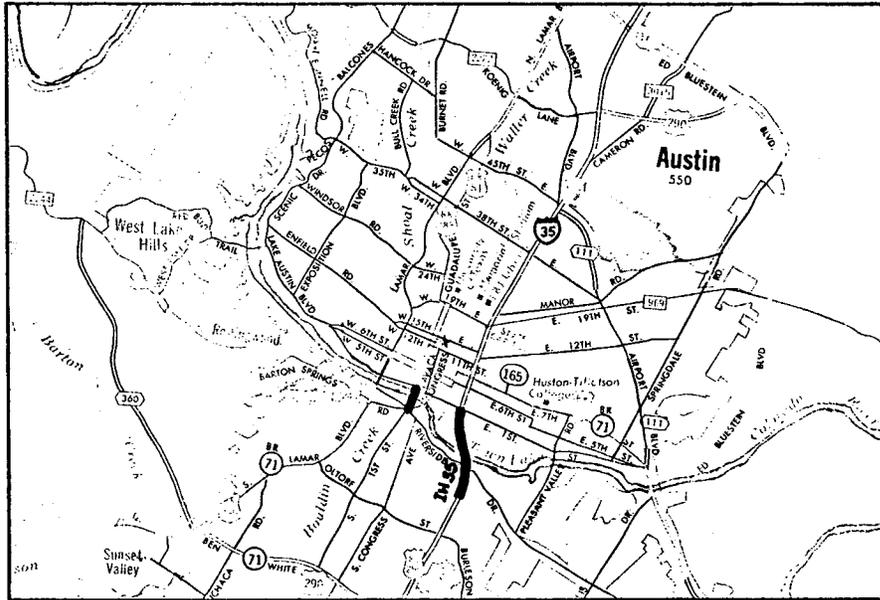


FIGURE 5 - TRAFFIC DATA FOR COLORADO RIVER CROSSINGS IN AUSTIN

provide a significant reduction in the time required to travel from northwest Waco or from the Waco Airport to the Dallas Highway.

Traffic assignments for this new facility projected 1,660 vehicles per day in 1970 increasing to 4,110 vehicles per day by 1985. However, the average daily traffic on the facility during its first year of operation (1970) exceeded 6,000. The total screen line (all crossings across the Brazos River in Waco) traffic increased only 5 percent after the opening of FM 3051 (see Figure 6). However this "apparent induced traffic" of 4,000 vehicles per day constitutes approximately 67% of the total traffic on the new facility.

The opening of a new junior college adjacent to this facility prior to its completion complicates the identification of induced traffic. The enrollment in McLennan Community College was approximately 1,200 students in 1970. This provides a drastic change in the trip attractions for the area, but it probably does not explain more than about 1,000 vehicles per day on FM 3051 since most of the traffic approaches the college from the south along 19th Street.

It should be noted that the traffic projections for FM 3051 were made before a junior college was founded in McLennan County and long before a campus site was selected. Therefore, the projections did not include traffic resulting from a campus of this type located adjacent to this facility.

Dallas - Ft. Worth Turnpike

The opening of the Dallas - Ft. Worth Turnpike in 1958 made it possible to travel from downtown Dallas to downtown Ft. Worth in 30 minutes. This trip

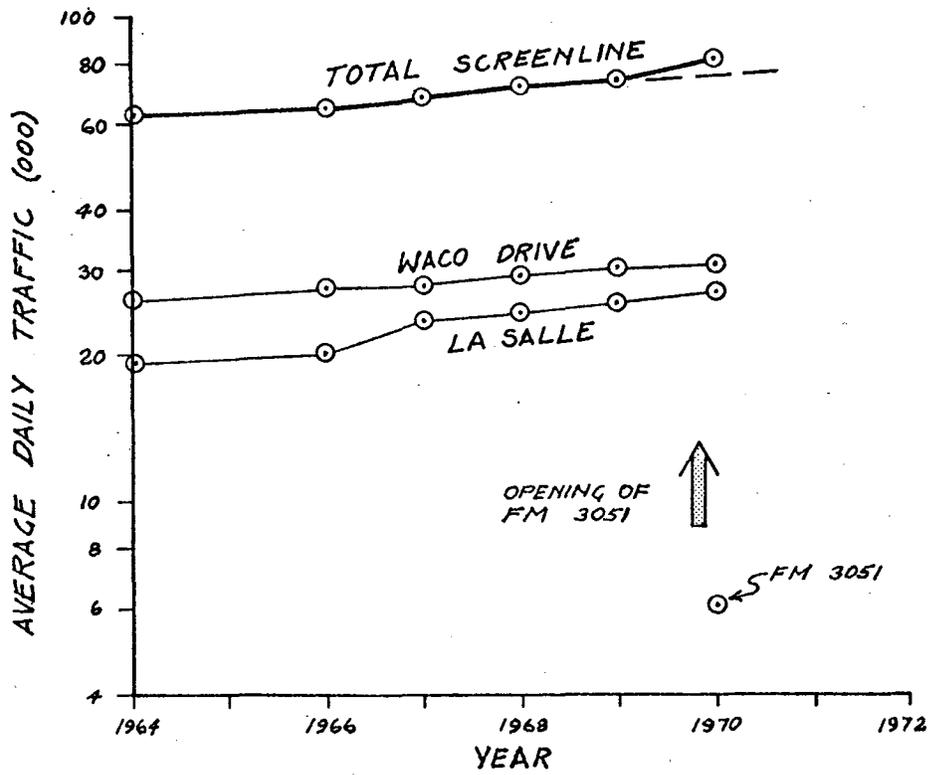
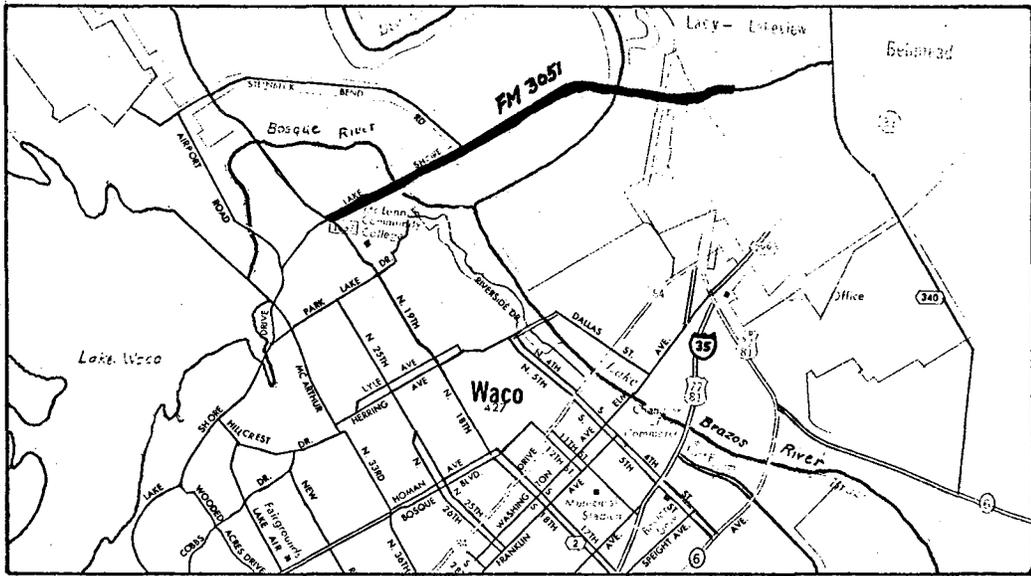


FIGURE 6 - TRAFFIC DATA FOR FM 3051 IN WACO

had previously required 2 to 3 hours due to congestion along U.S. 80 and Texas State Highway 183. The Turnpike originally had only 4 access locations between the terminal points on either end so that it served through traffic primarily.

No detailed measurements of traffic moving in the total corridor were made before and after the opening of the Turnpike so a precise measurement of induced traffic cannot be made. However, the Texas Highway Department maintains permanent count stations on U.S. 80 and on Texas 183 between Dallas and Ft. Worth, and the Turnpike Authority keeps records of traffic entering and exiting at each toll station. Thus, sufficient traffic data were available to estimate the "apparent induced traffic".

The traffic volume on the two highways decreased slightly before the opening of the Turnpike (see Figure 7). Then the total corridor (Turnpike, U.S. 80, & Texas 183) traffic jumped slightly. This fluctuation in traffic complicates the assessment of induced traffic but approximately 8,000 vehicles/day could be classified as "apparent induced traffic". This increment constitutes 20 percent of the corridor traffic and approximately 50 percent of the traffic on the Turnpike.

SUMMARY OF RESULTS

A summary of the results of this study is presented in Table 2. Two of the eight locations studied show no indications of induced traffic. The "apparent induced traffic" component in the other corridors ranged in magnitude from 4,000 vehicles/day to 35,000 vehicles/day constituting 5 percent to 21 percent of the corridor volume. If all of the "apparent induced traffic" were assumed to occur on the new facility it would constitute 27%

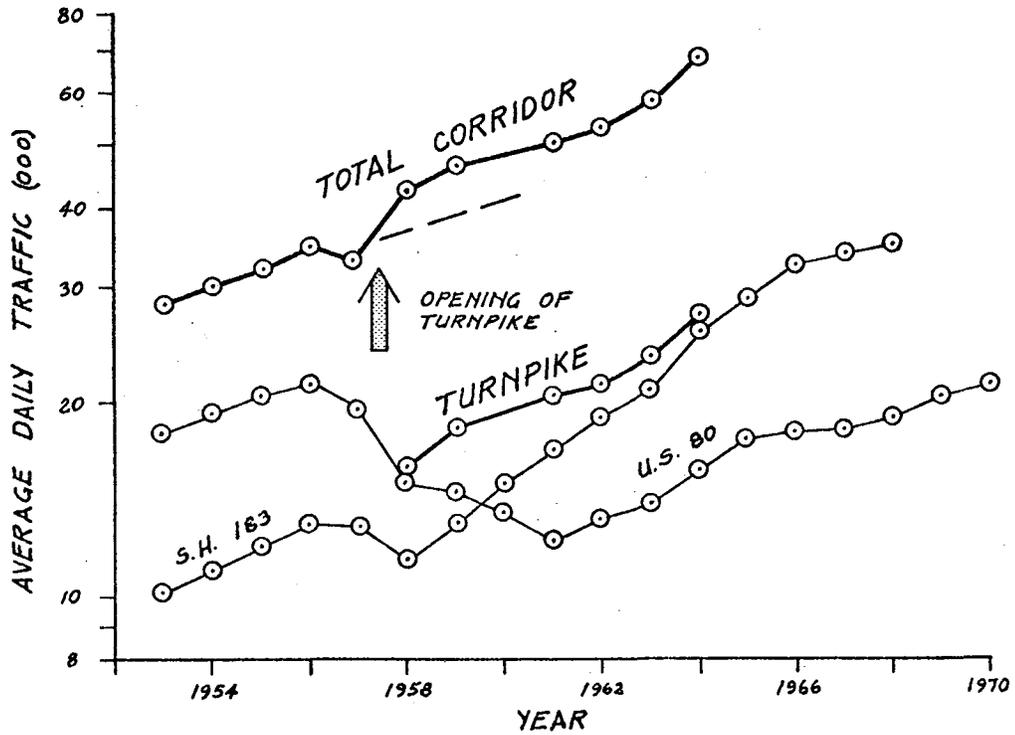
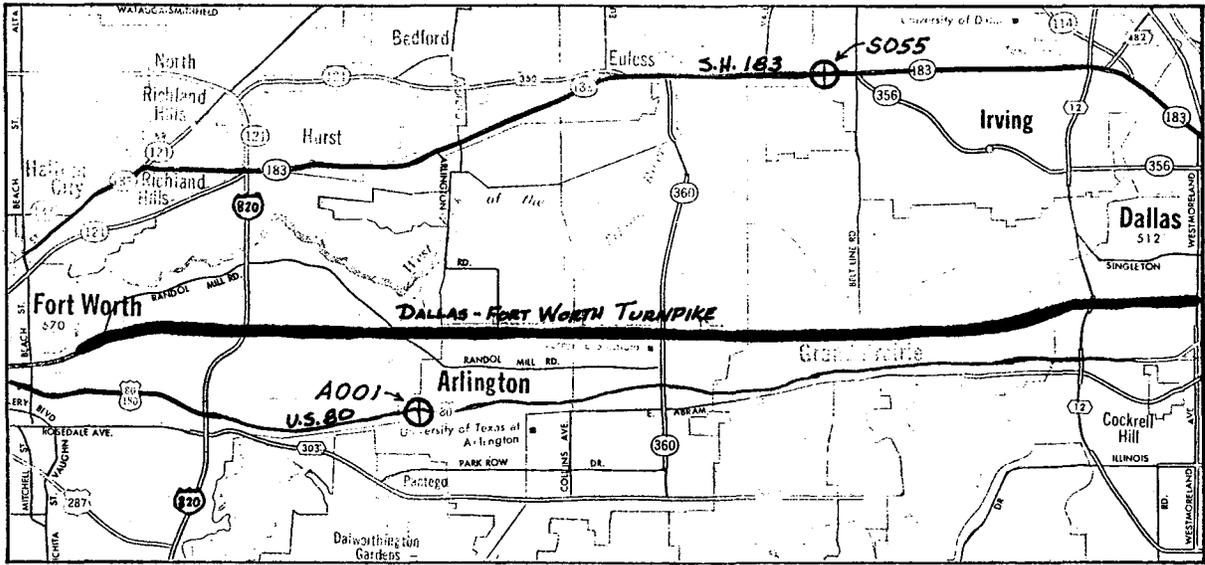


FIGURE 7 - TRAFFIC DATA FOR FT. WORTH-DALLAS TURNPIKE

TABLE 2 - SUMMARY OF RESULTS

			Traffic Volumes After Opening New Facility		"Apparent Induced" Traffic Component		
City	New Facility	Date Opened	Total Corridor	Facility	Magnitude	% Of Traffic In Corridor	% Of Traffic On New Facility
1. Houston	IH 610 Across Buffalo	1967	150,000	75,000	20,000 vpd	12%	27%
2. Houston	IH 10 near Shepherd	1969	400,000	65,000	0	0	0
3. Dallas	IH 20 across Downtown	1966	170,000	72,000	35,000	21%	49%
4. Ft. Worth	Texas 121 from Riverside to Beech	1964	35,000	13,500	5,000	15%	37%
5. Austin	1st Street Bridge	1954	50,000	9,000	0	0	0
6. Austin	IH 35 across Colorado River	1962	95,000	22,000	10,000	10%	45%
7. Waco	FM 3051 across Brazos River	1970	82,000	6,000	4,000	5%	67%
8. Dallas - Ft. Worth	Turnpike	1958	43,000	16,000	8,000	20%	50%

to 67% of the total traffic on the new facility. The magnitude of the "apparent induced traffic" component indicated by these studies is much larger than was expected.

CONCLUSIONS AND RECOMMENDATIONS

CHARACTERISTICS OF INDUCED TRAFFIC

The results of this study indicates that induced traffic, or at least the "apparent induced traffic", can be a very significant portion of the traffic on a new facility. This component of traffic appears to be even more significant than was anticipated prior to the study. In each instance where induced traffic was indicated it comprised at least 25 percent of the total traffic on the new facility. In three of these six locations the induced traffic component appears to be 45 percent or more of the initial traffic on the new facility.

Data reviewed in this study tended to substantiate intuitive assumptions that most induced traffic occurs during off-peak hours. Also, results of these analyses definitely indicate that a new facility will not necessarily generate induced traffic. Thus it appears that the following two conditions must be met before a substantial amount of induced traffic will occur on a new facility:

1. Major Change in Accessibility - The off-peak travel time must be reduced significantly.
2. Latent Demands Exceed Existing Capacity - The existing facilities have insufficient capacity so that they are acting as bottlenecks.

A major change in accessibility usually occurs when a new facility is installed across a natural barrier (river, mountain, etc.), along a route where no previous facility existed (diagonal route over grid system), or within a highly congested corridor. Two new freeways were opened in the same general

area of Houston at about the same time and one of them generated a substantial amount of induced traffic (IH 610 across Buffalo Bayou) while the other one showed no induced traffic (IH 10 between IH 610 and IH 45). In this case, IH 610 greatly increased the accessibility across Buffalo Bayou where previous capacity had been severely limited. On the other hand, IH 10 provided a significant increase in peak hour capacity between northwest Houston and the CBD but it did not substantially decrease the off-peak travel time that was available on parallel facilities.

A major change in accessibility, however, does not in itself result in a substantial quantity of induced traffic. For instance, the First Street Bridge across the Colorado River in Austin provided a major change in accessibility across the river when it was opened in 1954 but the total number of daily river crossings did not increase. This example corroborates the second condition needed for substantial induced traffic; i.e., the latent demand must exceed existing capacity to such an extent that a bottleneck situation exists even during off-peak hours.

The traffic trends plotted for several of the locations (Figures 1, 3, 5, and 7) exhibit the same slope before and after the opening of the new facility. This implies that once induced traffic occurs on a facility it becomes just like all other components of traffic and responds the same to growth forces. Thus if 25% of the traffic on a new facility in 1975 is induced traffic, then it is probable that 25% of the traffic on the facility in 1985 will be the result of growth from the original induced traffic.

CONSIDERATION OF INDUCED TRAFFIC IN FORECAST PROCEDURES

Macroscopic vs Microscopic Approach

Induced traffic might be accounted for in the forecast procedures by adjusting the trip generation rate per individual (or dwelling unit) in all zones affected by a new facility. This microscopic approach would fit easily into existing forecasting procedures, but extensive data would be required to isolate individual effects. Changes in trip generation patterns resulting from a major improvement in accessibility would need to be determined. This type of information is not available from previous O-D studies so numerous expensive surveys would be required if the microscopic approach were to be used.

A macroscopic approach might be used to determine an overall factor for potential induced traffic on a new facility. Existing forecasting procedures would be used to obtain a projection of traffic volume without induced traffic. Then an induced traffic factor could be determined based upon macroscopic measures of the change in accessibility afforded by the new facility and the level of congestion prior to its opening. A reasonably good estimate of the macroscopic factors can be made based upon available data. Thus the macroscopic approach is recommended for including induced traffic in forecast procedures.

The two primary factors that contribute to induced traffic area: (1) the change in accessibility and (2) the latent demand. A Separation Index and a Congestion Index can be used as a quantitative measures of accessibility and latent demand respectively. These two measures can then be used

to determine the Induced Traffic Factor for a proposed facility. Suggested procedures for determining the Induced Traffic Factor are discussed in the following paragraphs.

Separation Index

Current traffic forecasting procedures include the determination of a separation matrix that indicates the relative accessibility between zones. A separation matrix can be developed for conditions before and after the opening of a new facility. A Separation Index can then be calculated as shown below:

$$\text{Separation Index} = \frac{\Sigma(S_b - S_a)}{\Sigma S_b}$$

where: S_b = Interzonal separation before new facility opens.

S_a = Interzonal separation after new facility opens.

Σ = Summation of separation values for all zone pairs that show a significant change.

Thus the Separation Index will be normalized so that all values will lie between zero and unity. If the new facility causes no change in accessibility, the calculated Separation Index value will be zero. Conversely, if the change in accessibility between zones is so dramatic that all S_a values are essentially zero, the Separation Index will be unity.

Congestion Index

Most induced traffic seems to occur during off-peak periods so the measure used to indicate latent demand should include more than peak conditions. The average volume to capacity ratio experienced within a corridor during the highest 2000 hours of operation for the year should be a reasonably good measure of latent demand.¹ Thus the Congestion Index used is as follows:

$$\text{Congestion Index} = \frac{\sum_{i=1}^{2000} V_i}{2000 \times C}$$

where: V = Hourly volume for corridor

i = Ordinal ranking from 1 to 2000

C = Hourly capacity of corridor.

Highest hourly volume data are available for locations where permanent traffic recorders are installed. Based upon this data, the following relationship was found to remain reasonably constant:

$$\sum_{i=1}^{2000} V_i = 160 \times \text{AADT}$$

Thus the annual average daily traffic can be used in estimating the Congestion Index for locations where hourly volumes are not recorded.

Induced Traffic Factor

Congestion and Separation Indices were calculated for those locations included in this study. The amount of "apparent induced traffic" was subjectively converted into an Induced Traffic Factor for each location. These

¹See Appendix A for further discussion of Congestion Index.

values were then combined to form the graph shown in Figure 8 which can be used to estimate Induced Traffic Factors for new facilities.

Due to the limited number of suitable locations for which data were readily available, the variation of Induced Traffic Factors (ITF) could not be defined precisely for this graph. Thus it is recommended that incremental values of ITF be used. For example, if the Congestion Index is 0.45 and the Separation Index is 0.40 then the Induced Traffic Factor is 1.50. The precision of this graph is not sufficient to warrant interpolation between 1.25 and 1.50 at this time.

The Induced Traffic Factor should be applied to the assigned link volume developed using existing traffic assignment techniques to determine the total traffic that might occur on the new facility shortly after it is opened. The calculation procedure by which the Induced Traffic Factor would be applied is as follows:

$$\text{Total Forecast Traffic} = (\text{Assigned Link Volume}) \times (\text{Induced Traffic Factor}).$$

Once induced traffic occurs it tends to increase with time just as all other traffic on the facility. Thus, the same ITF used for initial forecasts should also be used for longer range forecasts.

Certainly the accuracy of this recommended procedure leaves much to be desired. Nevertheless, the incorporation of this step into existing traffic forecasting procedures should result in significantly better estimates of future traffic on those facilities that have the potential for induced traffic.

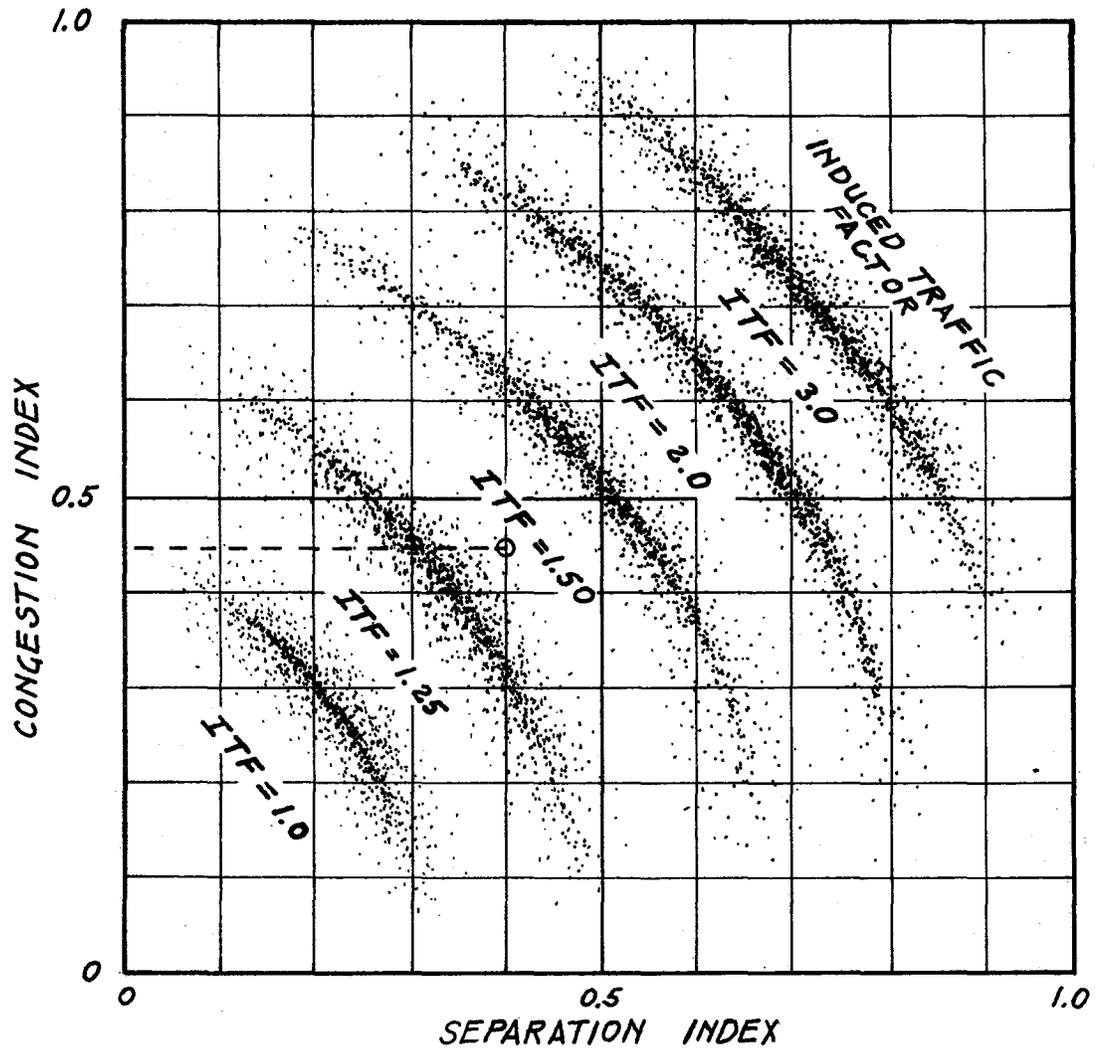


FIGURE 8 - ESTIMATION OF INDUCED TRAFFIC FACTOR

Example: If Congestion Index = 0.45 and Separation Index = 0.4 then ITF = 1.50

Where:

Congestion Index = Avg. V/C Ratio for corridor during highest 2000 hours of year prior to opening new facility.

Separation Index =
$$\frac{\sum (S_b - S_a)}{\sum S_b}$$
 for all zone pairs affected by new facility.

Total Traffic on New Facility = Forecast Volume x Induced Traffic Factor.

POSSIBLE FUTURE STUDIES

Sufficient data were not available for the locations studied to accurately separate the "apparent induced traffic" into proper categories. The most significant factor that could not be determined from available data was the amount of development that occurred during construction of the new facility and its impact on traffic. In order to determine this, changes in land use within the corridor during construction would have to be monitored.

Two planned construction projects in Texas that might be suitable for further study to increase the precision of Figure 8 are:

- IH 610 across the Houston Ship Channel
- The bridge to the Bolivar Peninsula.

Both of these locations are in the Houston-Galveston metropolitan area where an extensive transportation study is currently underway. Thus an accurate evaluation of the induced traffic on these facilities will require a minimum of additional data acquisition.

A license plate survey could be conducted of traffic using each facility shortly after it opens. Mail-out questionnaires can be used to obtain some basic information concerning the nature of these trips. These data will then be used to check the validity of the macroscopic approach to predicting induced traffic on new facilities. Although, data from these two locations would add to the precision of the Induced Traffic Factors shown in Figure 8, information will need to be collected at numerous other locations throughout the nation before the desired ultimate level of precision can be achieved. Collection of such extensive data, as opportunities occur, will probably require a number of years and will be very expensive.

APPENDIX A
TRAFFIC CONGESTION INDEX

MEASURE OF CONGESTION

Almost all urban highways facilities are congested during at least two hours on typical work days (morning peak and afternoon peak) - a total of about 500 hours per year. However, the results of this study indicate that induced traffic tends to occur during off-peak hours. Thus, the measure of congestion used for the Traffic Congestion Index should evaluate the level of congestion during periods that induced traffic might occur as well as during normal peak periods.

Drivers probably begin to sense some degree of congestion once the traffic volumes on a facility exceed half of its capacity. Hence, the sum of hourly volume to capacity ratios (V/C) for all hours in which the traffic volume exceeds half of the capacity might be used to measure the level of congestion.

Another indication of the relative level of congestion on highway facilities might be the average volume to capacity ratio during some predetermined number of hours. Hourly traffic volumes on major urban highways are usually higher on week-days than on week-ends. If traffic conditions are evaluated for the highest 2000 hours of the year (about 8 hours per work-day), the result should be a suitable measure of the congestion that would influence induced traffic.

These two potential measures of congestion were evaluated for five facilities in the Houston area known to have different levels of congestion. The results are shown in Table 3.

TABLE 3 - MEASURES OF CONGESTION

Location In Houston Area	Σ V/C For All Hours With V/C > 0.5	Avg. V/C During Highest 2000 Hrs.
1. Gulf Freeway at Cullen	2939	0.77
2. IH 610 at Buffalo Bayou	1750	0.73
3. Gulf Freeway near Gulfgate	1417	0.62
4. Baytown Tunnel	1075	0.62
5. Katy Freeway near Shepherd	25	0.38

Both measures of congestion result in the same ordering in terms of level of congestion; however, the average V/C during the highest 2000 hours seems to yield a better relative rating. Also, it is simpler to calculate than the other. Thus, the average V/C value during the highest 2000 hours of operation during the year was selected for the traffic Congestion Index. It is calculated as follows:

$$\text{Congestion Index} = \frac{\sum_{i=1}^{2000} V_i}{2000 \times C}$$

where: V = Hourly volume

i = Ordinal ranking up to 2000

C = Hourly capacity.

ESTIMATION PROCEDURES

Hourly traffic volumes are available for locations with permanent automatic traffic recorders so that ordinal rankings can be made. However, such data is not available for most facilities, but sufficient traffic measurements are usually made to determine an average daily traffic. Thus, if a relationship between the average daily traffic and the traffic volume during the highest 2000 hours exists, it would be extremely useful in estimating the congestion index.

Data from various permanent automatic traffic recorders¹ were analyzed to determine the relationship between average daily traffic and the total volume during the highest 2000 hours. A correlation between these two parameters is indicated by the data shown in Figure 9. Thus the summation of hourly volumes can be estimated as follows:

$$\sum_{i=1}^{2000} V_i = 160 \cdot \text{AADT}$$

where: V = Hourly volume

i = Ordinal ranking

AADT = Annual average daily traffic.

Of course, if hourly volume data is available for facilities being considered, the actual summation should be used since it would be more accurate than the estimated value.

¹Texas Highway Department, Permanent Automatic Traffic Recorders, Annual Report, 1970.

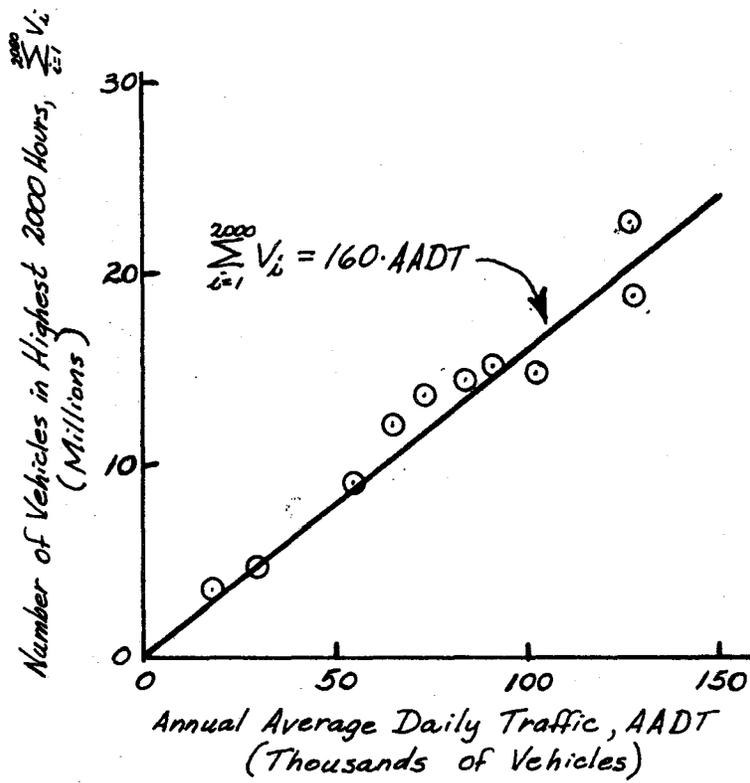


FIGURE 9 - ESTIMATION OF TRAFFIC VOLUME DURING HIGHEST 2000 HOURS