IMPACT OF REMOVAL OF TOLLS ON TRAVEL IN TIDEWATER VIRGINIA

Volume III — Coleman Bridge

by

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(The opinions, findings, and conclusions expressed in this report are those of the authors and not necessarily those of the sponsoring agencies.)

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PREFACE

Tolls and parking charges have been discussed as an alternative solution to the problem of congestion in urban transportation, but the lack of demonstration projects has largely precluded the generation of data by which the effectiveness of such charges can be monitored. The removal of tolls in Tidewater Virginia afforded the opportunity for several case studies to be undertaken. The results of these case studies are reported in three volumes, the third of which, that for the Coleman Bridge, is reported here. The results for the Hampton Roads Bridge-Tunnel and the James River Bridge are reported in Volumes I and II, respectively.

ABSTRACT

This report presents the results of a study of the effects of the removal of tolls at the James P. Coleman Bridge at Yorktown. Emphasis is placed upon examining immediate impacts; viz., changes in demand for travel, vehicle occupancy rates, carpooling activity, origin and destination patterns, and changes in jobs and residences. A survey methodology, supplemented with information from mechanical and manual traffic volume and composition counts, was used as the means of data collection.

In general, the removal of tolls precipitated some increase in traffic volumes; however, the 3.0% increase over the established historical trend was significantly smaller than the increase for either the Hampton Roads Bridge-Tunnel or the James River Bridge. Vehicle occupancy rates and carpooling did not, however, appear to be significantly affected by the removal of tolls. Similarly, origin and destination patterns remained unaltered after the removal of the tolls.

FINDINGS AND CONCLUSIONS

Tolls on the James P. Coleman Bridge were not a significant barrier to travel in Tidewater. The following items describe the changes which may be ascribed to the removal of tolls.

1. The removal of tolls has occasioned an increased tendency for persons over 65 years of age to travel across the Coleman Bridge.

2. In general, females are using Coleman Bridge more since the removal of tolls. The increase is nominal, however, with this segment of the populace making 4.0% more trips than before.

3. Traffic volume changes have been quite moderate. The average number of vehicles daily crossing the bridge during 1975 was 9,700 as compared to 10,700 during the after period study. This 10.3% increase over the 1975 ADT is only 3.1% greater than the expected trend increase for 1976.

4. The removal of tolls has had no significant effect upon seasonal variations in the ADT; that is, monthly variations for the study periods before and after the tolls were removed rise at approximately equivalent rates during the months of January through July and fall at equivalent rates from August through December.

5. Some noticeable changes in traffic composition have occurred. Passenger cars make up a slightly smaller percentage of the total traffic than they did prior to the removal of tolls. Whereas in 1975 cars made up 78.9% of the ADT, in 1976 they accounted for 74.0%. Two-axle and tractor-trailer trucks, as percentages of total volume, have remained slightly above 1975 levels.

6. While vehicle occupancy rates have not been significantly altered by the lifting of the tolls, several variables bear a significant relationship to the occupancy rate. Specifically, the following relationships have been noted.

    a. Groups that cross the bridge regularly exhibit lower occupancy rates than groups crossing infrequently.

b. Shopping trips typically have higher occupancy rates than work trips.

c. The longer the trip, the higher the occupancy rate.

d. Carpooling activity has been only slightly reduced by the removal of tolls.

7. The removal of tolls has brought about an increase in shopping trips.

8. No significant relationship has been observed between demand for travel and income level, either before or after the removal of tolls.

9. The data suggest that since the toll removal, more trips of shorter distance are being taken. Not only has the absolute length of trips fallen, the average trip time has fallen by about 3 minutes.

10. Approximately 3.0% of the respondents to the survey questionnaire have changed or will change their residence as a result of the toll removal. Many of these individuals are in the $12,000 - $15,000 per year income bracket.

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INTRODUCTION

While the price elasticity of demand for such consumer durables as housing and automobiles has been frequently estimated in the literature, relatively few empirical studies have dealt with the effect of price changes on the demand for vehicular trips other than for buses or other transit modes. A study by Simpson and Curtin, consulting engineers, represents one of the few empirical efforts to monitor the effects of changes in prices (in the form of tolls) on private and business trips. While Dash and Vey[1] found that the price elasticity of demand for trips was relatively inelastic on the Norfolk-Elizabeth River Tunnel in Virginia for a toll change of $0.30 to $0.40, other studies of Virginia's Tidewater Area have indicated that existing tolls have prevented the Hampton Roads region from achieving its socioeconomic potential.[2,3] These studies revealed, for example, that only 1.4% (18,474) of the total daily vehicular trips (1,300,000) in the Hampton Roads region were crossings of the Hampton Roads channel. In addition, the finding that the occupancy rate for each vehicle crossing the channel was much higher than the region-wide average served as an indication of the barrier imposed by the existing toll structure. One of the implications of these findings is that the number of trips demanded both by individuals and businesses is price elastic; i.e. a small change in tolls will bring about a relatively larger change in the number of vehicular trips.

On June 1, 1976, three of the most expensive tolls in Tidewater Virginia (those for the Hampton Roads Bridge-Tunnel, James River Bridge and Coleman Bridge) were removed. The potential impacts of the removal of these tolls upon traffic behavior and socioeconomic activity have been partially reviewed in the report entitled "The Hampton Roads Joint Transportation Study."[4]

Using a modeling technique, the authors of that report examined the economic feasibility and impact of a proposed third crossing of Hampton Roads. While this feasibility determination was the principal objective of the study, several alternative methods of accommodating transportation demands, including an adjustment of the toll on existing facilities, were examined. The results of the study reflected the anticipated changes in economic growth and traffic volumes under the different toll pricing policies. Generally, the lowest toll rates were expected to account for the largest population and economic growth as well as the largest increase in the number of vehicles crossing Hampton Roads. On the other hand, greater tolls were expected to decrease the rate of population growth, economic growth, and, thus, vehicular travel.

As is shown by the above, the evidence that has been obtained on the effects of tolls on traffic mix and flow is conflicting, primarily because of the infrequent occurrence of opportunities to empirically study price change effects.

PURPOSE AND SCOPE

Although the "Joint Transportation Study"[4] and a related paper by Bellomo[5] have reported anticipated impacts from changes in tolls upon traffic behavior and economic activity in the Hampton Roads region, the models used in that research were calibrated on projected rather than actual data. From the viewpoint of transportation planning, it is preferable to have evidence on actual rather than proposed toll changes. The removal of toll charges on the Hampton Roads Bridge-Tunnel (I-64 in Norfolk), the James River Bridge (Routes 17 and 258 in Newport News) and the Coleman Bridge (Route 17 in Yorktown) afforded an excellent opportunity to obtain evidence on actual changes (see Figure 1).

The overall purpose of the research, a portion of which is reported here, was to monitor the short-range effects that the removal of these toll charges have had upon transportation and socioeconomic activity in the Hampton Roads region, and to suggest the extent to which different toll levels have acted as barriers to travel in the region. The specific objectives were to —

1. examine motorist (sample population) characteristics;

2. monitor the changes in traffic volume;

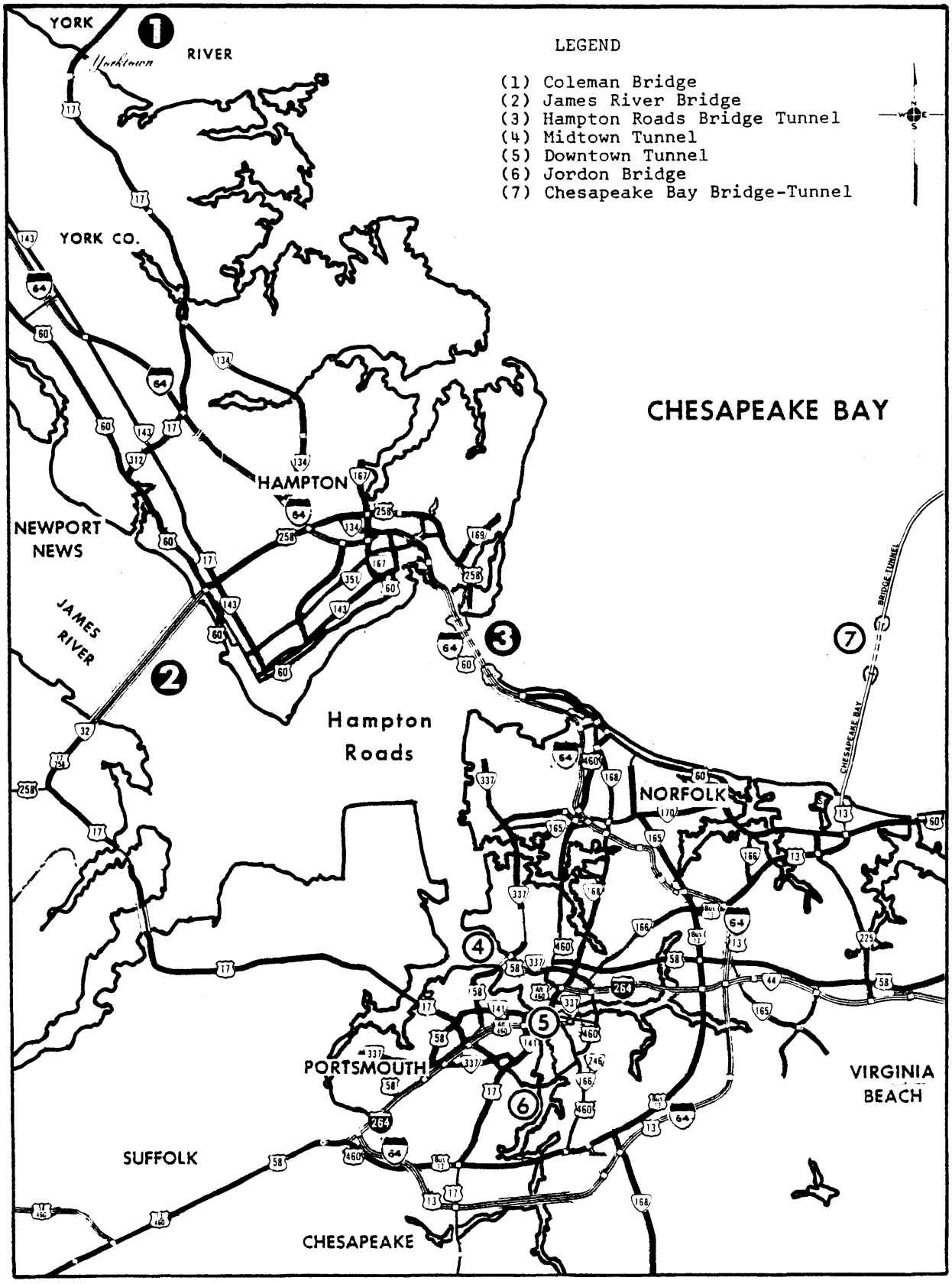

Figure 1. Highways and toll facilities in Tidewater area.

3. investigate the changes in traffic composition;

4. review the changes in vehicle occupancy rates and the propensity to carpool;

5. examine changes in trip purposes; and

6. investigate variations in travel patterns.

Although the monitoring of long-range effects may be desirable at a later date, this study was restricted to the immediate impacts created by the removal of the tolls.

Not only has this study provided objective data for assessing the feasibility of removing toll charges on other transportation facilities, it provides valuable insights into what might reasonably be expected to result from the use of pricing schemes as traffic control mechanisms. Furthermore, the results provide planners in the Tidewater area with information concerning emerging traffic patterns and trends which will be helpful in meeting the area's future transportation needs.

METHODOLOGY

To examine the effect of the removal of tolls, it was necessary, insofar as possible, to eliminate the impact of other factors bearing on the use of the facility. If there were discernible trends, either upward or downward, in the traffic using the Coleman Bridge they had to be taken into account by establishing historical trends based on conditions that had existed for several years prior to the removal of tolls. To eliminate distortions due to seasonal variations, monthly trends during before and after study periods were established and compared.

The methodology employed included mechanical and manual traffic volume and composition counts, a before questionnaire survey, an after questionnaire survey, and telephone contacts with many people from local governments, retail associations, and real estate agencies. Before discussing the data analysis, several comments will be made about data compilation.

Volume Counts

The Traffic and Safety Division and the Toll Facilities Division of the Virginia Department of Highways and Transportation have

secured vehicular traffic volumes at the James P. Coleman Bridge for many years. For the present study, the Department data for the past eight years were obtained to establish historical trends in total volumes and the composition by types of vehicles. The revenue data supplied by the Toll Facilities Division also reflected the commuter ticket usage before the tolls were removed.

After the removal of tolls, the Toll Facilities Division continued to secure vehicular volume counts with mechanical recorders, and made these data available to the researchers. In addition manual volume counts were made by Research Council personnel to determine traffic composition and vehicle occupancy rates.

Before Questionnaire Survey

To acquire travel information before the tolls were removed, a questionnaire was developed and distributed to a sample of the motorists traveling across the Coleman Bridge. The questionnaire requested information about the type of vehicle, origin, destination and purpose of trip, vehicle occupancy rate, respondent characteristics, aspects of latent demand, and whether or not the commuter ticket was used to pay the toll.

Of the 9,735 vehicles which daily crossed the facility, approximately one-half (4,248) were sampled on May 19, 1976. As the travelers entered the facility to pay the toll they were handed the questionnaires along with letters of explanation concerning the research project. (Copies of the letter and questionnaire are in Appendix A.) To facilitate the return of the questionnaire the respondent was required only to refold it (after filling it in) and drop it in a mailbox.

After Questionnaire Survey

Approximately five months after removal of the tolls, an interval that was thought to be sufficient to allow for short-range adjustments to the absence of the tolls, an after questionnaire survey was conducted.

The questionnaire developed for the after survey was similar to the one used in the previous survey; however it contained additional questions concerning participation in carpools and changes in travel since the tolls were removed. (The questionnaire is in Appendix B.) Because of the congestion and hazardous conditions

it creates, the roadside method of distributing the questionnaires was not used in the after survey. Instead, a license plate survey was employed in which a random sample of license plate numbers were recorded and traced through the Division of Motor Vehicles files for names and addresses. Those motorists in the sample (3,526, or approximately one-fourth of the total population) were mailed a questionnaire with a letter of explanation requesting they execute and return it by mail. As in the before survey, the respondent had only to refold the questionnaire and drop it in the mail. While the license plate survey is an effective procedure for securing travel information, it is limited to the vehicles licensed in Virginia since the Division of Motor Vehicles does not have out-of-state registration information.

Telephone Survey

Persons with several real estate agencies, chambers of commerce, retail merchants associations, department stores, and multiple listing services were contacted by telephone to seek information relative to resident and employment relocations which may be attributed to the removal of tolls on the Coleman Bridge. While all of the agencies expressed an interest in the study, few were able to provide pertinent data.

SURVEY RESULTS

Characteristics of the Sample Population

The George P. Coleman Memorial Bridge spans the York River on Route 17 and connects Gloucester Point with Yorktown. The approximately 1.28 km (0.80 mi.) facility cost $9,000,000 and was opened to traffic in 1952. Table 1 presents the toll rates on the facility in 1976.

The average daily traffic (ADT) in 1975 was 9,735 vehicles. A sampling rate of 50.0% yielded a sample population of 4,248 motorists for the survey taken prior to the removal of tolls. Of the sample population, 1,207 motorists, or 28.0%, responded to the survey. Males made up 65.8% of the respondents, while females accounted for 34.2%. The median annual income group was that comprising people in the $15,001 to $25,000 bracket, and the majority of respondents (51.2%) were professionals. Forty-six percent were between 21 and 39 years of age, 43.0% were between 40 and 65, and 5.0% were over 65. The trip length distribution showed the largest category to be trips greater than 72 km (45 mi.) and the mean trip length to be approximately 49.6 km (31 mi.).

Table 1

1976 Tolls for James P. Coleman Bridge
(One-way Trip)

Type of Vehicle	Toll
Automobile	
Cash	$0.75
Commuter ticket (sold in groups of 12)	0.30
Commercial	
2-ton or less	
2-axle	1.00
3-axle	1.25
2-ton or more	
2-axle	1.50
3-axle	1.75
Tractor-trailer	
3-axle	2.00
4-axle	2.50
5-axle	3.00

In the phase of data collection after the removal of tolls, a sample rate of approximately 25.0% during a 12-hour survey period yielded a sample population of 2,423. Of this group 888, or 37.0%, completed and returned the survey questionnaire.

Table 2 shows the makeup of the samples by age group for the before and after surveys. The 21-39 year age group accounted for 46.3% of the before sample and the 40-65 year group made up 43.0%. In the after period the number of people in the 21-39 year group decreased, while the older (over 65) group made more trips than before the tolls were removed. A review of Table 3 also reveals that the older age group increased their travels: The percentage of retired people crossing the facility more than doubled after the tolls were removed. Table 3 also reveals slight increases in the percentage of homemakers, the unskilled and the category marked "other" who responded to the after survey. Table 4 presents the composition of the sample by annual income. Professionals comprised the largest percentage of respondents in both the before and after surveys.

Table 2

Age Distribution of Respondents

Age	Percentage of Respondents	
	Before	After
Under 21	3.7	3.0
21-39	46.3	36.9
40-65	43.0	46.5
No response	1.8	4.1

Table 3

Occupation Distribution of Respondents

Occupation	Percentage of Respondents	
	Before	After
Professional	31.3	21.5
Business manager	10.9	13.6
Clerical	9.2	7.2
Craftsman	12.5	11.3
Machinist	5.0	3.7
Unskilled	2.9	3.6
Homemaker	9.9	10.1
Retired	7.0	14.4
Other	11.4	14.6

Table 4

Composition of Sample by Annual Income

Income (Dollars)	Percentage of Respondents	
	Before	After
< 9,000	12.5	15.2
9,000 - 12,000	14.1	13.5
12,001 - 15,000	15.3	15.5
15,001 - 25,000	31.8	30.0
25,001 - 30,000	10.0	6.6
> 30,000	9.3	8.0
No response	7.1	11.1

The distributions of key socioeconomic variables may be summarized as follows:

1. The income distribution for the after survey was almost identical to that for the before survey (Table 4).

2. There was a drop in the percentage of respondents classified as professional in the after survey.

3. There was a 4.0% increase in women responding in the after survey.

The socioeconomic characteristics of the respondents in the before and after surveys were sufficiently similar to allow the researchers to make inferences concerning behavior and attitudes based upon statistical comparisons of responses from the two groups.

Commuter Ticket Usage

Because of the cost differential between commuter ticket and single ticket tolls (see Table 1), the method of toll payment was investigated. For example, an individual who had used a commuter ticket and crossed the facility daily in traveling to and from work immediately realized a net increase in spendable income of almost $200 per year. Those who crossed eight times per week but did not use the commuter ticket realized savings of approximately $312 per year. Depending upon the type of payment method used, there would be different levels of benefit resulting from the removal of tolls and thus possibly different types of behavior exhibited. In short, an examination of commuter ticket usage was important because of the insight it could provide into the relationship between out-of-pocket toll prices and number of trips taken.

Of the respondents surveyed during the 12-hour survey period prior to the removal of tolls, 84.1% used a commuter ticket costing $0.30 for each one-way trip; the remainder paid $0.75. Because the survey period included the morning and afternoon peak work hour traffic, it is understandable that such a high percentage of those surveyed used the ticket. Cross tabulations indicated that income level was not significantly related to whether or not respondents used a commuter ticket (purchased in groups of 12) prior to the removal of tolls. While it was hypothesized that respondents in higher income groups might have less tendency to purchase commuter tickets than would lower income groups because the cost of tolls would represent a smaller portion of their budget, this expectation was not supported. The data showed that there was no greater

tendency to purchase the ticket among income groups earning greater than $15,000 per year than among lower income groups. However, the data showed that craftsmen, business managers, and clerical workers were much more likely to use the commuter ticket than were machine operators.

While a significant relationship was found between toll ticket usage and trip type for Hampton Roads crossings, that finding was not duplicated for Coleman Bridge crossings. In general, there was little variance in the use of toll tickets for working or shopping trips.

With respect to vehicle occupancy rates and commuter ticket usage, a significant relationship was found; viz., lone motorists were more likely to use the commuter ticket than those vehicles carrying one or two passengers. Only among the vehicles carrying 5 passengers was the commuter ticket used as extensively as among one-occupant vehicles. It had been anticipated that there would be a higher occupancy rate for vehicles carrying reduced fare commuter ticket users than for those carrying regular fare patrons. It was reasoned that if patrons attempt to minimize the cost of travel, those who cross frequently will search for carpools to spread the costs of travel. Since carpoolers are likely to cross at least as frequently as noncommuters, then it was reasoned that carpoolers would further reduce the cost of travel to and from work by purchasing commuter tickets. However, as the data above indicate, no such relationship was found. While discussion in later sections may shed some light on this finding, it is sufficient at this point to suggest that the level of the toll ($0.75) does not significantly enter into drivers' decisions because of the relatively small portion of total trip cost the toll represents.

Changes in Traffic Volumes, a Reflection of Changing Travel Demand

While in the long run the removal of tolls may precipitate subtle changes in traffic patterns and economic activity, the most noticeable immediate result of a change in the toll structure is a variation in traffic volumes.

As previously mentioned, it was necessary to establish the annual growth trend in travel to isolate the impact of the removal of tolls. The historical trends of traffic crossing the facility are presented in Figure 2.

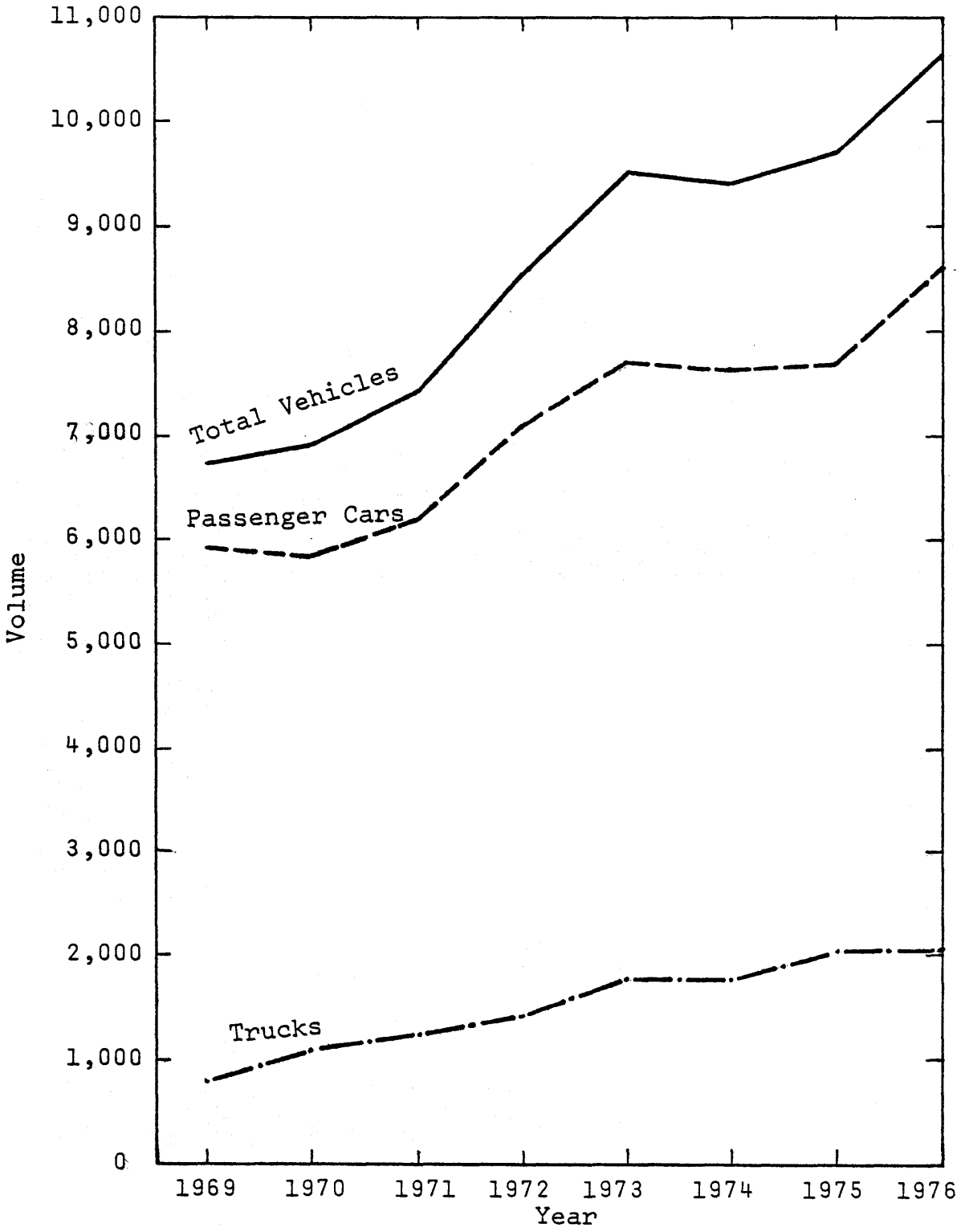

Figure 2. Average annual daily traffic volume — Coleman Bridge.

Traffic volumes on the Coleman Bridge have been steadily rising since 1969. The average annual daily traffic volume (AADT) in 1969 was approximately 6,750 vehicles; since that time, volumes increased through 1975 at an average annual rate of 7.2%, bringing the 1975 AADT to slightly in excess of 9,700 vehicles. As Figures 2 and 3 show, most of the absolute increase in traffic for that period was in passenger vehicles. The average daily truck traffic rose by nearly 180 vehicles per year, from approximately 930 per day to 2,000, and bus traffic remained relatively constant. The composition of traffic changed, although not significantly, during the period; while passenger cars increased substantially in absolute number, their relative share in the total traffic volume fell by 7% from 88% in 1969 to 81% in 1975.

From the above, one can conclude that changes in traffic volumes over the Coleman Bridge were predictable and rather moderate prior to the removal of tolls in June 1976. The historical traffic trends indicate that the average annual daily traffic volume for 1976 would have been approximately 10,398 vehicles had the tolls remained in effect during all of 1976. Referring to Figure 2, the curves for total volumes and passenger vehicles (exclusive of pickups and vans) indicate an increase in the AADT in 1976, even though five months of the 1976 data represent traffic flow in the presence of tolls. The 1976 AADT was almost 10,700, a 10.3% increase over 1975 and a 3.1% increase over the expected 1976 AADT based upon the historical trend.

More detailed traffic volume changes are given in Figures 3 and 4. Figure 3 shows the average daily traffic monthly before and after the toll removal. Clearly, the removal of tolls has not had any significant effect upon month-to-month variations in the average daily traffic. That is to say, the monthly variations before and after the removal of tolls rise at approximately equivalent rates during the months of January through July and fall at nearly equivalent rates from August through December. The data for the month of January after the toll removal do not follow the typical pattern, a phenomenon the authors found unexplainable. Apparently, a one-time shift in the traffic volume occurred. Again referring to Figure 3, the curve for the volumes after the toll removal (June 1976 through May 1977) indicates that the shift for the typically low volume month, January, was about 4,200 vehicles per day.

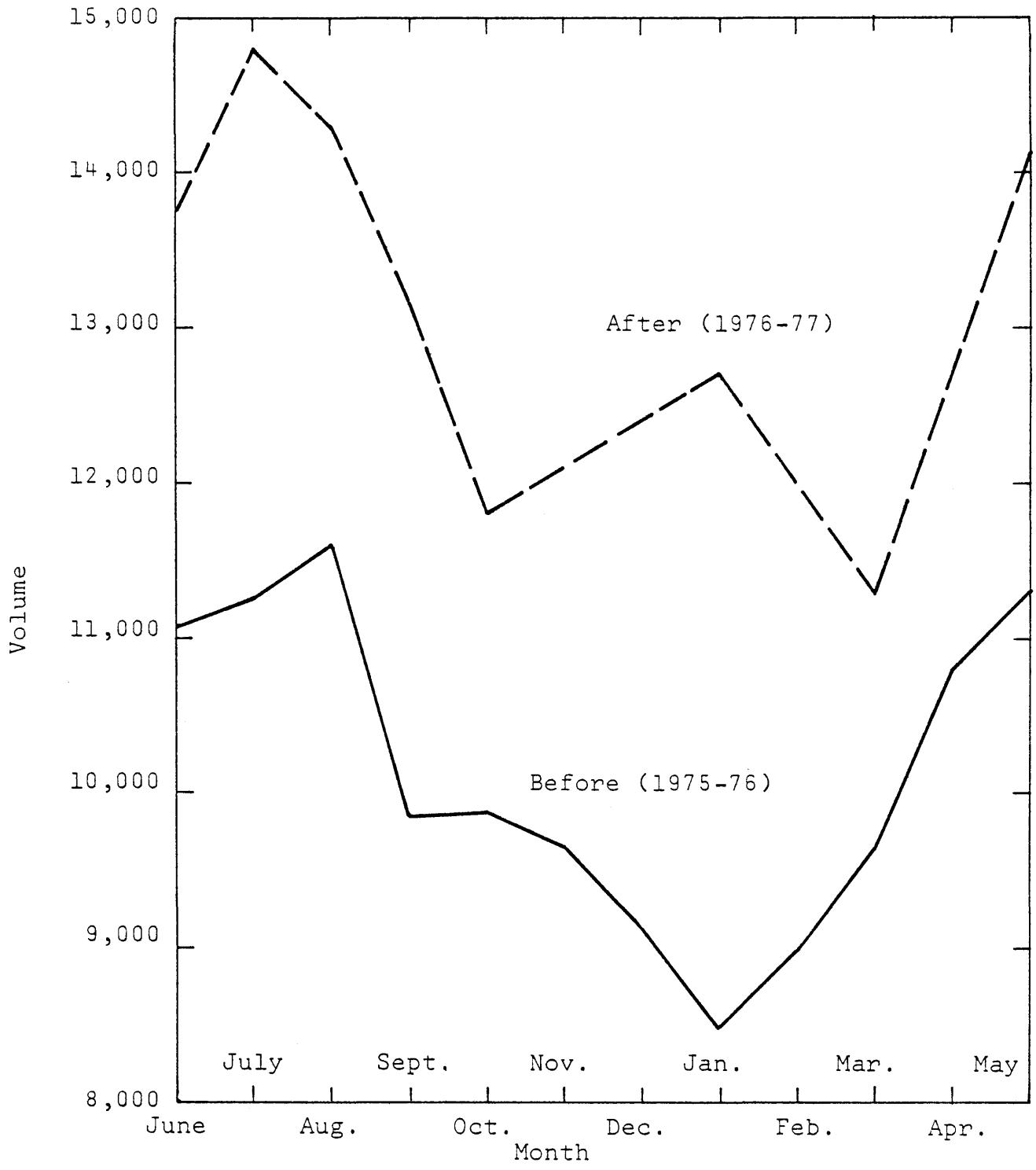

Figure 3. Monthly traffic volumes — Coleman Bridge. Before and after removal of tolls.

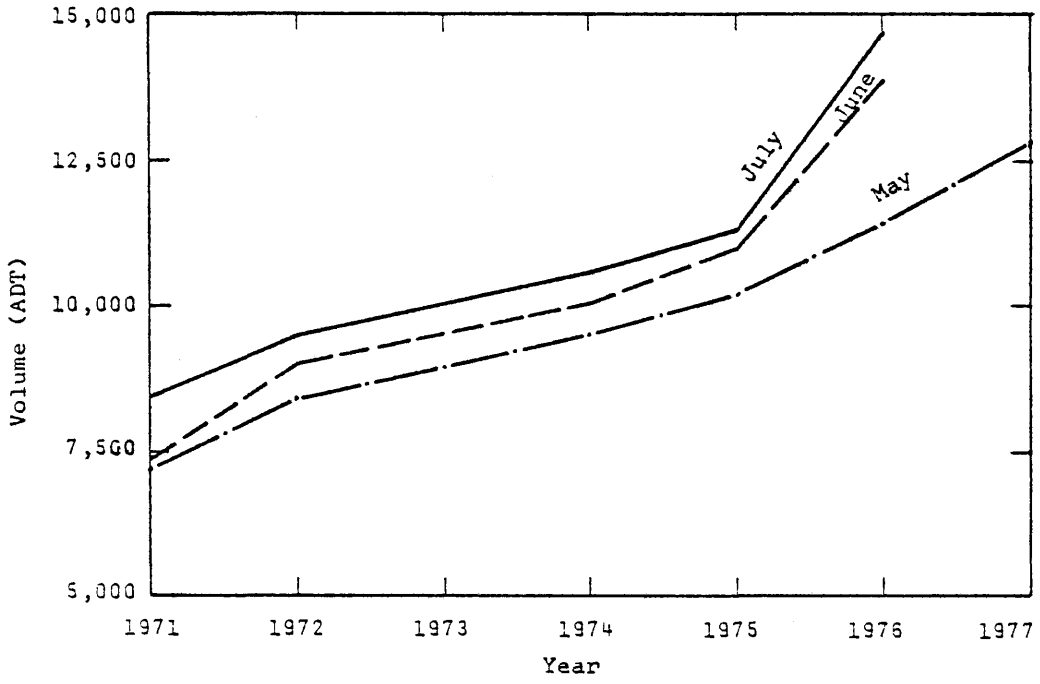

Figure 4. Three-month monthly travel trends — Coleman Bridge.

Figure 4 is a graphical comparison of the trends in the ADT for May, June, and July from 1971 through the after study period ending in May 1977. The bottom graph shows how the 1971 ADT for the month of May compares with the 1977 ADT for May. The rate of increase in the ADT for each of the months shown has been fairly moderate, about 8.6% during the period 1971 through 1975. As evidenced by the similarity in the slopes of the curves, the rates of increase from 1971 through 1975 were comparable for the three months. However, the similarity does not extend past the end of May 1976, the date the tolls were lifted. The projected traffic for July would have been approximately 11,750 vehicles per day if the tolls had remained in effect; the actual average volume was 14,100 vehicles per day.

The above data indicate that after the tolls were lifted there was a moderate increase in the number of vehicles using the Coleman Bridge. The greatest increase in traffic occurred during the first month after the tolls were lifted; since that time only slight monthly volume increases, approximately equal to the historical growth, have been observed.

Changes in Traffic Composition

Traffic composition was important in this study for two reasons. First, it was used to detect changes, if any, in the numbers of different types of vehicles crossing Coleman Bridge induced by the removal of the tolls. As previously mentioned, the tolls were considered a possible barrier to trade within the region and data were required to determine if the truck traffic and, therefore, trade changed. Second, the information was helpful in checking the sample population used in the questionnaire surveys against the general population using the facility.

After the tolls were removed, periodic manual classification counts were secured and the composition of traffic was recorded. This manual classification information is presented in Appendix C and is summarized in Table 5 along with 1975 statistics, representing the before period, obtained from the Traffic and Safety Division.

Table 5

Traffic Composition — Coleman Bridge
(In Percentages)

Period	Type of Vehicle					
	Cars	Pickups & Vans	Trucks			Other
			2-Axle	3-Axle	Tractor-Trailer	
1975	78.9	16.6	2.3	0.6	1.3	0.3
July 1976	75.9	16.3	2.5	1.5	2.7	1.1
Aug. 1976	77.1	16.7	3.1	0.6	1.8	0.7
Sept. 1976	75.9	18.8	2.7	0.2	1.1	0.9
Oct. 1976	75.1	18.5	2.8	0.9	2.3	0.4
Mar. 1977	72.7	19.7	3.8	0.8	2.6	0.5
May 1977	74.1	19.2	2.6	1.2	1.2	1.7

The ADT classification volumes shown in Table 5 reveal that currently passenger cars make up a slightly smaller percentage of the total traffic than they did prior to the toll removal. Whereas in 1975 cars comprised 78.9% of the ADT, they currently make up 74.0%. Pickups and vans have increased by about 1.0% since the tolls were lifted. The data also indicate that truck traffic as a percentage of the total volume, particularly that portion represented by 2-axle and tractor-trailer trucks, has remained above the 1975 volumes. This seems to imply some type of generated economic activity as a result of free crossing.

With respect to the types of vehicles surveyed, the before data showed that of the 1,206 vehicles whose owners responded, 80.8% were Virginia autos, 4.0% were out-of-state cars, 12.8% were vans or pickups, 1.2% were 2-axle trucks, and about 1.0% were trailers. The distribution for the after survey is quite similar. The classification distribution for 100% counts compares favorably with the survey classification volumes, thus indicating the acceptability of the samples drawn as inferential data bases. The data on the composition of traffic utilizing Coleman Bridge during 1975 (ADT volumes) and July and August 1976 show, for example, the similarity between the survey classification distributions and actual classification volumes (see Table 5).

Changes in Vehicle Occupancy Rates and Carpooling

Occupancy rates have been periodically monitored since the tolls were removed. Unfortunately no reliable on-site counts are available for the period before the tolls were removed. While the questionnaire for the before survey did contain a question concerning vehicle occupancy, the authors prefer not to make inferences about changes in absolute occupancy rates based upon a single day's distribution. Survey results are, however, presented later in the report. The monthly occupancy data gathered since the removal of tolls are given in Appendix D and are plotted in Figure 5. From Figure 5 it can be seen that after the removal of the tolls occupancy rates declined until March, when an upward trend began.

While the data in Figure 5 show that the average occupancy rates fell from 1.82 to a low of 1.46 in the months after the toll removal, the authors are reluctant to suggest the extent to which this pattern is different from the typical monthly variations. In fact, in the authors' opinion, it cannot reasonably be argued that a significant reduction in the occupancy rate has resulted from the toll removal. Referring to Figure 5, notice particularly that from July to January the rate fell by only 11.0%. This result is quite in contrast to the significant reduction in occupancy resulting from the toll removal on the Hampton Roads Bridge-Tunnel. The difference in the amounts of the levies at the toll facilities most likely accounts for the different results. (See Volume I.)

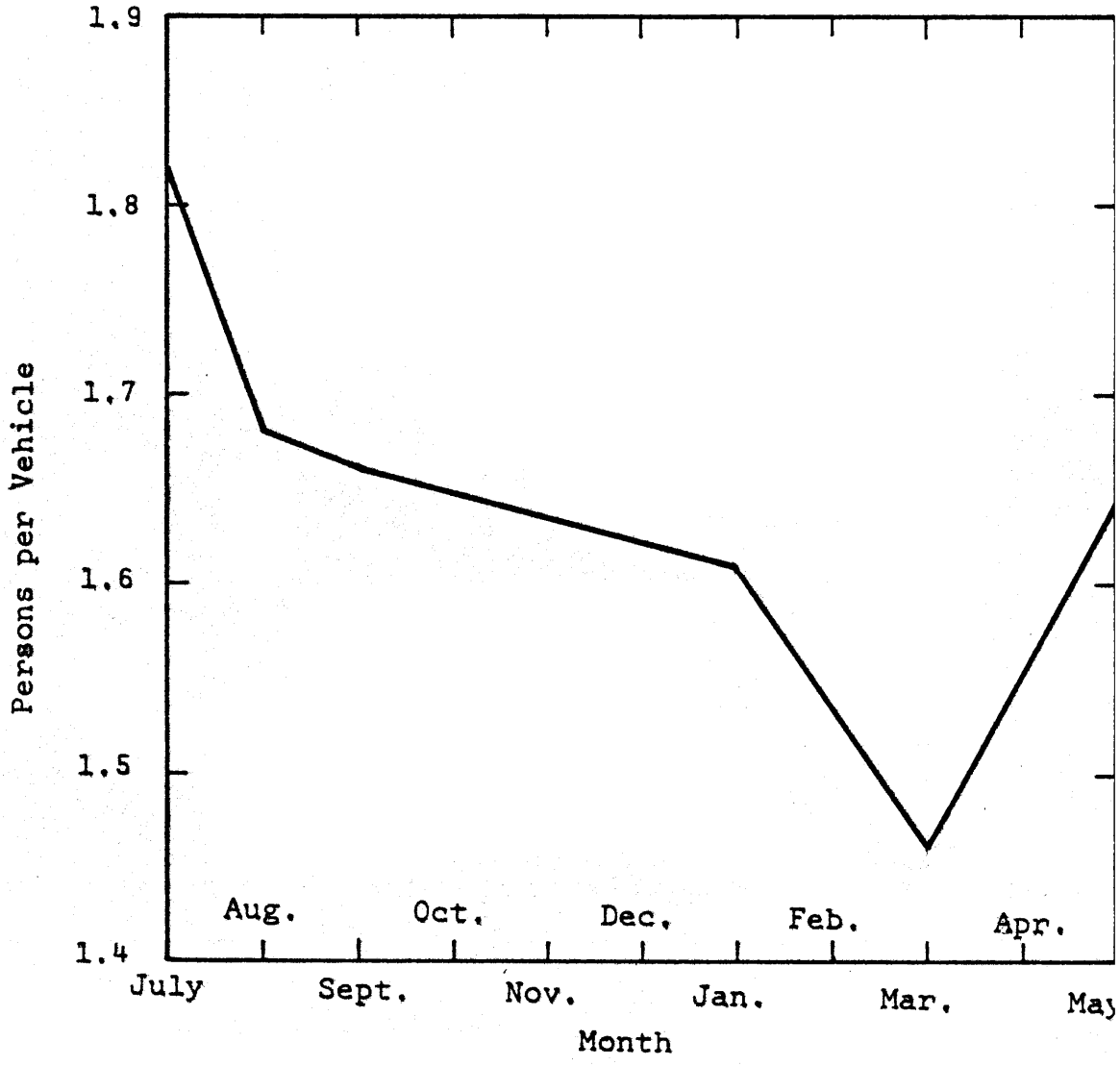

Figure 5. Vehicle occupancy rates after removal of tolls at Coleman Bridge.

There are several variables that obviously should be examined for their bearing on occupancy rates. Among these are age, income, occupation, length of trip, tendency to carpool, and trip purpose. Because the authors wish to examine only these interrelationships and not before/after comparisons, only the after survey results are discussed.

With respect to occupancy and age, cross tabulations show a significant relationship. As would be expected, retired individuals ride together more often than other age groups. The relationship between income and occupancy rate proved to be non-linear. Figure 6 shows that low income groups, as expected, have higher occupancy rates than some other groups; however the relationship isn't linearly inverse. Rather, the rate drops for middle income groups and then rises again for those respondents earning more than $25,000.

Occupation appeared to have a significant influence on the occupancy rate. Table 6 presents the mean occupancy rate for each occupational class. While armchair theorizing may lead one to hypothesize that commuters would have higher occupancy rates than travelers who cross less frequently, the data show the opposite relationship to hold. In particular, the groups that travel more frequently exhibit lower occupancy rates than groups traveling relatively infrequently. After the toll removal, students, business managers, and machinists represented the classes with lowest mean occupancy rates; the unskilled, homemakers, and clericals had higher rates than other classes.

One might reasonably hypothesize that occupancy rate would vary by trip purpose. Table 7 presents data consistent with this hypothesis. Work trips are typically characterized by a lower occupancy rate than other kinds of trips, particularly shopping trips. It is ironic that although work trips make up the large majority of trips taken, the occupancy rate for that type of trip is lower than the rate for any other category. Note that the data in Table 8 are consistent with the occupancy rate by trip purpose data. The people who travel most frequently across Coleman Bridge exhibit the lowest occupancy rates. Turning to trip duration, the length of trip seems to have some bearing on the occupancy rate (Table 9). In general, the longer the length of the trip, the higher the occupancy rate.

The removal of the tolls was hypothesized to have reduced the tendency to carpool. An examination of carpooling by trip purpose showed that, particularly for the work-oriented trip, a small reduction in carpooling occurred. For shopping trips, however, a significant increase was recorded. This information is summarized in Table 10. A brief comment is in order concerning these results. Because of the rather slight decrease in carpooling observed, the authors suggest that carpooling is a habit which tends to be less influenced by marginal changes in cost than might be expected at first glance. More specifically, carpooling is a function not only of the level of tolls but also of trip length, frequency, and travel time.

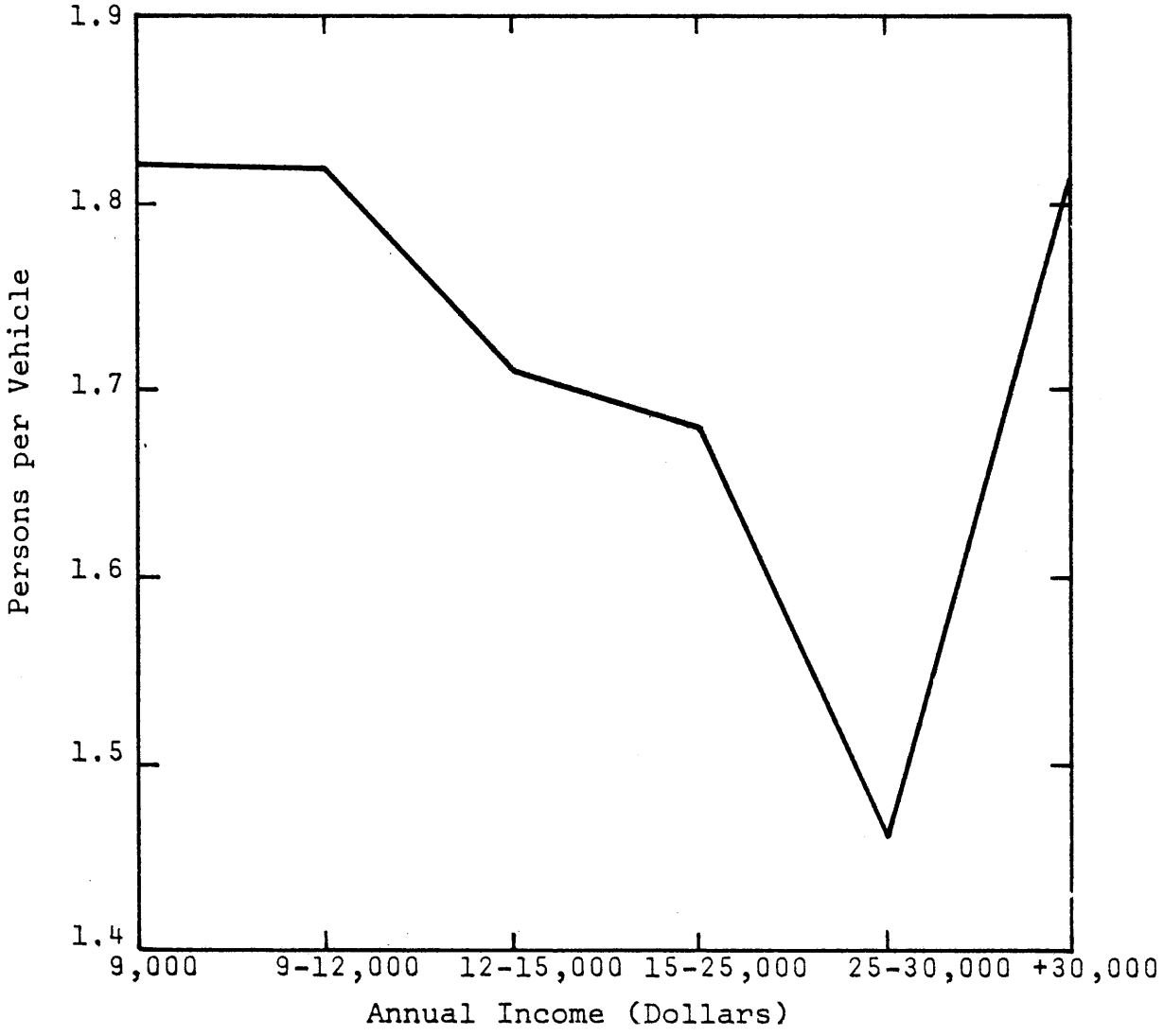

Figure 6. Vehicle occupancy rates and income for after period.

Table 6

Vehicle Occupancy by Occupation, After Period

Occupation	Occupancy Rate
Professional	1.61
Business manager	1.52
Clerical	1.91
Craftsman	1.68
Operator	1.57
Unskilled laborer	2.03
Homemaker	2.01
Retired	1.88
Student	1.24

Table 7

Vehicle Occupancy by Trip Purpose, After Period

Trip Purpose	Occupancy Rate
Origin	
Home	1.73
Work	1.63
Shopping	1.89
Other (Recreational, school, etc.)	1.65
Destination	
Home	1.74
Work	1.53
Shopping	1.80
Other (Recreational, school, etc.)	1.75

Table 8

Vehicle Occupancy by Number of Crossings

Number of Crossings	Occupancy Rate
> 10 per week	1.56
4-6 per week	1.77
2 per week	1.82
1 per week	1.96
2 per month	1.81
< 6 per year	1.95

Table 9

Mean Occupancy Rate by Trip Duration After Toll Removal

Trip Duration in Minutes	Occupancy Rate
0-15	1.71
16-20	1.63
21-25	1.64
26-35	1.68
36-45	1.75
46-60	1.66
61-75	1.81
> 75	1.93

Table 10

Percentage of Carpools by Trip Destination

Destination	Carpool	
	Before	After
Home	15.2	15.0
Work	29.2	28.7
School	8.0	0.0
Shopping	7.4	5.6
Other	12.2	12.2

Changes in Trip Purpose

Because all trip types or purposes are not equally ranked by travelers in terms of importance, the consequences of tolls cannot be capsulized by simply examining the total number of trips taken before and after the tolls were removed. More insight is provided through a perspective of how trip types were affected.

The data in Tables 11 and 12 show clearly that since tolls were lifted the "shopping" and "other" category trips have increased. Such a reaction to the removal of tolls is consistent with normal expectations concerning price elasticity of demand. Specifically, essential work trips were being made prior to the toll removal, and there was no reason to expect a significant change in the number of these trips. However, shopping trips

frequently provide some recreational value and thus cannot always be classified as essential. To the extent that travel is considered to be a good which is to some degree a luxury item in people's budgets, a fall in the price should increase the quantity demanded. Thus, the increase in shopping oriented trips was expected.

Table 11

Trip Purposes, Before Period
(Percentages in Parentheses)

Origin	Destination					
	Home	Work	School	Shopping	Other	Total
Home	14 (2.3)	372 (61.2)	15 (2.5)	52 (8.5)	155 (25.5)	608 (51.0)
Work	296 (78.1)	39 (10.3)	1 (0.3)	4 (1.1)	37 (9.8)	377 (31.7)
School	8 (72.7)	1 (9.1)	0 (0.0)	0 (2.8)	2 (2.8)	11 (3.0)
Other	112 (70.0)	25 (15.6)	1 (0.6)	3 (1.9)	19 (11.9)	160 (13.4)
Total	462 (38.8)	439 (36.8)	17 (1.4)	60 (5.0)	214 (18.0)	1,192 (100.0)

Table 12

Trip Purposes, After Period
(Percentages in Parentheses)

Origin	Destination					
	Home	Work	School	Shopping	Other	Total
Home	17 (3.6)	189 (39.9)	31 (6.5)	51 (10.8)	186 (39.2)	474 (54.0)
Work	134 (75.3)	18 (10.1)	5 (2.8)	2 (1.1)	19 (10.7)	178 (20.3)
School	21 (84.0)	0 (0.0)	1 (4.0)	0 (0.0)	3 (12.0)	25 (2.8)
Shopping	46 (85.2)	5 (9.3)	0 (0.0)	2 (3.7)	1 (1.9)	54 (6.1)
Other	118 (79.7)	16 (10.8)	0 (0.0)	0 (0.0)	14 (9.5)	148 (16.8)
Total	336 (38.2)	228 (25.9)	37 (4.2)	55 (6.3)	223 (25.4)	879 (100.0)

Changes in Travel Patterns

In the following sections examinations are made of the changes in frequency of crossings, length of trips, origins and destinations of trips, jobs, and residences in an attempt to determine the effects of the removal of tolls on travel patterns.

Change in Frequency of Crossings

Although the removal of the toll generated more cross regional traffic on Coleman Bridge, the magnitude of this increase was not as great as it was on Hampton Roads. The average number of trips taken per week prior to the tolls was 4.95. After the toll removal, trips taken increased to an average of 5.77 per week. Table 13 presents the distributions of trips before and after the toll removal. Notice the significant changes in the "10 per week" and "less than six per year categories." While both males and females are making more trips, females seem to have been only slightly more affected as a group than males in the sense that

they have increased their tendency to take more trips by only about 1.0% over males. Note in Table 14 that among traveling females there was an 8.1% increase in the group making more than 10 crossings per week. Males increased their percentage in this category by 6.8%.

The survey results show that respondents in the over 65 years of age group are traveling more frequently; that is, they account for a larger percentage of the total trips taken. Before the toll removal 5.1% of trips were taken by this group while afterwards this figure rose to 9.7%.

Since occupation is highly correlated with level of income and the demand for travel is somewhat a function of income, it was expected that the less well-paid occupational categories might change their demand for trips after the tolls were removed. The data do not reveal significant differences in demand changes by occupational category, however. Furthermore, the results of cross tabulations between number of crossings and income, shown in Table 15, do not strongly exhibit a tendency on the part of lower income groups to travel more. The relatively minor toll charge of $0.30 probably accounts for the fact that toll removal had little effect on demand for travel by income category.

It should be noted that demand for travel can be examined from several perspectives. Changes in traffic volumes are a reflection of either an increase or decrease in the number of trips typically taken by demanders. Furthermore, one can argue that if a reduction in tolls is expected to increase the number of trips, it should likewise be expected to have some effect on trip length. Prior to the removal of the tolls, the mean trip length of those surveyed was 49.6 km (31 mi.) and averaged 43.87 minutes travel time. After the tolls were lifted, travel time averaged 40.10 minutes per trip. Table 16 presents the relationship between number of crossings and trip lengths. While no data for length of trip in miles were available, one can safely argue that if any change has occurred, it is that of a reduction because capacity was identical in the before and after phase, yet traffic volumes (congestion) were higher. The implication of such results is that trip distance has not been significantly increased by the removal of tolls. A more likely occurrence is that more trips of either the same length or shorter length are being generated. The data presented in Table 17 tend to support this hypothesis.

Table 13

Number of Crossings, in Percentages
(N = 888)

Number of Crossings	Before	After
> 10 per week	36.5	43.8
4-6 per week	17.2	19.5
2 per week	11.6	12.0
1 per week	9.4	8.7
2 per month	8.8	8.0
< 6 per year	15.4	7.3
NR	1.0	0.7

Table 14

Number of Crossings for Females, in Percentages
(N = 330)

Number of Crossings	Before	After
> 10 per week	35.8	43.9
4-6 per week	19.1	19.7
2 per week	12.1	14.2
1 per week	10.0	9.4
2 per month	7.0	7.0
< 6 per year	15.8	5.5
NR	0.3	0.3

Table 15

Number of Crossings by Income, in Percentages

Number of Crossings	Under $9,000		$9,001-12,000		$12,001-15,000		$15,001-25,000		$25,001-30,000		Over $30,000	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
> 10 per week	30.4	35.6	45.0	50.8	33.6	47.8	36.8	45.1	33.9	35.6	42.3	47.9
4-6 per week	15.6	20.7	15.0	14.2	22.6	23.2	15.0	20.3	20.3	20.3	16.9	12.7
2 per week	10.4	12.6	8.3	10.0	15.3	13.0	12.4	11.3	15.3	16.9	4.2	9.9
1 per week	10.4	11.1	9.2	9.2	8.8	5.1	8.3	6.4	6.8	6.8	12.7	15.5
2 per month	14.1	13.3	9.2	6.7	8.0	5.8	5.6	5.6	8.5	10.2	8.5	9.9
< 6 per year	15.6	5.9	11.7	7.5	10.9	4.3	21.8	10.5	15.3	10.2	14.1	4.2
No response	3.7	0.7	1.7	0.2	0.7	0.1	0.0	0.2	0.0	0.0	1.4	0.0

Table 16

Trips by Average Trip Length

Number of Trips	Average Length (minutes)	
	Before	After
> 10 per week	33.7	32.6
4 per week	39.0	36.4
2 per week	39.4	42.4
1 per week	47.4	49.2
2 per month	53.2	56.0
< 6 per year	48.4	67.1

Table 17

Trip Length by Destination

Destination	Average Length of Trips (minutes)	
	Before	After
Home	44.2	40.8
Work	39.4	35.2
School	37.3	34.2
Shopping	46.4	34.3
Other (recreational, visiting, etc.)	54.3	47.5

Changes in Origins and Destinations of Trips

In order to review origin and destination patterns of travelers in Tidewater, the area was divided into traffic zones as shown in Figure 7. The volumes and relative frequencies are presented in Table 18 and tables showing the number of trips between the zones are shown in Appendix E.

The data show that the largest percentages of total trips originated in zones 22, 14, 21, and 5, both before and after the tolls were removed.

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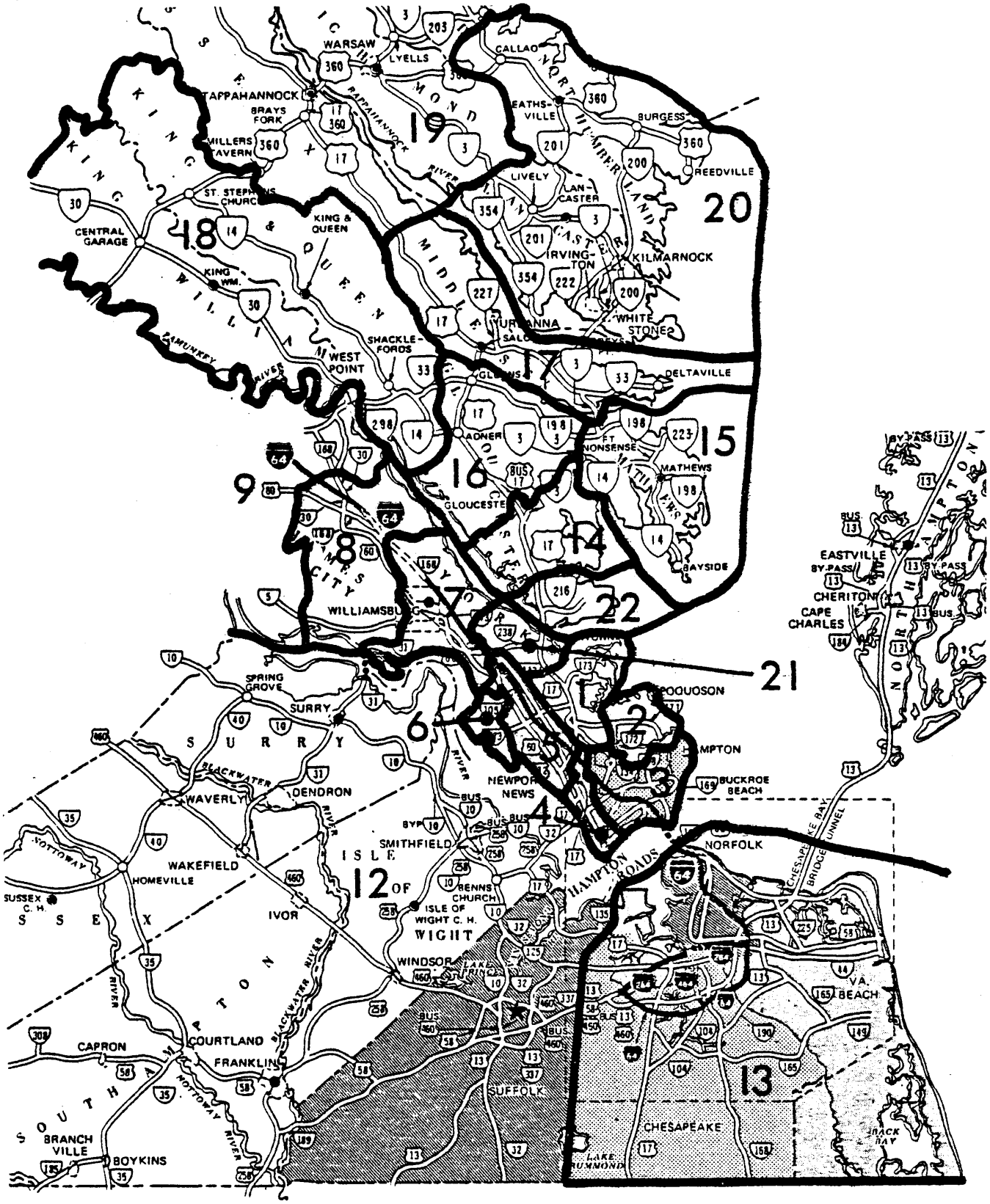

Figure 7. Traffic zones

Table 18

Traffic Volumes by Zone of Origin and Destination

Zone	Origin				Destination			
	Volume		Relative Frequency		Volume		Relative Frequency	
	Before	After	Before	After	Before	After	Before	After
1	22	24	1.9	2.7	29	23	2.4	2.6
2	29	15	2.4	1.7	27	14	2.3	1.6
3	72	51	6.1	5.8	125	63	10.5	7.1
4	88	66	7.4	7.5	111	54	9.4	6.1
5	90	81	7.6	9.2	103	75	8.7	8.5
6	23	13	1.9	1.5	25	13	2.1	1.5
7	56	54	4.7	6.1	69	64	5.8	7.2
8	4	3	.3	.3	1	1	.1	.1
9	8	11	.7	1.2	2	3	.2	.3
10	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-
12	12	1	1.0	.1	11	4	.9	.5
13	48	40	4.0	4.5	45	37	3.8	4.2
14	173	128	14.6	14.5	138	123	11.6	13.9
15	80	42	6.7	4.8	73	54	6.2	6.1
16	9	6	.8	.7	7	6	.6	.7
17	30	21	2.5	2.4	24	24	2.0	2.7
18	3	-	.3	-	1	2	.1	.2
19	35	17	3.0	1.9	43	27	3.6	3.1
20	25	8	2.1	.9	14	15	1.2	1.7
21	95	88	8.0	10.0	92	86	7.8	9.7
22	285	215	24.0	24.3	247	196	20.8	22.2
23	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-
Total	1,187	884	100.0	100.0	1,187	884	100.0	100.0

Of those trips generated south of the bridge and traveling north, 83.0% were destined for zones 22, 14, and 15 before the tolls were removed. After the removal, this figure fell to 78.4%. Of the trips generated north of the bridge and traveling south, 74.0% were destined for zones 21, 5, 7, 3, and 4 before the tolls were removed, and there were no significant changes in the origin-destination patterns afterwards.

While cross tabulations between origin/destination patterns and occupancy rate, propensity to carpool, trip purpose, and income level were developed and may be reviewed upon request, the cell sizes by zone were considered too small to allow conclusions, and, thus, are not presented in the report.

Changing Residences and Jobs

Approximately 3.0% of the respondents have either changed residences or will change as a result of the removal of tolls. Several variables were tested for their influence on changing residence, among them income and prior and current numbers of crossings. Cross tabulations showed that people who changed residences after the toll removal were likely individuals earning $12,001 - $15,000 per year. Further, the data indicated that individuals who changed their residence made very few trips across the bridge prior to the removal of tolls. Specifically, 46.0% of those who changed residences made fewer than 12 trips per year across the facility. After the removal of tolls and their move, 5.4% of this group made 10 or more crossings per week.

The data available concerning changing jobs are quite limited. Of the respondents to the survey, 2.0% changed jobs or planned to change jobs as a result of the toll removal. Cross tabulations showed that 30.0% of those who changed jobs made fewer than 6 trips per year prior to the toll removal. After the toll removal and a change in jobs, 59.0% of this group were making 10 or more trips per week. Income level was not a significant influence on the decision to change jobs.

ACKNOWLEDGEMENTS

The authors express appreciation to the personnel of the Transportation Planning Division of the Virginia Department of Highways and Transportation for their assistance and cooperation in this research. Specifically, Transportation Planning Engineer Oscar K. Mabry suggested that the study be undertaken, and R. E. Campbell, B. R. Clarke, and M. F. Dunn, Jr. provided valuable suggestions about data collection in the early stages of the study. E. G. Ketron coordinated the after phase of data collection with the Division of Motor Vehicles.

Special thanks go to J. K. Brookshire, Jr., assistant district engineer in the Suffolk District, and his staff for providing valuable monthly traffic volume reports; to L. H. Dawson, Jr., assistant traffic and safety engineer, for making available traffic recorders; and to the staff of the Division of Motor Vehicles for providing the names and addresses of those persons sampled in the after phase of the study.

Appreciation is extended to several members of the Research Council staff. In particular, acknowledgement is made of the contribution of Jerry Korf of the data systems group; John Shelor, who supervised the data collection activities; Susan Kane, our secretary; Harry T. Craft, who edited the report; and the technicians and student helpers who assisted in the data collection.

The study was financed with Highway Planning and Research funds administered by the Federal Highway Administration of the U. S. Department of Transportation.

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DEPARTMENT OF CIVIL ENGINEERING

COMMONWEALTH of VIRGINIA

HIGHWAY & TRANSPORTATION RESEARCH COUNCIL

May 18, 1976

JACK H. DILLARD, HEAD
VIRGINIA HIGHWAY & TRANSPORTATION RESEARCH COUNCIL

BOX 3817 UNIVERSITY STATION
CHARLOTTESVILLE, VIRGINIA 22903

IN REPLY PLEASE REFER TO FILE NO. 30.2.6

Dear Motorist:

As the research branch of the Virginia Department of Highways and Transportation we are conducting a study to find out how the removal of tolls on the Coleman Bridge will affect automobile and truck travel. The first part of the study is to collect information from the people who pay the tolls to use the facility.

In an effort to reduce or eliminate your delay and inconvenience while we are conducting this survey, the mail-back questionnaire method of data collection is being used instead of the roadside interview technique. To help us get the needed information, we are asking that you please complete the attached questionnaire and drop it in a convenient mailbox for return to us. No postage is required. IF YOU SHOULD RECEIVE MORE THAN ONE QUESTIONNAIRE FROM THIS LOCATION OR OTHER LOCATIONS DURING THE COURSE OF THIS SURVEY, PLEASE COMPLETE AND RETURN ALL OF THEM.

Thank you for your cooperation and assistance. The accuracy and success of this survey are dependent on your help.

APPENDIX A (CONT.)

This Survey is Sponsored by the Virginia Department of Highways and Transportation

THE FOLLOWING QUESTIONS CONCERN THE TRIP YOU WERE MAKING WHEN YOU RECEIVED THIS QUESTIONNAIRE ON ROUTE 17 AT THE COLEMAN BRIDGE TOLL PLAZA. YOU WERE TRAVELING TOWARD GLOUCESTER POINT IN THE NORTH-BOUND DIRECTION.

Please Answer all Questions and Drop in Mailbox — No Postage Required

---

A. What type of vehicle did you use for this trip? (circle one)

1. Passenger Car - Virginia
2. Passenger Car - Out of State
3. Pickup or Van
4. Two-axle truck
5. Three-axle truck
6. Tractor-Trailer
7. Other - specify_____

B. Where were you coming from?

_____
(Specify street no. & name, city & state)

C. Was the place you came from? (circle one)

1. Your home 2. Place of work 3. School 4. Shopping
5. Other (specify)_____

D. Where were you going?

_____
(Specify street no. & name, city & state)

E. Was this place? (circle one)

1. Your home 2. Place of work 3. School 4. Shopping
5. Other (specify)_____

F. What time did this trip begin?_____A.M._____P.M. and end?_____A.M._____P.M.

G. Did you use the reduced toll commuter ticket? (circle one) 1. Yes 2. No

H. How many persons (including driver) were in your vehicle on this trip? _____

I. How frequently do you cross the Coleman Bridge? Include both directions; a round trip is 2 crossings. (circle one)

1. 2 or more crossings a day
2. 4 crossings per week
3. 2 crossings per week
4. 4 crossings per month
5. 2 or less crossings per month

J. What will you do when the tolls are removed? (circle one)

1. Make the same number of trips as now
2. Make fewer trips
3. Make more trips

K. Please indicate your Sex. (circle one) 1. Male 2. Female

L. Please indicate your Age. (circle one) 1. under 21 2. 21-39 3. 40-65 4. over 65

M. What is your Occupation? _____

N. What was the combined annual income of all members of your household in 1975? (circle one)

1. under $9,000
2. $9,001 - $12,000
3. $12,001-$15,000
4. $15,001-$25,000
5. $25,001-$30,000
6. over $30,000

O. In general, what are your feelings toward the removal of tolls and what effects will it have upon your shopping, working, and traveling activities?

_____
_____
_____
_____

THANK YOU — PLEASE FOLD AND MAIL

ARTMENT OF HIGHWAYS & TRANSPORTATION
J. E. HARWOOD, COMMISSIONER

N. S. G. BRITTON
DEPUTY COMMISSIONER AND
CHIEF ENGINEER

ROYER, JR.
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UNIVERSITY OF VIRGINIA 1899
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COMMONWEALTH of VIRGINIA

HIGHWAY & TRANSPORTATION RESEARCH COUNCIL

BOX 3817 UNIVERSITY STATION
CHARLOTTESVILLE, VIRGINIA 22903

October 19, 1976

CK H. DILLARD, HEAD
IGINIA HIGHWAY & TRANSPORTATION RESEARCH COUNCIL

IN REPLY PLEASE REFER TO FILE NO. 30.2.6

Dear Car Owner:

As the research branch of the Virginia Department of Highways and Transportation, we are conducting a study to determine how the removal of tolls on several Tidewater bridges will affect automobile and truck travel in the area. The second part of this study consists of collecting information from the people who paid tolls before June 1, 1976, but who are now using the facilities toll-free.

In an effort to reduce or eliminate your delay and inconvenience while we conduct this survey, the mail-back questionnaire method of gathering information is being used instead of the roadside interview. A vehicle registered in your name was observed crossing the Coleman Bridge on October 19, 1976, and the attached brief questionnaire concerns that trip. To help us get the needed information, we ask that you or the person who made the trip please answer the questionnaire and drop it in a convenient mailbox for return to us. No postage is required. IF YOU SHOULD RECEIVE MORE THAN ONE QUESTIONNAIRE DURING THE COURSE OF THIS SURVEY, PLEASE COMPLETE AND RETURN ALL OF THEM.

Thank you for your cooperation. The accuracy and success of this survey are dependent on your help.

Sincerely,

Gary R. Allen
Research Economist

R. N. Robertson
Research Engineer

APPENDIX B (CONT.)

This Survey is Sponsored by the Virginia Department of Highways and Transportation

A VEHICLE REGISTERED IN YOUR NAME WAS OBSERVED ON ROUTE 17 AT THE COLEMAN BRIDGE DURING THE MORNING OF OCTOBER 19, 1976 TRAVELING TOWARD GLOUCESTER POINT IN THE NORTHBOUND DIRECTION. THE FOLLOWING QUESTIONS CONCERN THAT TRIP AND MAY BE ANSWERED BY EITHER YOU OR THE PERSON WHO WAS DRIVING THE VEHICLE.

Please Answer all Questions and Drop in Mailbox - No Postage Required

---

I. Errors in recording license plates do occur. If this form was sent to you by error, please check here and return. _____

II. What type of vehicle did you use for this trip? (circle one)
1. Passenger Car
2. Pickup or Van
3. Two-Axle Truck
4. Three-Axle Truck
5. Tractor-Trailer
6. Other -(specify) _____

III. A. At what address did this trip begin? _____
Street Number, City (County), State

B. Was this place? (circle one) 1. Your Home 2. Work 3. School
4. Shopping Area 5. Other (specify) _____

IV. A. At what address did this trip end? _____
Street Number, City (County), State

B. Was this place? (circle one) 1. Your Home 2. Work 3. School
4. Shopping Area 5. Other (specify) _____

C. How long did it take you to get there? (circle one)
1. 0-15 min.
2. 16-20 min.
3. 21-25 min.
4. 26-35 min.
5. 36-45 min.
6. 46-60 min.
7. 61-75 min.
8. more than 75 min.

V. How many persons rode with the driver on this trip? (circle one)
1. 0 riders
2. 1 rider
3. 2 riders
4. 3 riders
5. 4 riders
6. 5 riders
7. 6 riders
8. 7 riders
9. 8 riders
10. 9 or more riders

VI. A. About how often do you cross the Coleman Bridge? Include both directions; a round trip is 2 crossings. (circle one)
1. 10 or more crossings a week
2. 4-6 crossings a week
3. 2 crossings a week
4. 2 crossings every 2 weeks
5. 2 crossings a month
6. less than 6 a year

B. About how often did you cross the Coleman Bridge before the toll was removed? A round trip is 2 crossings. (circle one)
1. 10 or more crossings a week
2. 4-6 crossings a week
3. 2 crossings a week
4. 2 crossings every 2 weeks
5. 2 crossings a month
6. less than 6 a year

VII. A. Do you car pool to and from work? (circle one) 1. Yes 2. No
B. Did you car pool before the tolls were lifted? (circle one) 1. Yes 2. No

VIII. A. Please indicate your sex. (circle one) 1. Male 2. Female
B. Please indicate your age. (circle one) 1. under 21 2. 21-39 3. 40-65 4. over 65
C. What is your occupation? _____
D. What was the combined annual income of all members of your household in 1975? (circle one)
1. under $9,000
2. $9,000-$12,000
3. $12,001-$15,000
4. $15,001-$25,000
5. $25,001-$30,000
6. over $30,000

IX. A. Will the removal of the toll cause you to change your residence? (circle one) 1. Yes 2. No
B. Will the removal of the toll cause you to change jobs? (circle one) 1. Yes 2. No

X. Comments _____

THANK YOU - PLEASE FOLD AND MAIL

APPENDIX C

CLASSIFICATION TRAFFIC VOLUMES

NORTHBOUND LANE

Hour	Cars	Pickups & Vans	2-Axle	3-Axle	Tractor-Trailer	Other	Total
July 22, 1976, a.m.							
7:00-7:30	43	32	6	2	1	0	84
7:30-8:00	112	29	13	2	0	0	156
8:00-8:30	124	21	5	6	0	3	159
8:30-9:00	108	39	6	3	0	0	156
9:00-9:30	72	24	6	5	2	2	111
9:30-10:00	91	19	13	4	4	2	133
10:00-10:30	116	26	1	3	7	2	155
10:30-11:00	122	34	11	4	2	0	173
11:00-11:30	123	20	4	7	3	2	159
11:30-12:00	127	37	3	4	8	6	185
p.m.							
12:00-12:30	125	30	2	2	1	1	161
12:30-1:00	153	27	6	6	4	1	197
1:00-1:30	123	25	6	3	2	4	163
1:30-2:00	141	38	5	2	2	0	188
Subtotal	1,580	401	87	53	36	23	2,180
Percentages	72.5	18.4	4.0	2.4	1.6	1.1	100.0

SOUTHBOUND LANE

a.m.							
7:00-7:30	384	130	4	1	1	3	523
7:30-8:00	231	42	3	1	3	0	280
8:00-8:30	149	35	4	0	1	0	189
8:30-9:00	152	31	7	2	7	0	199
9:00-9:30	154	28	2	1	3	4	192
9:30-10:00	152	25	7	0	3	0	187
10:00-10:30	162	26	6	1	2	0	197
10:30-11:00	146	38	8	0	5	0	197
11:00-11:30	143	29	4	1	4	3	184
11:30-12:00	101	25	7	2	0	1	136
p.m.							
12:00-12:30	158	26	8	0	0	1	193
12:30-1:00	128	31	8	2	4	1	174
1:00-1:30	154	29	12	0	2	2	199
1:30-2:00	134	34	7	0	1	0	176
Subtotal	2,348	529	87	11	36	15	3,026
Percentages	77.6	17.5	2.9	0.3	1.2	0.5	100.0
TOTALS	3,928	930	174	64	72	38	5,026
PERCENTAGES	75.45	17.86	3.34	1.23	1.38	0.73	100.0

APPENDIX C (cont.)

NORTHBOUND LANE

Hour	Cars	Pickups & Vans	2-Axle	3-Axle	Tractor-Trailer	Other	Total
August 26, 1976, a.m.							
7:00-7:30	54	17	3	1	2	2	79
7:30-8:00	123	37	13	2	1	1	177
8:00-8:30	120	35	7	1	1	1	165
8:30-9:00	96	26	3	1	6	2	134
9:00-9:30	93	27	12	4	3	0	139
9:30-10:00	93	24	13	1	6	1	138
10:00-10:30	95	24	3	0	4	2	128
10:30-11:00	124	21	4	0	6	0	155
11:00-11:30	125	21	13	4	5	0	168
11:30-12:00	136	30	5	0	2	1	174
p.m.							
12:00-12:30	136	36	7	0	6	1	186
12:30-1:00	128	18	10	0	4	2	162
Subtotal	1,323	316	93	14	46	13	1,805
Percentages	73.3	17.5	5.2	0.8	2.5	0.7	100.0

SOUTHBOUND LANE

a.m.							
7:00-7:30	397	126	3	1	2	9	538
7:30-8:00	258	49	3	0	1	0	311
8:00-8:30	200	24	4	0	1	2	231
8:30-9:00	133	23	1	0	7	1	165
9:00-9:30	141	25	6	1	4	0	177
9:30-10:00	158	28	3	0	1	2	192
10:00-10:30	162	30	8	1	2	2	205
10:30-11:00	147	25	3	3	4	0	182
11:00-11:30	134	29	4	1	6	1	175
11:30-12:00	163	34	7	0	4	1	209
p.m.							
12:00-12:30	153	23	0	0	2	0	178
12:30-1:00	104	19	5	4	3	1	136
Subtotal	2,150	435	47	11	37	19	2,699
Percentages	79.6	16.1	1.8	0.4	1.4	0.7	100.0
TOTAL	3,473	751	140	25	83	31	4,504
PERCENTAGES	77.11	16.67	3.11	0.56	1.84	0.69	100.0

APPENDIX C (cont.)

NORTHBOUND LANE

Hour	Cars	Pickups & Vans	2-Axle	3-Axle	Tractor-Trailer	Other	Total
Sept. 20, 1976, p.m.							
2:00-2:30	186	36	8	0	5	1	236
2:30-3:00	148	22	3	1	1	1	176
3:00-3:30	138	30	9	0	5	1	183
3:30-4:00	168	48	5	0	3	0	224
4:00-4:30	396	136	8	2	3	3	548
4:30-5:00	312	78	6	0	2	11	409
5:00-5:30	285	72	6	0	4	6	373
5:30-6:00	217	66	3	0	2	3	291
6:00-6:30	173	61	3	0	2	2	241
6:30-7:00	117	29	0	0	2	0	148
Subtotal	2,140	578	51	3	29	28	2,829
Percentages	75.7	20.4	1.8	0.1	1.0	1.0	100.0

SOUTHBOUND LANE

Sept. 20, 1976, p.m.							
2:00-2:30	173	37	16	1	5	2	234
2:30-3:00	138	27	8	0	2	3	178
3:00-3:30	158	31	7	1	3	1	201
3:30-4:00	142	39	12	3	4	0	200
4:00-4:30	122	33	3	0	0	2	160
4:30-5:00	194	36	5	0	2	1	238
5:00-5:30	119	38	14	0	1	0	172
5:30-6:00	119	27	6	1	4	1	158
6:00-6:30	119	29	3	0	1	1	153
6:30-7:00	122	22	3	0	0	1	148
Subtotal	1,406	319	77	6	22	12	1,842
Percentages	76.3	17.3	4.2	0.3	1.2	0.7	100.0
TOTAL	3,546	897	128	9	51	40	4,671
PERCENTAGES	75.92	19.20	2.74	0.19	1.09	0.86	100.0

APPENDIX C (Cont.)

SOUTHBOUND LANE

Hour	Cars	Pickups & Vans	2-Axle	3-Axle	Tractor-Trailer	Other	Total
October 19, 1976, a.m.							
7:30-8:00	280	71	1	4	8	0	364
8:00-8:30	152	40	2	0	4	0	198
8:30-9:00	151	28	3	1	5	0	188
9:00-9:30	78	15	4	0	2	0	99
9:30-10:00	209	37	8	5	9	0	268
10:00-10:30	144	33	1	3	2	1	184
10:30-11:00	134	21	5	1	6	1	168
11:00-11:30	135	34	3	4	7	0	183
11:30-12:00	126	31	9	5	5	0	176
p.m.							
12:30-1:00	115	37	6	0	4	1	163
1:00-1:30	110	34	8	4	5	1	162
1:30-2:00	99	23	13	0	3	1	139
2:00-2:30	116	34	6	4	3	0	163
2:30-3:00	137	31	6	6	3	3	186
3:00-3:30	130	27	3	1	8	1	170
3:30-4:00	145	32	8	1	3	1	190
4:00-4:30	144	37	6	1	1	1	190
4:30-5:00	160	31	11	0	5	0	207
5:00-5:30	123	20	3	1	5	1	153
5:30-6:00	137	35	4	0	2	2	180
6:00-6:30	112	28	0	0	5	0	145
Subtotal	2,937	679	110	41	95	14	3,876
Percentages	75.8	17.5	2.8	1.0	2.5	0.4	100.0

APPENDIX C (cont.)

NORTHBOUND LANE

Hour	Cars	Pickups & Vans	2-Axle	3-Axle	Tractor-Trailer	Other	Total
October 19, 1976, a.m.							
7:30-8:00	105	39	5	2	5	1	157
8:00-8:30	117	27	7	2	2	1	156
8:30-9:00	83	30	9	3	6	0	131
9:00-9:30	64	18	1	2	3	0	88
9:30-10:00	101	36	14	0	2	1	154
10:00-10:30	83	28	7	5	3	0	126
10:30-11:00	90	34	11	1	11	1	148
11:00-11:30	99	18	6	1	7	0	131
11:30-12:00	93	22	5	0	4	0	124
p.m.							
1:00-1:30	118	21	4	0	2	0	145
1:30-2:00	124	23	7	2	5	0	161
2:00-2:30	122	27	2	3	6	0	160
2:30-3:00	141	26	6	1	5	1	180
3:00-3:30	171	24	6	0	6	0	207
3:30-4:00	192	45	6	0	6	1	250
4:00-4:30	394	109	5	1	5	2	516
4:30-5:00	319	87	1	2	2	10	421
5:00-5:30	277	73	4	1	3	2	360
5:30-6:00	205	63	3	3	4	0	278
6:00-6:30	148	44	3	1	1	0	197
Subtotal	3,046	794	112	30	88	20	4,090
Percentages	74.5	19.4	2.7	0.7	2.2	0.5	100.0
TOTAL	5,983	1,473	222	71	183	34	7,966
PERCENTAGES	75.11	18.49	2.79	0.89	2.30	0.43	100.0

APPENDIX C (cont.)

SOUTHBOUND LANE

Hour	Cars	Pickups & Vans	2-Axle	3-Axle	Tractor-Trailer	Other	Total
March 17, 1977, a.m.							
7:00-7:15	234	92	3	0	7	1	337
7:15-7:30	195	60	3	1	4	2	265
7:30-7:45	158	38	1	1	1	1	200
7:45-8:00	115	26	3	1	2	0	147
8:00-8:15	89	23	2	0	1	0	115
8:15-8:30	74	18	4	1	4	0	101
8:30-8:45	74	17	4	2	5	0	102
8:45-9:00	79	9	1	0	4	1	94
9:00-9:15	69	7	1	1	0	0	78
9:15-9:30	49	18	5	0	2	0	74
9:30-9:45	60	11	4	0	2	0	77
9:45-10:00	64	19	1	0	4	0	88
10:00-10:15	82	23	3	0	4	1	113
10:15-10:30	57	11	2	0	2	1	73
10:30-10:45	56	11	4	1	5	0	77
10:45-11:00	65	13	3	1	2	0	84
11:00-11:15	67	13	3	0	5	0	88
11:15-11:30	50	16	4	4	2	0	76
11:30-11:45	58	21	1	0	0	0	80
11:45-12:00	31	5	2	0	0	0	38
Subtotal	1,726	451	54	13	56	7	2,307
Percentages	74.8	19.5	2.3	0.6	2.4	0.3	100.0

APPENDIX C (cont.)

NORTHBOUND LANE

Hour	Cars	Pickups & Vans	2-Axle	3-Axle	Tractor-Trailer	Other	Total
March 17, 1977, a.m.							
7:00-7:15	28	5	0	0	1	0	34
7:15-7:30	22	14	3	1	6	2	48
7:30-7:45	40	17	5	0	0	1	63
7:45-8:00	77	17	5	0	0	0	99
8:00-8:15	73	21	2	1	0	1	98
8:15-8:30	55	24	2	0	3	1	85
8:30-8:45	38	16	5	1	1	0	61
8:45-9:00	56	10	3	0	3	0	72
9:00-9:15	52	15	1	2	5	0	75
9:15-9:30	41	23	9	1	1	0	75
9:30-9:45	63	9	8	0	0	2	82
9:45-10:00	29	13	6	2	2	2	54
10:00-10:15	49	16	8	4	1	0	78
10:15-10:30	40	14	6	0	1	0	61
10:30-10:45	59	18	5	1	0	1	84
10:45-11:00	59	9	6	0	5	0	79
11:00-11:15	47	11	2	0	1	0	61
11:15-11:30	55	9	6	1	5	0	76
11:30-11:45	50	11	3	2	5	1	72
11:45-12:00	39	7	1	0	2	0	49
Subtotal	972	279	86	16	42	11	1,406
Percentages	69.1	19.8	6.1	1.1	3.0	0.8	99.9
TOTAL	2,698	730	140	29	98	18	3,713
PERCENTAGES	72.66	19.66	3.77	0.78	2.64	0.48	100.0

APPENDIX C (cont.)

SOUTHBOUND LANE

Hour	Cars	Pickups & Vans	2-Axle	3-Axle	Tractor-Trailer	Other	Total
May 18, 1977, p.m.							
12:30-12:45	62	17	4	2	0	1	86
1:00-1:15	58	15	4	1	2	0	80
1:30-1:45	52	14	2	1	2	0	71
2:00-2:15	54	14	5	5	0	2	80
2:30-2:45	67	21	6	1	1	1	97
3:30-3:45	70	16	4	0	3	0	93
4:00-4:15	78	30	4	2	1	1	116
Subtotal	441	127	29	12	9	5	623
Percentages	70.8	20.4	4.7	1.9	1.4	0.8	100.0

NORTHBOUND LANE

p.m.							
12:45-1:00	77	7	3	2	1	2	92
1:15-1:30	64	12	3	1	0	0	80
1:45-2:00	53	12	2	2	6	0	75
2:15-2:30	71	17	0	2	2	2	94
2:45-3:00	73	19	4	1	2	4	103
3:45-4:00	142	26	4	3	2	2	179
4:15-4:30	153	50	3	1	0	3	210
4:30-4:45	138	43	2	0	1	4	188
4:45-5:00	259	59	7	1	0	11	337
5:00-5:15	150	47	0	1	4	4	206
Subtotal	1,180	292	28	14	18	32	1,564
Percentages	75.4	18.6	1.8	0.9	1.2	2.1	100.0
TOTAL	1,621	419	57	26	27	37	2,187
PERCENTAGES	74.1	19.2	2.6	1.2	1.2	1.7	100.0

APPENDIX D

VEHICLE OCCUPANCY RATES

SOUTHBOUND LANE

Hour	Vehicles With the Following Number of Occupants						Total Vehicle Occupancy Rate
	1	2	3	4	5	>5	
July 22, 1976, a.m.							
7:05-7:20	124	44	9	6	2	1	1.50
8:05-8:20	55	16	3	6	0	2	1.61
9:05-9:20	37	29	10	8	1	2	2.00
10:05-10:20	40	20	13	6	2	2	1.99
11:05-11:20	27	29	8	4	2	3	2.10
12:05-12:20			BRIDGE OPEN				
1:05-1:20	50	32	14	5	2	2	1.89
Subtotal	333	170	57	35	9	12	1.79

NORTHBOUND LANE

July 22, 1976, a.m.							
7:35-7:50	53	11	3	4	1	0	1.46
8:35-8:50	48	28	3	6	0	2	1.71
9:35-9:50	33	26	8	1	1	0	1.71
10:35-10:50	47	39	8	3	5	2	1.90
11:35-11:50	45	33	7	8	6	0	1.96
12:35-12:50	44	34	10	10	2	3	2.04
1:35-1:50	41	36	8	8	3	0	1.92
Subtotal	311	207	47	40	18	7	1.84
TOTAL	644	377	104	75	27	19	1.82

APPENDIX D (cont.)

NORTHBOUND LANE

Hour	Vehicles With the Following Number of Occupants						Total Vehicle Occupancy Rate
	1	2	3	4	5	>5	
August 26, 1976, a.m.							
7:35-7:50	56	12	6	1	0	1	1.42
8:05-8:20	64	16	3	1	0	0	1.30
8:35-8:50	40	24	5	0	1	0	1.54
9:05-9:20	47	21	3	1	1	0	1.47
9:35-9:50	50	21	4	2	1	0	1.50
10:05-10:15	21	17	4	2	0	1	1.80
10:35-10:50	43	26	7	1	3	0	1.69
11:05-11:20	41	35	8	4	1	0	1.75
11:35-11:50	51	28	7	2	1	0	1.58
12:05-12:20	48	40	5	6	1	1	1.76
Subtotal	461	240	52	20	8	3	1.58

SOUTHBOUND LANE

August 26, 1976, a.m.							
7:05-7:20	195	65	19	13	4	3	1.59
7:40-7:55	97	19	3	3	0	0	1.28
8:00-8:15	71	24	9	3	2	0	1.54
8:25-8:40	74	15	8	2	2	1	1.49
8:50-9:00	25	12	6	3	1	0	1.79
9:05-9:20	46	30	10	6	2	0	1.81
9:30-9:45	37	25	7	4	3	3	1.99
10:25-10:40	41	24	12	9	3	1	2.02
10:50-11:05	34	36	12	10	5	2	2.21
11:20-11:35	29	30	10	9	1	1	2.08
11:45-12:00	49	38	7	4	4	2	1.86
12:10-12:25	40	29	7	8	1	0	1.84
Subtotal	738	347	110	74	28	13	1.74
TOTAL	1,199	587	162	94	36	16	1.68

APPENDIX D (cont.)

SOUTHBOUND LANE

Hour	Vehicles With the Following Number of Occupants						Total Vehicles	Total Vehicle Occupancy Rate
	1	2	3	4	5	>5		
Sept. 20, 1976, p.m.								
2:00-2:15	81	69	6	7	3	1	167	1.82
2:30-2:45	54	30	6	0	1	1	92	1.55
3:00-3:15	60	18	13	3	1	0	95	1.60
3:30-3:45	56	30	10	0	1	0	97	1.56
4:00-4:15	42	19	4	1	0	0	66	1.45
4:30-4:45	75	37	9	5	1	1	128	1.62
5:00-5:15	46	24	8	3	1	0	82	1.65
5:30-5:45	42	28	5	1	2	0	78	1.63
6:00-6:15	41	28	7	3	1	2	82	1.79
6:30-6:45	32	27	7	4	2	1	73	1.90
Subtotal	529	310	75	27	13	6	960	1.65

NORTHBOUND LANE

Sept. 20, 1976, p.m.								
2:00-2:20	96	60	16	7	1	2	182	1.70
2:25-2:45	58	42	9	5	3	0	117	1.74
2:50-3:10	58	47	10	3	0	0	118	1.64
3:20-3:40	82	39	8	2	1	0	132	1.49
3:45-4:05	107	59	18	6	1	0	191	1.61
4:15-4:35	204	95	33	24	4	4	364	1.74
4:40-5:00	151	46	23	13	5	16	254	1.91
5:10-5:30	150	78	11	7	3	3	252	1.59
5:35-5:55	117	57	10	6	2	2	194	1.58
6:05-6:25	106	40	10	4	0	0	160	1.45
6:30-6:50	47	35	8	0	2	0	92	1.64
Subtotal	1,176	598	156	77	22	27	2,056	1.66
TOTAL	1,705	908	231	104	35	33	3,016	1.66

APPENDIX D (cont.)

NORTHBOUND LANE

Hour	Vehicles With the Following Number of Occupants						Total Vehicles	Total Vehicle Occupancy Rate
	1	2	3	4	5	>5		
January 12, 1977, p.m.								
2:30-2:45	62	19	7	3	0	0	91	1.46
2:45-3:00	52	20	8	1	0	0	81	1.48
3:00-3:15	53	29	10	2	0	0	94	1.59
3:15-3:30	60	27	7	3	0	0	97	1.52
3:30-3:45	66	36	12	2	0	1	117	1.61
3:45-4:00	82	49	9	1	0	0	141	1.50
4:00-4:15	164	72	20	5	5	1	267	1.57
4:15-4:30	140	52	22	19	10	0	243	1.63
4:30-4:45	37	24	2	3	1	2	69	1.74
4:45-5:00	128	58	16	6	0	16	224	1.84
5:00-5:15	128	43	9	3	2	5	190	1.54
Subtotal	972	429	122	48	18	25	1,614	1.63
SOUTHBOUND LANE								
January 12, 1977, p.m.								
2:30-2:45	45	18	5	2	1	-	71	1.54
2:45-3:00	43	21	7	1	1	3	76	1.75
3:00-3:15	42	26	4	2	1	0	75	1.59
3:15-3:30	39	27	7	4	1	0	78	1.73
3:30-3:45	54	21	4	-	-	-	79	1.37
3:45-4:00	44	25	6	2	4	-	81	1.73
4:00-4:15	39	27	4	1	1	1	73	1.64
4:15-4:30	47	16	2	2	1	1	69	1.51
4:30-4:45	26	7	2	0	0	0	35	1.31
4:45-5:00	57	21	7	2	-	-	87	1.47
5:00-5:15	36	22	6	2	2	-	68	1.71
Subtotal	472	231	54	18	12	5	792	1.59
TOTAL	1,444	660	176	66	30	30	2,406	1.61

APPENDIX D (cont.)

SOUTHBOUND LANE

Hour	Vehicles With the Following Number of Occupants						Total Vehicles	Total Vehicle Occupancy Rate
	1	2	3	4	5	>5		
March 17, 1977, a.m.								
7:05-7:15	165	43	12	13	6	3	242	1.60
7:30-7:40	94	32	6	4	0	0	136	1.41
8:15-8:25	51	19	1	0	1	0	72	1.35
8:45-8:55	41	12	1	0	2	0	56	1.39
9:20-9:30	29	15	1	1	1	0	47	1.51
9:50-10:00	34	13	2	3	0	2	54	1.67
10:15-10:25	31	16	5	1	0	0	53	1.55
10:45-10:55	36	13	3	1	0	0	53	1.42
11:15-11:25	37	12	6	1	0	1	57	1.56
Subtotal	518	175	37	24	10	6	770	1.51

NORTHBOUND LANE

March 17, 1977, a.m.								
7:20-7:30	22	6	0	2	0	1	31	1.55
8:05-8:15	53	12	4	1	1	0	71	1.38
8:30-8:40	32	8	1	1	1	1	44	1.50
9:00-9:10	36	12	2	1	0	0	51	1.37
9:35-9:45	45	15	3	0	0	0	63	1.33
10:05-10:15	41	15	3	0	0	0	59	1.36
10:30-10:40	32	19	3	1	0	0	55	1.51
11:00-11:10	27	15	1	1	0	0	44	1.45
11:30-11:40	46	13	1	0	0	0	60	1.25
Subtotal	334	115	18	7	2	2	478	1.40
TOTAL	852	290	55	31	12	8	1,248	1.46

APPENDIX D (cont.)

SOUTHBOUND LANE

Hour	Vehicles With the Following Number of Occupants						Total Vehicles	Total Vehicle Occupancy Rate
	1	2	3	4	5	>5		
May 18, 1977, p.m.								
12:30-12:45	51	20	7	3	1	0	82	1.57
12:45-1:00	49	27	4	4	1	2	87	1.70
1:00-1:15	45	26	4	4	0	0	79	1.58
1:15-1:30	37	22	5	3	0	1	68	1.68
1:30-1:45	44	21	3	2	0	0	70	1.47
1:45-2:00	51	31	4	6	0	0	92	1.62
2:00-2:15	51	20	6	1	0	0	78	1.45
2:15-2:30	52	29	3	0	0	0	84	1.42
2:30-2:45	60	24	7	1	0	0	92	1.44
2:45-3:00	44	24	9	2	1	2	82	1.76
3:00-3:15	65	27	2	2	1	0	97	1.42
3:15-3:30	63	25	14	2	2	1	107	1.67
3:30-3:45	53	29	7	3	1	0	93	1.60
3:45-4:00	52	40	13	4	1	1	111	1.78
4:00-4:15	66	31	16	2	0	1	116	1.64
4:15-4:30	57	23	7	4	2	2	95	1.70
4:30-4:45	72	24	7	6	2	0	111	1.58
4:45-5:00	65	25	14	4	2	0	110	1.66
5:00-5:15	57	29	8	2	0	0	96	1.53
5:15-5:30	66	29	11	1	0	0	107	1.50
Subtotal	1,100	526	151	56	14	10	1,857	1.59

APPENDIX D (cont.)

NORTHBOUND LANE

Hour	Vehicles With the Following Number of Occupants						Total Vehicles	Total Vehicle Occupancy Rate
	1	2	3	4	5	>5		
May 18, 1977, p.m.								
12:30-12:45	60	30	7	4	1	0	102	1.59
12:45-1:00	44	31	10	4	2	1	92	1.83
1:00-1:15	36	33	4	4	4	0	81	1.85
1:15-1:30	42	30	4	1	3	0	80	1.66
1:30-1:45	51	38	4	4	2	0	99	1.67
1:45-2:00	46	19	8	1	0	1	75	1.57
2:00-2:15	51	28	7	3	2	2	93	1.74
2:15-2:30	53	30	8	1	0	2	94	1.63
2:30-2:45	55	31	7	7	0	1	101	1.70
2:45-3:00	53	33	10	4	1	1	102	1.72
3:00-3:15	61	31	4	3	0	0	99	1.48
3:15-3:30	75	33	7	5	1	0	121	1.54
3:30-3:45	100	47	5	2	1	2	157	1.49
3:45-4:00	97	57	16	7	3	0	180	1.68
4:00-4:15	177	68	20	9	6	0	280	1.57
4:15-4:30	116	49	25	7	11	3	211	1.85
4:30-4:45	115	45	16	9	2	2	189	1.69
4:45-5:00	202	79	26	12	3	16	338	1.77
5:00-5:15	126	47	18	7	2	8	208	1.73
5:15-5:30	122	57	19	8	2	1	209	1.63
Subtotal	1,682	816	225	102	46	40	2,911	1.67
TOTAL	2,782	1,342	376	158	60	50	4,708	1.64

APPENDIX E

ORIGIN AND DESTINATION DATA

Before Period

Origin Zone	Destination Zone 14	15	16	17	18	19	20	22	Total
1	6 27.3	3 13.6	1 4.5	0 0	0 0	0 0	0 0	12 54.5	22 4.0
2	8 27.6	2 6.9	1 3.4	1 3.4	0 0	1 3.4	0 0	16 55.2	29 5.2
3	24 33.3	11 15.3	1 1.4	3 4.2	0 0	3 4.2	4 5.6	26 36.1	72 13.0
4	16 18.2	13 14.8	1 1.1	7 8.0	1 1.1	3 3.4	0 0	47 53.4	88 15.9
5	25 27.8	16 17.8	1 1.1	5 5.6	0 0	2 2.2	1 1.1	40 44.4	90 16.3
6	5 21.7	5 21.7	0 0	1 4.3	0 0	1 4.3	1 4.3	10 43.5	23 4.2
7	18 32.1	6 10.7	0 0	0 0	0 0	3 5.4	0 0	29 51.8	56 10.1
8	1 25.0	0 0	0 0	0 0	0 0	1 25.0	0 0	2 50.0	4 .7
9	2 25.0	1 12.5	0 0	0 0	0 0	1 12.5	1 12.5	3 37.5	8 1.4
12	1 8.3	2 16.7	0 0	0 0	0 0	6 50.0	1 8.3	2 16.7	12 2.2
13	11 22.9	1 2.1	1 2.1	3 6.3	0 0	20 41.7	5 10.4	7 14.6	48 8.7
21	21 22.1	13 13.7	1 1.1	4 4.2	0 0	2 2.1	1 1.1	53 55.8	95 17.2
TOTAL	138 25.0	73 13.2	7 1.3	24 4.3	1 .2	43 7.8	14 2.5	247 44.8	547 100.0

APPENDIX E (cont.)

Before Period

Origin Zone	Destination Zone												
Zones	1	2	3	4	5	6	7	8	9	12	13	21	Total
14	9 5.2	5 2.9	33 19.0	35 20.1	26 14.9	7 4.0	21 12.1	0 0	0 0	3 1.7	9 5.2	25 14.4	173 26.7
15	3 3.7	5 6.3	15 18.8	13 16.2	15 18.8	6 7.5	6 7.5	0 0	0 0	0 0	4 5.0	13 16.2	80 12.3
16	1 11.1	0 0	3 33.3	2 22.2	1 11.1	0 0	1 11.1	0 0	0 0	0 0	0 0	1 11.1	9 1.4
17	0 0	1 3.3	9 30.0	4 13.3	4 13.3	2 6.7	3 10.0	0 0	0 0	0 0	3 10.0	4 13.3	30 4.6
18	0 0	0 0	2 66.7	1 33.3	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	3 .5
19	0 0	0 0	4 11.4	0 0	5 14.3	0 0	3 8.6	0 0	0 0	3 8.6	18 51.4	2 5.7	35 5.4
20	0 0	3 12.0	2 8.0	1 4.0	6 24.0	1 4.0	1 4.0	0 0	0 0	2 8.0	5 20.0	4 16.0	25 3.8
22	16 5.6	13 4.5	57 19.9	55 19.2	46 16.1	9 3.1	34 11.9	1 .3	2 .7	3 1.0	6 2.1	43 15.0	285 43.9
Total	29 4.5	27 4.1	125 19.2	111 17.1	103 16.0	25 3.8	69 10.6	1 .2	2 .3	11 1.7	45 7.1	92 14.1	640 100.0

APPENDIX E (cont.)

After Period

Origin Zone	Destination Zone								
Zones	14	15	16	17	18	19	20	22	Total
1	10 41.7	1 4.2		1 4.2				12 50.0	24 5.4
2	5 33.3	1 6.7	1 6.7			1 6.7		7 46.7	15 3.3
3	10 19.6	9 17.6	1 2.0	6 11.8		4 7.8	2 3.9	19 37.3	51 11.4
4	21 31.8	14 21.2		4 6.1		3 4.5	2 3.0	22 33.3	66 14.7
5	25 30.9	6 7.4	1 1.2	5 6.2		1 1.2		43 53.1	81 18.1
6	2 15.4	1 7.7	1 7.7	1 7.7	1 7.7	1 7.7	2 15.4	4 30.8	13 2.9
7	22 40.7	4 7.4	1 1.9	1 1.9		1 1.9	1 1.9	24 44.4	54 12.1
8	2 66.7							1 33.3	3 .7
9	3 27.3	2 18.2		1 9.1			1 9.1	4 36.4	11 2.5
12								1 100.0	1 .2
13	2 5.0	8 20.0		3 7.5		16 40.0	2 5.0	9 22.5	40 8.9
21	21 23.6	8 9.0	1 1.1	2 2.2	1 1.1		5 5.6	50 56.2	88 19.9
Total	123 27.5	54 12.1	6 1.3	24 5.4	2 .4	27 6.0	15 3.3	196 43.8	447 100.0

APPENDIX E (cont.)

After Period

Origin Zone	Destination Zone 1	2	3	4	5	6	7	8	9	12	13	21	Total
14	12 9.4	3 2.3	14 10.9	15 11.7	20 15.6	4 3.1	26 20.3	1 .8			9 7.0	24 18.8	128 29.3
15	2 4.8	2 4.8	4 9.5	7 16.7	10 23.8	2 4.8	4 9.5			1 2.4	5 11.9	5 11.9	42 9.6
16	1 16.7			2 33.3		1 16.7	2 33.3						6 1.4
17	1 4.8	1 4.8	5 23.8	1 4.8	2 9.5		4 19.0			1 4.8	4 19.0	2 9.5	21 4.8
19	1 5.9		4 23.5	1 5.9	2 11.8					1 5.9	7 41.2	1 5.9	17 3.9
20	1 12.5			1 12.5	1 12.5	1 12.5			1 12.5		2 25.0	1 12.5	8 1.8
22	5 2.3	8 3.7	36 16.7	27 12.6	40 18.6	5 2.3	28 13.0		2 .9	1 .5	10 4.7	53 24.7	215 49.2
Total	23 5.3	14 3.2	63 14.4	54 12.4	75 17.2	13 3.0	64 14.6	1 .2	3 .7	4 .9	37 8.5	86 19.7	437 100.0