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U.S. Department
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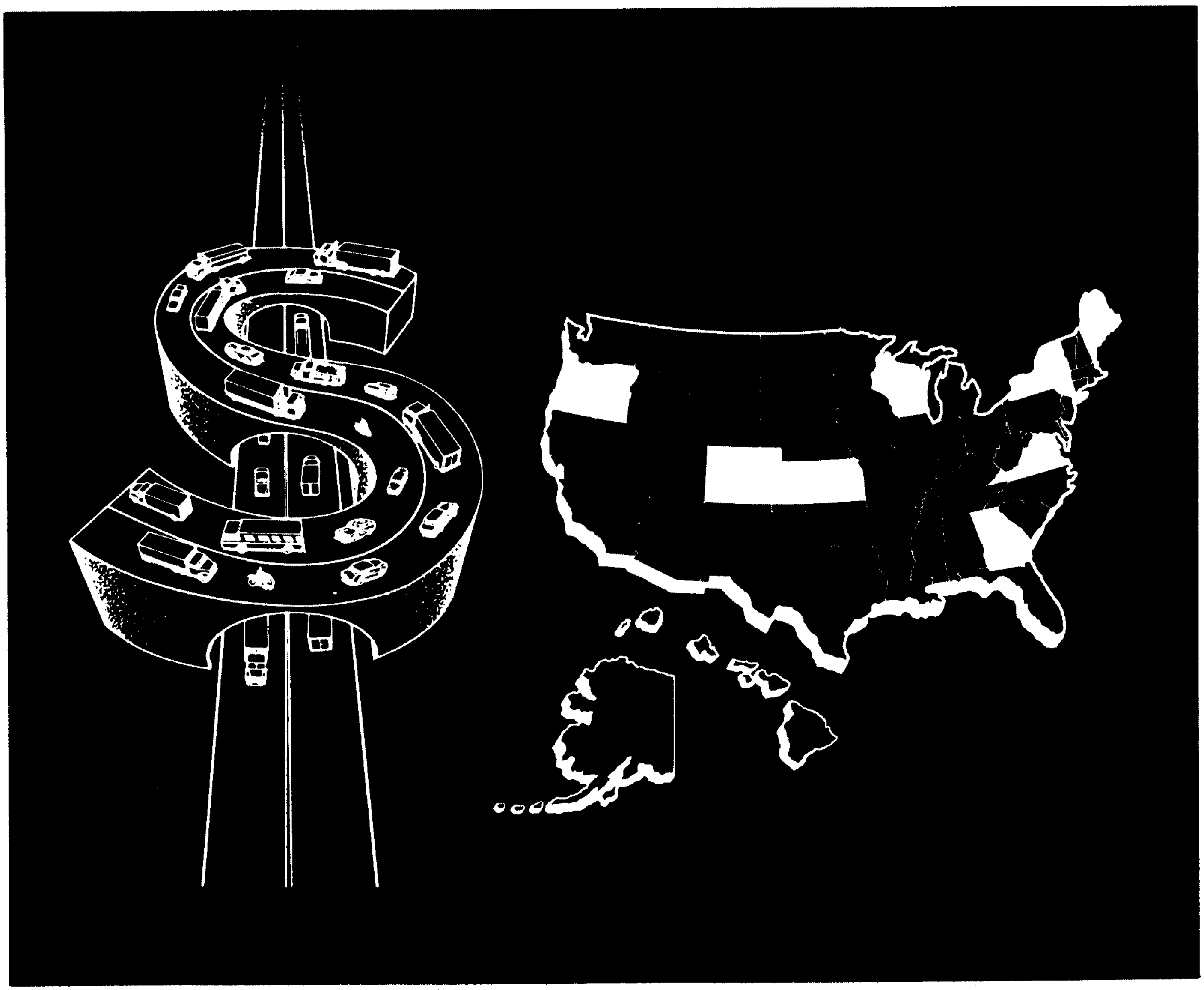
Federal Highway
Administration

# STATE HIGHWAY COST-ALLOCATION GUIDE

## Volume II: Technical Appendix



# STATE
# HIGHWAY COST ALLOCATION
# GUIDE
## VOLUME II
## TECHNICAL APPENDIX

Federal Highway Administration

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NOTE TO READERS:

All requests for or inquiries concerning any U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA), or Transportation Systems Center (TSC) publication, data, or computer program mentioned in this report should be made via the FHWA Division Office in your State Capitol.

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# INTRODUCTION

The material in this Volume expands on selected topics discussed in Volume I. It is intended to provide greater depth on the more important issues covered in Volume I and to introduce related topics considered to be of secondary interest in the main Volume.

Four appendices are contained in this Volume and correspond in sequence to Chapters II through V. The Glossary and Bibliography are identical to those presented in Volume I. **Appendix A** contains material on cost-allocation methods drawn largely from the 1982 Federal Highway Administration, Final Report on the Federal Cost Allocation Study (Appendices D and E). **Appendix B** provides an extensive survey of recent State cost-allocation study findings, recent changes in user charge rates, more discussion on revenue attribution methods, and an elaboration of reciprocity and proration agreements. **Appendix C** is a more in-depth treatment of economic impact analysis methods for analyzing changes in user charges and contains the analysis of truck size and weight limits. Finally, **Appendix D** contains data sources and data values from recent FHWA work thought to be potentially useful to cost-allocation analysts.

This set of appendices is not intended to be an independent treatment of the topics presented earlier, rather it provides supporting material on the previous chapters for the interested reader. Thus, the individual appendices will not treat those topics covered in their corresponding Volume I chapters where it is felt that sufficient details and references had been provided earlier.

The Guide was developed to assist States in the cost-allocation process. Its contents derive largely from recent State and Federal experience. In its preparation an Advisory Panel from AASHTO's Standing Committee on Planning (SCOP) provided extensive and continuous review, appraisal and suggested direction. Members of the U.S. Department of Transportation (DOT), both the Federal Highway Administration (FHWA) and Transportation Systems Center (TSC), participated in the writing of this Guide. The AASHTO panel and the DOT participants are listed on the next two pages.

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## APPENDIX A

## HIGHWAY COST ALLOCATION METHODS

### 1982 FEDERAL HIGHWAY COST ALLOCATION METHODS*

This appendix explains in more detail the cost assignment methods alluded to in Chapter II. The general approach is to divide aggregate expenditures into a number of expenditure category cells, and to apportion each of these cells based on the proportional vehicle class assignments of a number of representative design sections. Pavement costs are divided, for example, into the categories of new flexible, new rigid, rehabilitated flexible, and rehabilitated rigid pavements. Expenditures in each of these four categories are further divided into 50 parts: one for each of the five urban and five rural highway classes in each of five regions of the country. In each of these expenditure cells between 16 and 80 typical pavement sections are analyzed. The vehicle classes' cost responsibilities are individually determined on each section and then aggregated to determine the overall cost assignment of the cell.

### NEW PAVEMENT COSTS

#### New Pavement Thickness

The 1972 AASHO Interim Guide nomographs and design equations are followed as closely as possible to determine pavement thicknesses for each of a combination of hypothetical design loadings and other design parameters. For cost allocation purposes, far more accuracy is required than can be achieved from the use of the nomographs directly, since it is very small differences in thicknesses that determine cost responsibilities.

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*/ This appendix draws heavily upon Appendix D of the Final Report on the Federal Highway Cost Allocation Study, May 1982.

The need for accuracy poses no problems in the case of flexible pavements, since the nomographs (pages 19 and 20 of the AASHO Guide) are described directly by a design equation (Equation C-12, page 58 of the AASHO Guide). In the case of rigid pavements, however, the design equation (Equation D-15, page 103) gives different results than the nomographs (pages 25 and 26). Since the nomographs more closely correlate with pavement thickness design practice, new coefficients are necessary in the design equation to accurately describe the design nomographs.

Each of the equations, when solved iteratively, finds pavement thickness (slab thickness for rigid, structural number for flexible) as a function of anticipated ESAL loadings, terminal serviceability, and soil strength. Although the rigid pavement equation also included elastic modulus and strength parameters, the default values are deemed to be sufficiently representative and non-systematically variable to allow their direct use. All other design parameters have been varied within normal ranges to ensure that possible variations in cost responsibilities are revealed. The variations in each of these parameters are described below.

The form of the equation used for flexible pavements, derived directly from page 58, is:

$$W_{t18} = 10^{Z}(SN+1)^{9.36}/R$$

where

$$Z = G_t/B_{18} + .372S_i - 1.316$$

$W_{t18}$: Total number of 18-kip equivalent single axle loads

SN: Structural number of pavement

$G_t$: A function of pavement condition at end of design life

$B_{18}$: A function of pavement strength

$S_i$: Soil support value

R: A regional factor that accounts for climatic variables.

For rigid pavements, the nomograph-based coefficients and default values for concrete strength modify the equation of page 103 to be:

$$W_{t18} = 10^{Y}(D+1)^{6.98}((D^{.75} - 1.132)/(D^{.75} - .4069k^{.25}))^{1.2014P_t}$$

where

$$Y = G_t/B_{18} - 0.2212$$

D: Thickness of slab (inches)

k: modulus of subgrade reaction ($LBS/IN^3$)

$P_t$: Terminal pavement serviceability

THICKNESS DESIGN PARAMETERS

Traffic Loadings—Within each expenditure cell, the estimated annual vehicle miles traveled (VMT) by each of 38 vehicle classes in the base year are divided by the system mileage and days per year to derive average daily traffic (ADT) levels of each vehicle class on the typical section in the cell.

Axle loading distributions are applied to the ADT to derive the number of average daily axle loads of each of 50 axle weight categories of each axle type (single or tandem) within each vehicle class. Estimated growth factors are applied to this matrix of axle-weight distributions to derive a similar matrix for 1985 as well as the anticipated 20-year design period averages of total axle loads of each weight growth for all vehicle classes for both the base and future years.

If average traffic were used for all pavement sections, the resulting cost assignment would not be equivalent to the assignment resulting from varying the traffic on several sections and averaging the results. This is particularly true in the case of the minimum pavement approach, in which assignments might be zero for average traffic on some highway classes.

Another error that would result from using average traffic levels is that expenditures are made disproportionately on highway sections with higher traffic. Use of average traffic would tend to result in thinner average pavement designs than are actually built.

To account for the nonlinearity of traffic effects, a series of four traffic levels are chosen for each highway type in each region to represent equal expenditure subgroups. The choice of these levels is made based on truck ADT distributions on existing highway sections, since of all the readily available data truck ADT is the predominant determinant of required pavement thickness. The traffic levels are expressed as ratios of design traffic to average traffic, specific to each geographic region and highway type. In each case, all traffic is multiplied by the same factor since there is insufficient traffic inventory information to justify varying the vehicle class mix among the design sections.

Traffic information for pavement design for each highway type and region in this study thus consists of: (1) average daily traffic for each vehicle class, (2) distribution of the axle loads and types in each vehicle class, and (3) a set of traffic multipliers to equally scale each class's average traffic to appropriate typical values.

Projected Traffic Changes—Although the distribution of axle loads within each of the 38 study vehicle classes is expected to remain constant in future years, there will be different bases of growth or decline in travel by each class. Thus, the overall distribution of axle weights will change during the typical pavement design period.

In each case for design of new pavement, the actual anticipated axle loadings are used only to determine projected cumulative ESAL loadings. The 1977 or 1985 traffic distributions are used to assign costs among vehicle classes. Thus, a large number of 30-kip tandem axle loadings in, for example, the 15th year of a pavement's life would add thickness to a pavement design but would not cause costs to be assigned disproportionately to vehicle classes with current year 30-kip tandems. If costs were distributed based on the 20-year axle loadings of a vehicle class, existing vehicles would be over or undercharged depending on whether travel by other vehicles in their class is expected to grow or decline.

ESAL Values—Required pavement thickness is a function of the number of axle loads of each magnitude that will traverse the pavement. Since magnitudes of the axles vary, it is necessary to transform the relative effect of each axle to a common metric. Here, as traditionally, the standard axle is chosen as the 18-kip single axle. Other axles' expected pavement serviceability consumptions are expressed in terms of the number of 18-kip single axle applications that would cause equivalent consumption. The term "ESAL" is used here to express this relative consumption by a particular axle.

For flexible pavements, equation C-16, page 60 of the AASHO Guide, produces the following equation used in the study:

$$ESAL = 10^W((L_x + L_2)/19)^{4.79}/L_2^{4.33}$$

where

$$W = G_t/B_x - G_t/B_{18}$$

$L_x$: Axle load (thousands of pounds)
$L_2$: Dummy variable: 1 for single axles, 2 for tandems
$G_t$: Function of pavement serviceability
$B_x$: Function of axle weight and pavement strength
$B_{18}$: Function of pavement strength

For rigid pavements, equation D-19 (page 104) is used in the following form:

$$ESAL = 10^W((L_x + L_2)/19)^{4.62}/L_2^{3.23}$$

As indicated in the equations, the ESAL value of a given axle is not constant, but varies somewhat depending on the pavement strength and pavement condition. For a pavement of given strength, however, an axle's ESAL value given by the above equations expresses the relative consumption of pavement serviceability by that axle to a point of given pavement condition. This is true as long as the distribution of axle weights is constant over the pavement's life. An axle has less effect in the early life of a pavement than in the later life, so that the ESAL value understates the overall relative effect of those axles which are expected to increase their proportional frequency over the life of the pavement.

Terminal PSI's and Soil Descriptors—These parameters are varied to simulate the range of values expected to be found on each functional highway class in a particular geographic region. Three representative values of terminal PSI (Pavement Serviceability Index) are used for each expenditure cell: PSI's of 2.4, 2.7, and 3.0 for Interstate highways and 2.2, 2.4, and 2.6 for other highways.

Sets of three soil support values for flexible pavements and three subgrade moduli for rigid pavements are specified for each geographic region. Values selected range from soil support values of 2.2 to 5.8 and subgrade moduli of 80 to 390 ($LBS/IN^3$).

## ASSIGNMENT METHODS FOR NEW PAVEMENT THICKNESS COSTS

Minimum Pavement Thickness Method—As discussed in Chapter II, this method, which is recommended, consists of hypothetically removing traffic uniformly across vehicle classes until further removal would not reduce pavement thickness requirements. In this study, the minimum layer and slab thicknesses used are taken from the AASHO Guide. The minimum layer thicknesses for flexible pavements are: surface course, 2 inches; base course, 4 inches; and subbase course, 4 inches. Using standard values for each course, this is equivalent to a structural number of 2.08. For rigid pavements, a minimum slab thickness of 6 inches is used.

The portion of thickness that is greater than the minimum pavement thickness is assigned to all vehicles based on their contribution to the need for that thickness. As can be seen from the design equations shown earlier, for any given pavement thickness and design terminal PSI, this proportional thickness responsibility is determined by each vehicle's ESAL value.

To apply the procedure for each expenditure cell, the following steps are taken:

(1) One of each of the four traffic levels, three terminal PSI's, and three soil values cited above is specified.

(2) The traffic matrix is converted into corresponding ESAL values for an assumed middle-range pavement thickness.

(3) Pavement thicknesses are iteratively substituted into the design equation until there is a close match between served ESAL's and anticipated ESAL's.

(4) ESAL values are found which correspond to the new pavement thickness.

(5) Steps 3 and 4 are repeated until successive pavement thicknesses are very close together.

(6) Costs of the extra thickness are proportioned to each vehicle class based on that class's share of total ESAL's.

(7) Steps 1 through 6 are repeated for each of the other 35 pavement sections in the expenditure cell.

(8) The mean of the 36 proportional distributions is computed and used as the proportional pavement thickness cost responsibility distribution for the expenditure cell.

The process is then repeated for each of the 99 other new pavement expenditure cells. Results of this process are expressed as a set of thickness-responsibility shares for each vehicle class for each expenditure cell. The share of pavement thickness that is in excess of the minimum requirement is found to vary from zero percent (for many low volume road types, especially for rigid pavements) to 61 percent (for both rigid and flexible pavements on urban freeways in the western coastal region).

Updated Incremental Methods—Two variations of the updated incremental method, neither of which are recommended, are applied here: one with 15 increments and one with 6. The 6-increment application uses single-axle lower boundaries of 20, 16, 12, 7, 3, and 0 kips (as in the 1961-1965 study), while the 15-increment application lower boundaries are 26, 23, 20, 17, 14, 12, 10, 8, 6, 4, 3, 2, 1.2, 0.6, and 0 kips.

Weight-Added (Traditional) Incremental Method—As with the updated incremental approach, this method is not recommended but is presented for comparisons. Six increments are used, with identical increment boundaries to the 6-step updated approach.

The effect of this upward rounding is most pronounced in the lighter increments. Little justification can be made for upward-rounding of axle weights (or the use of only six increments) in light of modern data processing techniques.

**New Pavement Width**

As mentioned in Chapter II, the costs of pavement width beyond the minimum necessary for the narrowest vehicles are assigned to wider vehicles by an incremental process similar to that used in the incremental approach for pavement thickness. The process is as follows:

(1) Determine the typical required pavement widths as a function of vehicle width. This was done in this study by a consultant, Jack E. Leisch and Associates.[1/] Figure A-1 includes these findings from the Leisch report and summarizes the effect of width on lane and shoulder width.

Figure A-1

Required Lane and Shoulder Width as a Function of Vehicle Width

| Highway Class | Required Lane Width (Feet) | Required Shoulder Width (Feet) |
|---|---|---|
| Rural freeway | 6.5 + 0.75 w (maximum 12) | 4 + w |
| Rural principal arterial | 6.5 + 0.75 w | 4 + 0.75 w |
| Rural minor arterial | 6.5 + 0.75 w | 2 + 0.5 w |
| Rural collectors | 6.5 + 0.75 w | 4 |
| Urban freeeway | 6.5 + 0.75 w | 4 + w |
| Urban principal arterial | 7.95 + 0.475 w | ----- |
| Urban minor arterial | 6.9 + 0.6 w | ----- |
| Urban collector | 6.9 + 0.6 w | ----- |

(2) Convert width relationships to cost savings relationships. This is done by using relative unit costs by shoulders and lanes[2/*/] and by estimating the relative share of cost savings to be proportional to width savings. Cost savings for the minimum width vehicle (a 2.5 foot wide motorcycle) range from 19 percent on rural collectors to 35 percent on rural primary arterials. Cost savings for a 5-foot wide subcompact vary from 6 percent to 18 percent.

(3) Divide the vehicle population into width increments. The incremental lower boundaries used in this study are (in feet) 7.8, 7.33, 7.1, 6.8, 6.3, 5.8, 5.0, 2.5, 2.2, and 0, respectively. Manufacturers' and registration data are used to distribute each vehicle class's mileage across the width increments, with the implicit assumption that mileage per vehicle in each vehicle class is independent of width. For 28 of the 38 vehicle classes (buses and all but the lightest trucks), all vehicles are in the widest increment.

(4) For each width increment, apportion the incremental share of width costs to each vehicle within the width increment by its proportional share of pavement thickness costs. Suppose, for example, that the pavement thickness attribution process described in the previous section assigns 40 percent of thickness in a certain expenditure cell by ESAL's. Then each width increment would have 40 percent of its costs assigned by ESAL's, but the 40 percent is assigned only to vehicles within the width increment. The first increment's costs are assigned only to those trucks over 7.8 feet wide, for example, while the 7th, 8th, and 9th increments' shares are assigned to all vehicles except some or all motorcycles. The 10th increment, or basic width roadway, is assigned to all vehicles.

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*/ The authors recommend shoulder unit costs equal to lanes for Interstate and primary arterial pavements, 80 percent of lane costs for minor arterials, and 65 percent of lane costs for collectors.

The assignment of pavement width costs completes new pavement cost assignments by the incremental method since total thickness costs within each width increment are assigned to individual axles and hence to specific vehicle classes. The recommended approach, however, has only the extra-strength portion of thickness so assigned. The basic-strength portion is assigned to groups of vehicles based on their widths but not to individual vehicles or vehicle classes.

**Overall Assignment of New Pavement Costs**

Consideration of how new pavement costs vary with the width, axle weights, and number of passages of the vehicles using the pavement partially completes the assignment of new pavement costs to vehicle classes. In the recommended approach, however, the costs of the minimum thickness pavement have been divided into 10 groups based on width requirements but have not been assigned to the vehicle classes comprising those groups. For this purpose, the residual allocator is used. As discussed in Chapter II, the residual allocator used here is VMT, although other use measures could be just as appropriate.

Use of the residual allocator for within-group costs means that each group's costs are assigned to the vehicle classes represented in the group based on the proportion of use by each class within that group. If, for example, VMT is used as the use measure and if 3S-2's over 75 kips have 12 percent of the travel by all vehicles over 7.8 feet on rigid pavements on Interstate highways in the northeast, then that vehicle class is assigned 12 percent of the minimum-thickness, first-width-increment portion of costs of that expenditure cell. Costs that go to all vehicles are the minimum-width, minimum-thickness costs (designated in this study as residual costs). In this study, these "basic roadway" costs amounted to 35 percent of new pavement costs.

## COMPARISON OF NEW PAVEMENT COST ASSIGNMENTS

Figure A-2 compares four methods of assigning new pavement costs. The same methods of assigning width costs, within-group costs, and residual costs are used for all four methods, with only the approach used to assign pavement thickness costs varying. The 38 vehicle classes used in analysis have been reduced to 12 for display.

As shown in the figure, the recommended approach assigns heavy trucks more new pavement costs than any of the incremental approaches. The updated 15-step approach assigns approximately the same share to automobiles, but 35 percent less share to the heaviest combinations, 18 percent less to combinations overall, and 47 percent more to pickups and vans. Buses, all single unit trucks, and combinations up to 70 kips are assigned more by the updated incremental method.

The traditional 6-step incremental approach assigns 25 percent more costs to small autos than does the updated 15-step incremental, but 10 percent less to trucks as a whole, combinations as a whole, and the heaviest combinations. The larger the groupings, the more the characteristics of the lightest and heaviest vehicles are obscured.

Figure A-3 compares the overall assignments that result if only the new pavement assignment methods are varied.

Figure A-2

**Comparison of New Pavement Cost Assignments**

**(1985: Percentage of Costs Assigned to Each Vehicle Class)**

| Vehicle Class: | Min. Thickness (Recommended) Approach | Updated 15-Step Incremental | Updated 6-Step Incremental | Weight-Added 6-step Incremental |
|---|---|---|---|---|
| Passenger Vehicles | 47.51 | 53.68 | 56.56 | 58.29 |
| Autos | 33.60 | 34.08 | 36.67 | 38.47 |
| Large | 20.18 | 20.11 | 20.14 | 20.95 |
| Small | 13.42 | 13.98 | 16.53 | 17.52 |
| Motorcycles | 0.36 | 0.09 | 0.15 | 0.16 |
| Pick-ups and Vans | 12.48 | 18.34 | 18.70 | 18.67 |
| Buses | 1.06 | 1.16 | 1.05 | 0.99 |
| Intercity | 0.18 | 0.19 | 0.17 | 0.16 |
| Other | 0.88 | 0.97 | 0.88 | 0.83 |
| Trucks | 52.49 | 46.32 | 43.44 | 41.71 |
| Single Unit | 5.91 | 8.11 | 7.88 | 7.49 |
| Under 26 Kips | 2.91 | 4.63 | 4.60 | 4.38 |
| Over 26 Kips | 3.00 | 3.49 | 3.28 | 3.11 |
| Combinations | 46.58 | 38.21 | 35.55 | 34.22 |
| Under 50 Kips | 3.54 | 4.36 | 4.07 | 3.91 |
| 50 - 70 Kips | 7.03 | 7.97 | 7.44 | 7.13 |
| 70 - 75 Kips | 13.86 | 11.39 | 10.55 | 10.18 |
| Over 75 Kips | 22.15 | 14.49 | 13.50 | 13.00 |
| All Vehicles | 100.00 | 100.00 | 100.00 | 100.00 |

Figure A-3

## Comparison of Overall Cost Assignments

## Using Different New Pavement Cost Assignment Methods

(1985: Percentage of Costs Assigned to Each Vehicle Class)

| Vehicle Class: | Min. Thickness (Recommended) Approach | Updated 15-Step Incremental | Updated 6-Step Incremental | Weight-Added 6-step Incremental |
|---|---|---|---|---|
| Passenger Vehicles | 58.89 | 59.22 | 59.37 | 59.46 |
| Autos | 39.77 | 39.79 | 39.93 | 40.02 |
| Large | 23.40 | 23.40 | 23.40 | 23.44 |
| Small | 16.37 | 16.40 | 16.53 | 16.58 |
| Motorcycles | 0.50 | 0.48 | 0.49 | 0.49 |
| Pick-ups and Vans | 17.33 | 17.64 | 17.66 | 17.66 |
| Buses | 1.30 | 1.30 | 1.30 | 1.29 |
| Intercity | 0.27 | 0.27 | 0.27 | 0.27 |
| Other | 1.03 | 1.03 | 1.03 | 1.03 |
| Trucks | 41.11 | 40.78 | 40.63 | 40.54 |
| Single Unit | 7.89 | 8.01 | 8.00 | 7.98 |
| Under 26 Kips | 3.43 | 3.52 | 3.52 | 3.51 |
| Over 26 Kips | 4.46 | 4.48 | 4.47 | 4.46 |
| Combinations | 33.21 | 32.77 | 32.63 | 32.56 |
| Under 50 Kips | 2.75 | 2.79 | 2.77 | 2.77 |
| 50 - 70 Kips | 5.19 | 5.24 | 5.21 | 5.20 |
| 70 - 75 Kips | 9.36 | 9.23 | 9.18 | 9.16 |
| Over 75 Kips | 15.92 | 15.51 | 15.46 | 15.44 |
| All Vehicles | 100.00 | 100.00 | 100.00 | 100.00 |

## REHABILITATED PAVEMENT COSTS

### Pavement Deterioration Costs

The primary determinant of the amount of costs incurred for pavement rehabilitation is the rate of deterioration. To the extent that vehicles cause this deterioration, the costs are assigned to them. As discussed in Chapter II, a series of distress models has been developed by a consultant[3/] to express each of the major pavement distresses as a function of traffic and other variables. The relative importance of each of these distresses is assessed by estimating the magnitudes of each at the time of rehabilitation and weighting these magnitudes by appropriate factors that simulate each distress's role in the decision to rehabilitate.

Rigid and flexible pavements are subject to different distresses and are modelled separately. Rigid pavements are further divided into jointed plain, jointed reinforced, and continuously reinforced concrete pavements. The last of the three was not modelled in this study. The same distresses were considered for both plain and reinforced rigid pavements, although the models vary.

Both rigid and flexible pavements were modelled with respect to loss of skid resistance and general loss of serviceability (as measured by the Pavement Serviceability Index or "PSI"). Serviceability is to some extent a combining of the other important distresses but includes additional distresses that were not modelled here. Despite the apparent doublecounting of, for example, rutting (when it is given importance both on its own and as a component of PSI loss), such implicit dual consideration is a typical part of the rehabilitation decision and is, therefore, emulated.

The important flexible pavement distresses include:

(1) loss of serviceability

(2) alligator cracking

(3) rutting

(4) transverse cracking

(5) loss of skid resistance

Each of these is related to traffic. Loss of serviceability also includes such loss when it is due to expansive clay subgrades, and this loss was modelled separately and found to be independent of traffic. Similarly, transverse cracking includes thermal cracking which was also found to be independent of traffic.

The important rigid pavement distresses include:

(1) loss of serviceability

(2) faulting

(3) pumping

(4) loss of skid resistance

(5) joint deterioration

(6) cracking

(7) depression and swell.

The first six are functions of traffic while the last one is not.

## FLEXIBLE PAVEMENT DISTRESS MODELS

The models for these distresses are based on both empirical data and the VESYS Model. The general form of the equation is:

$$D = (T/W)^B$$

Where "D" is the normalized magnitude of the distress, "T" is the accumulated traffic that has traveled on the pavement, "W" is the amount of traffic needed to cause a defined level of deterioration, and "B" expresses the shape of the deterioration curve.

Distress magnitude is expressed as a normalized variable, with a value of zero at its threshold of occurrence and a value of one at its point of maximum importance (that is, the point at which a greater magnitude of distress would no longer affect the decision to rehabilitate). This is analogous to the AASHO Road Test Model which uses an assumed initial PSI of 4.2 (distress equals zero) and a specified terminal PSI, typically 2.5 or 2.0 (distress equals one). In this form, distress magnitude can directly multiply the maximum point loss allowed for a given distress in a numerical pavement weighting system.

Traffic is measured by equivalent axle loads (analogous to but not identical to the 18-kip ESAL's used in the road test model). The equivalence of one axle load to another varies considerably from one distress to another. For most of the distresses, the equivalence of an axle of given weight and type varies as a function of pavement strength, asphalt layer thickness, subgrade stiffness and climate. In general, the equivalence variability for a given axle is greater in these distress models than are ESAL variations in the road test model (which, after all, was developed based on data from a single climate and limited range of soils).

The maximum level of traffic, W, and the deterioration curve shape factor, B, are also functions of pavement, soils and climatic characteristics. A numerical comparison of the flexible pavement distress models used in this study with the road test model is most useful after averaging the results for a large number of typical sections, since the variation in predicted distress is substantial. The comparisons below use the entire set of pavement sections considered in this study, weighted by their relative incidences.

Loss of Serviceability--Although not a distress, but rather a measurement of the effect of all distresses, pavement serviceability is typically treated independently by pavement rating systems. According to this study's analysis, serviceability loss is responsible for 44 percent of the decision to rehabilitate.

Traffic's contribution to serviceability loss is modeled separately from that of expansive clay's. Although on some pavement sections PSI loss due to expansive clays is a major determinant of rehabilitation need, expansive clay subgrades are responsible for only a small share of PSI loss overall. In fact, loss of PSI due to expansive clay amounts to only 4 percent of the overall decision to rehabilitate.

The model of PSI loss that is due to traffic produces very similar results to the road test model. In order to directly compare the various models, regression analyses were made between axle loads and weighted average equivalencies to the standard 18-kip single axle. The resulting equations describe very closely the equivalence function for weighted average pavement design, soil, and climatic conditions. Using these equations for anything but comparative purposes is not recommended since there is considerable variation in the newly-derived equivalency function depending on these other factors and minor variation in the road test equivalency function.

For the anticipated nationwide distribution of Federal-interest pavement rehabilitations in 1985, the serviceability-loss equivalence function is:

$$E = R^{4.37} \text{ (for single axles)}$$

$$= (R/1.94)^{4.99} \text{ (for tandem axles)}$$

Where R is the ratio of the weight of the axle of interest to any reference single axle and E is the equivalent effect of the axle of interest with respect to the reference axle.

For comparison, an analagous regression was made across the typical pavement sections that would be used if the road test model were used to measure serviceability loss. The resulting function is:

$$E = R^{3.86} \text{ (for single axles)}$$

$$= (R/1.86)^{3.98} \text{ (for tandem axles)}$$

The exponent in this expression is somewhat lower than in the more complicated road test equation[4/] for two reasons: (1) axle weights are used directly instead of after the addition of a constant, and (2) deleted terms are also functions of axle weights and effectively temper the primary function.

Alligator Cracking--This distress accounts for 28 percent of the decision to rehabilitate. The equivalence function is:

$$E = R^{1.30} \text{ (single axles)}$$

$$= (R/2.89)^{1.45} \text{ (tandem axles)}$$

Alligator cracking, therefore, is much less strongly related to axle load magnitude than is PSI loss. Tandem axles in particular are responsible for proportionally less deterioration.

Rutting--Rutting accounts for 11 percent of the decision to rehabilitate and is nearly as strongly related to load magnitude as is loss of PSI. The equivalence function is:

$$E = R^{4.16} \text{ (single axles)}$$

$$= (R/1.98)^{4.83} \text{ (tandem axles)}$$

Transverse Cracking--Transverse cracking includes a load-related component and a non-load component (thermal cracking). Their respective shares are 6 percent and 3 percent of the decision to rehabilitate. The equivalence function for the load-related component is:

$$E = R^{1.73} \text{ (single axles)}$$

$$= (R/1.53)^{1.92} \text{ (tandem axles)}$$

Skid Resistance--Loss of skid resistance is an exception to the regression form used for other flexible pavement distresses. Instead of raising axle loads to an exponent, a better fit was achieved by considering the number of tires passing over a pavement. Thus, a single axle with dual tires (4 tires total) has twice the effect on loss of skid resistance as does a 2-tire axle. A tandem axle (8 tires) has 4 times the effect.

- Skid resistance is responsible for 8 percent of the decision to rehabilitate.

## RIGID PAVEMENT DISTRESS MODELS

The models for these distresses are based on empirical data. The general form of the equation is the same as for flexible pavements, as is the distress variable. Equivalence among axle loads is calculated somewhat differently, however. Axles are compared by applying appropriate exponents to the road test 18-kip ESAL's rather than to the weight of the axle.

As with flexible pavements, the effective axle-load equivalence exponent varies considerably from one distress to another, and even for a given distress. The shape factor, traffic to failure, and equivalence exponents all vary depending on pavement, soil, and climatic characteristics.

Loss of Serviceability—As with flexible pavements, this factor is responsible for the largest share of the decision to rehabilitate—40 percent. Loss of PSI is entirely load-related. The equivalence function is;

$$E = R^{3.17} \text{ (single axles)}$$

$$= (R/1.58)^{3.91} \text{ (tandem axles)}$$

An analagous regression for a road-test-based cost assignment yields:

$$E = R^{3.32} \text{ (single axles)}$$

$$= (R/1.61)^{4.31} \text{ (tandem axles)}$$

As for flexible pavements, the exponents are lower in the regression equation than in the design equation.[5/] In this case, however, the newly-developed function is somewhat lower than the road-test-based function.

Faulting—This distress is load-related and accounts for 19 percent of the decision to rehabilitate. The equivalence function is:

$$E = R^{0.67} \text{ (single axles)}$$

$$= (R/1.41)^{0.98} \text{ (tandem axles)}$$

Pumping—This distress accounts for 14 percent of the decision to rehabilitate. The equivalence function is:

$$E = R^{0.83} \text{ (single axles)}$$

$$= (R/1.29)^{1.65} \text{ (tandem axles)}$$

Loss of Skid Resistance--This distress accounts for only 3 percent of the decision to rehabilitate. The equivalence function is:

$$E = R^{1.74} \text{ (single axles)}$$

$$= (R/1.61)^{2.09} \text{ (tandem axles)}$$

Joint Deterioration--This distress accounts for 21 percent of the decision to rehabilitate. The equivalence function is:

$$E = R^{4.16} \text{ (single axles)}$$

$$= (R/1.51)^{5.30} \text{ (tandem axles)}$$

Cracking--This distress accounts for only 2 percent of the decision to rehabilitate. The equivalence function is:

$$E = R^{5.48} \text{ (single axles)}$$

$$= (R/1.56)^{6.81} \text{ (tandem axles)}$$

Depression and Swell--This distress accounts for only 1 percent of the decision to rehabilitate and is not related to the number of loads or their magnitude.

## Overall Assignment of Rehabilitated Pavement Costs

As for new pavements, rehabilitated pavement cost responsibility is multidimensional. The same width functions are used for rehabilitated pavements as were described earlier for new pavements. As with the recommended approach for new pavements, a portion of rehabilitated pavement costs are assigned first to groups of vehicles and then by the residual allocator (VMT in the recommended approach) to individual vehicles. In this case, the residual portion is 5 percent.

Figure A-4 compares the recommended approach for rehabilitated pavements with three other approaches. The same width functions and, when necessary, residual allocators are used in each of the approaches. The second approach uses the AASHO Road Test deterioration equations directly for cost assignment. The third approach uses the equations for 70 percent of the cost of rehabilitation and considers the other 30 percent to be unrelated to load. The fourth approach uses the updated, 15-step incremental method. The first and third approaches are the most reasonable and are the closest together in result. Figure A-5 compares overall cost assignments if only the approach used to assign rehabilitated pavement costs is varied. The recommended approach is used for all other cost categories in each case.

Using the road test equations directly probably overassigns costs to heavy vehicles since it is implicitly assumed that all pavement costs are related to load by the functions that were developed without considering non-load-related deterioration. An estimate of 30 percent of these costs being not related to load causes costs to be assigned very closely to the recommended approach.

Using the incremental approach is a total misapplication of a new pavement approach that is even faulty for new pavements. The comparison is made to show the magnitude of shifting of assigned costs toward light and middle-weight vehicles if this assignment method were used.

Figure A-4

**Comparison of Rehabilitated Pavement Assignment Methods**

**(1985: Percentage of Costs Assigned to Each Vehicle Class)**

| Vehicle Class: | Newly-Developed Relationships (Recommended) | Road Test Equations for 100% of Costs | Road Test Equations for 70% of costs | Updated (15-Step) Incremental |
|---|---|---|---|---|
| Passenger Vehicles | 30.29 | 7.66 | 31.21 | 59.75 |
| Autos | 15.40 | 0.84 | 17.47 | 29.22 |
| Large | 10.16 | 0.79 | 10.69 | 19.05 |
| Small | 5.23 | 0.05 | 6.78 | 10.17 |
| Motorcycles | 0.11 | 0.00 | 0.23 | 0.12 |
| Pick-ups and Vans | 12.51 | 2.89 | 10.58 | 28.87 |
| Buses | 2.27 | 3.92 | 2.93 | 1.54 |
| Intercity | 0.45 | 0.79 | 0.59 | 0.32 |
| Other | 1.82 | 3.13 | 2.34 | 1.22 |
| Trucks | 69.71 | 92.34 | 68.79 | 40.25 |
| Single Unit | 11.88 | 15.78 | 12.79 | 11.53 |
| Under 26 Kips | 4.14 | 4.89 | 4.52 | 6.71 |
| Over 26 Kips | 7.73 | 10.89 | 8.27 | 4.83 |
| Combinations | 57.84 | 76.56 | 56.00 | 28.72 |
| Under 50 Kips | 4.35 | 5.68 | 4.31 | 3.46 |
| 50 - 70 Kips | 8.29 | 11.48 | 8.51 | 5.45 |
| 70 - 75 Kips | 15.78 | 20.88 | 15.30 | 8.64 |
| Over 75 Kips | 29.42 | 38.53 | 27.88 | 11.17 |
| All Vehicles | 100.00 | 100.00 | 100.00 | 100.00 |

Figure A-5

**Effect of Rehabilitated Pavement Assignment Method**

**on Overall Cost Assignment**

**(1985: Percentage of Costs Assigned to Each Vehicle Class)**

| Vehicle Class: | Newly-Developed Relationships (Recommended) | Road Test Equations for 100% of Costs | Road Test Equations for 70% of costs | Updated (15-Step) Incremental |
|---|---|---|---|---|
| Passenger Vehicles | 58.89 | 50.20 | 59.25 | 70.21 |
| Autos | 39.77 | 34.18 | 40.57 | 45.08 |
| Large | 23.40 | 19.80 | 23.60 | 26.82 |
| Small | 16.37 | 14.38 | 16.96 | 18.26 |
| Motorcycles | 0.50 | 0.46 | 0.54 | 0.50 |
| Pick-ups and Vans | 17.33 | 13.63 | 16.59 | 23.62 |
| Buses | 1.30 | 1.93 | 1.55 | 1.02 |
| Intercity | 0.27 | 0.40 | 0.32 | 0.22 |
| Other | 1.03 | 1.53 | 1.23 | 0.80 |
| Trucks | 41.11 | 49.80 | 40.75 | 29.79 |
| Single Unit | 7.89 | 9.39 | 8.24 | 7.76 |
| Under 26 Kips | 3.43 | 3.72 | 3.58 | 4.42 |
| Over 26 Kips | 4.46 | 5.67 | 4.67 | 3.34 |
| Combinations | 33.21 | 40.41 | 32.51 | 22.02 |
| Under 50 Kips | 2.75 | 3.26 | 2.73 | 2.40 |
| 50 - 70 Kips | 5.19 | 6.42 | 5.28 | 4.10 |
| 70 - 75 Kips | 9.36 | 11.32 | 9.17 | 6.61 |
| Over 75 Kips | 15.92 | 19.42 | 15.33 | 8.90 |
| All Vehicles | 100.00 | 100.00 | 100.00 | 100.00 |

## STRUCTURE COSTS

### Bridge Strength Costs

Analysis of the cost of providing extra bridge strength follows a standard incremental approach, similar to the study of 20 years ago. Detailed designs are made for a sample of actual bridges, cost functions developed based on these designs, and appropriate weighting factors applied to these cost functions to develop an overall function for each expenditure cell. Each step of the process is described below.

#### SELECTION OF SAMPLE BRIDGES

Twelve bridges were chosen for detailed design analysis. The first step in the selection of these bridges involved identifying and categorizing all bridges built on the Federal-aid Highway System in the 1976 to 1978 base period. Bridge types are taken from the FHWA Bridge Inventory[6/] and include, for example, concrete slab, steel continuous girder, prestress concrete tee beam, etc.

Bridges of each type were sorted by main span length and by highway class. The sample was chosen to best cover the array. The less common bridges, such as aluminum, timber, and masonry could not be represented in the sample. The common bridge types that vary most in length were doubly represented so that effect of span length could be considered.

After selecting the characteristics of each bridge in the sample, specific bridges were chosen. Since detailed plans would have to be procurred from State highway departments, bridges were chosen in as few States as possible while still maintaining a representative sample. The types of bridges and their main span lengths are listed in Figure A-6. A more specific description can be found in a consultant report.[7/]

Figure A-6

Bridges Used for Bridge Strength Cost Analysis

| Type of Bridge: | Main Span Length (feet): |
|---|---|
| Concrete slab | 36 |
| Continuous slab | 37 |
| Concrete T-beam | 38 |
| Concrete girder | 40 |
| Prestess girder | 73 |
| Prestress continuous girder | 77 |
| Prestress box | 70 |
| Prestress box | 125 |
| Steel girder | 80 |
| Steel girder | 120 |
| Continuous steel girder | 64 |
| Continuous steel girder | 125 |

## COST FUNCTIONS FOR SAMPLE BRIDGES

The individual bridge cost functions were developed by a consultant using a standard incremental approach. Weight is successively removed from the heaviest vehicles until further weight reductions has no appreciable effect on bridge cost.

In this study, bridges were designed for 72 kip and 54 kip combinations and for 40, 30, 20, 10, and 5 kip single-unit vehicles. These 7 design vehicles correspond respectively to HS20, HS15, H20, H15, H10, H5, and H2.5 design loadings. The cost of each bridge design was estimated and formed the basis for the individual bridge cost functions.

The design process and results are reported in detail in the consultant report.[8/] Costs of the H2.5 bridge vary from 65 percent to 91 percent of the corresponding HS20 bridge costs, with costs of longer spans generally being less affected by vehicle weight reductions.

COST FUNCTIONS FOR EXPENDITURE CELLS

Within each geographic region and on each highway class, a variety of bridges were built during the base year. The PR-37 reports discussed in Chapter IV document dollars spent for each bridge type. Thus, a given expenditure cell cost function can be derived by simply weighting each individual cost function by the dollars spent in that expenditure cell on the corresponding types of bridges.

For rural Interstates in the northeast, for example, 4.6 percent of costs can be saved by reducing the design vehicle to a 40 kip single unit; an additional 2.8 percent can be saved by going to a 30 kip single-unit. Weight reductions to 20, 10, and 5 kips produce additional incremental savings of 4.9 percent, 5.2 percent, and 3.2 percent. Thus, a total of 20.7 percent of bridge costs could be saved by reducing maximum design vehicles from a 72-kip combination to a 5-kip single vehicle. Weight reductions below 5 kips have little effect on bridge costs since the dead weights of bridge members, snow, etc., begin to be more significant below this point.

## ASSIGNMENT OF VEHICLES TO WEIGHT GROUPS

Each of the vehicle classes used in this study consists of vehicles operating at a wide distribution of vehicular weights. Rather than assuming that the maximum gross weight of each class is representative of the class, vehicles of each class are distributed to each gross weight group based on the proportional amount of travel at the corresponding operating weights.

Vehicles are grouped according to the bending moment that they create on bridges of typical span. As was done in the Federal study of 20 years ago, combination vehicles' gross weights are divided by a constant factor (1.35) to convert them to equivalent single-unit weights. For verification of this factor, an H20 bridge (40,000 pound single-unit loading) was designed to compare with the HS15 bridge (54,000 pound combination). In most cases, the costs of the two bridges are very close together, but for three of the twelve sample bridges, the costs were over 2 percent apart, with the H20 bridge costing more in each case. Thus, heavy single-units are given the benefit of slightly lower assignments than would be made if it were feasible to separately design for singles and combinations on each bridge. Even then, a totally accurate assignment method would consider the moments produced by differential axle spacings and would require individual analysis of each vehicle. With fairly simple computer analysis it is easy to examine loadometer records for the moments produced and the observed gross vehicle weights. At the State level such an analysis is preferable. However, for the Federal study the choice of a single factor seemed to be a reasonable and practical approach. Figure A-7 summarizes the gross weights in each design increment.

Figure A-7

**Vehicle Gross Weights Included in Each Bridge Design Increment**

| Design Increment | Lower Boundary for Single Units (pounds) | Lower Boundary for Combinations (pounds) |
|---|---|---|
| HS20 | 40,000 | 54,000 |
| HS15 | 30,000 | 40,500 |
| H15 | 20,000 | 27,000 |
| H10 | 10,000 | 13,500 |
| H5 | 5,000 | 6,250 |
| H2.5 | 0 | 0 |

**Bridge Replacement and Repair Costs**

- Bridge repair costs are treated as entirely residual costs.

Costs of bridges that are built to replace existing bridges have a special set of relationships to vehicle characteristics. Costs of bridges that are built because of load-carrying deficiencies of existing bridges are partially incurred because larger-than-capacity vehicles want to use the bridge. Costs of correcting inadequate lane width are related to use by wider vehicles; costs of replacing bridges with fatigue-worn members are related to some exponent of the moment produced by each vehicle; costs of correcting inadequate overhead clearances are related to the existence of high vehicles. Costs related to vehicle characteristics, such as these, are at least partially assignable based on these characteristics.

## COSTS ASSIGNED BY VEHICLE CHARACTERISTICS

Because of the lack of adequate knowledge of the relationships between use and bridge wear, costs are not assigned in this study by any bridge deterioration basis. Because of lack of clear relationships and because of little effect on cost assignments, geometric deficiencies are not used in this study as a basis for cost assignment. Instead, only load deficiencies are used to specially assign bridge replacement costs.

Load deficiency costs are determined by prorating the cost of the replacement bridge by the relative importance of load deficiency in the overall decision to replace the bridge. The prorating is based on the straightforward calculation of bridge "sufficiency rating" scores with and without the load-carrying deficiency.[9/] The proportional loss in sufficiency caused by the inadequate load capacity of the bridge is assigned to the group of all vehicles heavier than the capacity.

A bridge with a sufficiency rating of 50 (out of a possible 100) has lost 50 points. If 10 of the lost points are due to the bridge having a capacity of 40,000 pounds, then vehicles above 40,000 pounds are given 20 percent of the cost. The estimated costs in each load capacity category are added for all replacement bridges in each expenditure cell and divided by the total estimated costs to develop the set of special replacement bridge cost functions.

## COMBINING STRENGTH AND DEFICIENCY CONSIDERATIONS

The special replacement bridge functions and the bridge strength functions are simultaneously applied to replacement bridge costs in much the same manner as are the width and strength functions for pavement, described earlier in this appendix. In this case, however, the simultaneous application of the two functions reduces to a simple addition since the vehicle groupings for the two functions are identical.

For example, the group of vehicles above 40,000 pounds (54,000 for combinations) in a given expenditure cell might be assigned 2.5 percent of costs because of load-carrying-capacity deficiencies and 4.8 percent of costs (based on incremental cost assignment) because of bridge strength needs. In total, then, that group of vehicles is assigned 4.8 percent plus 2.5 percent of the remaining 95.2 percent (100 percent minus 4.8 percent), or 7.18 percent of replacement bridge costs before width is considered.

### Overall Assignment of Bridge Costs

BRIDGE WIDTH COSTS

Lane and shoulder width requirements for bridges are identical to those shown in Figure A-1 for pavements. The process described for pavement width costs is also used for new bridge width, except that bridge shoulder width has the same unit cost as bridge lane width because there are no relative savings for bridge shoulders as there are for pavement shoulders. Replacement bridge cost assignment follows the same process except that the width increments are divided by the combined strength-and-deficiency function described above. Width costs are not considered for repaired bridges because no detailed breakdown is available to determine which repair costs are width related and which are not.

An independent determination of the variation of cost with deck width was made as part of the bridge incremental analysis.[10/] The results showed that due to the economies of scale in construction, the percent change in costs for the sample bridges in relevant width ranges are from .75 to .88 of the percent reductions in bridge width. A figure of .80 is used in this study: that is, a 20 percent reduction in bridge width results in a 16 percent reduction in bridge cost.

## ASSIGNMENT WITHIN GROUPS

As for new and rehabilitated pavements, assignment among vehicles in each assignment group is by a residual allocator used to weight the occurence of each vehicle within the group. In this study, VMT is ordinarily used as the residual allocator.

## COMPARISON OF BRIDGE COST ASSIGNMENTS

The recommended bridge cost assignment method described in Chapter II assigns new bridge costs by the incremental method with a basic bridge sufficient for H2.5 loading, replacement bridge costs by a special replacement function combined with the H2.5 incremental approach, and repaired bridges entirely as residual costs.

Figure A-8 compares the assignments that would result if the basic bridge strength were changed to H5 or H10 loadings instead of the recommended H2.5 loading. In all cases, the replacement bridge function is used, repaired bridges are treated as residual costs, width is considered, and VMT is used as the residual allocator.

As can be seen in the figure, increasing the strength of the basic bridge lessens the differences in assigned costs between light and heavy vehicles, although not drastically. Figure A-9 shows the effect that changing the basic bridge would have on overall cost assignments.

Figure A-10 shows the effects of (1) not using the replacement bridge, and (2) using the new bridge function for bridge repair. The former lowers the share to the heaviest vehicles while the latter increases it. Figure A-11 shows the effect this change would have on the overall cost assignment.

Figure A-8

**Comparison of Assigned Bridge Costs**

**for Alternative Basic-Strength Bridges**

**(1985: Percentage of Bridge Costs Assigned to Each Vehicle Class)**

| Vehicle Class: | H2.5 Basic Bridge | H5 Basic Bridge | H10 Basic Bridge |
|---|---|---|---|
| Passenger Vehicles | 65.02 | 68.17 | 72.69 |
| Autos | 46.04 | 48.45 | 51.73 |
| Large | 26.76 | 28.22 | 30.20 |
| Small | 19.28 | 20.23 | 21.54 |
| Motorcycles | 0.50 | 0.53 | 0.57 |
| Pick-ups and Vans | 17.27 | 18.15 | 19.56 |
| Buses | 1.21 | 1.04 | 0.83 |
| Intercity | 0.31 | 0.28 | 0.22 |
| Other | 0.90 | 0.76 | 0.61 |
| Trucks | 34.98 | 31.83 | 27.31 |
| Single Unit | 7.67 | 6.56 | 5.94 |
| Under 26 Kips | 3.78 | 3.21 | 3.16 |
| Over 26 Kips | 3.88 | 3.34 | 2.78 |
| Combinations | 27.32 | 25.27 | 21.37 |
| Under 50 Kips | 2.68 | 2.42 | 2.05 |
| 50 - 70 Kips | 5.15 | 4.67 | 3.85 |
| 70 - 75 Kips | 8.41 | 7.80 | 6.60 |
| Over 75 Kips | 11.08 | 10.38 | 8.87 |
| All Vehicles | 100.00 | 100.00 | 100.00 |

Figure A-9

**Comparison of Overall Cost Assignments**

**Using Different Basic-Strength Bridges**

**(1985: Percentage of Total Costs Assigned to Each Vehicle Class)**

| Vehicle Class: | H2.5 Basic Bridge | H5 Basic Bridge | H10 Basic Bridge |
|---|---|---|---|
| Passenger Vehicles | 58.89 | 59.52 | 60.41 |
| Autos | 39.77 | 40.25 | 40.89 |
| Large | 23.40 | 23.69 | 24.08 |
| Small | 16.37 | 16.56 | 16.81 |
| Motorcycles | 0.50 | 0.50 | 0.51 |
| Pick-ups and Vans | 17.33 | 17.51 | 17.78 |
| Buses | 1.30 | 1.26 | 1.22 |
| Intercity | 0.27 | 0.26 | 0.25 |
| Other | 1.03 | 1.00 | 0.97 |
| Trucks | 41.11 | 40.48 | 39.59 |
| Single Unit | 7.89 | 7.67 | 7.55 |
| Under 26 Kips | 3.43 | 3.32 | 3.31 |
| Over 26 Kips | 4.46 | 4.35 | 4.24 |
| Combinations | 33.21 | 32.81 | 32.04 |
| Under 50 Kips | 2.75 | 2.69 | 2.62 |
| 50 - 70 Kips | 5.19 | 5.10 | 4.94 |
| 70 - 75 Kips | 9.36 | 9.24 | 9.00 |
| Over 75 Kips | 15.92 | 15.78 | 15.48 |
| All Vehicles | 100.00 | 100.00 | 100.00 |

Figure A-10

**Comparison of Bridge Cost Assignments**

**Using Different Methods for Repaired and Replacement Bridges**

**(1985: Percentage of Bridge Costs Assigned to Each Vehicle Class)**

| Vehicle Class: | Recommended Assignment Method | Not Using Special Function for Replacement | Assigning Bridge Repair Costs as New Bridge Costs |
|---|---|---|---|
| **Passenger Vehicles** | 65.02 | 70.75 | 63.40 |
| Autos | 46.04 | 49.83 | 44.85 |
| Large | 26.76 | 29.22 | 26.03 |
| Small | 19.28 | 20.61 | 18.82 |
| Motorcycles | 0.50 | 0.55 | 0.49 |
| Pick-ups and Vans | 17.27 | 19.48 | 16.79 |
| Buses | 1.21 | 0.88 | 1.27 |
| Intercity | 0.31 | 0.21 | 0.33 |
| Other | 0.90 | 0.67 | 0.94 |
| **Trucks** | 34.98 | 29.25 | 36.60 |
| Single Unit | 7.67 | 6.48 | 7.88 |
| Under 26 Kips | 3.78 | 3.49 | 3.83 |
| Over 26 Kips | 3.88 | 2.99 | 4.05 |
| Combinations | 27.32 | 22.78 | 28.73 |
| Under 50 Kips | 2.68 | 2.25 | 2.80 |
| 50 - 70 Kips | 5.15 | 4.36 | 5.41 |
| 70 - 75 Kips | 8.41 | 6.92 | 8.86 |
| Over 75 Kips | 11.08 | 9.25 | 11.65 |
| **All Vehicles** | 100.00 | 100.00 | 100.00 |

Figure A-11

**Comparison of Overall Cost Assignments**

**Using Different Methods for Repaired and Replacement Bridges**

**(1985: Percentage of Total Costs Assigned to Each Vehicle Class)**

| Vehicle Class: | Recommended Assignment Method | Not Using Special Function for Replacement | Assigning Bridge Repair Costs as New Bridge Costs |
|---|---|---|---|
| Passenger Vehicles | 58.89 | 60.03 | 58.57 |
| Autos | 39.77 | 40.52 | 39.53 |
| Large | 23.40 | 23.89 | 23.26 |
| Small | 16.37 | 16.63 | 16.28 |
| Motorcycles | 0.50 | 0.51 | 0.50 |
| Pick-ups and Vans | 17.33 | 17.77 | 17.24 |
| Buses | 1.30 | 1.23 | 1.31 |
| Intercity | 0.27 | 0.25 | 0.27 |
| Other | 1.03 | 0.98 | 1.04 |
| Trucks | 41.11 | 39.97 | 41.43 |
| Single Unit | 7.89 | 7.66 | 7.93 |
| Under 26 Kips | 3.43 | 3.38 | 3.44 |
| Over 26 Kips | 4.46 | 4.28 | 4.49 |
| Combinations | 33.21 | 32.32 | 33.49 |
| Under 50 Kips | 2.75 | 2.66 | 2.77 |
| 50 - 70 Kips | 5.19 | 5.04 | 5.24 |
| 70 - 75 Kips | 9.36 | 9.06 | 9.45 |
| Over 75 Kips | 15.92 | 15.56 | 16.03 |
| All Vehicles | 100.00 | 100.00 | 100.00 |

## GRADING COSTS

### Steepness of Grade

If vehicles had more power and better stopping abilities, grades could be steeper. Therefore, whenever natural grades of terrain are steeper than currently allowable road grades, costs could be saved if the most slowly-climbing and descending vehicles were removed from the traffic stream. These hypothetically saved costs can be assigned to the hypothetically removed vehicles.

A consultant was hired to determine the costs that could be saved if vehicles were better able to negotiate grades. Overall assignment functions for each functional class were derived by considering the distribution of highway mileages in each type of terrain (mountainous, rolling, and flat). The cost savings expected in each terrain type were estimated by determining maximum grades as a function of weight-to-power ratios, calculating proportional savings in earthwork that could be expected in each terrain type as a function of maximum allowable grade, and applying these savings to the proportion of grading and drainage costs that involve earthwork. The cost functions are not applied to grading costs on existing highways that are incidental to projects such as safety improvements, etc.

Earthwork cost is related to vehicle characteristics by the function:[11/]

$$C = 1 - k\,((400 - W_p)/300)^{1.45} \qquad (\text{for } 100 \geq W_p \geq 400)$$

where

$C$ = proportion of grading costs compared to those incurred for the most demanding vehicles

$k$ = a constant, varying from 0.105 for Interstate highways in rolling terrain to 0.59 for collectors in mountainous terrain

$W_p$ = pounds per horsepower of the design vehicle.

Costs are assigned by this function to groups of vehicles in weight-to-power increments with lower boundaries of 100, 150, 200, 250, 300, and 350 pounds-per-horsepower.

Vehicles are placed in groups based on the proportional travel in a class by vehicles operating in each weight-to-power range. Power distributions are obtained from the Truck Inventory and Use Survey and applied to the operating weight distributions used generally in this study.

## Overall Assignment of Grading and Drainage costs

### GRADING WIDTH AND WITHIN GROUP COSTS

Grading width functions are identical to bridge width functions: unit costs are similar across the entire roadway width and cost reductions are assumed to be 80 percent proportional to width reductions.

Allocation of costs to vehicles within width and steepness incremental groups is the same as for pavements and bridges.

### ASSIGNMENT RESULTS

Figure A-12 compares nonincidental grading cost assignments that result from using and not using the grade steepness assignment function. Figure A-13 shows the effect that the function has on overall cost assignments.

Figure A-12

Comparison of Grading Cost Assignments

Using Different Methods for Assignment of Grade Steepness

(1985: Percentage of Grading Costs Assigned to Each Vehicle Class)

| Vehicle Class: | Recommended Assignment Method | Not Using Grade Steepness Function |
|---|---|---|
| Passenger Vehicles | 78.46 | 86.90 |
| Autos | 55.51 | 61.02 |
| Large | 33.15 | 36.59 |
| Small | 22.36 | 24.43 |
| Motorcycles | 0.69 | 0.76 |
| Pick-ups and Vans | 21.86 | 24.65 |
| Buses | 0.40 | 0.45 |
| Intercity | 0.07 | 0.08 |
| Other | 0.33 | 0.38 |
| Trucks | 21.54 | 13.10 |
| Single Unit | 5.36 | 4.79 |
| Under 26 Kips | 3.08 | 3.09 |
| Over 26 Kips | 2.28 | 1.71 |
| Combinations | 16.19 | 8.31 |
| Under 50 Kips | 1.63 | 1.00 |
| 50 - 70 Kips | 3.08 | 1.82 |
| 70 - 75 Kips | 4.66 | 2.34 |
| Over 75 Kips | 6.82 | 3.15 |
| All Vehicles | 100.00 | 100.00 |

Figure A-13

**Comparison of Overall Cost Assignments**

**Using Different Methods for Assignment of Grading Costs**

**(1985: Percentage of Total Costs Assigned to Each Vehicle Class)**

| Vehicle Class: | Recommended Assignment Method | Not Using Grade Steepness Function |
|---|---|---|
| Passenger Vehicles | 58.89 | 59.75 |
| Autos | 39.77 | 40.33 |
| Large | 23.40 | 23.75 |
| Small | 16.37 | 16.58 |
| Motorcycles | 0.50 | 0.51 |
| Pick-ups and Vans | 17.33 | 17.61 |
| Buses | 1.30 | 1.30 |
| Intercity | 0.27 | 0.27 |
| Other | 1.03 | 1.03 |
| Trucks | 41.11 | 40.25 |
| Single Unit | 7.89 | 7.84 |
| Under 26 Kips | 3.43 | 3.43 |
| Over 26 Kips | 4.46 | 4.40 |
| Combinations | 33.21 | 32.42 |
| Under 50 Kips | 2.75 | 2.68 |
| 50 - 70 Kips | 5.19 | 5.06 |
| 70 - 75 Kips | 9.36 | 9.12 |
| Over 75 Kips | 15.92 | 15.55 |
| All Vehicles | 100.00 | 100.00 |

# ESTIMATION OF EFFICIENT HIGHWAY USER CHARGES*

## INTRODUCTION AND SUMMARY

Concepts and estimated user charge responsibilities derived from the efficiency approach may be of interest from two perspectives:

(1) The definition and measurement of avoidable costs as operationalized under the efficiency criterion is one method for designing "fair" user charges, and can be compared to other methods for raising revenues with which to finance highway expenditures.

(2) Efficiency goes considerably beyond meeting the fairness test, in that it also seeks to alter user behavior in ways that make better use of scarce resources. It accomplishes this through the incentives created by user charges that are tied to the manner and amount of usage.

Although a large body of work has been directed at the various aspects of highway usage and associated costs, the newness of the effort at synthesis makes the results necessarily tentative. Economic efficiency has never been used as the sole basis for a cost allocation study, but its principles have often been cited as a fundamental goal of such studies, that is, more responsible use of the highway system. The detail provided in this section is to allow the reader as thorough a background in the subject as possible in the space allocated. The choice of study approach or combinations of approaches must be left to the study leaders.

Instead of attempting to set down a definitive summary of the current state-of-the-art, this report draws the argument and the evidence together in an abbreviated

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*/ This Appendix is a modification and update of Appendix E to the Final Report on the Federal Highway Cost Allocation Study, May 1982.

form that emphasizes the critical assumptions and parameters in the results presented. References are provided for obtaining more information about theory, methods, and previous studies.

**Criteria for Selecting Among User Charge Structures**

The standards against which to evaluate user charge instruments and rates are fundamentally two: efficiency and equity.

Efficiency. Short run efficiency assumes a given set of capital facilities, and seeks ways to secure the best possible utilization of those facilities. The theoretical mechanism for this optimization is pricing, interpreting the concept of a price broadly to include such factors as travel time and risk of accident, as well as user charges. Highway user charges are the most direct means for achieving short run efficiency with respect to the highway system.

Long run efficiency deals with finding the best program of investment in fixed facilities, while also satisfying the short run efficiency criterion. Analytically, the path to long run efficiency is followed by comparing the incremental costs and benefits of alternative projects, and investing (or disinvesting) in the appropriate links of the highway network. Although user charges inevitably have an influence on the actual pattern of investment and disinvestment, this report concentrates on pricing the usage of existing facilities rather than on optimizing long run investment.

Equity. The concept of equity as formulated in the public finance field is concerned with the distribution of costs and benefits among groups within society. Tax equity, in this framework, is achieved by requiring payments in accordance with either ability to pay or benefits received, neither of which may bear relationship to costs occasioned. Although it is essential that the redistributional impacts of alternative user charge schemes be thoroughly illuminated, and the imposition of equity constraints on efficiency solutions will be necessary both analytically and politically, there is no hard and fast way to assert that some user charges are equitable and others inequitable. Equity is inherently a matter of political choice. Technical analysis can contribute to the political debate by formulating equity constraints and displaying their consequences.

Most directly related to popular ideas of fairness is the notion of horizontal equity, which says that equals should be treated equally. Regarding highways, vehicles in equal circumstances — from the standpoint of the highway provider —should be charged equally, although there may be instances in which price discrimination between users is useful for achieving other efficiency and equity objectives. Another equity concern is the effect of public policy on the poor, more formally represented by the distribution of income among various groups, and whether a policy's impact is progressive (tends to reduce income disparities) or regressive. This concept is referred to as vertical equity. As a general rule, price manipulation (including highway user charge adjustments) is not a very effective policy instrument for redistributing income. Equity impacts of pricing policies need to be revealed, but equity, by itself, is not a sufficient basis for user charge design.

The above formulation of the equity concept is not the one that has traditionally guided highway cost allocation studies. Instead, the idea that vehicles should pay for the costs they occasion is described as "equitable" in the Congressional mandate for the Federal cost allocation study,[*/] and most state studies adhere to the same rationale. For highway services, it certainly seems fair that users should pay for the costs they occasion. It is more than simply equitable, however; asking users to pay an amount equal to the costs they create ensures that the benefits perceived by the users will be at least as great as the costs of their usage. The purpose of such user charges would appear to be the encouragement of efficient resource allocation.

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*/ Surface Transportation Assistance Act of 1978, Sec. 506 and 507.

Although a strong case can be made for basing highway user charges on efficiency grounds, implementing this approach requires that several obstacles be overcome:

(1) New instruments are required to actually collect user charges based on the efficiency criterion, and there is only a limited amount of previous experience upon which to judge the impacts of such instruments.

(2) Collection of efficient user charges would entail administrative costs which would at least partially offset the potential gains from efficient prices, but the magnitudes of the administrative costs have not yet been calculated.

(3) The concept that highway users should pay for the use and upkeep of the roads is widely accepted, but the specific consequences of an efficiency objective on the design and implementation of such charges is not well understood.

(6) For efficiency-based user charges to be even minimally effective, some degree of agreement and coordination must be achieved among all levels of government.

These considerations have prevented much reliance on efficiency for the design of current highway user charges, but there is nothing to prevent the future development and application of efficiency concepts to highway pricing. The choice is a matter of public and political preference. Deregulation is proceeding in the airline and railroad industries, while (minimal) user charges have been initiated for inland waterways. In all of these actions, intermodal price competition was an important concern. Electric power, telephone, postal service, and intercity bus enterprises face similar types of problems, and there is no reason for publicly operated facilities to stand out as being managed according to a different set of concepts from those used in analogous private industries. Whatever policy direction is taken next, private transportation modes and publicly owned modes should be priced comparably and treated analytically as similar sorts of beasts.

### Typical User Charge Results

A complete set of user charges for a particular vehicle is the result of combining two types of information. First, unit costs (cents per mile) are estimated for the various cost components, as functions of both the characteristics of the vehicle and the conditions under which it typically is operated. Cost components are primarily pavement damage and traffic delay; vehicle characteristics are things such as axle weight and pollution emissions; and operating conditions include pavement strength, environment, and congestion levels. Second, the actual operating conditions that the vehicle will encounter are estimated. Total pavement damages per year, for example, depend upon actual loaded weights, the types of pavements actually travelled over, and the total annual mileage for each vehicle.

Figure A-14 shows summary figures for five representative vehicle types. The cents-per-mile "efficient user charge" is an average for all types of operating conditions, and sums all of the component costs. A rural auto, for example, is assumed to be too light to cause pavement damage, travels only on uncongested rural roads, and generates too little pollution to have a measurable impact. An urban auto, in contrast, is assumed to be used regularly for peak-hour commuting and also contributes significantly to pollution. The medium truck is assumed to travel mostly on medium and light duty pavements, adding modestly to traffic delay and noise pollution. The heavy single-unit truck produces high per-mile costs because it is assumed to operate about a third of the time on light pavements that are vulnerable to damage, while the heavy combination operates primarily (assumed to be 80% rural) on lightly-congested heavy-duty pavements but travels a large number of miles per year. Truck charges are based on estimates of average actual gross weight, not registered gross weight or maximum capacity.

These examples are constructed from the cost estimates described below in greater detail, and from estimates of typical operating conditions. Costs of

FIGURE A-14

Estimated Total User Charges for Typical Vehicles and Conditions

| Type | Location | Description | Average Efficient User Charges (¢/mile) | Annual Mileage | Efficient Annual User Charges ($/year) | Estimated Current Annual Charges ($/year) |
|---|---|---|---|---|---|---|
| Auto | rural | | .6 | 11,000 | $ 66 | $ 130 |
| | urban | used for commuting | 8.8 | 9,000 | 792 | 160 |
| Truck | urban | medium single unit (40,000 lb GW) | 25.1 | 10,000 | 2,507 | 480 |
| | urban and rural | heavy single unit (60,000 lb GW) | 59.0 | 10,000 | 5,900 | 1,100 |
| | rural and urban | heavy combination (72,000 lb GW) | 22.0 | 50,000 | 11,000 | 4,500 |

actually collecting the charges are ignored. The results are estimates for each prototypical vehicle, and are not necessarily consistent with national averages for any specific vehicle class. The figures are intended to be comparable to common vehicle types and their associated operating conditions, but the numbers are built up from component parts rather than being aggregates averaged over units of travel. This distinction is important for interpreting the results, and its meaning should become clearer as the estimation methods are explained.

## Conclusions

As a consequence of working out the details of the conceptual framework and empirical methods, and producing quantitative estimates of efficient highway user charges, the following conclusions were drawn:

(1) The concepts of microeconomic theory and efficiency are applicable to the problem of highway user charge design and provide strong guidance for the construction and empirical estimation of such charges.

(2) The goal of efficient resource allocation should be a major criterion for user charge design, and perhaps this goal should be the dominant objective. Equity and efficiency can be evaluated within the same analytic framework and properly balanced through an informed political process.

(3) Efficient user charges could raise almost $80 billion annually (ignoring collection costs and assuming revenues from different types of charges are additive), in contrast to the $50 billion currently spent on highways by all levels of government or the $30 billion now raised by user fees.

(4) Much of the previous highway research has not taken efficient user charge design into account, and there are many gaps in the basic knowledge needed to construct such charges. Some examples are the effects of pavement damage on user costs, the effects of congestion on user costs, the contributions of different vehicles to congestion and accidents under various traffic conditions, and the valuation of such intangibles as noise, travel time, and air and water pollution.

(5) The user charges estimated here do not include any fixed fees or access charges, such as registration fees. Efficient charges vary with usage for a given vehicle, and the principal instrument which does this among current charges is the fuel tax. User taxes of the registration or weight-fee type could be used to supplement the revenues raised from efficient prices.

(6) Many degrees of compromise are possible between ideal user charges and practical implementation of the charges. Accuracy must be traded off against ease and cost of administration, but the criterion can still be efficiency as a normative basis for implementing practical user charge structures.

(7) The dollar value of the (net benefits) welfare gains from efficient user charges is another degree more difficult to estimate than the charges themselves, but the direct gains alone would be significant. Short run net benefits could be in the range of $10 billion annually (again, ignoring collection costs), and long run gains might grow to be much larger. Efficient pricing of and investment in the highway system would have large beneficial effects because of the central role of highways in the economy.

## CONCEPTUAL FRAMEWORK

A perspective has gradually emerged in the transportation field over the last several decades that views transportation services as an output consumed by individual users rather than as a public good consumed by everyone. From this perspective, the allocation of scarce capital resources toward competing productive ends becomes the fundamental investment question, and the setting of user charges becomes an instrument for achieving efficient utilization of the available stock of facilities.

These issues should be independent of the institutional structure by which a transportation service is provided and priced, and independent of the mode of transportation. Unfortunately, highway user charges are determined in a context that makes the consideration of efficient allocation of resources awkward at best. Instead, taxes are imposed on selected groups, by several levels of government, in order to meet budget requirements that are agreed upon through political means.

To pose the alternative, design and estimation of ideal highway user charges is undertaken in this study through the application of microeconomic theory.[*/] This is an approach based entirely on efficiency, making no explicit recognition of the principles of equitable taxation that have guided previous highway cost studies. The concept of charging vehicles in accordance with "cost occasioned" is retained but in a much narrower and more precisely defined form.

### Efficient Pricing

The purpose of an efficient price is to maximize net benefits to society. To achieve this, it is necessary to confront the individual consumer with the full social costs of his or her decision. The level of consumption is determined by users,

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[*/] Review and synthesis of potentially applicable theory was conducted in previous studies (Lee, 1981, and Boyd, 1981) done for the Federal Highway Cost Allocation Study (HCAS).

weighing the costs to themselves against the benefits to themselves, and not by transportation planners or economists. No instrument is more neutral in this respect (less coercive) than a price. Because paying the price means the consumer must forego some other alternative, the benefits to the consumer will always be at least as great as the price paid. If the price also indicates the value of the resources society must give up in order to create the good or service consumed, the consumption decision that makes the individual better off will also be one which makes society better off.

For highway user charges to perform as efficient prices, it is desirable that:

(1) Each vehicle pay the marginal cost of its usage, on each occasion of use;

(2) The benefits from usage accrue directly to the user, whether or not they are eventually passed on to others (e.g., consumers of products shipped by highway); and

(3) The user accurately perceives both the benefits and the price of each occasion of use, including the benefits and prices of substitute alternatives.

"Marginal" cost means that the relevant costs are those which would not be incurred if the vehicle did not make the trip. If the costs would be avoided by not making the trip, then these are the costs against which the user should weigh his or her benefits. Hence, only variable costs are of interest in determining efficient prices; fixed costs, by definition, are not affected by the passage of a particular vehicle and could not be avoided if the trip were not made.

Whether users reap the benefits, and whether users correctly perceive the benefits and the costs to themselves, are questions for which there are no definitive answers. The preponderance of expert opinion probably lies on the side of saying that there are no external benefits of highway consumption beyond the benefits to users. Although the evidence suggests that users tend to be only partially aware of the prices they pay and the associated benefits of usage, users still appear to be in the best position to make the tradeoffs between the costs and benefits of usage. When it comes to determining who uses the highways, and when and how, the norm of the private market with many buyers and many price-service combinations is an applicable model.

### Second-best Conditions

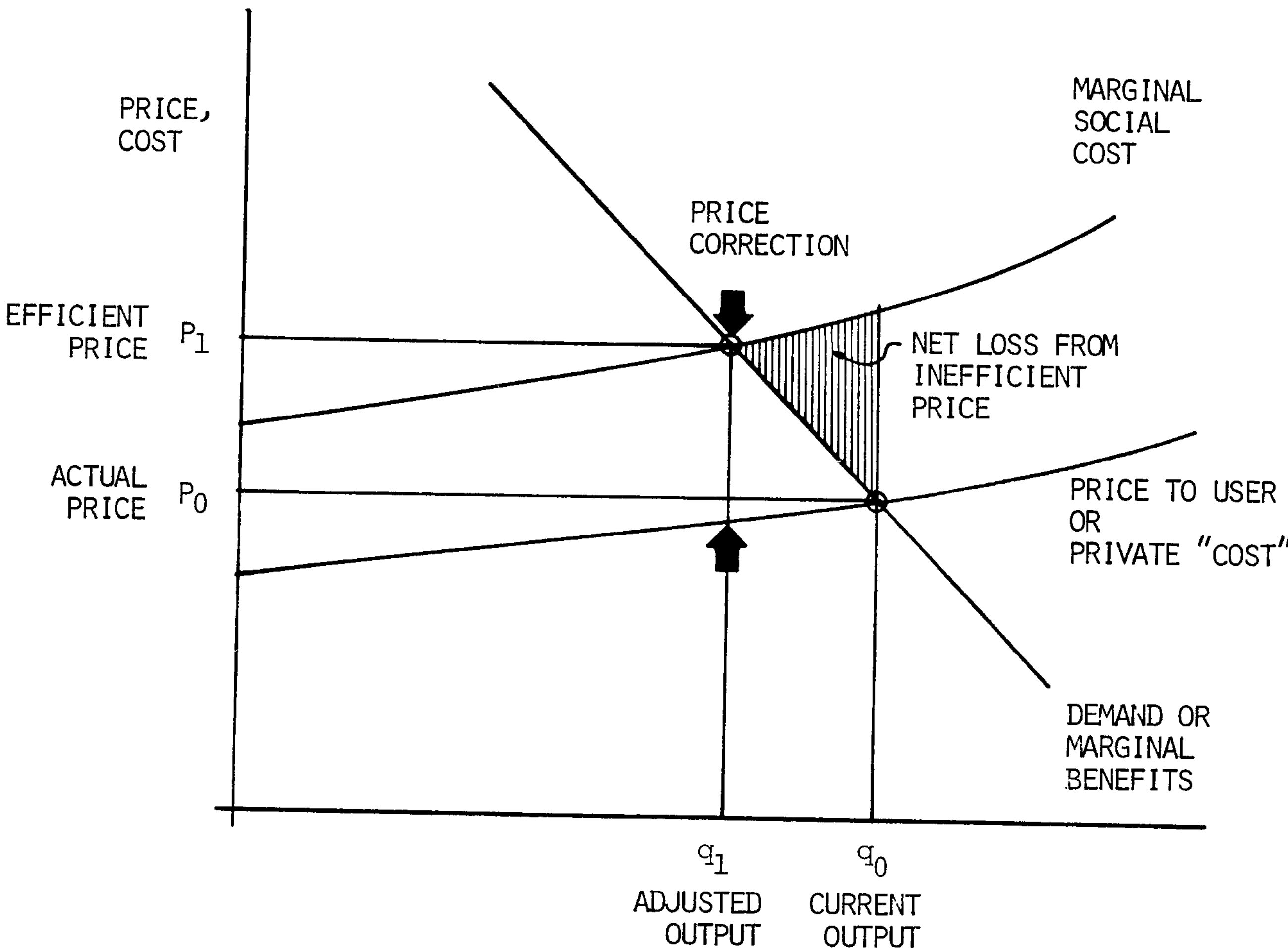
Requiring that users of the highway system pay the marginal costs of their usage does not necessarily lead toward efficient resource allocation unless the rest of the world also prices at marginal cost. Obviously, the rest of the world does not. It is then a matter of judgment whether efficient highway prices will improve or worsen aggregate welfare, and this judgment must be based on knowledge of such things as competition in transportation and related sectors, relationships between marginal costs and prices for goods and services that are substitutes or complements for highway services, and demand elasticities and cross-elasticities. The working assumption here is that highway user charges that are closer to marginal cost than present charges will improve efficiency in the highway sector as well as the economy as a whole.

### Public and Private Costs

Two reasons exist (if efficiency is the object) why a public agency might insert a price into a market. One is the obvious one that where the expenses incurred in providing the service are paid by the public sector, the government is the natural entity to charge a price. The second reason is that users may be paying a price in private markets but the price paid is not equal to the marginal social cost. Time delay, air pollution, and accidents are examples of costs for which there is a difference between the price paid by the user and the marginal cost to society.

Figure A-15 illustrates the distinction between private and social costs. The marginal social cost curve indicates the cost of an additional unit of service

Figure A-15. EFFICIENCY GAINS FROM CORRECT PRICING



at each level of output. By "cost" is meant the value of the resources which society must give up in order to obtain the increment of output, without regard to who actually bears the cost. The price curve indicates the amount of money, time, inconvenience etc., the person must pay who is making the decision about consuming the output. If there is a difference between the marginal cost to society and the price to the individual, consumers (highway users) will be biased in their decisions.

For the case shown, where private cost is below social cost, users are biased toward overconsumption: the incremental benefits of the output are less than the incremental costs. The inefficient price of $p_0$ leads to a level of usage of $q_0$, while the correct price of $p_1$ reduces the volume of traffic down to the efficient level of $q_1$. The demand curve indicates the marginal willingness-to-pay of each additional user, and thus the benefits of each trip to the user. All trips above the volume of $q_1$ create marginal costs that exceed the marginal benefit. If the number of trips taken is $q_0$, the reduction in net benefits over a volume of $q_1$ is represented by the shaded area. This is the loss of net benefits (opportunity cost, welfare loss) from pricing at the inefficient level. For the case where the price to the user is higher than the cost to society, a similar efficiency loss occurs from underconsumption: users forego benefits that exceed the costs to society, because the price is too high.

Several kinds of costs, such as air pollution and user costs from pavement damage, follow a pattern similar to the one just described. Each vehicle is subjected to the average level of noise, pollution, accident risk, and tire wear that apply to the traffic stream, but the individual costs are lower than the costs that could be avoided if any given vehicle were removed from the stream. The shapes of the curves will be different for each type of effect, but the deviation between social and private cost is common to many costs of highway travel.

**The Marginal User**

On first blush it might appear that each user should pay a different price, i.e., the first vehicle pays the marginal cost of the first vehicle and only the $q_1^{th}$

vehicle pays the price of $p_1$. This would be a misconception. Every vehicle is a marginal vehicle in the sense that any one could be removed and thereby avoid the costs to society of $p_1$. If the principle is followed of charging each vehicle for the consequences of its decision to use the highway, then every vehicle should pay the price of $p_1$. There is no "first arrivals get the best prices" deal.

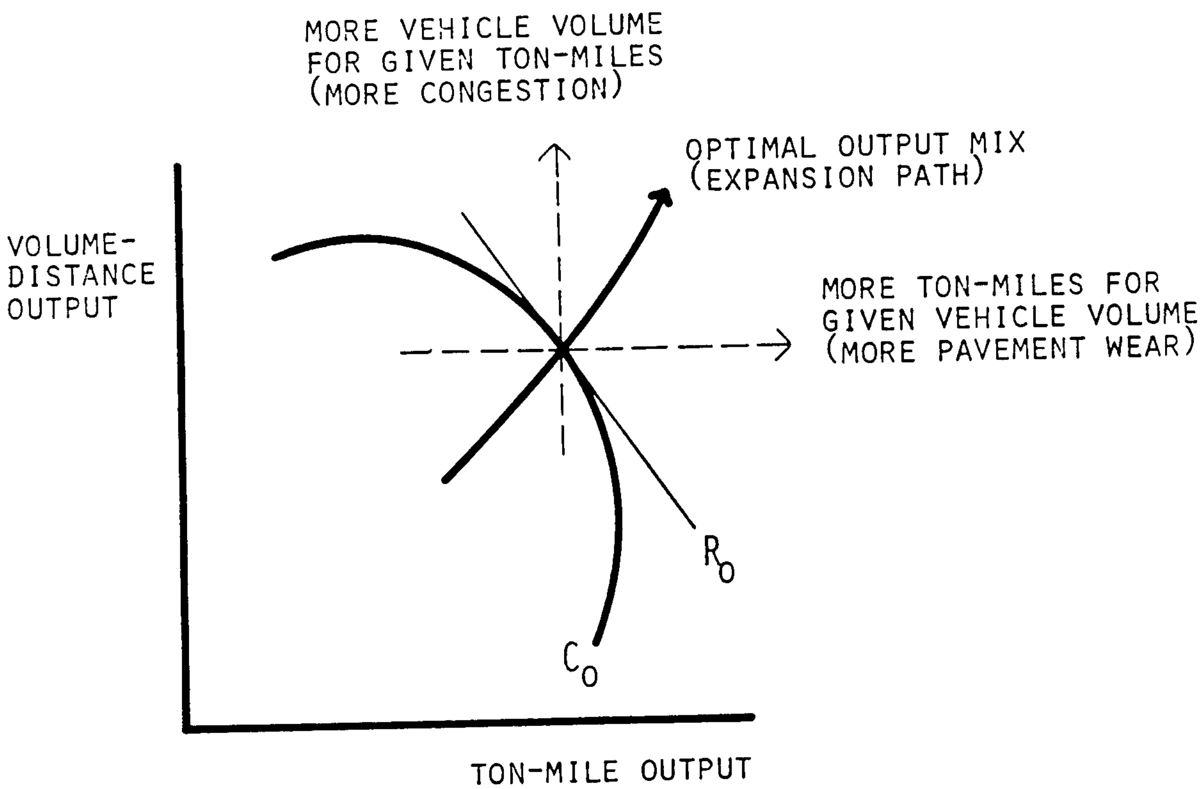
Lest this appear terribly unfair, it should be emphasized that there are no charges levied for fixed costs; the only way the producer can efficiently recover any outlays for fixed facilities is to add tolls or "surcharges" to private costs. Attempts to allocate items of fixed cost into the price will raise the charge to the user above the private cost level, but the results will not be efficient unless the price charged is coincidentally and consistently the same as the marginal cost.

**Outputs of the Highway System**

The highway system is a set of facilities that provides space on which to operate vehicles. The vehicles carry passengers and goods, most vehicles being used primarily for one purpose or the other but not both. In combination with the vehicles, highways produce movement of people (passenger miles) and goods (ton miles). The highway facilities themselves, then, provide a capacity to move volume and weight. Stronger highways can move more weight for a given volume; more lane-miles of highway can move larger volumes of vehicles.

These two dimensions of highway output — volume-distance and weight-distance — are represented as the axes in Figure A-16. Choosing the optimal combination is a design problem to be solved by comparing the demand for passenger and goods movement with the costs of supplying each, under various configurations. For a given set of facilities, increasing the output of vehicle volumes while holding ton-miles constant means increased congestion, and increasing the output of ton-miles while holding volumes constant means greater pavement wear. In the long run, investment and disinvestment can alter the vehicle capacity and pavement strength

Figure A-16. PRIMARY DIMENSIONS OF HIGHWAY OUTPUT



of segments of the system, so as to approach the optimum.

Along the vehicle volume dimension, the unit of measure is the standard passenger car equivalent (PCE). Each vehicle takes up some effective amount of road space, and competition for this space results in congestion. Along the weight movement dimension, the unit of measure is the equivalent single 18,000-pound axle load (ESAL). Pavement damage per axle load is thought to be related to axle weight. Thus the output of the highway system is a combination of PCE-miles and ESAL-miles, or simply, PCEs and ESALs.

The constant-cost curve $C_0$ displays a shape indicating that combinations of vehicle capacity and strength that are close to the optimum produce more total output than other combinations and that there are some minimum levels on each dimension below which output on both dimensions is sacrificed. If the two dimensions of output could be sold separately in competitive markets, then the prices would determine the optimal output mix. For a given total cost, the ratio of prices is represented by the line $R_0$; the point of tangency to the cost curve gives the mix of volume-distance and weight-distance outputs that yields the total output of the highest value. At this level of abstraction the prices and curves do not have a verifiable empirical content, but the practical process by which the optimum mix is approached is the incremental benefit-cost evaluation of highway investment projects and programs.

**Variable Costs**

The variable costs listed in Figure A-17 include those represented by public expenditures as well as some falling on private users and non-users. For public costs, the price is zero unless a user charge is imposed. For the private costs, it is the difference between social and private cost that is of interest in designing user charges; if there is no difference, there is no need for a price correction.

FIGURE A-17

Variable Costs of Highway Usage

I. Public Sector Outlays (and associated costs)

Pavement damage
- pavement restoration or loss of user benefits
- user costs from pavement roughness

Highway administration and services

II. Private User Costs

Vehicle Interference
- delay
- accidents among vehicles
- increased vehicle operating costs

Negative externalities
- air pollution
- water pollution
- noise
- visual intrusion
- danger to non-users and property

Pavement Wear. Damage to the surface of the pavement caused by the passage of a vehicle depends upon the axle loads imposed by the vehicle and the strength of the pavement. The direct costs of this wear are represented by either the costs of restoring the pavement to its original condition or the loss of user benefits from not restoring the pavement. Indirect costs occur to users due to delay, vehicle wear, fuel consumption, accidents, and discomfort from operating on rough pavement.

Administration and Services. Several costs associated with administration of the highway system and providing services to highway users can be regarded as variable costs. Requirements for traffic police and vehicle code enforcement tend to go up with vehicle volumes. Some accident costs, such as police response, emergency public medical treatment, and court expenses for liability litigation are not included in private insurance premiums.

Vehicle Interference. Congestion is the result of interaction between the limited vehicle capacity of a given facility and the demands for space by individual users. The costs of congestion occur in the form of excess travel time, increased expected damage and injury from accidents among vehicles, and additional vehicle operating costs for wear and fuel. All are measured relative to what the costs would be under uncongested or free flow conditions.

Negative Externalities. Air pollution and noise are real costs to members of society even though dollar amounts do not appear in public budgets (prevention or control costs sometimes do appear as expenditures, but these are only weakly related to damage costs). The higher the rate of emissions from a vehicle and the more sensitive and more numerous the persons impacted, the higher is the marginal cost of a vehicle trip. The essential characteristic of an externality is that it escapes normal market transactions, so that the valuation of negative external effects must be accomplished by political or other surrogate means.

This summary listing of variable costs is meant to be exhaustive in scope, although not in detail. If the highway system has been efficiently designed and maintained and output is not subject to economies of scale, then efficient prices to users will be sufficient to recover all of the long run costs of the system. Even though the prices are based on variable costs, under these conditions they will raise revenues that cover fixed costs as well. An important purpose of the attempt to estimate the full magnitudes of efficient prices is to assess the extent to which such prices could finance the construction and operation of the system. The results indicate that the revenues would be far greater than those raised by existing user charges.

**Administrative Costs of Pricing**

For prices to serve as guides to efficient resource allocation, they must be clearly tied to usage in both reality and the consumer's mind. Annual registration fees that are invariant with respect to the amount or location of travel can only serve as very crude prices at best. This need for prices to be based on the amount of travel and the specific conditions under which it is consumed makes accurate pricing difficult and perhaps exhorbitantly costly in many circumstances.

The orientation of this report is to estimate what the correct prices would be, as if their collection were costless. Qualitative judgments are offered regarding which costs of travel are not likely to be feasibly priced, but no quantitative tradeoffs between the benefits of improved capacity utilization and administrative costs of imposing ideal user charges are attempted. These questions are critical and must be addressed eventually, but the initial problem is to gain an idea of what good prices would look like. Ultimately, the question is whether some attempt at efficient pricing is better than the present method, however imperfect the pricing mechanism. Rough approximations can be improved with experience, and experience may be the most effective way to achieve accuracy.

## ESTIMATION METHODS AND RESULTS

Application of the economist's concept of efficiency to public policy implies that the government should seek to maximize the net social benefits resulting from the activities in which it engages. Efficient highway user charges are those which will lead to the greatest surplus of benefits over costs, for a given stock of capital facilities. Because the scope of estimating efficient highway prices is large and because no comprehensive set of marginal cost highway user charges appears to have been made previously, the result of the current work is still very rough. At present, the concepts and methods are at least as important as the numerical results.

The year 1981 was selected as the representative analysis period for several reasons. A static equilibrium framework is implied by the concepts and methods used, and given conditions (observed and assumed) rather than trends are relevant to this approach. Data and previous results could only support one analysis year (forecasting under the many assumptions required would be largely fictional), and 1981 is the most illustrative. Some data are used directly from prior years, if they were judged to be the best estimators of the desired data.

### Caveats

No exercise of this dimension could be carried through without innumerable assumptions and simplifications. Although listing each explicit and implicit assumption at each step of the analysis would be burdensome and distracting, it is essential that a clear understanding of the general flavor of the analysis be communicated at the outset.

The dominant principles are completeness and completion, i.e., every cost element that belongs in an efficient highway user charge is covered, and a quantitative estimate of at least the order of magnitude is made. Methods are streamlined, and results evaluated on the basis of sensitivity testing and redundancy. Instruments for collecting the ideal tolls are ignored and are assumed to be costless; the choices of how accurate the charges should be and what pricing mechanisms to use is a subsequent analysis. Many of the data and engineering relationships upon which the price estimates are based are known to be inadequate, and steps are being taken to improve them, but better information is not yet available. Finally, all benefits of highway usage are presumed to be captured by users, and passed on to indirect beneficiaries through normal market mechanisms.

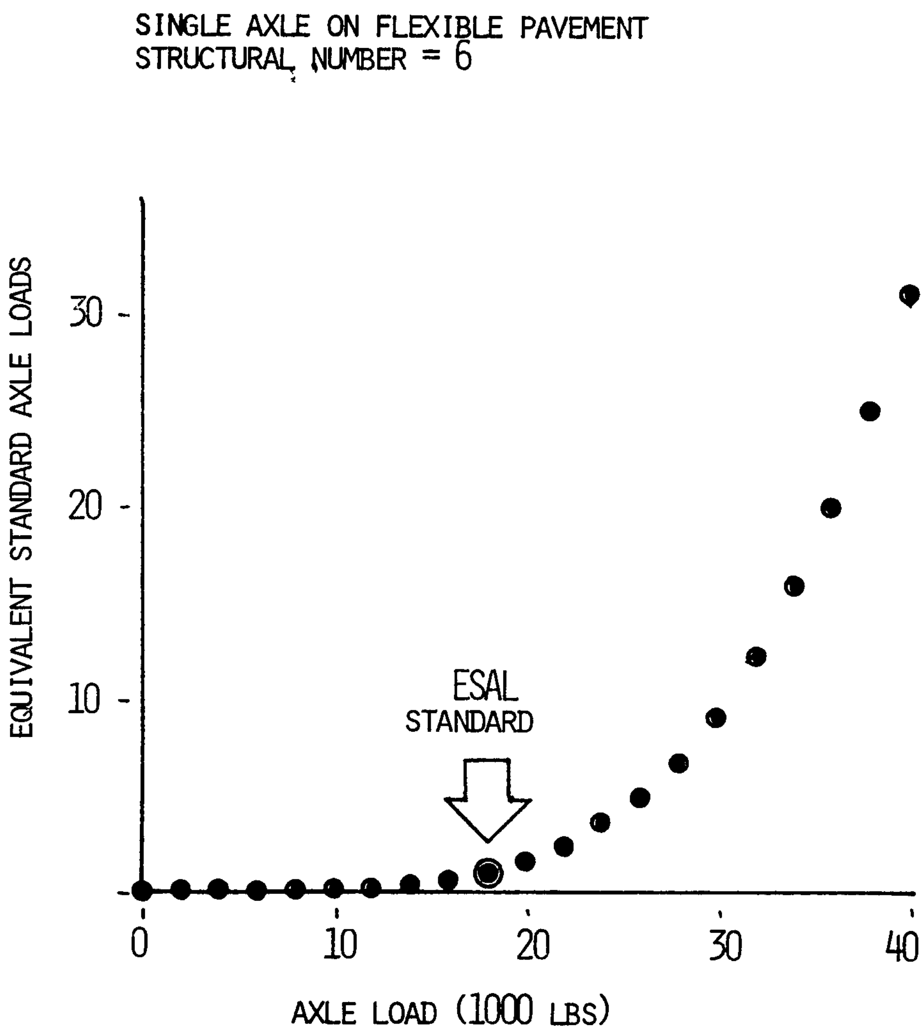
### Pavement Wear

Costs of pavement wear consist of two parts: the cost of repairing the damage to the pavement, and the additional user costs to vehicles traveling over damaged pavement. If restoration of the pavement were instantaneous after the passage of each vehicle that caused damage, the user costs would be zero. If restoration of the pavement never occurred, pavement wear costs would include only the user costs. An efficient design, maintenance, and operating program seeks to minimize the sum of the two costs, and correct pavement damage charges will normally include both components.

## PAVEMENT REPAIR

Highway pavements are designed to carry a forecast traffic volume over a lifetime of approximately twenty years. The major design consideration determining the thickness of the pavement is the expected number of axle load applications. Travel by various weights of vehicles is translated into ESALs using factors derived from the AASHO road test conducted in the 1950's (AASHO, 1962). The factors embody the relationship, shown in Figure A-18, that loss of pavement serviceability on a given road increases with the fourth power of the weight on the axle. A legally loaded 80,000-pound 5-axle tractor-semitrailer combination truck (also known as a 3-S2 or 18-wheeler) generates about two ESALs per mile of travel. Relatively, this typical heavy truck is wearing out the pavement at a rate about 5,000 times that of the family car and about one quarter the rate of the same truck loaded to 100,000 pounds. Each ESAL, however, has less effect on a thicker pavement because pavement strength increases with roughly the seventh power of thickness. Pavement construction cost, in contrast, increases less from linearly with thickness.

Figure A-18. AASHO EQUIVALENCE FACTORS FOR PAVEMENT DAMAGE



Incorporating these engineering relationships into user charges that encourage efficient utilization of the highway system has several implications:

(1) The charges should be high enough so that whenever a vehicle adds to the wear of the pavement, the benefits to the user (as expressed by his willingness to pay for the damage in user charges) are at least as great as the costs of the damage to society.

(2) Fees should accelerate steeply with increased axle weight.

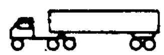
(3) Vehicles which use more axles to carry the same weight should be charged less.

(4) Heavy vehicles should face substantially lower charges when they travel on heavy duty rather than light duty roads.

Axle Weight per Vehicle Mile. The pavement impact caused by a given vehicle is the sum of the ESAL factors for all its axles. Tandem axles distribute weight differently than two single axles spaced farther apart, so a different set of equivalence factors applies to tandem axles (AASHTO Interim Design Guide). For a given gross weight (vehicle weight plus load) and vehicle, the weight on each axle can be estimated and the equivalence factors summed. This has been done for the trucks displayed in Figure A-19.

Current truck weight fees (Federal and most states) are based on fully loaded gross weight, not on actual weight, actual VMT, or strength of the roads actually traveled upon. It may be that the patterns of loads and travel are similar for most heavy vehicles, but a charging system that is not tied to the actual pavement deterioration created by the vehicle can only have very muted efficiency incentives. In fact, the incentive generated by a fixed weight fee is to overload undersized vehicles and overuse them. Data on average actual gross weight and VMT for each vehicle class have been estimated by FHWA, and used in the calculations below (Arlee T. Reno, et al., June 1981), but additional information is required to attach costs to a specific vehicle. Several states have truck fees based on actual distance, graduated by registered gross weight, and toll roads charge by actual distance.

Figure A-19. EXAMPLE TRUCK CONFIGURATIONS AND ESALs

| VEHICLE TYPE | | | FULLY LOADED GROSS WEIGHT (1000 LBS) | ESAL* PER VMT |
|---|---|---|---|---|
| SINGLE UNIT | S2 |  | 33 | 1.9 |
| SINGLE UNIT | S3 |  | 47 | 1.4 |
| COMBINATION | 3-S2 |  | 80 | 2.3 |
| COMBINATION | 2-S1-2 |  | 80 | 4.0 |
| COMBINATION | 3-S2-4 |  | 105 | 1.0 |
| COMBINATION | 2-S1-2-2 |  | 105 | 1.36 |

* FLEXIBLE PAVEMENT

Environmental Effects. The ability of a pavement to withstand loads is known to be severely affected by weather and soil conditions, in addition to pavement construction, but the variation in strength of the same pavement over different weather conditions is quantitatively almost unknown. In the design of pavements, a "regional factor" is incorporated in order to account for differences in climate. For a given location in the U.S., the factor is some number between 1.0 and 3.0. The number represents a judgmental summary of the susceptibility of pavements to freezing, moisture, temperature variations, soil condition, etc., at that location. No information is implied, for example, about whether the regional factor indicates a difference between regions that is constant and stable under most conditions or one that averages a large variation from one season to another. Spring thaw time is regarded as offering conditions most vulnerable to pavement damage, but the sensitivity of the pavement at this time relative to other conditions is not readily quantifiable.

In addition to the quantitative relationships between climatic conditions and the strength of the pavement, another point that is not well understood is the distinction between "pure" environmental damage and damage that results from the interaction of traffic and weather. When a heavy vehicle traverses a pavement made susceptible to damage by moisture, say, the marginal cost of the passage of that vehicle at that time is much higher than at other times. Thus a properly calibrated set of user charges would impose a higher pavement damage charge (for the same vehicle) when pavements are more vulnerable. Such damage, resulting from the interaction between usage and weather, is the full responsibility of the vehicle; without the vehicle the damage would not occur. If the weather causes deterioration, however, that is independent of usage (i.e., cannot be explained statistically by correctly specified functions of usage), then that residual damage is a "pure" consequence of the environment and hence a fixed (unchargeable) cost. Notice that this amount is not necessarily the deterioration that would occur if there were no traffic; it is the amount of deterioration that is unrelated to traffic.

Pavement Wear Costs. The amount of deterioration caused by the passage of a single vehicle is effectively impossible to measure for most moderate and heavy duty highways. Several strategies that utilize sample or aggregate information can be considered, but the one chosen was to divide the expenditure required for pavement restoration by the cumulative load placed on the pavement. The adequacy of this approach is dependent upon several assumptions:

(1) Resurfacing of pavement and shoulders is the typical means of correcting damage to pavement. This means that resurfacing is the most likely technology that will be used and that most roads will eventually be resurfaced rather than abandoned or reconstructed.

(2) Over the lifetime of the pavement, resurfacing leaves the highway neither better nor worse than when it started. This means that resurfacing does no more and no less than restore the damage caused by wear.

(3) The investment represented by resurfacing corrects damage caused by usage, not by purely environmental factors.

(4) The marginal cost of pavement wear is equal to the average cost. This implies that the incremental deterioration caused by a particular vehicle is affected by neither the amount of deterioration that has already taken place nor the volume of traffic.

(5) Differences caused by weather in the vulnerability of pavements to axle loads are not great enough to overwhelm the relationship between axle weight and pavement damage for a given road design.

Although maintenance is not mentioned, it is assumed that normal practice will be to fill potholes, apply surface coatings, and make other repairs that derive the intended life from the pavement. Costs for these activities have not been included in the resurfacing costs, so they might be regarded as an offset to whatever upward bias may be contained in the assumptions listed.

Pavement Lifetime. In contrast to the transformation of different vehicle configurations and gross weights into the unidimensional ESAL measure, the transformation of different highway cross-sections into a single measure of strength is handicapped by numerous unknowns. Roads are frequently designed to last twenty years, but many last longer or fall apart sooner and the reasons are not always apparent. Strength itself is a multidimensional characteristic (summarized by the structural number of a flexible pavement or the effective depth of a rigid pavement) and can be increased for a given road design in numerous ways. Thus the estimation of the strength of existing highways, averaged by functional class, is subject to a great deal of uncertainty. Unfortunately, because of the non-linear relationship between the ability of a pavement to withstand stress and pavement thickness, small errors in estimating average strength result in large errors in calculated ESAL lifetimes.

For these reasons, ESAL life is a critical parameter in estimating pavement damage costs. Both ESAL life and resurfacing costs are shown in Figure A-20 for a range of road types that are intended to represent the various functional classes. Costs are estimated expenditures in 1981 dollars, averaged across the country. Accuracy of ESAL lifetimes can be improved by documenting actual experience, by obtaining better data on the actual distribution of cross-sections and condition of segments within the functional class, and by controlled tests that predict pavement strength under usage conditions. Current practice of pavement design is a blend of all of these, but the AASHO equations constitute a core element. For example, an ESAL lifetime of one million could result from a structural number of 4, soil strength of 3, a regional factor of 1.5, and a terminal pavement serviceability of 2.0, according to the modified AASHO design equation. Unit costs of resurfacing will also vary from state to state.

**User Costs**

Reduced pavement quality increases vehicle wear, fuel and other operating costs, travel time, accidents, and discomfort. For a given amount of reduction in

FIGURE A-20

Estimated Pavement Repair Costs per ESAL by Functional Systems. ($1981)

| | Rural | | | Urban | | |
|---|---|---|---|---|---|---|
| Functional System | Per-mile cost of Resurfacing and Shoulders ($1,000) | ESAL Life-time (millions) | Resurfacing Cost ($/ESAL mile) | Per-mile cost of Resurfacing and Shoulders ($1,000) | ESAL Life-time (millions) | Resurfacing Cost ($/ESAL mile) |
| Interstate | 518* | 6.0 | $ .09 | 2,242* | 9.0 | $ .25 |
| Arterial | 310 | 1.5 | $ .21 | 986 | 1.5 | $ .66 |
| Collector | 112 | .4 | $ .28 | 321 | .5 | $ .64 |
| Local | 40 | .08 | $ .50 | 80 | .1 | $. 80 |

* Unit resurfacing costs were estimated using tables in FHWA, "Performance-Investment Analysis Process," Technical Report, U.S. DOT, September 1978.

surface quality, the user cost of that reduction depends upon the volume of vehicles using the facility and the length of time until the surface is restored. Because heavy axle loads result in lower surface quality, the resulting increased user costs are a consequence of the passage of heavy vehicles. The effects of axle loads on user costs are complicated by the multidimensional nature of pavement quality and by the interactive effects among user costs.

Pavement stress and pavement quality. In relating axle load applications to pavement wear, a linear relationship was assumed, so that the lifetime costs of pavement restoration could be spread uniformly over the ESALs giving rise to the damage. Although it is necessary pragmatically to assume the same thing for reduction in surface quality, the two are not necessarily tied together.

The accepted measure of pavement quality is the Pavement Serviceability Index (PSI), a composite number which relates various indicators of pavement distress to apparent overall surface quality. The distress indicators possess a degree of objective reality, but the overall rating is necessarily subjective. Despite the difficulties of collapsing pavement quality into a single dimension, however, it is assumed here that such a measure can be constructed and that PSI constitutes a useful approximation to the measurement of pavement quality.

For a given pavement structure, PSI serves as both an indicator of pavement life as well as surface quality. Restoration is triggered at a PSI of 2.0 -2.5, and new high-quality pavement is generally 4.5 - 5.0 PSI. Although it may be that the ratio of a unit of pavement damage to a unit of surface quality reduction differs over the life of the pavement, or that both are nonlinear, current evidence does not warrant the use of separate or nonlinear models. Hence, an ESAL is regarded as the measure of a unit damage to pavement and a unit reduction in surface quality, both of which are constant over the life of a given pavement structure.

Surface Quality and User Costs. Evidence of pavement distress appears in the form of roughness, rutting, cracking, faulting, blowups, potholes, etc., and these characteristics reduce ride quality and increase running costs. Although the existence of relationships between surface quality and user costs has always been acknowledged for paved versus unpaved roads, the precise effects of pavement deterioration on user costs are still not much more than guesses.*/

One of the complicating factors is that, to the extent that rough pavement reduces speed, it reduces fuel consumption while increasing vehicle wear. Not known is the degree to which better fuel mileage from lower speed is offset by energy losses in bouncing and swaying. Neither accidents nor ride comfort, moreover, can be quantified in regard to their sensitivity to pavement quality. Thus the estimates of efficient pavement repair charges contained in Figure A-21 are based on some nominal functional relationships, but their validity has not been adequately established. The impact of surface condition on user costs is undoubtedly significant, but the empirical basis is still weak.

Discounting for Time. For the pavement replacement portion of pavement damage costs, the damage and the replacement occur at different points in time. The vehicle could, in principle, be allowed to pay its share of the replacement costs at the time the overlay or reconstruction expenditure was incurred, or the vehicle could pay the discounted value of the same amount at the time the vehicle caused the damage. It would make no difference whether the vehicle operator or the road authority held the revenues between the time of damage and the time of replacement, assuming either entity could invest the funds at the same real rate of return.

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*/ Relationships contained in FHWA, Highway Investment Analysis Package 1979 were used to generate the estimates in this report, and additional research is being sponsored by FHWA.

FIGURE A-21

Efficient Pavement Damage Charges by Functional System
(cents per ESAL Mile)

| Functional System | Pavement Repair | User Costs: Vehicle Wear | User Costs: Travel Time | User Costs: Running Cost | Total |
|---|---|---|---|---|---|
| Interstate | | | | | |
| Rural | 5.0 | 3.8 | .9 | -.9 | 8.7 |
| Urban | 15.0 | 10.6 | 2.4 | -2.9 | 25.2 |
| Arterial | | | | | |
| Rural | 13.0 | 4.1 | 1.0 | -1.1 | 17.0 |
| Urban | 41.0 | 7.6 | 7.0 | .3 | 55.9 |
| Collector | | | | | |
| Rural | 17.0 | 3.2 | .8 | -.9 | 20.1 |
| Urban | 40.0 | 6.6 | 6.1 | .2 | 52.9 |
| Local | | | | | |
| Rural | 31.0 | 2.4 | .6 | -.7 | 33.4 |
| Urban | 50.0 | 9.7 | 9.0 | -.4 | 68.3 |

In practice, the vehicle would pay at the time the damage was done, and the replacement cost would be discounted from the expected time the pavement replacement would take place. Thus, even if the amount of damage per ESAL were constant over the life of the pavement, the efficient charge for pavement replacement would increase as the time for replacement approached. Old roads would have higher charges than new ones.

This somewhat unappealing prescription is offset by the inclusion in the pavement damage charge of user costs, which operate in the reverse direction. The longer a pavement remains in a damaged state before it is restored, the higher will be the cumulative user costs suffered by vehicles subsequent to the one doing the damage, holding other things (e.g., traffic volumes) constant. The quantitative magnitudes will not balance exactly, but at least a pavement damage charge that is independent of the time until restoration can serve as a good approximation to an efficient pavement damage charge.

In calculating the pavement damage charges shown in Figure A-21, an average time to replacement of seven years was employed, both for purposes of discounting (at seven percent per year) pavement restoration costs and for accumulating user costs. The latter are also discounted.

**Efficient Pavement Damage Charges**

Combining the discounted pavement repair costs with the three user cost components leads to the results in Figure A-21. They are intended to include only variable costs, but the methods used may not effectively separate these from fixed costs.[*/] Thus, the marginal cost of an ESAL depends upon the strength of the pavement

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[*/] Other estimates of pavement repair costs have been prepared by Markow, 1982, and System Design Concepts, 1982. These estimates use different methods than those described here, and the costs per ESAL are somewhat lower.

(thicker pavement means less damage from a given axle) and the volume of usage (larger volumes mean higher user costs). User costs per ESAL tend to be dominated by the vehicle wear component, and reduced wear from high pavement strength is partially offset by higher ADTs on heavy duty pavements.

## ADMINISTRATION AND SERVICES

Management and administration of the highway system require a wide variety of services performed by many levels of government. Some of the costs are fixed costs, unrelated to the usage of the highways in the short run, and therefore not relevant to efficient pricing. Highway and motor vehicle agencies at the Federal, state, regional, county, and city levels fall in this category, with the exceptions mentioned next. Variable costs of such services as traffic control are more directly related to highway usage, and there is some basis for pricing them, from both the standpoints of efficient pricing and of user charge recovery for public sector expenditures. These costs include traffic police, highway patrol, other police services such as accident reporting, retrieval of stolen vehicles, and testimony in highway-related litigation, public court costs related to traffic enforcement and liability litigation, public costs of accidents, and various other services to motorists.

Most of these costs are represented by public expenditures, but the expenditures do not appear in highway-identified budgets. Thus, they are commonly overlooked when tabulating the costs of highway services. The magnitudes are not large on a per-vehicle-mile basis, but they are not insignificant either. The few studies that have attempted to extract empirically the costs from the various municipal and state budgets suggest that the costs are approximately $.004 per vehicle mile in urban areas (Lee, 1972; Lee, 1980).

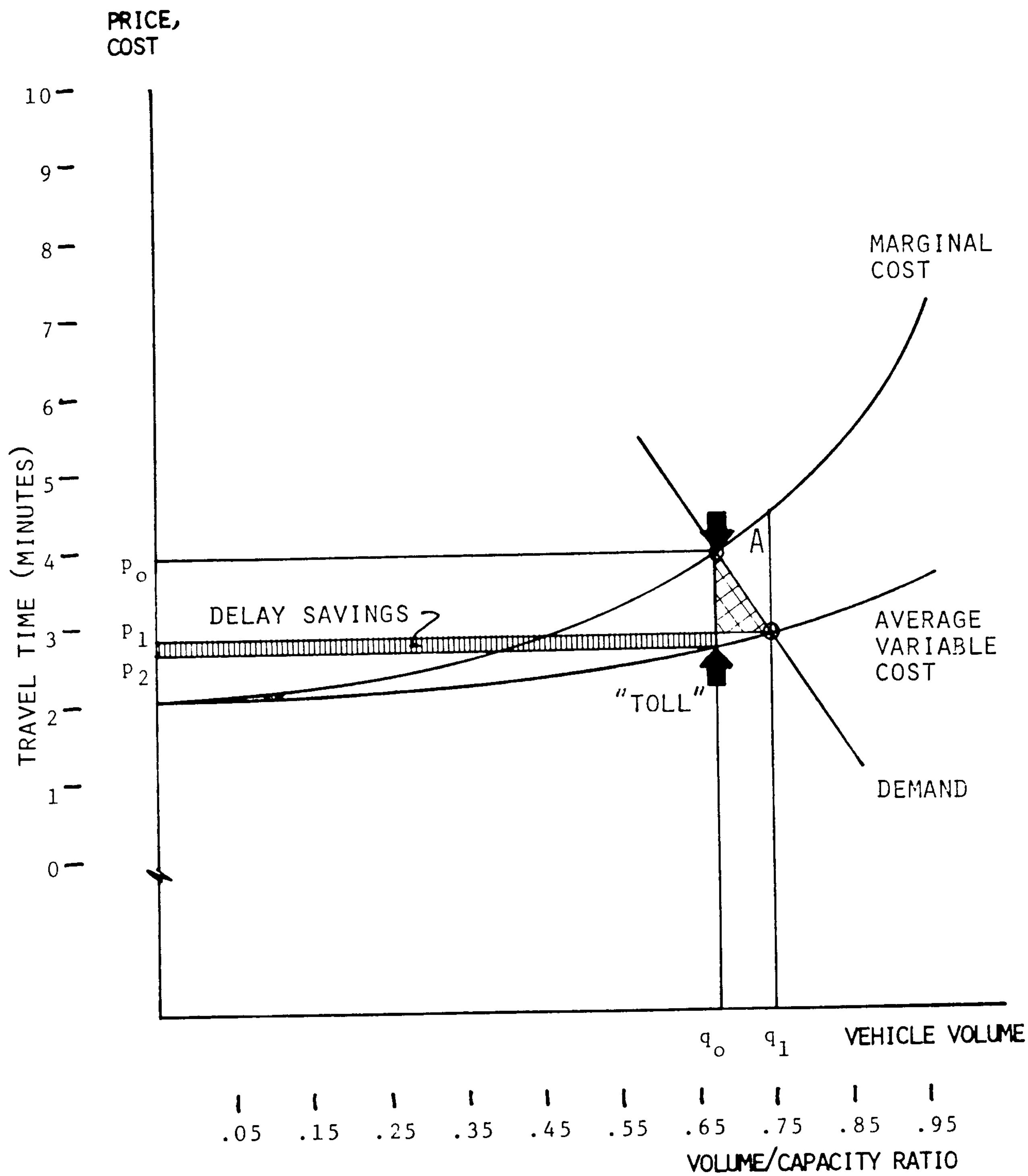
## VEHICLE INTERFERENCE

As more vehicles occupy space on the same roadway, interactions among the vehicles become increasingly important. These interactions have three effects: one is the decrease in speed below free-flow speeds, resulting in additional travel time or delay; the second is the increase in operating costs caused by congested conditions; and the third is the increase in accidents among vehicles.

### Congestion

Figure A-22 represents the microeconomic formulation of the congestion problem (Mohring, 1976), which is a more specific form of the relationships shown in Figure A-15. Average variable cost (AVC) includes vehicle wear and operating costs, pavement wear, and travel time, and excludes user taxes. This curve corresponds roughly to the price to the user and determines the volume of travel by its intersection with the demand curve. Because average cost rises with increasing volumes, the marginal cost of additional trips at any given volume must be above the average cost. The major component of the increase in average cost, and hence the difference between average and marginal cost, is excess travel time or delay. Drivers are assumed to know the average travel times they will face when entering a given traffic stream, but they do not consider the increase in total travel time (for all vehicles) caused by their presence. To internalize this effect -- forcing the user to balance benefit against marginal cost -- requires a price surcharge or toll that varies with the level of congestion. For the volume-capacity relationships implied by the cost curves and the demand schedule shown, the correct toll is the difference between $p_o$ and $p_2$. The effect will be to reduce vehicle volume from $q_1$ to $q_0$, at which point the average cost faced by the vehicle plus the toll will exactly equal

Figure A-22. EFFICIENT PRICING OF CONGESTION



the marginal cost. All vehicles in the stream pay this toll.

When the vehicle volume drops from $q_1$ down to $q_0$, costs are avoided equal to the area under the marginal cost curve, while benefits are lost equal to the area under the demand curve. The net effect is an efficiency gain (more benefits than costs) represented by the three-sided area labeled A. These efficiency gains are composed of delay savings to vehicles remaining on the facility minus the consumer surplus lost by vehicles tolled off. The first of these two components is indicated by the vertically shaded rectangle and the second by the hatched triangle. The difference between them is exactly equal to area A.

These abstract concepts can be operationalized directly. Using traffic engineering relationships, average travel time curves can be constructed for different road types. The curve for urban non-interstate roads has been calibrated to the lefthand vertical scale. Marginal travel times are derived from the average travel time function. The horizontal scale has been converted to volume-capacity units, measuring both volume and capacity in PCEs. Demand is given by an arc elasticity of -.33 measured from the observed volume-price combination (e.g., $p_1$, $q_1$). This information yields a reduction in vehicle volume from .75 to .67 for the example in the figure, at which point the difference between average and marginal travel time is 1.02 minutes. Using a value of travel time of $.08 per minute ($4.80 per hour per vehicle), the efficient toll is $.082 per vehicle mile. An estimated 30 billion miles of travel (VMT) occur annually on U.S. streets at a v/c ratio of between .7 and .8, which would drop to 27 billion with the toll and produce $2.2 billion in revenues.*/ Additional details for one functional system are given in Figure A-23.

*/ These are taken from Shuldiner, 1981; parallel and quantitatively similar estimates were prepared for the Federal Highway Cost Allocation Study by Stoner and Marshall, 1981.

FIGURE A-23

Time Delay Charges by Functional System

Urban Non-Interstate Highways:

| Initial V/C | Average Time* | Marginal Time** | Toll*** | Initial VMT | Revenues**** |
|---|---|---|---|---|---|
| 0.05 | 2.17 | 2.20 | 0.0023 | 15 | 0.03 |
| 0.15 | 2.23 | 2.30 | 0.0074 | 59 | 0.43 |
| 0.25 | 2.30 | 2.47 | 0.0138 | 104 | 1.40 |
| 0.35 | 2.37 | 2.66 | 0.0216 | 142 | 2.96 |
| 0.45 | 2.46 | 2.89 | 0.0314 | 111 | 3.31 |
| 0.55 | 2.57 | 3.19 | 0.0439 | 82 | 3.36 |
| 0.65 | 2.69 | 3.62 | 0.0601 | 52 | 2.86 |
| 0.75 | 2.86 | 4.29 | 0.0817 | 30 | 2.20 |
| 0.85 | 3.09 | 5.53 | 0.1117 | 52 | 5.09 |
| 0.95 | 3.50 | 9.58 | 0.1600 | 96 | 13.18 |
| | | | | | 34.83 |

* Average travel time in minutes per mile based on linear speed-density and free speed of 28 miles per hour.

$$= \frac{4.29}{1 + (1-V/C)^{\frac{1}{2}}}$$

** Marginal travel time in minutes per mile

$$= \text{average time} \quad 1 + \frac{0.5\ V/C}{(1-V/C) + (1-V/C)^{\frac{1}{2}}}$$

*** Toll in dollars per PCE vehicle mile with a value of time = 8¢ per vehicle minute ($4.80 per vehicle hour), at the adjusted (price elasticity = -.33) V/C and VMT (neither are shown). Initial VMT stated in millions annually.

**** Revenues in $billions per year from given toll at adjusted PCE volume.

FIGURE A-23 (cont'd). Time Delay Charges by Functional System

| Initial V/C | Initial Volume | Average Time | Marginal Time | Adjusted Volume | Efficient Toll | Total Revenues |
|---|---|---|---|---|---|---|
| **Rural Interstates** | | | | | | |
| .05 | 42.0 | 1.21 | 1.23 | 41.8 | .001 | .05 |
| .15 | 46.0 | 1.25 | 1.30 | 45.4 | .004 | .19 |
| .25 | 31.0 | 1.28 | 1.38 | 30.2 | .008 | .23 |
| .35 | 11.0 | 1.32 | 1.47 | 10.6 | .012 | .13 |
| .45 | 5.0 | 1.37 | 1.59 | 4.7 | .018 | .08 |
| .55 | 3.0 | 1.41 | 1.72 | 2.8 | .025 | .07 |
| .65 | 6.0 | 1.47 | 1.89 | 5.5 | .034 | .19 |
| .75 | 8.0 | 1.53 | 2.10 | 7.2 | .046 | .33 |
| .85 | 5.0 | 1.59 | 2.38 | 4.4 | .063 | .27 |
| | 157.0 | | | 152.6 | | 1.54 |
| **Rural Other** | | | | | | |
| .05 | 212.0 | 1.21 | 1.23 | 211.1 | .001 | .27 |
| .15 | 153.0 | 1.25 | 1.30 | 150.9 | .004 | .63 |
| .25 | 106.0 | 1.28 | 1.38 | 103.4 | .008 | .80 |
| .35 | 53.0 | 1.32 | 1.47 | 51.1 | .012 | .62 |
| .45 | 30.0 | 1.37 | 1.59 | 28.5 | .018 | .50 |
| .55 | 15.0 | 1.41 | 1.72 | 14.0 | .025 | .34 |
| .65 | 9.0 | 1.47 | 1.89 | 8.3 | .034 | .28 |
| .75 | 6.0 | 1.53 | 2.10 | 5.4 | .046 | .25 |
| .85 | 3.0 | 1.59 | 2.38 | 2.6 | .063 | .16 |
| .95 | 3.0 | 1.68 | 2.80 | 2.6 | .089 | .23 |
| | 590.0 | 14.11 | 17.86 | 577.9 | .300 | 4.08 |
| **Urban Interstates** | | | | | | |
| .05 | 7.0 | 1.21 | 1.23 | 7.0 | .001 | .01 |
| .15 | 15.0 | 1.25 | 1.30 | 14.8 | .004 | .06 |
| .25 | 29.0 | 1.28 | 1.38 | 28.3 | .008 | .22 |
| .35 | 36.0 | 1.32 | 1.47 | 34.7 | .012 | .42 |
| .45 | 25.0 | 1.37 | 1.59 | 23.8 | .018 | .42 |
| .55 | 9.0 | 1.41 | 1.72 | 8.4 | .025 | .21 |
| .65 | 9.0 | 1.47 | 1.89 | 8.2 | .034 | .28 |
| .75 | 16.0 | 1.53 | 2.10 | 14.4 | .046 | .66 |
| .85 | 20.0 | 1.59 | 2.38 | 17.5 | .063 | 1.10 |
| .95 | 15.0 | 1.68 | 2.80 | 12.9 | .089 | 1.15 |
| | 181.0 | | | 170.0 | | 4.53 |

Distribution of VMT by Level of Service. Estimates of VMT by functional systems are available for several historical as well as forecast years, but data on the distributions of those VMT by level of service or v/c ratio have not been tabulated. Several sources yield some partial insights on these distributions, but the only way that quantitative estimates can be constructed is to first disaggregate average daily traffic (ADT) into peak and off-peak and then to apply standard distributions of volumes by annual hours at each volume. These constructed distributions are then reaggregated to obtain the initial VMT distribution shown in Figure A-23. Because of lumpiness in the data, these distributions were "smoothed" so as to even out excessive highs and lows. The level of reliability of these estimates could be easily improved by better statistical sampling and questionnaire design in data collection activities that are already being undertaken.

Volume-Delay Functions. Traffic engineers have accumulated a large amount of structural information about vehicle flows and road capacities, but the information is not so robust that it leads to a unique mathematical relationship between volume and delay on a given facility. There is little doubt that the general shape is similar to that shown as AVC in Figure A-22, but there is a considerable degree of lattitude in how fast the curve rises at the low end versus how fast it rises at high levels of congestion. There is also much uncertainty about how operating conditions affect the functional form and calibration of the curve.

An assumption of linearity between speed and vehicle density was used to derive the results shown in Figure A-23. Perhaps a dozen other approaches might also be used, and roughly half a dozen were tested for sensitivity purposes. The flatter the relationship is at the low congestion end, the more sensitive the results become to the distribution of VMT at high v/c levels. A linear speed-density model yielded modest total revenues in comparison to other functional forms, but revenues are produced at most v/c ratios. Other models tend to result in noticeable congestion charges only at higher v/c ratios, resulting in higher total revenues with much greater concentration in urban areas. Although the evidence is slightly stronger for the existence of small (rather than zero) congestion effects at low and moderate volume levels, the conclusion is far from definitive and the policy implications are large. In other words, the question of whether congestion tolls are generally applicable over most of the system or relevant only to medium or large urban areas is an important one for practical user charge design.

In addition to the shape of the volume-delay function, the problem of associating a functional form with particular capacity and operating conditions is far from simple. Two-lane behavior is different from four lanes or divided highways; signalized segments do not work the same way as access-controlled segments; the shape of the functional relationship may change radically in response to random disturbances. Most research that has been done on these topics has not been oriented toward the measurement of marginal cost, so drawing any cost inferences is risky.

Demand Elasticity. Empirical evidence is weak, but a reasonable fallback position is to assume that the overall elasticity of travel is -1.0 with respect to price. Because time and the associated congestion charges would amount to roughly one-third of the total cost of travel to the automobile operator, a price elasticity of -.33 was used for adjusting the vehicle volumes in response to the congestion charges. Although the results are not highly sensitive to this parameter, it is of considerable importance in any given traffic situation for the calculation of the correct toll charge. In the aggregate, biases toward overestimating the optimal charge at one v/c level are more or less balanced by compensating biases at other levels because of the interdependencies between demand periods.

The elasticity parameter was used as if the demand curves by v/c level were independent of each other, whereas in fact the demand at one level is highly affected by the price charged at nearby levels. Although there is no doubt that an increase in price in one demand period increases the demand in other periods, even the most complex travel demand models do not handle these relationships and the quantitative understanding of interdependencies between demand periods is insufficient to justify attempting to incorporate it. There is some average elasticity that will give the same aggregate results as the more complex model, and there is no reason to assert that the complex form would be more accurate using currently available data.

Estimation Procedure. The sequence of steps used to produce Figure A-23 can be summarized in terms of Figure A-22 and the previous discussion:

(1) Estimate the vehicle volumes of traffic that do or will occur on each functional system in one year.

(2) Convert the volume estimates into passenger car equivalent (PCE) volumes.

(3) Estimate the distribution of PCE volumes by congestion (v/c) levels for each functional system.

(4) Construct a volume-delay curve for each functional system, and establish the user price (including time) for each v/c level (the intersection of the initial or observed volume with the demand curve, in Figure A-22).

(5) Estimate the adjusted volume resulting from efficient pricing using the marginal cost curve derived from the volume delay curve, and an elasticity.

(6) Calculate the congestion charge as the difference between marginal and average variable cost at the adjusted volume (v/c) level. Also calculate the revenues that would be raised, the delay savings, and the loss of consumer surplus.

(7) The charge, stated in dollars per PCE-mile for a v/c level on a functional system, can be translated into a per-vehicle-mile user charge for a specific vehicle by multiplying its PCE value by the per-PCE charge rate associated with the road and conditions.

Passenger Car Equivalents. Both the equivalent single axle load (ESAL) concept and the passenger car equivalent (PCE) concept were developed for the purpose of measuring the capacity (weight or volume) of a highway in standard units. The need for such measures derives from methods of highway design. By means of equivalency factors, different mixes of vehicle sizes, weights, and performance characteristics in the future traffic stream can be transformed into the standard units, allowing a common design procedure to be used for a variety of vehicle mixes.

Because these measures are rooted in the design of capacity, care must be exercised in using equivalency factors for purposes other than those intended:

(1) The concept employed for design purposes may not always be compatible with the concept suitable for the measurement of cost, especially variable cost.

(2) The empirical measurement of the concept as used in traffic or pavement engineering may constitute a modified implementation of the concept.

Although both ESALs and PCEs are useful units for measuring cost, there are points at which both the concepts and their operational measures differ between engineering design and economic cost.

Tables of PCEs have been used for several decades, and recent research has confirmed at least the general magnitudes of the factors (PRC Voorhees, 1981; Seguin et al., 1982; Cunagin and Messer, 1982). For a vehicle of a given size and power-to-weight ratio, its PCE is a function of the type of highway (two-lane or multilane), grades (steepness and length), the amount of traffic (volume-to-capacity ratio), and the mix of trucks in the stream. Because of the design emphasis, the PCE factors apply only at capacity, but because design levels of service encompass the full range of actual usage levels, this is not a practical limitation on the use of estimated PCEs.

Three concepts of vehicle volume equivalency have been generally used in the past:

(1) Equivalent Delay. When a vehicle of a specific type is added to a traffic stream, the number of passenger cars

that must be removed from the stream in order to hold constant the total vehicle hours of travel expended by the stream is the PCE for the specific vehicle type, under the particular conditions.

(2) Lagging Headway. The distance between the rear bumper of the specific vehicle and the rear bumper of the preceding vehicle is taken to be the effective amount of road space occupied by the specific vehicle.

(3) Relative Overtakings. The distribution of desired speeds for the specific vehicle and highway conditions of interest is matched against the distribution for a stream of only passenger cars. The ratio of overtakings by passenger cars of the specific vehicles ralative to the overtakings that would occur for the same volume of passenger cars is the PCE for the specific vehicle type.

The equivalent delay or "time consumption" approach is entirely consistent with the economic concept of vehicle interference. In principle, the marginal contribution of a specific vehicle to a traffic stream, relative to the passenger car standard, is the number of passenger cars displaced by the vehicle so as to leave total delay unchanged. Any ripple effects are included, and a vehicle which causes headways to decrease due to speed reduction is still awarded its correct PCE. The "space consumption" approach requires that all traffic effects of a vehicle be contained in the distance between it and the vehicle ahead, which ignores such impacts as increased spacing of following vehicles due to visual obstruction.

Empirical measurement has relied heavily on the third method or, more recently, computer simulations that replicate experimentally any combination of vehicles and conditions. The results of these analyses must be judged against what is reasonable from experience and what is consistent with known relationships, keeping in mind that the absolute impact of a passenger car (the standard) changes with conditions. Some of the patterns are these:

- Larger and heavier vehicles have higher PCEs than small and light (relative to their power) vehicles.
- The steeper the grades (primarily up), the greater the difference between the performance of heavy vehicles and standard cars.
- The greater the number of lanes, the smaller is the impact of heavy vehicles on the stream.
- The higher the volume of traffic relative to capacity, the greater is the impact of heavy vehicles on the stream.
- The (relative) marginal impact of an additional heavy vehicle on a traffic stream with many trucks is less than the same vehicle's impact on a stream with few trucks. On steep grades, however, heavy vehicle PCEs are roughly constant over vehicle mixes, or increase slightly with higher percentages of trucks.
- Conditions that generate very high PCEs (e.g., mountainous two-lane roads with heavy congestion) are rare in practice, so that the quantitative importance of precisely accurate PCE values is small.
- PCEs for congested urban highways, where vehicle interference is a major cost of highway travel, are generally low (under 3), implying that all vehicles contribute to total delay in roughly similar magnitudes (even a factor of two, of course, is a significant difference for calibrating interference charges).
- An important area of uncertainty lies in estimating PCEs for vehicles on urban non-interstate highways, where intersections, turning movements, property access, and numerous unique

conditions make empirical estimation difficult. In such situations, capacity itself and hence v/c ratios are hard to determine accurately.

Figure A-24 shows PCEs generalized for three vehicle types and average terrain conditions over extended highway segments (HCM, 1965).

**Accidents**

Highway accidents cause personal injury and property damage. Personal injury may be completely reversible, given sufficient medical treatment and time, or it may leave some permanent injury, or it may result in fatality. Property damage may occur to vehicles, contents of vehicles, road structures, or property that is not part of the roadway. Costs of accidents include emergency treatment and police, administration of the private insurance system, and adjudication of liability claims. Accidents occur between vehicles, between a single vehicle and some inanimate object or non-human animal, and between vehicles and pedestrians or vehicles and cyclists.

For damage to private property and minor personal injury, the costs of restoration are fairly well reflected by private markets, and the insurance system arranges to assign responsibility and pay the costs. For major personal injury and fatalities, the basis for valuation is more obscure and the private insurance system may ignore some costs and misjudge others. Damage to public property is frequently not counted in damage payments, and public service costs are not covered. In addition, marginal cost may be substantially different from average cost even when total costs are exhaustive. This leads to three categories of accident cost that require attention:

(1) Public service costs, which are covered in the Administration and Services category above;

(2) Private costs that are overlooked by the insurance system but are a consequence of highway travel; and

FIGURE A-24

Generalized Passenger Car Equivalents

| Terrain | Level | | | Rolling | | | Mountainous | | |
|---|---|---|---|---|---|---|---|---|---|
| Level of Service | A | B-C | D-E | A | B-C | D-E | A | B-C | D-E |
| volume/capacity | .3 | .5-.7 | .8-.95 | .3 | .5-.7 | .8-.95 | .3 | .5-.7 | .8-.95 |
| FREEWAYS AND EXPRESSWAYS | | | | | | | | | |
| Pickups & Vans utility vehicles | 1.0 | 1.1 | 1.2 | 1.0 | 1.1 | 1.2 | 1.1 | 1.2 | 1.4 |
| Single Unit Trucks (2 axles) | 1.1 | 1.2 | 1.5 | 1.2 | 1.3 | 1.7 | 1.3 | 1.5 | 2.0 |
| Single Unit Trucks (more than 2 axles) | 1.1 | 1.3 | 1.6 | 1.2 | 1.4 | 1.8 | 1.5 | 4.0 | 5.0 |
| Buses | 1.1 | 1.3 | 1.6 | 1.2 | 1.4 | 1.7 | 2.0 | 5.0 | 6.0 |
| Combination Trucks | 1.1 | 1.4 | 1.9 | 1.2 | 1.6 | 2.2 | 5.0 | 8.0 | 9.0 |
| URBAN ARTERIALS | | | | | | | | | |
| Pickups and Vans utility vehicles | 1.0 | 1.1 | 1.2 | 1.0 | 1.1 | 1.2 | | | |
| Single Unit Trucks (2 axles) | 1.1 | 1.2 | 1.5 | 1.2 | 1.3 | 1.7 | | | |
| Single Unit Trucks (more than 2 axles) | 1.2 | 1.4 | 1.8 | 1.3 | 1.5 | 2.1 | | | |
| Buses | 1.2 | 1.3 | 1.6 | 1.4 | 2.0 | 3.0 | | | |
| Combination Trucks | 1.4 | 1.7 | 2.5 | 2.0 | 3.0 | 4.0 | | | |

FIGURE A-24 (cont'd)

Generalized Passenger Car Equivalents

| Terrain | Level | | | Rolling | | | Mountainous | | |
|---|---|---|---|---|---|---|---|---|---|
| Level of Service | A | B-C | D-E | A | B-C | D-E | A | B-C | D-E |
| volume/capacity | .3 | .5-.7 | .8-.95 | .3 | .5-.7 | .8-.95 | .3 | .5-.7 | .8-.95 |
| TWO-LANE RURAL ROADS | | | | | | | | | |
| Pickups and Vans recreational vehicles | 1.1 | 1.2 | 1.4 | 1.1 | 1.2 | 1.5 | 1.3 | 1.8 | 2.3 |
| Single Unit Trucks (2 axles) | 1.2 | 1.3 | 1.3 | 1.8 | 2.0 | 2.2 | 1.5 | 2.1 | 2.8 |
| Single Unit Trucks (more than two axles) | 1.5 | 1.5 | 1.5 | 2.5 | 3.0 | 3.0 | 6.0 | 6.0 | 7.0 |
| Buses | 2.0 | 2.0 | 2.0 | 3.0 | 4.0 | 4.0 | 6.0 | 6.0 | 6.0 |
| Combination Trucks | 3.0 | 2.5 | 2.0 | 4.0 | 5.0 | 5.0 | 7.0 | 10.0 | 12.0 |
| TWO-LANE URBAN STREETS | | | | | | | | | |
| Pickups and Vans utility vehicles | 1.1 | 1.2 | 1.4 | 1.2 | 1.3 | 1.5 | 1.3 | 1.6 | 1.7 |
| Single Unit Trucks (2 axles) | 1.2 | 1.2 | 1.2 | 1.6 | 1.6 | 1.6 | 2.0 | 2.0 | 2.0 |
| Single Unit Trucks (more than 2 axles) | 1.6 | 1.6 | 1.6 | 2.5 | 2.5 | 2.5 | 7.0 | 7.0 | 7.0 |
| Buses | 2.0 | 2.0 | 2.0 | 4.0 | 4.0 | 4.0 | 6.0 | 6.0 | 6.0 |
| Combination Trucks | 3.0 | 3.0 | 3.0 | 5.0 | 5.0 | 5.0 | 10.0 | 10.0 | 10.0 |

Sources: Highway Capacity Manual, 1965; PRC Voorhees, 1981; Seguin, et al., 1982; Cunagin and Messer, 1982; some figures are interpolated from sources.

(3) Under- or overpricing that results from a deviation between average user cost and marginal social cost.

All other accident costs are assumed to be paid by the user in at least approximate accordance with the expected risk the user creates.

Marginal versus Average Accident Costs. When a vehicle hits a patch of ice and slides into the ditch, or the driver falls asleep and runs into a tree, the average or expected cost of the accident is the same as the marginal cost. If all costs not suffered directly by the driver are covered by insurance, the insurance premium represents the expected value of the accident. There is no difference between the cost to the operator and the cost to society. When an accident involves two or more vehicles, however, the principle of paying for all costs that could be avoided leads to a counterintuitive result: for an accident in which either one of two drivers could have prevented the accident by not using the highway, the marginal cost for each driver is the total cost of the accident.[*/] Liability for the accident is immaterial; if the driver who is "not at fault" had stayed home and thereby avoided the accident, then the costs of the accident are just as much a consequence of his or her decision to make the trip as they are a consequence of the driver supposedly at fault.

To the extent that accidents could be prevented by more than one person, efficient user charges will recover more than the total costs of accidents. It might be inevitable that a drunk driver will hit somebody, and one victim is substitutable for another; the accident will not be avoided except by removing the drunk driver. Those who "cause" accidents are more likely to be involved in an accident, and efficient user charges should include this factor. For cases where it takes two vehicles to make an accident, however, the marginal cost for either vehicle (and hence the efficient price) is the total cost of the accident. Because an accident is, in part, a random event, the price is based on expected values rather than actual accidents.

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*/ This argument is from Vickrey, 1969.

As long as the level of traffic is high enough to permit the possibility of two or more vehicles having an accident, some kind of congestion charge to equate marginal cost with price paid is potentially applicable, even though there is no detectable delay or increased operating cost. Thus there are two reasons why the marginal accident cost for a given vehicle may be higher than the average cost paid by the vehicle: the marginal cost for each vehicle is the total expected cost of accidents, not just a portion, and each vehicle added to the traffic stream increases the probability of accident.

Traffic Volumes and Accidents. Empirical analysis probably requires that the functional relationship between traffic volumes and accidents be separated from the expected cost per accident, i.e.,

$/VMT = $/accident x accidents/VMT

where the costs may be disaggregated by type of accident and by type of vehicle or vehicle mix. The relationship is compounded somewhat, however, by the interaction between v/c and the cost per accident. Fatalities are less likely in slow moving, congested traffic streams, making the number of accidents greater but the cost per accident lower. If fatalities are valued somewhere in the $300,000 range, the benefits of reduced speed from congestion outweigh the costs of more accidents, for some speed and volume classes (Stoner and Marshall, 1981). Depending upon the evidence available, separating accidents into types may be sufficient to alleviate this problem.

Effects of Different Vehicle Types. The marginal cost of accidents for a given vehicle is the incremental accident costs that will occur from adding that particular vehicle to a given traffic stream. Each vehicle should pay the costs that could be avoided were that vehicle to be removed from the stream. All other things being equal, the cost of an accident decreases with increases in the size of a car, for the same accident, but such costs are likely to vary systematically with both the type of vehicle being considered and the mix of vehicles in the traffic stream. Adding a light passenger vehicle to a flow of heavy trucks may increase accidents costs much more than the addition of a heavy truck, in part because of the differences in performance characteristrics between light and heavy vehicles and in part because of the vulnerability of the light vehicle to damage from heavy vehicles. A similar rationale might apply to the addition of a heavy truck to a stream of passenger vehicles. With respect to the costs of accidents among vehicles, there may be diseconomies from disparate vehicle types sharing the same facility. If this is true, efficient prices for accident risk will be higher (for the same vehicle) the more incompatible is the traffic stream.

Quantitative estimation of accident cost and vehicle volume relationships, however, has not yet proved to be satisfactory. The share of total costs that arises from multiple vehicle accidents is hard to discern and the complicating interactions among vehicles are poorly understood. Attempting to combine these various effects into marginal cost figures leads to results that are small in magnitude and not especially plausible, so no tabulations have been incorporated into the user charge estimates.

**Vehicle Operating Costs**

Vehicle interference from congestion causes increased fuel consumption from forced speed changes, and increased tire and vehicle wear from speed changes and braking. At speeds over approximately 45 mph, reduced speed tends to reduce fuel consumption and tire wear per vehicle mile, but these effects are offset in part by the involuntary stop-and-go nature of the speed reduction. Operating costs as a function of running speed have been extensively tabulated, but the speed-change effects of congestion are hard to quantify. As yet, the figures presented here do not include this factor.

## NEGATIVE EXTERNALITIES

Much thought has gone into policy alternatives for dealing with externalities, across both theoretical and practical dimensions. Many apparent conflicts have been reconciled, and misconceptions corrected, to the point that a coherent conceptual structure is readily available. The distinctions that are important for guiding highway user charge design and estimation are outlined below (Baumol and Oates, 1975).

### Efficient Externality Charges

Negotiated Rights Versus Pollution Taxes. The overall objective in correcting externalities is to incorporate them into market processes, i.e., internalize them so that individual consumption and production decisions will take the real social costs into account. One approach has been the Coase-Buchanan-Turvey negotiated settlement strategy, which depends upon an initial assignment of property rights and market mechanisms for exchange of these rights. Rights can be in the form of authority to generate a given level of pollution or freedom from pollution greater than a set level. An important conclusion from this line of thought is that efficient resource allocation (including pollution levels) will result without regard for the initial distribution of property rights. The alternative approach is a Pigouvian tax, which proposes that sources of pollution be taxed or fined according to the amount of damage created. Producers of externalities will then have the incentive to find both the cheapest way to reduce the externality and the socially efficient amount to produce.

A critical limitation of the negotiated rights approach is that it requires participation by all parties affected by the externality, including sources and receptors. If the decision (the price and the amount of externality) needs to be made frequently (e.g., every time a vehicle passes a house) or the number of persons affected is large (e.g., highway users and adjacent landowners), then the negotiation strategy is not a realistic practical possibility. It is important, however, to articulate a current distribution of property rights that is regarded as fair and to compensate owners for windfall losses in property value that result from increases in noise, fumes, and other negative externalities.

The imposition of a Pigouvian tax is necessary when large numbers of persons are involved, and such a tax could be implemented as a highway user charge. Depending upon whether the externality is depletable or non-depletable, the tax should either be used to compensate those who absorb the externality or go into the public treasury.

Depletable and Non-depletable Externalities. Some externalities operate like a public good: consumption of the externality by one recipient does not reduce the amount available to others. Polluted air can be breathed by few or many persons, without affecting the amount of polluted air available, so that the disbenefits of air pollution are increased if dense residential development occurs alongside highways. This perception has led to the proposition that the recipients of pollution should be taxed (so they will avoid the pollution) as well as the producers, but this is incorrect. For the requirement to be satisfied that each individual be faced with the marginal cost of his or her action, no tax or payment is needed for the recipients of non-depletable externalities because they already face the marginal costs of their actions. They will protect themselves efficiently because the consequences of their actions are already internalized. Only the producers need to be taxed in order to equate private costs with social costs.

Depletable externalities are less common in connection with highways, and the compensation side more awkward. For emissions of lead, asbestos dust, tire and other particulates, and litter, the amount that is absorbed in one place reduces the amount that must be absorbed elsewhere. As is true for the producers of externalities, the costs of reducing the externality are less for some than for others. Thus, efficiency can be aided by paying those receptors who will absorb the pollution at least social cost. For highway user charge purposes it is not essential that a compensation mechanism be established in order for efficient effluent charges on users to be effective, but it is nonetheless necessary to know how the various depletable externalities are both directly and ultimately absorbed, as well as the costs incurred by each receptor.

Joint Production. For practical purposes, it will always be true that at least one way of reducing an externality will be to reduce the level of output of the associated activity, e.g., vehicle travel. In the case of strict joint production, where the mix of output between the desired activity and the externality is fixed, the only way to reduce the externality will be to reduce output. At the other extreme is the situation in which it is always cheaper (less outlay or less loss of benefits) to reduce the externality by some means other than reducing output. No obvious cases of either extreme apply to highway travel, and the typical situation is one for which reducing output is one of several means of reducing the impacts of the externality.

**Dollar Valuation of Externalities**

In principle, the marginal cost of an externality should be based on the loss of utility for all persons impacted. Anything less implies that some affected individuals would be willing to pay more to remove the externality than the producers gain from producing it. If producers find that the charge for producing the externality is greater than the cost of not producing it, then the producer's action to reduce the externality will result in lower damage plus control costs for society as a whole. Thus there is normally an actual level of damage plus control costs and an ideal or efficient level that is lower. Externality charges should be based on actual damages, although prices based on optimal control can sometimes be substituted.

In practice, there are three strategies for estimating externality costs:

(1) Damage Costs. Where damage takes the form of treatable medical injuries, damage to property in the form of physical destruction or dirt, loss of agricultural production, and similiar effects where restoration is reasonable and market

prices reflect social costs, actual expenditures are a good measure of the value of damage. Lost earnings and other opportunity costs must be imputed. Some of the problems with this approach are uncertainty about the magnitude of the impacted population, uncertainty about whether the expenditures result in more than or less than than true restorations, and uncertainties about the degree to which the expenditures can be attributed to the specific source of pollution.

(2) Revealed Preference. Surrogate markets can sometimes be used to reveal how much willing buyers would be willing to pay to avoid a particular externality. Some effects of noise, air pollution, and danger to nonusers are sufficiently localized to allow buyers of real property, renters of residential of commerical property, or pedestrians to demonstrate the amount of money or time they would be willing to forego in order to be free of the externality. Because the choices are normally made in packages in which the components of the transaction are not broken into separate prices, deriving prices from revealed preferences depends upon multivariate statistical analysis.

(3) Optimal Control Costs. If the optimal control program could be estimated or were known, then the reduction in damage from the existing to the optimal would be at least as great as the costs of achieving the optimal. For example, if EPA ambient standards are optimal, then compliance costs constitute a lower bound on the value of the damage currently occurring that is above the standards. There is obviously some tautology here, because the optimal control

program depends in part on knowing the value of the damages from failing to control the externality. Another problem is valuation of the residual levels of externality that will exist after the optimal control program is in effect, because these residuals should also be included in efficient user charges.

Whatever the method used, some compromise is inevitable between the objective of measuring marginal cost and the empirically easier means for calculating average cost. There is probably a significant difference between the marginal and the average variable costs of externalities, but currently available data and methods tend to measure averages for subsets of conditions rather than true marginal cost.

**Air and Water Pollution**

The same toxic materials may wind up as air pollution or water pollution or both, at different stages in their production and diffusion. Two essential characteristics of air and water pollution resulting from highway usage are the physical nature of the pollutants (gasses, particulates, solutions) and the natural (rather than market) processes by which they travel from the sources through the environment.

Models of pollution. A general schematic model of pollution is shown in Figure A-25, indicating four steps in the analysis of pollution costs:

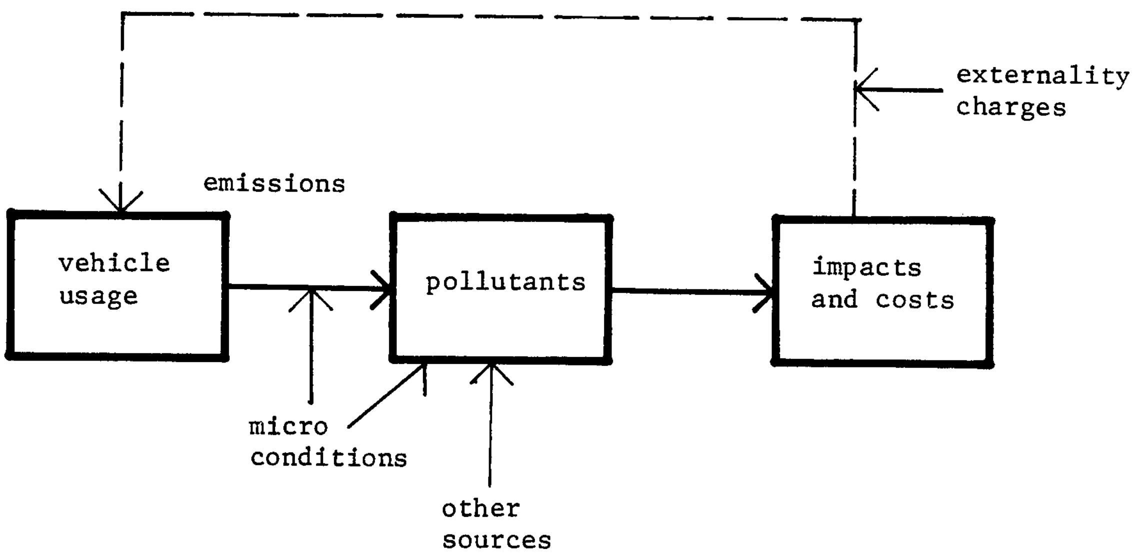
(1) Determination of emissions as a function of vehicle characteristics, road type, traffic volume and mix, and climate.

(2) Analysis of the transmission, diffusion, and transformation of pollutants after they are emitted and until they impact receptors.

(3) Documentation of the impacts of various types of pollutants on various receptors.

(4) Valuation of the impacts on receptors and attribution of the costs to units of output.

Figure A-25. GENERAL MODEL OF POLLUTION IMPACTS



Environmental scientists have constructed numerous mathematical models of steps one, two and three, and environmental economists have directed attention to step four. The ties between steps are often weak or missing, however, and many significant gaps remain. Current knowledge is easier to synthesize qualitatively than quantitatively, but ranges of values have been obtained for dollar costs of several kinds of highway emissions (Haugaard, 1981).

Only variable costs are of concern in this study, so that environmental or neighborhood impacts that occur as a consequence of constructing a highway but are not changed by the amount of usage — i.e., effects that occur whether or not the highway has any traffic — are ignored in the following discussion. A listing of the major air and water pollutants from highway users is given in Figure A-26.

Emissions and Micro-Scale Conditions. Emissions rates in grams per vehicle mile for the five major pollutant groups (carbon monoxide, hydrocarbons, nitrogen oxides, sulfur oxides, particulates) have been tabulated for six vehicle categories in Figure A-27. These give averages over vehicle types and ages within the category, and make prototypical assumptions about condition and tuning of the vehicle, type of fuel used, average speed, weather and temperature, and altitude of operation. Actual emissions for a specific vehicle will depend upon these factors and others.

Pollution Levels. Ambient pollution levels are related to emissions, but also to many meteorological and topographic variables, as well as the presence of other pollutant sources. Hydrocarbons and nitrates combine in the presence of sunlight to create oxidants, a constituent of smog. Some pollutants are toxic only when accumulated in heavy concentrations, usually in geographically limited areas (e.g., carbon monoxide); others are accumulated over large regional airsheds. For several reasons, it is necessary to deal with large aggregates and then assign shares of "causality" to individual vehicles. This assignment cannot be more than approximate, although such an approach tends to balance out the disparities, i.e., a vehicle overcharged in one place may be undercharged in another.

FIGURE A-26.
Air and Water Pollutants from Highway Travel

| Emission | Transmission | Damage |
|---|---|---|
| carbon monoxide (CO) | addumulation and diffusion | affects lungs, blood, brain |
| nitrogen oxides (NOx) | transformed into smog | causes respiratory ailments, visual impairment |
| hydrocarbons (HC) | | |
| sulfur dioxide (SO2) | transformed into sulfuric acid | contributes to acid "rain" |
| asbestos | diffuses as dust | carcinogenic |
| lead (Pb) | diffuses as particulate | causes blood poisioning and brain damage |
| tire particles | " | dust |
| pavement particles | " | " |
| petroleum residuals | crankcase ventilation and storm runoff | air and water pollution |
| fumes | air diffusion | unpleasant smell |

FIGURE A-27

Vehicle Pollutant Emissions Rates for 1977
(grams/mile)

| | CO | HC | NOx | SOx | Particulates |
|---|---|---|---|---|---|
| Autos | 53.10 | 7.58 | 3.77 | .13 | .47 |
| Pickups | 68.05 | 12.16 | 4.79 | .18 | .47 |
| Motorcycles | 28.0 | 5.66 | .25 | .03 | .19 |
| Heavy Duty Gasoline Vehicles | 184.89 | 31.43 | 12.04 | .36 | .40 |
| Heavy Duty Diesel Vehicles | 28.7 | 4.6 | 20.9 | 2.8 | 1.3 |

Vehicle Pollutant Emissions Rates for 1985
(grams/mile)

| | CO | HC | NOx | SOx | Particulates |
|---|---|---|---|---|---|
| Autos | 15.44 | 2.72 | 1.75 | .13 | .29 |
| Pickups | 31.61 | 5.90 | 3.93 | .18 | .33 |
| Motorcycles | 27.63 | 7.18 | .26 | .03 | .19 |
| Heavy Duty Gasoline Vehicles | 145.79 | 15.36 | 12.47 | .36 | .40 |
| Heavy Duty Diesel Vehicles | 28.7 | 4.6 | 20.9 | 2.8 | 1.3 |

Source: EPA (1977), Appendix D.

Damage Costs. The approach most commonly followed to estimating air pollution costs is to estimate damages with respect to what would have occurred without the pollution and place prices on those damages. Three kinds of damages are included for this study: human health (mortality and morbidity), materials (soiling, physical deterioration), and vegetation (crops, ornamentals). Health impacts are estimated using regression analysis of epidemiological data for urban areas. Costs of health impacts are made up of medical bills and loss of earnings due to illness or premature death. Materials damages are based on deterioration properties and aggregate damage estimates for 32 kinds of materials, and the total costs allocated to different pollutants. Both regression analyses and plant surveys have been used to estimate damages to vegetation, for 77 crops plus shade trees and other ornamental trees and shrubbery. Total damage costs from all sources of the pollutants considered are shown in Figure A-28.

Most of the pollutants emitted by highway users also come from other sources, and there is no way of knowing which source caused which damage. The strategy used to assign pollution costs to vehicles was to convert the costs into per-gram units (Figure A-29) and multiply by the applicable emissions rates to get the cents-per-mile charge for a particular vehicle. Using Figures A-27 and A-29, an average automobile travelling 10,000 miles per year in an average urban area creates damages at the rate of .62 cents per mile or approximately $62 per year. A diesel truck in urban travel creates costs at a rate of 1.6 cents per vehicle mile. These numbers are rough averages, and the actual contributions to damage costs of the same vehicle under different conditions appears to be subject to wide variation.

Water pollution. Highway users generate pollution that finds its way into watercourses as well as into the air. The approach used for the analysis of air pollution would seem to be applicable to water pollution as well, but little empirical research has yet been carried out.

FIGURE A-28.
Aggregate Air Pollution Damage Costs from All Sources
($ 1981 millions)

| | CO | HC | NOx | SOx | Particulates |
|---|---|---|---|---|---|
| Health | 1629.2 | 4278.2 | 8544.4 | 9106.8 | 6675.9 |
| Materials | 226.9 | 1868.7 | 8049.7 | 15533.5 | 5144.3 |
| Vegetation | 205.1 | 205.1 | 20.9 | | |

Source: derived from Haugaard, 1981.

FIGURE A-29.
Air Pollution Damage Cost Rates
(¢ gram 1981)

| | CO | HC | NOx | SOx | Particulates |
|---|---|---|---|---|---|
| Health | .00158 | .01583 | .03798 | .03324 | .04748 |
| Materials | .00025 | .00765 | .03958 | .06273 | .04048 |
| Vegetation | | .00076 | .00091 | .00007 | |
| TOTAL | | | | | |
| Urban | .00183 | .02375 | .07789 | .09605 | .08796 |
| Rural | | .00048 | .00058 | .00004 | |

Source: derived from Haugaard, 1981.

Asbestos, lead, particulates, road salts, and petroleum residuals are among the water pollutants with origins in highway usage. Some are deposited on the highway and washed into streams and rivers by rainfall. Some end up in lakes and oceans, some in the soil. Used crankcase oil is often poured out onto the ground by do-it-yourself auto mechanics. De-icing chemicals applied to streets in the winter are injurious to roadside vegetation and accumulate in streams and lakes. Costs may occur in the form of destroyed or stunted vegetation, polluted water supplies, loss of fish and wildlife, and some of the same kinds of health and materials damage that are caused by air pollution.

Although there is no serious doubt in regard to the direction of impact of highway usage on water pollution, and the magnitude of the impacts are probably significant, insufficient evidence currently exists to attempt to estimate efficient prices. Water pollution, then, is an omitted external cost in the results presented in this report.

**Noise**

Sources of highway noise include tires moving over pavement, engine exhaust, operation of engines and related equipment, friction of brakes shoes on drums or discs, air brake operation, transmission and drive train friction, and horns. Propagation of noise is quite well understood, and measures that attenuate undesirable sound can be evaluated with respect to their effectiveness. The impacts, however, of types of noise, their frequency spectra, repetitiveness, background levels, time of day, and other factors, is less well understood. Noise can cause hearing loss, interference with conversation and sleep, increased tension and nervousness, and reduced benefits from radios and phonographs. Medical costs and control costs can both be considered in evaluating noise effects, but revealed preference studies using property value data have provided the best information to date.

Noise Emissions. The measurement of noise is fundamentally the measurement of energy and is implicitly a rate. Thus a particular vehicle operating under given conditions produces a volume of noise that can be metered at a given location; if the conditions are stable, the reading will be constant. The numerical scale is arbitrary, but the scale widely accepted and used is the decibel (dB) scale. For noise affecting humans, the energy level of each frequency can be weighted in proportion to the sensitivity of the human ear to the frequency, and the resulting measure is referred to as A-weighted decibels (dBA). Additional factors affecting the impact of the noise, and hence its measurement, are its repetitiveness, duration, and time of day. Sudden loud noises are generally more annoying that the same energy spread more uniformly over time, and noise at night is more objectionable than daytime noise. The $L_{eq}$ scale translates total noise over a given period into a single steady-state noise equivalent, and the $L_{dn}$ scale weights nighttime noise more heavily to get a day-night equivalent scale. The measure used in this study is the $L_{eq}$ form of the dBA scale.*/

In measuring highway noise, the most important variables for describing source levels are vehicle volumes, percentage of trucks (medium and heavy), and the speed. Stated crudely,

sound level = (vehicle volume)x(emissions per vehicle)/distance

with the emissions per vehicle measured at a given speed and a distance of 50 feet. Relationships of this sort allow noise contours to be estimated for different source characteristics, and distances. Figure A-30 shows noise emission rates for three vehicle types relative to the emission level of the standard passenger car, based on a noise emission standard of 86 dBA (EPA has proposed a standard of 75 dBA). Figure A-31 shows the estimated costs per vehicle mile of these emissions.

Attenuation and Abatement. Propagation and transmission of noise can be controlled in three kinds of ways: reduce emissions at the source, erect barriers

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*/ Results given here are based on original work by Hokanson, et al., 1981, which relies heavily, in turn, on Nelson, 1978.

FIGURE A-30

Noise Passenger Car Equivalence Factors

| Emissions Standard (dBA) | Vehicle Class | 55 mph | 45 mph | 35 mph |
|---|---|---|---|---|
| 86 | Autos | 1 | 1 | 1 |
| | Medium Trucks | 12 | 13 | 14 |
| | Heavy Trucks | 30 | 38 | 54 |

Source: Hokanson, et al., December 1981.

FIGURE A-31

Noise Costs per Vehicle Mile for Urban Highways
($ 1981)

| | Vehicle Type | | |
|---|---|---|---|
| Functional System | Auto | Medium Truck | Heavy Truck |
| Interstate | $ .0006 | $ .007 | $ .020 |
| Other | $ .0012 | $ .017 | $ .065 |

Source: derived from Hokanson, et al., 1981.

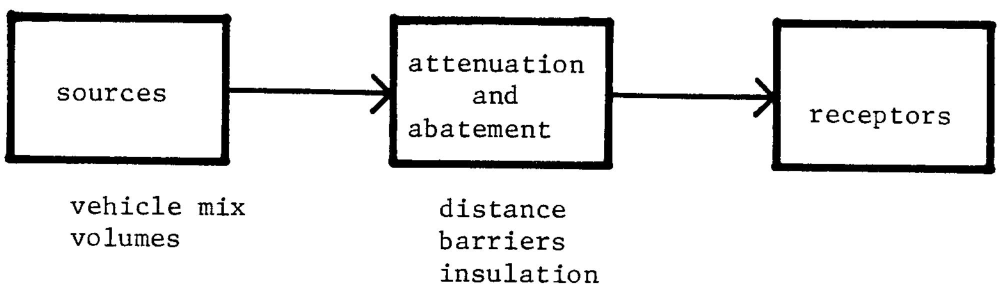
between the source and adversely affected receptors, and insulate buildings so as to reduce interior sound levels. With present vehicles, road designs, building construction, and related conditions, the most cost-effective method for reducing sound levels appears to be emissions controls, but the efficient noise level to be sought is still subject to debate. Figure A-32 suggests a general model for addressing the problem of noise damage estimation and noise abatement.

Noise barriers have been designed and constructed in a variety of locations and with a variety of designs and materials. The costs of such barriers can be readily related to the amount of noise reduction, but the evaluation of noise barriers is complicated by the related visual impacts. Many residents and property owners sheltered, or proposed to be sheltered, by noise barriers have expressed the opinion that they find the solution worse than the cure. Hence the approach of using control costs as some quantitative bound on damage costs has not so far been workable.

Receptors and Damages. Several studies have undertaken careful statistical analyses of residential property values as a means for extracting the noise component of the price of a housing unit. By comparing sales values for a variety of properties on a variety of characteristics, including noise, the willingness to pay for a noise-free environment can be estimated. The best estimate is -.4% of market value per dBA ($L_{eq}$). This rate, annualized and estimated in 1981 dollars for urban areas, works out to about $21 per housing unit per year as the cost of one dBA of noise.

Interpretation of decibel levels is somewhat subjective, but acceptable levels for various purposes have evolved with experience. A steady level of 90 dBA quickly leads to hearing loss and is considered intolerable except for unusual industrial conditions under which it is more effective to provide workers with protectors. A level of 55 dBA outdoors can interfere with sleep indoors with the windows closed, and EPA has established 60 dBA as the level at which not more than 20% of the affected population will be "highly annoyed." For the estimates of damage reported here, 55 dBA was taken as the base from which to measure "excess" dBA, implying that noise levels below that do not cause significant damage. Obviously, a zero noise level is neither feasible nor especially desirable.

Figure A-32. NOISE GENERATION AND IMPACTS



It remains then, to estimate the number of receptors affected above the threshold, and by how much they are affected, for each functional system. Considering only urban areas and only residential uses, the results are determined by the vehicle volumes and the density of residential units within the distance bands that experience excess dBA. For urban Interstates, the results average out to roughly .3 cents per vehicle mile, with the large variation among vehicle types shown in Figure A-31. No allowance has been made for commercial activities impacted by noise impacts.

A deeper problem that has also not been treated is the degree of nonlinearity in the relationships. An additional vehicle added to an already noisy street may cause little marginal damage even though the average impact is substantial. As with air pollution, there is a dose-response relationship such that some portion of the population is highly sensitive to impact and another portion is largely insensitive. The assumption here is that the types and levels of noise impacts from highways are such that the middle sensitivity group is the one affected and the relationship is approximately linear over the relevant range.

## EFFICIENT CHARGES FOR PROTOTYPICAL CONDITIONS

Of the variable costs listed in Figure A-17 as relevant to the construction of efficient user charges, six have been quantified to the point of dollar estimates under some limited sets of average conditions: pavement repair, pavement user costs, administration, excess time delay, air pollution, and noise. Pavement damage and congestion delay are the costs of major significance, the others being small as per-vehicle-mile rates. Of the costs not estimated in cents per vehicle mile of travel, accidents looks to be the only category that might lead to a substantial increase in user charges if more were known about causal relationships. Other marginal costs may be large in the aggregate but small in relation to VMT.

Nine vehicle types have been selected for illustration in Figure A-33, matching the salient vehicle characteristics to the conditions under which they might be operated. The rural auto causes little pavement damage because of light axle weights, it encounters little congestion so causes little delay, and the externalities it generates are easily diffused and impact few people. Such a vehicle is probably overcharged

FIGURE A-33

Efficient User Charges for Example Vehicles under Specific Conditions
(cents/VMT)

Efficient User Charges for Example Vehicles under Specific Conditions
(cents/VMT)

| Vehicle Type | Location | Key Parameters | Components of Efficient Prices: Pavement Repair | User Costs | Adminis-tration | Excess Delay | Air Pol-lution | Noise | TOTAL | Existing Average User Fees |
|---|---|---|---|---|---|---|---|---|---|---|
| Auto (3,000 lb GW) | Rural | v/c = .05 | | | .3 | .3 | | | .6 | 1.3 |
| Auto (3,000 lb GW) | Urban | v/c = .85 | | | .7 | 11.2 | 1.5 | .1 | 13.5 | 1.7 |
| Van or Pickup (5,000 lb GW) | Suburban or small town | v/c = .55<br>PCE = 1.0<br>ESAL= 0.0 | | | .5 | 4.4 | .8 | .1 | 5.8 | 1.5 |
| Truck single unit 3 axle (40,000 lb GW) | Small urban | v/c = .35<br>PCE = 1.2<br>ESAL= .8 | 25.6 | 7.5 | .5 | 2.2 | .2 | .2 | 36.2 | 4.8 |
| Truck combination 5 axle, 3-S2 (72,000 lb GW) | Rural Interstate | v/c = .15<br>PCE = 1.2<br>ESAL= 1.6 | 8.0 | 5.9 | .3 | .4 | | | 14.6 | 9.0 |
| Truck combination 5 axle, 3-S2 (72,000 lb GW) | Urban Interstate | v/c = .35<br>PCE = 1.2<br>ESAL= 1.6 | 24.0 | 16.3 | .3 | 1.4 | 3.0 | 4.0 | 49.0 | 9.0 |

FIGURE A-33 (cont.)
Efficient User Charges for Example Vehicles under Specific Conditions
(cents/VMT)

Efficient User Charges for Example Vehicles under Specific Conditions
(cents/VMT)

| Vehicle Type | Location | Key Parameters | Components of Efficient Prices: Pavement Repair | User Costs | Adminis-tration | Excess Delay | Air Pol-lution | Noise | TOTAL | Existing Average User Fees |
|---|---|---|---|---|---|---|---|---|---|---|
| Truck or Bus 2 axle (28,000 lb GW) | Urban | v/c = .45<br>PCE = 1.4<br>ESAL = .9 | 37.0 | 13.4 | .5 | 4.3 | 1.6 | 2.0 | 58.8 | 5.0 |
| Truck single unit 3 axle (60,000 lb GW) | Urban collector or local | v/c = .25<br>PCE = 2.0<br>ESAL = 4.0 | 180.0 | 64.0 | .5 | 3.1 | 4.0 | 8.0 | 259.6 | 11.0 |
| Truck combination 4 axle (100,000 lb GW) | Rural arterial | v/c = .05<br>PCE = 3.0<br>ESAL = 27.2 | 408.0 | 95.2 | .3 | .3 | | .2 | 504.0 | 5.0 |
| Truck combination 9 axle, 3-S2-4 (105,000 lb GW) | Rural Interstate | v/c = .15<br>PCE = 3.0<br>ESAL = 1.0 | 5.0 | 3.7 | .3 | 1.2 | | .1 | 10.3 | 9.0 |

by a small amount, because fuel taxes and registration fees are largely insensitive to urban-rural locations and congestion. At the other end of the auto scale, an urban commuter travelling during peak periods contributes noticeably to both congestion and pollution. Another example is the suburban van or pickup, which generally avoids congested and polluted areas and is still too light to affect the pavement, but is nonetheless being undercharged by a factor of roughly four. A medium truck travelling in lightly congested urban areas incurs a mix of costs that includes damage of light pavements and significant negative externalities. The typical five-axle combination tractor-semitrailer operating entirely on heavy duty pavements in rural areas creates damages about half again greater than its user charge payments, while the same vehicle operating on urban Interstates generates costs over five times its estimated payments. Considerable guesswork lies behind these examples, and the specific conditions listed and implied may not be average for vehicles in the class represented.

The second page of the figure portrays four medium and heavy vehicles that have unusual characteristics with respect to cost impacts, but the vehicles and conditions are not necessarily uncommon. ESAL factors shown in the Figure assume that the vehicle is loaded to its legal limit. An urban transit bus and a local moving van or hauling service truck are similar in that they apply a moderate amount of weight to the pavement through two axles and generally a total of six tires. They also contribute to congestion and pollution. As with all of these vehicles, their actual average current user charges are heavily conjectural, because disaggregated data are very limited and states and localities impose widely varying types and levels of user charges. Urban transit buses generally pay no user fees. The next vehicle described is a heavy three-axle truck such as a concrete mixer, which can have a severe impact on light or medium duty roads. Its user fees are estimated to be somewhat higher than the average on a vehicle-mile basis because whatever fixed fees it pays are spread over a relatively modest annual mileage. Third on the list is an extremely destructive vehicle that might be a bulk agricultural hauler exempted from weight limits, a lumber truck, a coal hauler, or an illegally overloaded combination truck. The source of the damage is a very heavy load distributed on too few axles. Finally, a large twin trailer or double-bottom is represented by the last example, and its costs are quite modest for the conditions assumed for it. Because no accident cost relationships are contained in the component cost estimates, the potential contribution to accidents of this especially long vehicle has been ignored. The same would be true for triple-bottom combination trucks. For all of these vehicles, the efficient user charge estimates are very sensitive to the assumed fourth-power relationship between axle weight and pavement damage, and the distribution of gross weight to axles. Thus the precision of these large per-mile user charge estimates should be regarded as low. It is quite likely, however, that some vehicle-and-road combinations create damages that are both far from the average and untouched by existing user charge structures.

## REVENUES AND EFFICIENCY GAINS

Because the estimation of efficient prices starts with the individual vehicle under particular conditions (e.g., road strength, congestion levels), the total revenues that would be generated are obtained by adding up all the charges to each vehicle for each type of operating condition. A heavy truck operating ten percent of its mileage on light duty roads and the rest on Interstates would pay a different user charge than an otherwise identical truck operating half its mileage on light roads. Total revenues would change if any vehicle, or group of vehicles, chose to operate under different conditions. There is no overall "budget" that is being spread over highway users so as to raise a given amount of revenues. Efficient user charges are determined at the microscopic level, and total revenues depend upon summing the charges to each user under each set of operating conditions.

## Current Operating Conditions

Highway mileage by functional class, and annual VMT by vehicle class, have been extensively tabulated for many years. Strength and condition of the existing road mileage, and the usage of each functional class by each vehicle class, are less precisely known. Congestion levels, including those creating only modest delay, are also not well documented. This information is improving but it has not previously been used for estimating efficient user charges, and definitions and data collection methods are sometimes not easily adapted.

In this study, efficient user charges were estimated for representative prototypes, weighted to match the averages and distributions of characteristics that apply to the existing system and its users. Even if the correct user charges were known with certainty, there would be a large degree of error in estimating total revenues just because of the need to estimate averages of actual operating conditions.

## Demand Response to Different Prices

Another source of error in the revenue estimates is the amount by which usage of the highways will change in response to changes in user charges. The elasticities used for constructing the revenue estimates assume that the elasticity with respect to the total cost of travel is -1.0. Thus, if the component being priced (e.g., travel time) amounts to about thirty percent of the total vehicle operating cost, the price elasticity for that component will be -.30. This does not mean that an overall increase in price of, say, ten percent will result in a decrease of ten percent in the freight or passengers moved; nor does it generally imply a reduction of ten percent in either axle (ESAL) miles or vehicle (PCE) miles. It does mean an approximately ten percent drop in output as measured along the actual expansion path of output, but none of the efficient user charges apply directly to this output. Hence the choice of elasticities is more judgmental than empirical, and better empirical information is needed.

As was mentioned in connection with vehicle interference, no explicit adjustments were made for interaction effects between interrelated demands. In reality, off-peak demand will be increased by efficient charges that raise peak-period prices, and the demand for moderately loaded axles will increase if the charges for heavy axles are increased more steeply than moderately loaded axles. ESAL-miles would decrease with higher axle weight charges, but axle miles would probably increase, i.e., approximately the same ton miles would be carried on more axles. Vehicle miles at high levels of congestion would decrease, but total vehicle miles might stay the same (shifting the travel to uncongested periods) or passenger miles might stay the same while vehicle miles decreased (higher occupancy). Demand responses to changes in price depend upon both how highly valued the essential travel is, and what alternatives exist for satisfying that demand while reducing consumption of the factor that is being priced. The evidence available for estimating these elasticities is scanty, and reasonable guesses are about the best that can be done.

In simplified form, the procedure for estimating the revenues from efficient prices consisted of these steps:

(1) Estimate correct prices for each component for each vehicle class for each functional system.

(2) Combine the components in each output dimension, pavement repair and user costs affecting the ESAL-mile charge, and travel time, externalities and administrative costs affecting the PCE-mile charge.

(3) Estimate 1981 PCE-mile and ESAL-mile travel by vehicle class and functional system, and current variable user charge (primarily fuel tax) rates.

(4) Apply the relevant elasticity to travel by vehicle class and functional system, to obtain adjusted PCE volumes and ESAL miles.

(5) Calculate the revenues that would be raised by the efficient prices at the adjusted output quantities.

The results for each of the two dimensions of output are shown in Figures A-34 and A-35. Axle-weight revenues would come more than proportionately (to VMT) from the Interstate and other primary systems, because that is where the heavy truck VMT is concentrated. This pattern is less than offset, in the aggregate, by the fact that lower level functional systems are much more susceptible to pavement damage from heavy axles. Vehicle inteference charge revenues would be derived predominantly from urban non-Interstates, although all systems would generate some amount of these revenues.

Total revenues, according to these scenarios, would be well over $60 billion, which is roughly twice the amount currently raised by all user charges at all levels of government.[*/] The revenues would also be substantially greater than the roughly $50 billion currently spent each year on the highway system by all levels of government for all purposes, but not as much as the annualized capital replacement cost of the entire existing system (over $100 billion if it is assumed that the government has to obtain a market rate of return on funds invested in highways). Efficient prices, then, could be primary mechanisms for financing highway expenditures.

**Efficiency Gains**

As mentioned above, the net benefits from more efficient prices are called efficiency gains or welfare gains. The nature of the gains depends upon the output and the changes contemplated, but inefficiencies stem from either too low a price (marginal costs of some portion of consumption exceed the marginal benefits) or too high a price (users are deterred even though the benefits would exceed the costs). A generalized example was shown in Figure A-15, in which the price to users lies below the cost curve. The shaded area represents the net loss from incorrect pricing, or the gains in efficiency that could be obtained by shifting from incorrect to correct

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*/ Summing the revenue totals for both output dimensions yields a figure of almost $80 billion, but this addition may overstate revenues to the extent that ESAL charges deter some PCE travel, and vice versa.

FIGURE A-34

Revenues from Efficient Pavement Damage Charges
($ 1981 billions)

| | Vehicle Class* 1 | 2 | 3 | 4 | 5 | Total |
|---|---|---|---|---|---|---|
| Current VMT** | 21.11 | 27.09 | 28.57 | 30.35 | 6.21 | 113.33 |
| Current ESAL-VMT | .61 | 7.79 | 28.33 | 59.55 | 28.20 | 124.48 |
| Adjusted ESAL-VMT*** | .61 | 7.35 | 24.99 | 50.21 | 16.81 | 99.97 |
| Revenues by Functional System | | | | | | |
| Interstate | .02 | .26 | 1.27 | 2.98 | 1.21 | $ 5.74 |
| Arterial | .11 | 1.22 | 3.80 | 5.16 | 1.12 | $11.41 |
| Collector | .03 | .38 | 1.00 | 2.06 | .63 | $ 4.10 |
| Local | .05 | .60 | 1.33 | 1.84 | .37 | $ 4.19 |
| Total Revenues | $ .21 | $2.46 | $7.40 | $12.04 | $3.33 | $25.44 |
| Efficiency gain | $ .0 | $ .10 | $ .74 | $ 1.83 | $2.30 | $ 4.96 |

* Vehicle classes are based on average actual ESALs per vehicle mile, not on axle configuration or visual type.

| Class | ESALS per vehicle mile | HCAS classes |
|---|---|---|
| 1 | under .1 | 6,9,13,31,35 |
| 2 | .1 to .5 | 4,5,10,11,14,18,21,24,27 |
| 3 | .5 to 1.5 | 12,15,16,19,28,32,36,37,38 |
| 4 | 1.5 to 3.5 | 17,22,25,29,30,33,34 |
| 5 | over 3.5 | 20,23,26 |
| Omitted | 0 | 1,2,3,7,8 |

** Vehicle miles of travel by medium and heavy vehicles, in billions annually.

*** ESAL-weighted VMT, adjusted in anticipated response to efficient prices, in billions annually.

FIGURE A-35

Revenues and Efficiency Gains from PCE-Mile Charges
($1981 billions)

| Functional System | Rural Interstate | Rural Other | Urban Interstate | Urban Other | Total |
|---|---|---|---|---|---|
| Current VMT* | 134 | 539 | 159 | 688 | 1,521 |
| Current PCE-VMT | 157 | 593 | 181 | 730 | 1,662 |
| Adjusted PCE-VMT** | 153 | 581 | 165 | 663 | 1,563 |
| Total Revenue | $1.54 | $4.09 | $6.53 | $41.82 | $53.98 |
| Average revenues*** | 1.01 | .70 | 3.96 | 6.30 | 3.48 |
| Efficiency gains**** | $ .08 | $ .15 | $ .68 | $ 4.74 | $ 5.65 |

* 1980 vehicle miles of travel on U.S. highways, in billions annually.

** VMT transformed into PCE-VMT and adjusted in response to the congestion toll using an elasticity of -.33, in billions annually.

*** Average revenue per PCE-VMT, in cents.

**** Net benefits in the short run from imposing efficient PCE-mile charges, including delay savings, pollution and noise reduction, and loss of consumer surplus, measured in billions of dollars annually.

pricing. In this instance, the incremental costs to society of the additional output are greater than the incremental benefits to the users. In the reverse case, where price is higher than marginal costs, the incremental benefits of greater output exceed the incremental costs.

The calculations already made in estimating efficient prices, existing prices and travel, and adjusted PCE and ESAL outputs, allows for the calculation of efficiency gains. For each vehicle class, functional system, and output dimension, the shaded area is computed as if it were a triangle; the method is the same whether the existing price for the specific conditions is above or below marginal cost. Results have been aggregated and included in Figures A-34 and A-35. These estimates are, of course, another degree less precise than the estimates upon which they are based. The effort should be regarded as no more than a pilot attempt to develop quantitative measures of the extent of resource misallocation associated with highway user charges that are not ideal from the perspective of the efficiency criterion.

Current usage, user charges, and modeled cost functions, as used to construct the efficiency gains, summarize what is known about the costs and benefits of highway usage. Left unspecified are the exact forms by which benefits are realized and costs are avoided. It is possible to suggest, however, what the gains might consist of. For a reduction in ESAL miles, the costs avoided are pavement repair and the user costs resulting from rough pavements. The benefits lost would probably be negligible, in that most of the shipping would still take place but in vehicles that had more axles for the amount of weight carried. Overloaded three-to-five axle single units and combinations would decrease, and either more vehicle miles would be covered by the same vehicles or more miles would be covered by doubles and triples. This would entail additional operating cost and/or user charges to the trucker, so some of the costs of doing less pavement damage would be transferred to shippers and consumers, but in a way that net benefits from travel would increase.

Along the PCE dimension, the benefits are primarily travel time savings. Congestion creates a "deadweight" loss, in this case in the form of passenger time spent in travel that produces no useful result. Some travel time is necessary to produce a trip, but the excess delay does not increase the value or amount of output, namely the trip. The only purpose served is to ration the amount of vehicle capacity available among those willing to pay for it. Without a PCE-mile charge, or congestion toll, the payment is in excess delay time, a resource that has value to society but is used up in congestion, to no gain. With a congestion charge, the payment for vehicle space is in money, which is nothing more than a transfer from the viewpoint of society as a whole. No valuable resources are consumed other than those required to actually impose the charge, yet the revenues can be used for highway capital improvements or other valuable purposes. Incentives created by a congestion charge are all favorable with respect to resource allocation: non-urgent trips can be deferred to non-peak periods, high occupancy vehicles have an inherent advantage the greater is the congestion, and individuals are left to their own free will as to how to respond to the scarcity implied by the peak-period price.

Efficiency gains represent better uses of resources, and are likely to be quantitatively small in comparison to total expenditures or revenues. The resources consumed in pavement repair resulting from an overloaded truck are not wasted, for example; the truck derives benefits even while damaging the road. The gains in efficiency come from discouraging that vehicle when the benefits to the trucker are less than the costs of the damage. It is often difficult to distinguish between revenues and expenditures, on the one hand, which represent flows of resources, and efficiency gains (or losses) on the other, which constitute net benefits from a rearrangement of the flows. These efficiency gains are significant because the highway system is such a central and integral part of the transportation system and the economy as a whole.

**Long Run Efficiency Gains**

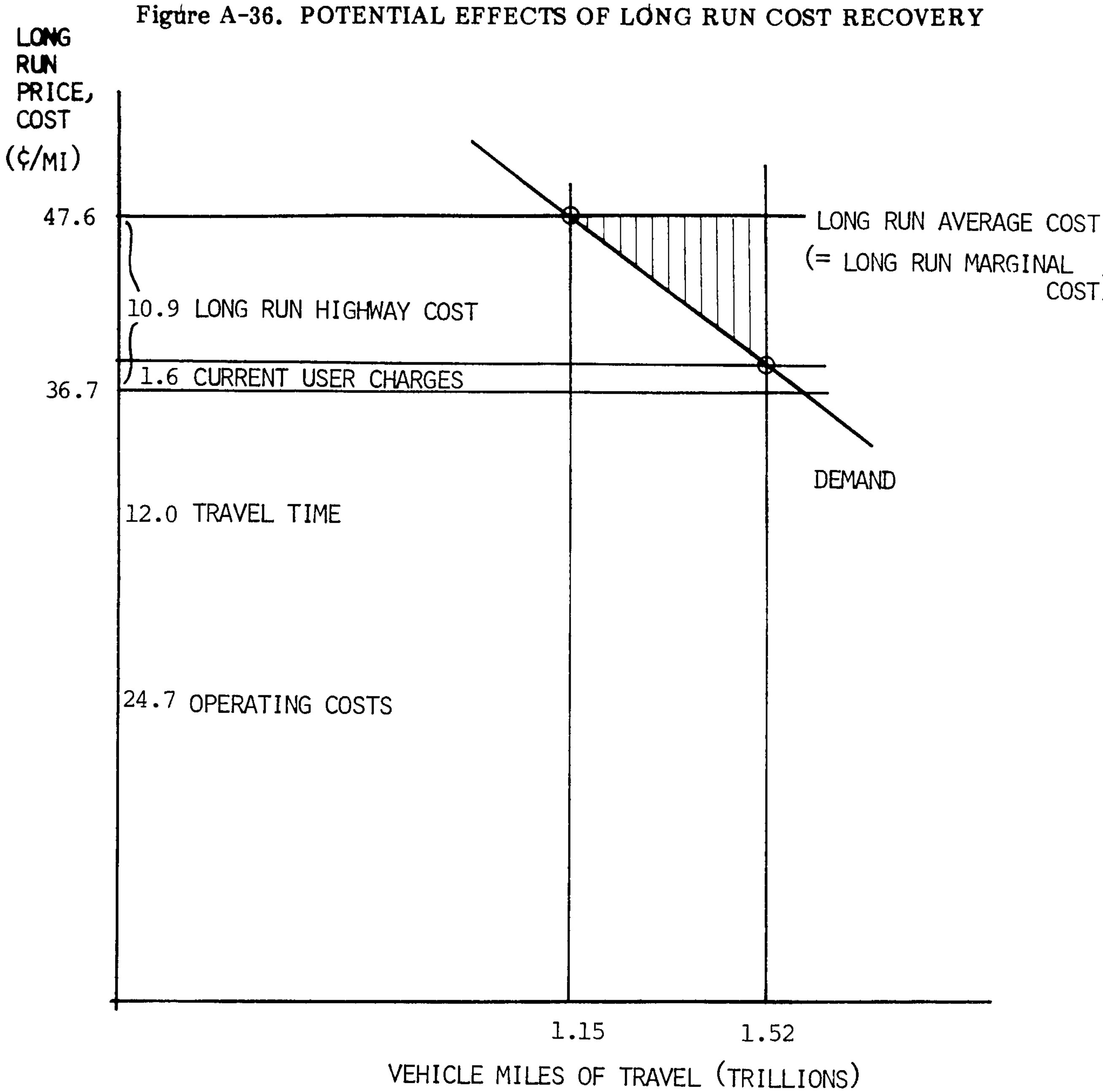
Efficiency gains in the long run come from investing or disinvesting until the capital stock itself is optimal. In a first-best world, the marginal social benefit from a dollar of investment in all activities would be equal, because otherwise resources could be reallocated to increase total net benefits. The highway system, the steel industry, the railroads, etc., would all be scaled to their most productive capacities.

If an approximation of this first-best world can be practically achieved, it is through a sequence of benefit-cost calculations for alternative investments in both private and public sectors. Although we can hope this process will take place, its outcome cannot possibly be forecast with present information and tools. Instead, a technique identical to the one used for short run efficiency impacts can be constructed, using demand, cost, and current price. For the long run, full average costs and prices are needed, plus a demand curve that represents long run demand.

The analysis shown in Figure A-36 estimates travel demand under current prices and also under the imposition of highway user charges high enough to bring total travel price up to the level of long run marginal cost (assumed to be equal to long run average cost for this case). The prices include vehicle wear and operating costs, vehicle capital costs, and travel time. The overall price elasticity of travel is assumed to be equal to -1.0, with highway user charges forming an inescapable component. If some of these charges are levied indirectly through excise taxes (such as on fuel), it is additionally assumed that the rates necessary to impose the correct price do not create significant economic distortions (e.g., trucks are not inefficiently fuel efficient).

The results show an efficiency gain on the order of $15 billion per year. Implicitly, the gains come from redeploying some resources currently used in highway transportation to more productive purposes. No clue is provided as to what these other purposes are, or why they are more productive. The conclusion is based solely on the observation that pricing below cost leads to too much output and the welfare triangle whose magnitude we just estimated.

Figure A-36. POTENTIAL EFFECTS OF LONG RUN COST RECOVERY



In the short run, the net costs of inefficiency represented by the welfare triangle are conceptually robust, consisting of excess travel time and pavement damage on highways. In the long run, the aggregate analysis just carried out above is a significant degree less conclusive. To regard the $15 billion as an efficiency gain it is necessary to assume that there are no scale economies (long run average cost is constant, and thus equal to long run marginal cost) and that price is equal to short run marginal cost. Because efficient prices vary with vehicle type and levels of congestion, the efficient long run price is a whole set of charges and not a single number. Thus the equivalence of short and long run marginal cost must be interpreted as an average of efficient prices weighted by VMT.

There is also no necessity for efficient prices to result in efficient investment in the long run. The hypothesis that forcing full cost recovery from users will stimulate cost-beneficial investment may be a persuasive one, but this result is more a matter of faith than theory.

**Methods for Collecting Efficient User Charges**

It is the nature of efficient prices that they are more costly to collect than lump sum "taxes" that do not depend upon the amount or actual characteristics of consumption. Only the weight-distance and fuel tax (and a few minor excise taxes such as on tires and parts) vary in any direct relationship with the amount of use a vehicle makes of the highways, and the relationship of the fuel tax to either ESAL- or PCE-related costs is negligible. To impose anything approximating efficient highway user charges, new pricing instruments will need to be developed.

For axle weight charges, attention can be focused on the small proportion of vehicles falling in the heavy weight classes, because light vehicles create relatively little damage. A weight-distance tax (based on actual loaded weight and actual distance) would transfer relatively unproductive efforts at weight limit enforcement to the more effective purpose of collecting appropriate user fees from heavy trucks.

With weigh-in-motion scales beginning to reach the point where no interference in the traffic stream is required, the feasibility of a high-yield weight-distance charge at the state level is quite promising.

For congestion charging, the collection costs are probably higher, and the need for national coordination would be substantial. Resistance to congestion pricing has always been great, most especially among administrators and users of the highway system. The image of myriad toll gates seems to spring to mind. In fact, a wide array of technologies are available for the purpose, and few involve toll collection of the toll booth form. At the very crude end of the scale are parking surcharges graduated by time of day, and peak tolls on selected facilities. Exclusive-use lanes for high occupancy vehicles, and area licenses that require display of a special permit to be in congested areas during peak periods, are some of the intermediate methods. At the high-technology end, the hardware for automatically metering each vehicle for the amount of time it spends in congested areas is not especially demanding by current standards. The problem is in generating the consensus necessary to apply it.

The administrative costs of implementing more efficient user charges should unquestionably be given proper consideration in choosing how far to go in this direction, and certainly the gains from better pricing will not outweigh the costs of obtaining them in many sets of circumstances. There are situations, however, where large efficiency gains (as well as substantial revenues) could be obtained for relatively little cost, and these possibilities should not be dismissed as infeasible without giving them serious consideration.

# REFERENCES

## APPENDIX A


1. Saag, J.B. and J. E. Leisch, "Synthesis of Information on Roadway Geometric Causal Factors," Jack E. Leisch & Associates, U.S. Department of Transportation, FHWA, 1981.
2. Ibid., p. 13.
3. Rauhut, J.B., R.L. Lytton and M.I. Darter, "Pavement Damage Functions for Cost Allocation: Executive Summary, U.S. Department of Transportation, FHWA/RD-84/117, 1981.
4. AASHO, Interim Guide, p. 60. Equation C-16.
5. Ibid. Equation D-19.
6. U.S. Department of Transportation, Federal Highway Administration, Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (Washington, DC, 1979), p. 17.
7. Sinclair, Incremental Analysis, p. 5.
8. Ibid.
9. Op. Cit., U.S. DOT - Recording and Coding Guide.
10. Op. Cit., Sinclair.
11. Saag, Roadway Geometrics, p. 5.

# APPENDIX B

## USER FEE OPTIONS AND ALTERNATIVES

### INTRODUCTION

This appendix expands on several of the topics discussed in Chapter III. The contents include a review of current tax rates, their changes from 1979 through 1981, a brief review, by State, of highway revenue sources other than user fees and general fund revenues, a discussion of revenue attribution techniques for first, second and third structure taxes, and finally a discussion of existing reciprocity and proration agreements. This appendix is intended to provide the analyst with more detail on these topics than Chapter III, yet will not be a comprehensive coverage of these issues. The interested reader will have to explore the references provided.

### CURRENT USER FEES

#### CURRENT STATE PRACTICES

**Motor Fuels**

In almost all cases State motor fuel receipts are the largest single highway revenue source. Fuel tax rates per gallon vary from zero, in some cases for special fuels, to 17¢ per gallon. Figures B-1 through B-3 contain information on the various State practices with regard to motor fuels. Table B-1 is data for 1983, B-2 and B-3 are for 1982.

As highway funding needs have outpaced revenue sources there has been a tendency to rely on increases in motor fuels taxes to provide the needed funds. Figures B-4 through B-6 clearly indicate this trend, for the years 1979-1981. Also apparent in these figures is that States accelerated the pace of adjustments to these rates over the period.

One form of adjustment that is apparent in these Figures is that some States that previously relied on fixed rate taxes chose to adopt variable, ad valorem, type taxes. This feature automatically adjusts for changes in inflation, which was a major cause of the shortage between revenues and highway needs. Figure B-7 lists the States that, as of January, 1984, had variable tax rates as all or part of the basis for fuels taxes. Figure B-8 provides total revenues from motor fuels, by State, for 1982. While the purpose of indexing has been to allow for a painless upward adjustment in user fees, any drop in fuel prices will result in a parallel drop in fuel tax revenues. One remedy for this potential drop is to establish a floor below which the rate cannot fall.

FIGURE B-1

STATE TAX RATES ON MOTOR FUEL - JANUARY 1, 1984

(CENTS PER GALLON)

| STATE | GASOLINE | DIESEL | L.P.G. | GASOHOL | |
|---|---|---|---|---|---|
| | RATE | RATE | RATE | RATE | EXEMPTION |
| ALABAMA | 11 | 12 | (1/) | 2/ 8 | 3 |
| ALASKA | 8 | 8 | 0 | 0 | 8 |
| ARIZONA | 12 | 12 | 12 | 12 | 0 |
| ARKANSAS | 9.5 | 10.5 | 7.5 | 3/ 0 | 9.5 |
| CALIFORNIA | 9 | 9 | 6 | 2/ 9 | 0 |
| COLORADO | 12 | 13 | 13 | 2/ 7 | 5 |
| CONNECTICUT 4/ | 14 | 14 | 14 | 13 | 1 |
| DELAWARE | 11 | 11 | 11 | 11 | 0 |
| DIST. OF COL. 5/ | 14.8 | 14.8 | 14.8 | 14.8 | 0 |
| FLORIDA | 6/ 9.7 | 6/ 9.7 | 6/ 9.7 | 5.7 | 4 |
| GEORGIA | 7.5 | 7.5 | 7.5 | 7.5 | 0 |
| HAWAII | 7/ 8.5 | 8.5 | 6 | 8/ 8.5 | 0 |
| IDAHO | 14.5 | 14.5 | 14.5 | 10.5 | 4 |
| ILLINOIS | 11 | 13.5 | 11 | 11 | 0 |
| INDIANA 5/ | 11.1 | 11.1 | 11.1 | 11.1 | 0 |
| IOWA | 13 | 15.5 | 13 | 10 | 3 |
| KANSAS | 11 | 13 | 10 | 6 | 5 |
| KENTUCKY 5/ 9/ | 10 | 10 | 10 | 2/ 6.5 | 3.5 |
| LOUISIANA | 8 | 8 | 8 | 2/ 0 | 8 |
| MAINE | 14 | 14 | 14 | 14 | 0 |
| MARYLAND | 13.5 | 13.5 | 13.5 | 10.5 | 3 |
| MASSACHUSETTS 5/ | 11 | 11 | 6.6 | 11 | 0 |
| MICHIGAN 5/ | 15 | 15 | 15 | 2/ 11 | 4 |
| MINNESOTA | 17 | 17 | 17 | 15 | 2 |
| MISSISSIPPI | 9 | 10 | 1/ 8 | 9 | 0 |
| MISSOURI | 7 | 7 | 7 | 7 | 0 |
| MONTANA | 15 | 17 | 0 | 8 | 7 |
| NEBRASKA 5/ | 15.4 | 15.4 | 15.4 | 10.5 | 5 |
| NEVADA | 12 | 12 | 12 | 8 | 4 |
| NEW HAMPSHIRE | 14 | 10/ 14 | 14 | 14 | 0 |
| NEW JERSEY | 8 | 8 | 4 | 8 | 0 |
| NEW MEXICO 5/ | 11 | 11 | 11 | 2/ 0 | 11 |
| NEW YORK 4/ | 8 | 10 | 8 | 8 | 0 |
| NORTH CAROLINA | 12 | 12 | 12 | 11/ 11 | 1 |
| NORTH DAKOTA | 13 | 12/ 13 | 13 | 8 | 5 |
| OHIO 5/ | 12 | 12 | 12 | 13/ 8.5 | 3.5 |
| OKLAHOMA | 14/ 6.58 | 6.5 | 6.5 | 14/ 6.58 | 0 |
| OREGON | 9 | 15/ 9 | 15/ 9 | 9 | 0 |
| PENNSYLVANIA 4/ | 12 | 12 | 12 | 12 | 0 |
| RHODE ISLAND 4/ 5/ | 13 | 13 | 13 | 13 | 0 |
| SOUTH CAROLINA | 13 | 13 | 13 | 16/ 13 | 0 |
| SOUTH DAKOTA | 13 | 13 | 11 | 9 | 4 |
| TENNESSEE | 10 | 13 | 10 | 6 | 4 |
| TEXAS | 5 | 6.5 | 1/ 5 | 17/ 0 | 5 |
| UTAH | 11 | 11 | 11 | 18/ 6 | 5 |
| VERMONT | 13 | 14 | 0 | 13 | 0 |
| VIRGINIA 4/ 9/ | 11 | 11 | 11 | 2/ 3 | 8 |
| WASHINGTON | 16 | 16 | 16 | 2/ 14.4 | 1.6 |
| WEST VIRGINIA 19/ | 10.5 | 10.5 | 10.5 | 10.5 | 0 |
| WISCONSIN | 15 | 15 | 15 | 15 | 0 |
| WYOMING | 8 | 20/ 0 | 20/ 0 | 4 | 4 |

Source: Federal Highway Administration. From, as yet, unpublished material but similar to tables in Highway Statistics, Table MF-121T.

## FIGURE B-1 (CONT.)

| STATE | SALES TAX | |
|---|---|---|
| | PERCENT | REMARKS |
| ALABAMA | 4 | APPLIES TO NONHIGHWAY USE OF DIESEL FUEL. |
| ARKANSAS | 3 | APPLIES TO GASOHOL ONLY. |
| CALIFORNIA | 4.75 | APPLIES TO SALES PRICE INCLUDING FEDERAL AND STATE MOTOR-FUEL TAXES. LOCAL GOVERNMENTS ASSESS AN ADDITIONAL 1.25% EXCEPT IN BAY AREA THE RATE IS 1.75%. FROM JANUARY 1, 1983 THROUGH DECEMBER 31, 1987 THERE IS A 5 CENTS PER GALLON GASOHOL TAX EXEMPTION. |
| GEORGIA | 3 | A SECOND MOTOR-FUEL TAX APPLIES TO SALES PRICE INCLUDING FEDERAL MOTOR-FUEL TAX. |
| HAWAII | 4 | APPLIES TO SALES PRICE EXCLUDING FEDERAL AND STATE MOTOR-FUEL TAXES BUT GASOHOL IS EXEMPTED. |
| ILLINOIS | 5 | APPLIES TO SALES PRICE EXCLUDING FEDERAL AND STATE MOTOR-FUEL TAXES. MOST LOCAL GOVERNMENTS ASSESS AN ADDITIONAL 1% TAX. GASOHOL IS TAXED AT 1% FROM JANUARY 1, 1984, THROUGH DECEMBER 31, 1992, AND AT 5% THEREAFTER. |
| INDIANA | 5 | APPLIES TO SALES PRICE EXCLUDING FEDERAL AND STATE MOTOR-FUEL TAXES. GASOHOL IS TAXED AT 2% UNTIL JULY 1, 1984 AND AT 1% THEREAFTER. |
| KANSAS | 3 | STATE SALES TAX AND 1.5% MAXIMUM OF CITY AND COUNTY SALES TAXES ARE PAID ON AVIATION FUEL WHICH IS NOT SUBJECT TO REFUND. |
| MICHIGAN | 4 | APPLIES TO SALES PRICE INCLUDING FEDERAL MOTOR-FUEL TAX EXCEPT FOR THOSE WHO HAVE A SALES TAX EXEMPTION CERTIFICATE. |
| MISSISSIPPI | 5 | APPLIES TO SALES PRICE INCLUDING FEDERAL AND STATE MOTOR-FUEL TAXES. |
| NEW YORK | 4 | APPLIES TO SALES PRICE INCLUDING FEDERAL MOTOR-FUEL TAX. LOCAL GOVERNMENTS ASSESS ADDITIONAL TAX VARYING FROM 1% TO 4%. |
| TENNESSEE | 0.033 | APPLIES TO RETAIL SALES OF GASOLINE, DIESEL FUEL, AND MOTOR OILS. IN ADDITION, WHOLESALE SALES OF GASOLINE AND DIESEL FUEL ARE SUBJECT TO TAX AT 0.0166%. |
| VIRGINIA | 2 | APPLIES TO RETAIL SALES WITHIN A COUNTY OR CITY WHICH IS A MEMBER OF ANY TRANSPORTATION DISTRICT IN WHICH A HEAVY RAIL COMMUTER MASS TRANSPORTATION SYSTEM OR A BUS COMMUTER MASS TRANSPORTATION SYSTEM IS OWNED AND OPERATED BY A TRANSPORTATION AGENCY. |
| WEST VIRGINIA | 5 | APPLIES TO THE AVERAGE WHOLESALE PRICE AS DETERMINED ANNUALLY BY THE TAX COMMISSIONER. HOWEVER THE PRICE CANNOT BE SET AT LESS THAN 97 CENTS PER GALLON. |

1/ OWNERS OF VEHICLES REGISTERED IN THE STATE PAY AN ANNUAL DECAL FEE IN LIEU OF A GALLONAGE TAX.

2/ EXEMPTION FROM STATE MOTOR-FUEL TAX PROVIDED ALCOHOL WAS MADE IN THE STATE FROM AGRICULTURAL COMMODITIES PRODUCED WITHIN THE STATE. IN VIRGINIA, ALCOHOL MUST ALSO BE DISTILLED IN A PLANT THAT DOES NOT USE NATURAL GAS OR A PETROLEUM BASED PRODUCT AS A PRIMARY FUEL. IN MICHIGAN, IN ADDITION TO THE ABOVE PROVISION, THE GASOHOL TAX RATE IS 14 CENTS PER GALLON IF ALCOHOL IS NOT PRODUCED WITHIN THE STATE OR IN A STATE WHICH PROVIDES AN EQUIVALENT TAX REDUCTION FOR GASOHOL CONTAINING ALCOHOL PRODUCED IN MICHIGAN.

3/ EXCISE TAX ON ALCOHOL FUELS (ETHANOL OR METHANOL) CONTAINING NOT MORE THAN 15% GASOLINE OR DIESEL FUEL IS ONE-HALF THE RATE OF THE USE FUEL TAX FROM JANUARY 1, 1982 UNTIL JANUARY 1, 1989.

4/ A "GROSS RECEIPTS TAX" IS ASSESSED IN CONNECTICUT (2%), NEW YORK (2%), RHODE ISLAND (1%), VIRGINIA (3%), AND PENNSYLVANIA (6%).

5/ "VARIABLE TAX." RATES ARE DETERMINED AT VARIOUS TIMES OF THE YEAR.

6/ RATE CONSISTS OF A FIXED RATE OF 4 CENTS PER GALLON PLUS A 5 PERCENT SALES TAX APPLIED TO THE AVERAGE RETAIL PRICE OF MOTOR FUEL ESTABLISHED ANNUALLY BUT PRESENTLY $1.148 PER GALLON.

7/ COUNTY TAX OF 4 TO 6.5 CENTS PER GALLON IS ALSO ADDED.

8/ COUNTY TAX OF 3.5 CENTS PER GALLON IS ALSO ADDED BUT EXEMPTED FROM SALES TAX.

9/ A 2% SURTAX IS IMPOSED ON FUEL PURCHASED FOR ANY VEHICLE WITH 3 OR MORE AXLES IN KENTUCKY AND A 2 CENTS PER GALLON SURTAX IS IMPOSED ON FUEL PURCHASED FOR ANY INTERSTATE PROPERTY VEHICLE WITH 3 OR MORE AXLES IN VIRGINIA.

10/ IN NEW HAMPSHIRE A $10.00 DECAL IS REQUIRED FOR ALL DIESEL VEHICLES.

11/ RATE APPLIES JULY 1, 1983 THROUGH JUNE 30, 1984. FROM JULY 1, 1984 THROUGH JUNE 30, 1985, TAX WILL BE 12 CENTS PER GALLON. GASOHOL CONTAINING ETHANOL PRODUCED FROM AGRICULTURAL OR FORESTRY WASTE PRODUCTS OR BY-PRODUCTS IS TAXABLE AT THE RATE OF 7 CENTS PER GALLON FROM OCTOBER 1, 1983 THROUGH JUNE 30, 1985. FROM JULY 1, 1985 THROUGH JUNE 30, 1992, THE TAX ON ALL GASOHOL WILL BE 7 CENTS PER GALLON.

12/ DIESEL FUEL BLENDED WITH RECOVERED OIL OR AGRICULTURALLY DERIVED ALCOHOL IS TAXED AT 9 CENTS PER GALLON.

13/ A DEALER IS REFUNDED 35 CENTS PER GALLON FOR EACH QUALIFIED FUEL (ETHANOL AND METHANOL) THAT IS BLENDED WITH UNLEADED GASOLINE.

14/ INCLUDES INSPECTION FEE OF 0.08 CENT PER GALLON.

15/ TAX IS PAID BY USERS FOR VEHICLES NOT UNDER THE JURISDICTION OF PUBLIC UTILITIES COMMISSION. VEHICLES UNDER JURISDICTION OF PUBLIC UTILITIES COMMISSION AND PAYING MOTOR-CARRIER FEES ARE EXEMPT FROM PAYMENT OF THESE TAXES.

16/ GASOHOL TAX WAS ESTABLISHED AT 6 CENTS PER GALLON UNTIL JUNE 30, 1985 UNLESS A $5 MILLION CEILING ON ASSOCIATED REVENUES WAS REACHED. THE CEILING WAS REACHED PRIOR TO JANUARY 1, 1983.

17/ EFFECTIVE JULY 1, 1983, GASOHOL EXEMPTION IS A VARIABLE RATE WITH MAXIMUM OF 5 CENTS PER GALLON. THE VARIABLE RATE IS SET QUARTERLY TO LIMIT THE TOTAL YEARLY EXEMPTION TO $10,850,000.

18/ REDUCED RATE DOES NOT TAKE EFFECT UNTIL STATE CERTIFIES THAT THERE IS A PLANT IN UTAH PRODUCING AT LEAST ONE MILLION GALLONS OF METHANOL PER YEAR FOR COMMERCIAL USE (ALSO APPLIES TO ETHANOL).

19/ IN ADDITION TO THE 10.5 CENTS PER GALLON MOTOR FUEL TAX, THERE IS A CONSUMER SALES AND SERVICE TAX OF 4.85 CENTS PER GALLON.

20/ A FEE OF 1.1 MILLS PER TON-MILE IS LEVIED IN LIEU OF GALLONAGE TAX ON DIESEL FUEL AND L.P.G.

# FIGURE B-2
# STATE TAXATION OF GASOLINE

BASED ON INFORMATION OBTAINED FROM STATE AUTHORITIES AND ON THE LAWS OF THE STATES

TABLE MF-101
SHEET 1 OF 2
STATUS AS OF JANUARY 1, 1982

| STATE | TAX RATE (CENTS PER GALLON) (1) | TAX PAID IN FIRST INSTANCE BY- (2) | TAX COMPUTED ON BASIS OF- (3) | DATE TAX DUE 1/ (4) | TAX COLLECTED AND ADMINISTERED BY- (5) |
|---|---|---|---|---|---|
| ALABAMA | 2/ 11 | DISTRIBUTORS, REFINERS, RETAILERS, OR STORERS | QUANTITIES SOLD | 20TH | DEPARTMENT OF REVENUE |
| ALASKA | 2/ 8 | DEALERS AND USERS | QUANTITIES SOLD AND USED | LAST | DEPARTMENT OF REVENUE |
| ARIZONA | 9.6 | IMPORTERS | QUANTITIES IMPORTED | 25TH | DEPARTMENT OF TRANSPORTATION, MOTOR VEHICLE DIVISION |
| ARKANSAS | 3/ 9.5 | WHOLESALE DISTRIBUTORS (FIRST RECEIVERS) | INSHIPMENTS OR RECEIPTS | 25TH | DEPARTMENT OF FINANCE AND ADMINISTRATION, MOTOR FUEL TAX SECTION |
| CALIFORNIA | 7 | DISTRIBUTORS (MANUFACTURERS AND IMPORTERS) | QUANTITIES DISTRIBUTED | 1ST (OF 2ND MONTH) | STATE BOARD OF EQUALIZATION ASSESSES AND STATE CONTROLLER COLLECTS |
| COLORADO | 9 | DISTRIBUTORS AND REFINERS | REFINERY INVOICE GALLONAGE | 25TH | DEPARTMENT OF REVENUE, MOTOR FUEL TAX DIVISION |
| CONNECTICUT | 11 | LICENSED DISTRIBUTORS | QUANTITIES SOLD AND USED | 25TH | DEPARTMENT OF REVENUE SERVICES, COMMODITIES TAX CONTROL |
| DELAWARE | 11 | WHOLESALE DISTRIBUTORS | QUANTITIES SOLD AND USED 4/ | 25TH | DEPARTMENT OF PUBLIC SAFETY, MOTOR FUEL TAX DIVISION |
| DIST. OF COL. | 5/ 13 | LICENSED IMPORTERS | QUANTITIES SOLD AND USED | 25TH | DEPARTMENT OF FINANCE AND REVENUE |
| FLORIDA | 8 | LICENSED DISTRIBUTORS | FIRST SALE AND TRANSFER IN STATE | 20TH | DEPARTMENT OF REVENUE |
| GEORGIA | 6/ 7.5 | LICENSED DISTRIBUTORS (WHOLESALERS, RETAILERS) | QUANTITIES DISTRIBUTED AND USED | 20TH | DEPARTMENT OF REVENUE, MOTOR FUEL TAX DIVISION |
| HAWAII | 2/ 8.5 | MANUFACTURERS, PRODUCERS, REFINERS, IMPORTERS, AND DISTRIBUTORS | QUANTITIES MANUFACTURED, PRODUCED, REFINED, IMPORTED AND SOLD OR USED | LAST | DEPARTMENT OF TAXATION |
| IDAHO | 2/ 11.5 | LICENSED DISTRIBUTORS | QUANTITIES RECEIVED | LAST | TAX COMMISSION, MOTOR FUELS DIVISION |
| ILLINOIS | 7.5 | LICENSED DISTRIBUTORS | QUANTITIES SOLD AND USED | LAST | DEPARTMENT OF REVENUE |
| INDIANA | 5/ 10.5 | LICENSED DISTRIBUTORS | QUANTITIES RECEIVED | 20TH | DEPARTMENT OF STATE REVENUE, MOTOR FUEL TAX DIVISION |
| IOWA | 13 | LICENSED DISTRIBUTORS | QUANTITIES RECEIVED AS SHOWN BY BILL OF LADING OR MANIFEST | LAST | DEPARTMENT OF REVENUE, EXCISE TAX DIVISION |
| KANSAS | 8 | WHOLESALE DISTRIBUTORS | QUANTITIES RECEIVED OR IMPORTED | 25TH | DEPARTMENT OF REVENUE, SALES AND EXCISE TAX BUREAU |
| KENTUCKY | 5/ 7/ 10.1 | WHOLESALERS AND REFINERS | QUANTITIES RECEIVED AND WITHDRAWN FROM STORAGE TERMINALS | 25TH | DEPARTMENT OF REVENUE, SELECTIVE EXCISE TAX SECTION |
| LOUISIANA | 8 | MANUFACTURERS, REFINERS, AND IMPORTERS | QUANTITIES SOLD AND USED | 20TH | DEPARTMENT OF REVENUE, PETROLEUM PRODUCTS TAX DIVISION |
| MAINE | 9 | WHOLESALE DISTRIBUTORS | QUANTITIES SOLD AND USED | LAST | BUREAU OF TAXATION, EXCISE TAX DIVISION |
| MARYLAND | 9 | FIRST PERSON IN STATE WHO HANDLES FUEL | QUANTITIES SOLD AND USED | LAST | COMPTROLLER, GASOLINE TAX DIVISION |
| MASSACHUSETTS | 5/ 11.2 | DISTRIBUTORS | QUANTITIES SOLD AND USED | 8/ LAST | DEPARTMENT OF REVENUE |
| MICHIGAN | 2/ 11 | WHOLESALE DISTRIBUTORS | QUANTITIES RECEIVED | 20TH | DEPARTMENT OF TREASURY, MOTOR FUEL TAX DIVISION |
| MINNESOTA | 13 | LICENSED DISTRIBUTORS | INSHIPMENTS | 23RD | DEPARTMENT OF REVENUE, PETROLEUM DIVISION |
| MISSISSIPPI | 9 | WHOLESALE DISTRIBUTORS AND PRODUCERS | QUANTITIES RECEIVED | 20TH | STATE TAX COMMISSION |
| MISSOURI | 7 | DISTRIBUTORS | QUANTITIES RECEIVED | LAST | DEPARTMENT OF REVENUE, BUSINESS TAX BUREAU |

Source: Highway Taxes and Fees: How They Are Collected and Distributed. US DOT/FHWA, 1982.

# FIGURE B-2 (CONT.)
# STATE TAXATION OF GASOLINE

BASED ON INFORMATION OBTAINED FROM STATE AUTHORITIES AND ON THE LAWS OF THE STATES

TABLE MF-101
SHEET 2 OF 2
STATUS AS OF JANUARY 1, 1982

| STATE | | TAX RATE (CENTS PER GALLON) (1) | TAX PAID IN FIRST INSTANCE BY- (2) | TAX COMPUTED ON BASIS OF- (3) | DATE TAX DUE 1/ (4) | TAX COLLECTED AND ADMINISTERED BY- (5) |
|---|---|---|---|---|---|---|
| MONTANA | 2/ | 9 | MANUFACTURERS AND IMPORTERS | IMPORTS PLUS REFINERY DISTRIBUTION | 25TH | DEPARTMENT OF REVENUE, MOTOR FUELS TAX DIVISION |
| NEBRASKA | 2/ 5/ | 13.9 | IMPORTERS, PRODUCERS, AND REFINERS | QUANTITIES IMPORTED OR PRODUCED | 20TH | DEPARTMENT OF REVENUE |
| NEVADA | | 10.5 | LICENSED DEALERS (DISTRIBUTORS) | QUANTITIES DISTRIBUTED | 25TH | DEPARTMENT OF TAXATION, REVENUE DIVISION |
| NEW HAMPSHIRE | | 14 | IMPORTERS, PRODUCERS, OR REFINERS | SALES | LAST | DEPARTMENT OF SAFETY, ROAD TOLL ADMINISTRATION |
| NEW JERSEY | | 8 | IMPORTERS, PRODUCERS, OR REFINERS | QUANTITIES SOLD OR USED | (8/) | DEPARTMENT OF THE TREASURY, DIVISION OF TAXATION |
| NEW MEXICO | 5/ | 9 | DISTRIBUTORS | IMPORTS PLUS PRODUCTION | 25TH | BUREAU OF TAXATION AND REVENUE, RETURNS PROCESSING DIVISION |
| NEW YORK | | 8 | DISTRIBUTORS | QUANTITIES SOLD AND USED | (8/) | DEPARTMENT OF TAXATION AND FINANCE PROCESSING DIVISION |
| NORTH CAROLINA | | 12 | FIRST PERSON IN STATE WHO SELLS OR USES FUEL (DISTRIBUTOR) | RECEIPTS OR SALES; DISTRIBUTOR'S OPTION | 20TH | SECRETARY OF REVENUE, GASOLINE TAX UNIT |
| NORTH DAKOTA | | 8 | WHOLESALE DISTRIBUTORS | QUANTITIES SOLD AND USED | 25TH | TAX COMMISSIONER, GASOLINE TAX DIVISION |
| OHIO | 5/ | 10.3 | DISTRIBURORS | RECEIPTS | LAST | TREASURER AND TAX COMMISSIONER |
| OKLAHOMA | | 6.58 | DISTRIBUTORS, MANUFACTURERS, AND REFINERS | QUANTITIES IMPORTED OR SOLD AND USED | 20TH | TAX COMMISSION, MOTOR FUEL DIVISION |
| OREGON | 2/ | 8 | WHOLESALE DISTRIBUTORS | QUANTITIES SOLD AND USED | 25TH | DEPARTMENT OF TRANSPORTATION, MOTOR VEHICLE DIVISION |
| PENNSYLVANIA | 2/ 5/ | 11 | REGISTERED DISTRIBUTORS | QUANTITIES USED, OR SOLD AND DELIVERED | (8/) | DEPARTMENT OF REVENUE |
| RHODE ISLAND | 5/ | 12 | DISTRIBUTORS | QUANTITIES SOLD AND USED | 25TH | DEPARTMENT OF ADMINISTRATION, DIVISION OF TAXATION |
| SOUTH CAROLINA | | 13 | WHOLESALE DISTRIBUTORS | QUANTITIES SOLD AND USED | 20TH | TAX COMMISSION |
| SOUTH DAKOTA | 2/ | 13 | IMPORTERS AND DISTRIBUTORS | INSHIPMENTS | LAST | DEPARTMENT OF REVENUE, MOTOR FUEL TAX DIVISION |
| TENNESSEE | | 9 | WHOLESALE DISTRIBUTORS | QUANTITIES RECEIVED AND STORED | 20TH | DEPARTMENT OF REVENUE, ACCOUNTING DIVISION, PETROLEUM TAX DIVISION, GASOLINE TAX SECTION |
| TEXAS | | 5 | PERSON MAKING FIRST SALE OR USE IN STATE | QUANTITIES SOLD OR USED | 25TH | COMPTROLLER OF PUBLIC ACCOUNTS, FUELS TAX DIVISION |
| UTAH | 2/ | 11 | DISTRIBUTORS | QUANTITIES DISTRIBUTED | 25TH | TAX COMMISSION |
| VERMONT | | 11 | LICENSED DISTRIBUTORS | RECEIPTS OR SALES | LAST | DEPARTMENT OF TAXES, SALES AND USE TAX DIVISION, MOTOR FUEL TAX SECTION |
| VIRGINIA | 2/ 7/ | 11 | IMPORTERS, PRODUCERS, REFINERS AND SOME DEALERS | QUANTITIES SOLD OR USED | (8/) | DIVISION OF MOTOR VEHICLES, FUELS TAX DEPARTMENT |
| WASHINGTON | 2/ 5/ | 13.5 | DISTRIBUTORS | QUANTITIES SOLD AND USED | 25TH | DEPARTMENT OF LICENSING, PRORATE AND FUEL TAX DIVISION |
| WEST VIRGINIA | | 10.5 | DISTRIBUTORS | ACTUAL METERED GALLONS SOLD | LAST | DIVISION OF EXCISE AND LICENSE TAXES |
| WISCONSIN | | 13 | LICENSED WHOLESALERS | QUANTITIES RECEIVED | 20TH | DEPARTMENT OF REVENUE |
| WYOMING | 2/ | 8 | WHOLESALERS PAY TAX ON FUEL SOLD DIRECTLY TO RETAILERS. | QUANTITIES SOLD AND USED | LAST | DEPARTMENT OF REVENUE AND TAXATION. REFUNDS ADMINISTERED BY TREASURER'S OFFICE. |
| PUERTO RICO | 2/ | 16 | WHOLESALE DISTRIBUTORS | QUANTITIES RECEIVED | (8/) | DEPARTMENT OF TREASURY, BUREAU OF EXCISE TAXES |

1/ DATE TAX IS DUE IN MONTH FOLLOWING MONTH OF RECEIPT OR SALE OF GASOLINE. SEE TABLE MF-121 FOR INFORMATION ON STATES WHICH HAVE "VARIABLE TAX RATES", GASOHOL RATE AND SALES TAX.

2/ GASOLINE USED IN AIRCRAFT IS TAXED AT THE FOLLOWING RATES PER GALLON: ALABAMA, 2.7 CENTS; ALASKA, NEW HAMPSHIRE, SOUTH DAKOTA, UTAH, VIRGINIA AND WYOMING, 6 CENTS; HAWAII AND MONTANA 1 CENT; IDAHO, 3.5 CENTS; MICHIGAN AND OREGON, 3 CENTS; NEBRASKA AND PUERTO RICO, 5 CENTS; PENNSYLVANIA, 1.5 CENTS; WASHINGTON, 2 CENTS. MARINE USE IS TAXED AT 5 CENTS PER GALLON IN ALASKA.

3/ IN BORDER CITIES AND TOWNS OR IN ESTABLISHMENTS WITHIN 800 FEET (ONE MILE FOR ESTABLISHMENTS ADJACENT TO THE INTERSTATE SYSTEM) OF THE BORDERS OF LOUISIANA, MISSOURI, OKLAHOMA AND TEXAS, GASOLINE SOLD AND DELIVERED TO PASSENGER CAR FUEL TANKS IS TAXED AT THE RATES OF THOSE ADJOINING STATES PLUS 1 CENT.

4/ FOR DISTRIBUTORS HAVING AVERAGE TAXABLE SALES AND/OR USE OF 500,000 GALLONS OR MORE PER MONTH, THE TAX IS PREPAID ON 75 PERCENT OF JUNE'S ESTIMATED GALLONAGE EACH YEAR.

5/ VARIABLE TAX RATE. RATE SHOWN IS AS OF OCTOBER 1, 1981. SEE TABLE MF-121 FOR BASIS OF TAX.

6/ THERE IS ALSO LEVIED A 3 PERCENT TAX ON THE RETAIL PRICE OF GASOLINE EXCLUDING THE STATE MOTOR FUEL TAX OF 7.5 CENTS. THE TAX IS LEVIED WHEN SOLD TO THE CONSUMER.

7/ TRUCKS OR COMBINATIONS WITH MORE THAN TWO AXLES PAY AN 11-CENT TAX IN KENTUCKY AND VIRGINIA.

8/ IN MASSACHUSETTS, THE MAY TAX IS DUE JUNE 20; IN NEW JERSEY, THE TAX IS DUE ON THE NEXT TO THE LAST BUSINESS DAY; IN NEW YORK, THE TAX IS DUE ON THE 27TH, EXCEPT THE FEBRUARY REPORT IS DUE ON MARCH 20; IN PENNSYLVANIA, THE TAX IS DUE ON THE NEXT TO THE LAST BUSINESS DAY; IN SOUTH DAKOTA, AS OF 1-1-82 REPORT AND TAX WILL BE DUE AT THE END OF EACH MONTH; IN VIRGINIA, THE TAX MUST BE RECEIVED ON THE FIFTH DAY, OR THE NEXT DIVISION BUSINESS DAY IF THE FIFTH IS NOT A WORKING DAY, OF THE SECOND MONTH; IN PUERTO RICO, THE TAX IS DUE 15 DAYS AFTER RECEIPT, EXCEPT WHEN THE REFINERY IS ALSO THE WHOLESALE DISTRIBUTOR, WHEN PAYMENT IS MADE BY THE 10TH OF THE MONTH FOLLOWING RECEIPT.

# FIGURE B-3

# STATE TAXATION OF SPECIAL FUELS

BASED ON INFORMATION OBTAINED FROM STATE AUTHORITIES AND ON THE LAWS OF THE STATES

TABLE MF-102
SHEET 1 OF 3
STATUS AS OF JANUARY 1, 1982

| STATE | TAX RATE (CENTS PER GALLON) 2/ | TAX PAID IN FIRST INSTANCE BY- +TAX APPLIES TO HIGHWAY USE ONLY | DATE TAX DUE 3/ | TAX COLLECTED AND ADMINISTERED BY- | REMARKS 4/ |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| ALABAMA | 5/ 12 | + WHOLESALERS (DISTRIBUTORS) OR LICENSED USERS | 20TH | COMMISSIONER OF REVENUE - MONTGOMERY | RETAILER, IF NOT LICENSED AS A DISTRIBUTOR MUST BUY TAX-PAID FUEL. TRANSIT USE IS TAXED. |
| ALASKA | 5/ 8 & 0 | DEALERS AND USERS | LAST | DEPARTMENT OF REVENUE - JUNEAU | RETAILER COLLECTS THE TAX IN THE FIRST INSTANCE WHEN HEATING FUEL IS SOLD AS MOTOR FUEL. TRANSIT USE IS TAXED. |
| ARIZONA | 9.6 | USERS AND VENDORS | 25TH | DIVISION OF MOTOR VEHICLES, TAX REVENUE SECTION - PHOENIX | VENDOR COLLECTS TAX WHEN FUEL GOES INTO A HIGHWAY-VEHICLE TANK. TRANSIT USE IS TAXED. |
| ARKANSAS | 10.5 & 7.5 | DIESEL SUPPLIERS (WHOLESALERS OR DISTRIBUTORS) AND L.P.G. USERS | 25TH | DEPARTMENT OF FINANCE AND ADMINISTRATION, MOTOR FUEL TAX SECTION - LITTLE ROCK | BONDS REQUIRED: LICENSED SUPPLIER, FUEL BOND; INTERSTATE USER, FUEL-USER BOND; RETAILER HANDLING STATE INVOICES, PERFORMANCE BOND. FLAT-FEE LICENSE IS REQUIRED OF DOMESTIC L.P.G. USER, IN LIEU OF GALLONAGE TAX. RETAIL BUYER PURCHASES TAX-PAID FUEL. FUEL USED IN CITY BUSES IS REFUNDABLE. |
| CALIFORNIA | 5/ 7 & 6 | + RETAILERS OR USERS | LAST | BOARD OF EQUALIZATION, DEPARTMENT OF BUSINESS TAXES SACRAMENTO | USER BUYS TAX-PAID FUEL WHEN DELIVERED INTO VEHICLE TANK, AND TAX-FREE FUEL WHEN DELIVERED INTO BULK STORAGE TANK. USER IS GIVEN CREDIT IN TAX RETURN FOR TAX PAID TO RETAILER. IN LIEU OF A GALLONAGE TAX ANNUAL FEES ARE LEVIED ON L.P.G. VEHICLES. TRANSIT USE IS EXEMPT FROM 6 CENTS OF THE 7 CENT TAX. |
| COLORADO | 9 | + USERS | 25TH | DEPARTMENT OF REVENUE, MILEAGE AND FUEL TAX SECTION - DENVER | TRANSIT USE IS TAXED. |
| CONNECTICUT | 11 | + RETAILERS OR USERS | 20TH | DEPARTMENT OF REVENUE SERVICES, COMMODITIES TAX CONTROL - HARTFORD | USER CAN PAY THE TAX DIRECTLY, OR TO A LICENSED SELLER WHO PAYS THE TAX TO THE STATE. TRANSIT USE IS SUBJECT TO REFUND OF FIFTY-PERCENT OF TAX PAID. |
| DELAWARE | 11 | + RETAILERS OR USERS | 25TH | DEPARTMENT OF PUBLIC SAFETY, MOTOR FUEL TAX DIVISION - DOVER | RETAILER BECOMES LIABLE FOR THE TAX WHEN FUEL IS PLACED IN SUPPLY TANK OF USER'S VEHICLE. USER WHO ACQUIRES TAX-FREE FUEL BECOMES LIABLE FOR THE TAX WHEN FUEL IS PLACED IN SUPPLY TANK OF HIS VEHICLE. TRANSIT USE IS TAXED. |
| DIST. OF COL. | 6/ 13 | LICENSED IMPORTERS | 25TH | DEPARTMENT OF FINANCE AND REVENUE - WASHINGTON | TRANSIT USE IS EXEMPT. |
| FLORIDA | 8 | LICENSED DEALERS | 20TH | DEPARTMENT OF REVENUE - TALLAHASSEE | USER CAN BUY TAX-PAID FUEL FROM A LICENSED DEALER, OR OBTAIN A NON-EXPIRING DEALER LICENSE. TRANSIT USE IS TAXED. |
| GEORGIA | 7/ 7.5 | LICENSED DISTRIBUTORS (WHOLESALERS, RETAILERS) AND LICENSED USERS | 20TH | DEPARTMENT OF REVENUE, MOTOR FUEL TAX DIVISION - ATLANTA | USER BUYS TAX-PAID FUEL; BUT SOME USERS MAY BECOME LICENSED DISTRIBUTORS AND PAY THE TAX DIRECTLY TO THE STATE. USER LICENSED AS DISTRIBUTOR CAN OBTAIN EXEMPTION OR REFUND FOR NONHIGHWAY USE. |
| HAWAII | 8.5 & 6 | DISTRIBUTORS | LAST | DEPARTMENT OF TAXATION - HONOLULU | TRANSIT USE IS TAXED. |
| IDAHO | 11.5 | RETAILERS OR LICENSED USERS, INCLUDING TRUCKS | 8/ 25TH | DEPARTMENT OF LAW ENFORCEMENT AND TAX COMMISSION - BOISE | USER FEES ARE PAID ON WEIGHT AND DISTANCE TRAVELED IN LIEU OF GALLONAGE TAX FOR TRUCKS OVER 16,000 POUNDS GROSS WEIGHT. INTENT IS TO PRODUCE THE EQUIVALENT OF 11.5 CENTS PER GALLON. TRANSIT USE IS TAXED. |
| ILLINOIS | 7.5 | LICENSED DISTRIBUTORS, SPECIAL-FUELS SUPPLIERS OR BULK USERS OF SPECIAL FUELS | LAST | DEPARTMENT OF REVENUE - SPRINGFIELD | MOST NONHIGHWAY USE IS EXEMPT. TRANSIT USE IS EXEMPT. |
| INDIANA | 6/ 10.5 | + LICENSED DEALERS, AND LICENSED USER | 15TH | DEPARTMENT OF REVENUE, MOTOR FUEL TAX DIVISION - INDIANAPOLIS | SPECIAL FUEL DEALER COLLECTS TAX WHEN FUEL IS PLACED IN VEHICLE TANK. FUEL IS DELIVERED TAX-FREE TO USER WITH STORAGE TANK AND USER PAYS TAX MONTHLY ON GALLONS USED IN VEHICLES. DEALER CAN COLLECT TAX ON FUEL DELIVERED INTO BULK STORAGE UPON ANNUAL WRITTEN AGREEMENT WITH USER AND MOTOR FUEL TAX DIVISION. LOCAL TRANSIT USE IS EXEMPT. |
| IOWA | 13.5 & 13 | + RETAIL DEALERS OR LICENSED USERS | LAST | DEPARTMENT OF REVENUE - DES MOINES | WHEN FUEL IS SOLD IN BULK FOR HIGHWAY USE, THE SELLER MUST BE LICENSED AS A DISTRIBUTOR AND THE BUYER MUST BE LICENSED AS A TAX-FREE DEALER OR USER. TAX-PAID LICENSES ARE ISSUED AT THE DISCRETION OF THE DEPARTMENT OF REVENUE. NO LICENSE NEEDED WHEN FUEL IS SOLD FOR NONHIGHWAY USE. USE IN URBAN TRANSIT BUSES IS EXEMPT. NO LICENSES REQUIRED BY USER IF DELIVERY MADE TAX PAID INTO A MOTOR VEHICLE SPECIAL FUEL HOLDING TANK. |
| KANSAS | 10 & 7 | + "USER-DEALERS" | 25TH | DEPARTMENT OF REVENUE, SALES AND EXCISE TAX BUREAU - TOPEKA | USER-DEALER PAYS TAX ON FUEL PLACED IN SUPPLY TANK OF VEHICLE. WHEN FUEL IS SOLD IN BULK FOR HIGHWAY USE, THE SELLER MUST BE A LICENSED DISTRIBUTOR AND THE BUYER MUST BE A LICENSED DEALER OR USER. TAX-PAID LICENSES ARE ISSUED AT THE DISCRETION OF THE DIRECTOR. NO LICENSE NEEDED WHEN FUEL IS SOLD FOR NONHIGHWAY USE. L.P.G. USER MAY PAY TAX BASED ON SCHEDULE OF NUMBER OF MILES PER GALLON OR FARM L.P.G. USER MAY PAY IN ADVANCE ON 1,200 GALLONS PER VEHICLE, 100 GALLONS PER MONTH. TRANSIT USE IS TAXED. |
| KENTUCKY | 6/ 10.1 | + LICENSED SPECIAL-FUELS DEALERS (IMPORTERS, WHOLESALERS) | 25TH | DEPARTMENT OF REVENUE, SELECTIVE EXCISE TAX SECTION - FRANKFORT | USE IN TRUCKS OR COMBINATIONS OF MORE THAN TWO AXLES IS SUBJECT TO A 2 PERCENT SURTAX. CITY TRANSIT OPERATED WITHIN KENTUCKY IS EXEMPT. |
| LOUISIANA | 8 | + SUPPLIERS (WHOLESALERS) | 20TH | DEPARTMENT OF REVENUE, PETROLEUM PRODUCTS TAX DIVISION - BATON ROUGE | USER OR DEALER PAYS TAX TO SUPPLIER. TRANSIT USE IS TAXED. |
| MAINE | 9 | + RETAILERS OR USERS | 8/ LAST | BUREAU OF TAXATION, EXCISE TAX DIVISION - AUGUSTA | LICENSED DEALER COLLECTS TAX ON FUEL DELIVERED INTO VEHICLE FUEL TANK FOR HIGHWAY USE. LICENSED USER PAYS TAX ON ALL FUEL USED ON PUBLIC HIGHWAYS; CREDIT IS ALLOWED FOR FUEL PURCHASED TAX-PAID FROM LICENSED DEALER. CERTIFIED TRANSIT USE IS REFUNDABLE. |
| MARYLAND | 5/ 9 | RETAILERS OR LICENSED AND BONDED USERS | LAST | COMPTROLLER, GASOLINE TAX DIVISION - ANNAPOLIS | FLEET OPERATORS, IF LICENSED AND BONDED AS DIESEL USERS, CAN FUEL TRUCKS FROM OWN STORAGE TANKS AND PAY TAX. L.P.G. USERS WITH BULK FUEL REGISTER AS BONDED USERS. ALL OTHERS BUY TAX-PAID FUEL. USE BY MASS TRANSIT ADMINISTRATION BUSES AND CERTAIN MUNICIPAL BUS COMPANIES IS EXEMPTED. |
| MASSACHUSETTS | 6/ 11.2 | LICENSED SPECIAL-FUELS SUPPLIERS | (8/) | DEPARTMENT OF REVENUE | SUPPLIERS MAY SELL TAX-FREE IF FUEL IS SOLD IN CONTAINER TO OTHER USER-SELLERS AND NOT DIRECTLY INTO REGISTERED VEHICLE TANK. TRANSIT USE IS TAXED, BUT REFUNDED FROM GENERAL FUND. |

Source: Highway Taxes and Fees.

# FIGURE B-3 (CONT.)
# STATE TAXATION OF SPECIAL FUELS

BASED ON INFORMATION OBTAINED FROM STATE AUTHORITIES AND ON THE LAWS OF THE STATES

TABLE MF-102
SHEET 2 OF 3
STATUS AS OF JANUARY 1, 1982

| STATE | TAX RATE (CENTS PER GALLON) 2/ | TAX PAID IN FIRST INSTANCE BY: *TAX APPLIES TO HIGHWAY USE ONLY | DATE TAX DUE 3/ | TAX COLLECTED AND ADMINISTERED BY | REMARKS 4/ |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| MICHIGAN | 5/ 11 & 9 | * LICENSED DEALERS | 20TH | DEPARTMENT OF TREASURY, MOTOR FUEL TAX DIVISION LANSING | DIESEL TAX IS COLLECTED WHEN FUEL IS DELIVERED INTO HIGHWAY VEHICLE TANK, OR FOR PRIVATE MARINE USE. PERSONS SERVICING THEIR OWN VEHICLES ARE CLASSIFIED AS "DEALERS-USERS", AND ARE LIABLE FOR TAX ON DIESEL FUEL OBTAINED TAX FREE. THE L.P.G. TAX IS COLLECTED BY A "LICENSED DEALER" (ANY PERSON WHO SELLS OR DELIVERS L.P.G. FOR HIGHWAY USE). DIESEL FUEL, USED IN TRANSIT VEHICLES WITH A CAPACITY OF 10 OR MORE PERSONS, IS ALLOWED AN 11 CENT REFUND. THERE IS A 6 CENTS PER GALLON DISCOUNT IF DIESEL MOTOR FUEL IS DELIVERED INTO THE FUEL SUPPLY TANKS OF COMMERCIAL MOTOR VEHICLE WHICH IS LICENSED AT THE RATE OF $92 FOR A RESIDENT VEHICLE AND $12 FOR A NON-RESIDENT VEHICLE |
| MINNESOTA | 13 | LICENSED DEALERS OR USERS | 23RD | DEPARTMENT OF REVENUE, PETROLEUM DIVISION - ST. PAUL | WHEN LICENSED AS A BULK PURCHASER OF SPECIAL FUEL, USER PAYS TAX TO STATE ON FUEL DELIVERED INTO BULK STORAGE FACILITIES. OTHER USERS PAY TAX TO SELLER WHEN FUEL IS PLACED IN VEHICLE SUPPLY TANK. TRANSIT SYSTEMS OWNED BY CITIES OR TOWNS ARE EXEMPT. |
| MISSISSIPPI | 10 & 8 | WHOLESALERS, RETAILERS (DISTRIBUTORS) | 20TH | STATE TAX COMMISSION - JACKSON | L.P.G. USERS PAY THE FOLLOWING ANNUAL FEES: VEHICLES UNDER 10,000 POUNDS G.V.W., $100; 10,000 - 20,000 POUNDS, $150; OVER 20,000 POUNDS, 8 CENTS PER GALLON ($150 MINIMUM PER YEAR). FARM PICKUP TRUCKS OF 6,000 POUNDS G.V.W. OR LESS CAN BE REFUNDED ANY PORTION OF THE $100 FEE UNUSED AT THE RATE OF 8 CENTS PER GALLON OF ACTUAL USE. TRANSIT USE IS TAXED. DIESEL USERS WHO SERVICE PRIVATE PASSENGER VEHICLES AND LIGHT TRUCKS FROM OWN DUAL PURPOSE STORAGE TANKS ARE REQUIRED TO PAY THE FOLLOWING ANNUAL FEES: PASSENGER VEHICLES - $135.00 PER YEAR, LIGHT TRUCKS NOT EXCEEDING 18,000 LBS - $150.00 PER YEAR |
| MISSOURI | 7 | * RETAILERS (DEALERS) OR USERS | LAST | DEPARTMENT OF REVENUE, BUSINESS TAX BUREAU - JEFFERSON CITY | TRANSIT USE IS TAXED |
| MONTANA | 11 & 0 | WHOLESALERS, RETAILERS, OR USERS | 8/ 25TH | DEPARTMENT OF REVENUE - HELENA | LICENSED DEALERS COLLECT TAX ON FUEL PLACED IN SUPPLY TANKS OF USERS AND REMIT TAX TO THE DEPARTMENT OF REVENUE. USERS BUYING BULK FUEL REMIT TAX DIRECTLY TO THE DEPARTMENT OF REVENUE. TRANSIT USE IS TAXED. IN LIEU OF A GALLONAGE TAX A SPECIAL LICENSE TAX IS LEVIED ON VEHICLES USING L.P.G. |
| NEBRASKA | 6/ 13.9 | * RETAILERS (DEALERS) | 20TH | DEPARTMENT OF REVENUE - LINCOLN | USER WHO BUYS IN WHOLESALE QUANTITIES AND SERVICES HIS OWN EQUIPMENT PAYS TAX DIRECTLY TO STATE. TRANSIT USE IS EXEMPT. |
| NEVADA | 10.5 | LICENSED USERS OR DEALERS (RETAILERS) | 8/ LAST | DEPARTMENT OF MOTOR VEHICLES, MOTOR CARRIER DIVISION - CARSON CITY | RETAILER SELLS TAX-FREE FUEL TO LICENSED USER AND COLLECTS TAX FROM UNLICENSED USER. TRANSIT USE IS TAXED |
| NEW HAMPSHIRE | 14 | * USERS | 8/ LAST | DEPARTMENT OF SAFETY, ROAD TOLL ADMINISTRATION - CONCORD | TRANSIT USE IS TAXED. |
| NEW JERSEY | 8 & 4 | * SELLERS | 15TH | DEPARTMENT OF THE TREASURY, DIVISION OF TAXATION - TRENTON | TAX IS PAID ON FIRST SALE KNOWINGLY MADE FOR HIGHWAY USE. IF ULTIMATE USE IS UNKNOWN AT TIME OF PURCHASE, USER MAKES PAYMENT TO STATE UNDER SPECIAL LICENSE. TRANSIT USE IS REFUNDABLE |
| NEW MEXICO | 6/ 9 | * USERS | 8/ 25TH | MOTOR TRANSPORTATION DIVISION, OPERATIONS BUREAU - SANTA FE | DEALER COLLECTS AND REMITS TO STATE THE TAX ON FUEL DELIVERED INTO THE SUPPLY TANK OF VEHICLE OWNED OR OPERATED BY AN UNLICENSED USER OR A USER LICENSED AS A "CASH USER". TAX ON VEHICLES WITH A GROSS WEIGHT OF 26,000 POUNDS OR LESS MUST BE PAID AT TIME OF PURCHASE. AN ANNUAL FEE MAY BE PAID INSTEAD OF SPECIAL-FUELS TAX ON L.P.G. VEHICLES OF 26,000 POUNDS OR LESS. TRANSIT USE IS TAXED. |
| NEW YORK | 10 & 8 | RETAILERS OR BULK USERS | 8/ 27TH | DEPARTMENT OF TAXATION AND FINANCE, PROCESSING DIVISION - ALBANY | RETAILER AND USER WHO BUY FUEL TAX FREE AND PAY TAX ON FUEL PLACED IN VEHICLE SUPPLY TANK MUST REGISTER WITH THE DEPARTMENT OF TAXATION AND FINANCE. UNDER CERTAIN CONDITIONS FUEL USED IN OMNIBUSES AND TAXICABS IS SUBJECT TO A REFUND OF THE DIESEL FUEL TAX AT THE RATE OF 3 CENTS PER GALLON. DIESEL FUEL USED IN OMNIBUSES OPERATED IN LOCAL TRANSIT SERVICE AND ALL SCHOOL BUSES OWNED BY NON PUBLIC SCHOOLS IS SUBJECT TO FULL REFUND |
| NORTH CAROLINA | 12 | * LICENSED SUPPLIERS (DISTRIBUTORS) | 25TH | DEPARTMENT OF REVENUE, GASOLINE TAX DIVISION - RALEIGH | LICENSED USER SELLER (BULK USER OR RESELLER WITH BULK STORAGE) AND LICENSED USER WHOSE VEHICLE IS REGISTERED IN STATE BUY TAX PAID FUEL. TRANSIT USE IS TAXED |
| NORTH DAKOTA | 8 | LICENSED DEALERS (WHOLESALERS) | 25TH | TAX COMMISSIONER, GASOLINE TAX DIVISION - BISMARCK | FUEL USED FOR HEATING, AGRICULTURAL, INDUSTRIAL OR RAILROAD PURPOSES IS EXEMPT BUT SUBJECT TO SPECIAL 2 PERCENT EXCISE TAX. OTHER NON-HIGHWAY USES ARE REFUNDABLE EXCEPT FUEL USED IN PUBLIC CONTRACT WORK WHICH IS TAXED; AVIATION JET FUEL IS REFUNDABLE BUT SUBJECT TO THE 4 PERCENT EXCISE TAX. TRANSIT USE IS TAXED |
| OHIO | 6/ 10.3 | * WHOLESALERS, RETAILERS, OR USERS | 20TH | DEPARTMENT OF TAXATION, DIVISION OF SALES, EXCISE, AND HIGHWAY USE TAX - COLUMBUS | TAX IS PAID ON FIRST SALE KNOWINGLY MADE FOR HIGHWAY USE. IF ULTIMATE USE CANNOT BE DETERMINED, USER IS LIABLE FOR THE TAX. PUBLIC TRANSIT USE IS REFUNDED AT 6 CENTS PER GALLON FOR BUSES WITH A CAPACITY OF MORE THAN 18 PERSONS AND OPERATED PRIMARILY IN ONE OR MORE MUNICIPALITIES |
| OKLAHOMA | 6.5 | * USERS (DEALERS) TAX IS NOW LEVIED ON DELIVERY INTO STORAGE (DIESEL) | 20TH | TAX COMMISSION, MOTOR FUEL DIVISION - OKLAHOMA CITY | TAX IS LEVIED ON USE. USE IS DEFINED AS (1) PLACING OF FUEL INTO SUPPLY TANK OF A VEHICLE FOR HIGHWAY USE; (2) CONSUMPTION ON HIGHWAY OF FUEL IMPORTED IN TANK OF COMMERCIAL VEHICLE. LOCAL PUBLIC BUSES SEATING TEN OR MORE ARE EXEMPT FROM TAX. IN LIEU OF A GALLONAGE TAX, AN ANNUAL FLAT FEE OF $50 IS LEVIED ON AUTOMOBILES AND PICKUP TRUCKS WITH A CAPACITY OF NOT OVER .75 TON, USING L.P.G. AFTER JULY 1, THESE VEHICLES PLUS VANS, NOT EXCEEDING 1 TON, MUST PAY $25 FOR REMAINDER OF CALENDER YEAR. |

# FIGURE B-3 (CONT.)

# STATE TAXATION OF SPECIAL FUELS

BASED ON INFORMATION OBTAINED FROM STATE AUTHORITIES AND ON THE LAWS OF THE STATES

TABLE MF-102
SHEET 3 OF 3
STATUS AS OF JANUARY 1, 1982

| STATE | | TAX RATE (CENTS PER GALLON) 2/ | TAX PAID IN FIRST INSTANCE BY- +TAX APPLIES TO HIGHWAY USE ONLY | DATE TAX DUE 3/ | TAX COLLECTED AND ADMINISTERED BY- | REMARKS 4/ |
|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) |
| OREGON | 5/ | 8 | + RETAILERS OR USERS | 20TH | DEPARTMENT OF TRANSPORTATION, MOTOR VEHICLES DIVISION - SALEM | TAX IS PAID BY USER FOR VEHICLES NOT UNDER JURISDICTION OF PUBLIC UTILITIES COMMISSION. VEHICLES UNDER JURISDICTION OF PUBLIC UTILITIES COMMISSION AND PAYING MOTOR-CARRIER FEES ARE EXEMPT FROM PAYMENT OF SPECIAL-FUELS TAX. FUEL USED BY A PUBLICLY ORGANIZED MASS TRANSPORTATION DISTRICT IS REFUNDABLE. |
| PENNSYLVANIA | 5/ 6/ | 11 | + WHOLESALERS, RETAILERS, OR USERS | NEXT TO LAST | DEPARTMENT OF REVENUE - HARRISBURG | TAX IS PAID BY PERSON WHO PLACES FUEL IN VEHICLE TANK. TRANSIT USE IS TAXED EXCEPT FOR PUBLICLY OWNED TRANSIT, WHICH IS EXEMPT. |
| RHODE ISLAND | 6/ | 12 | WHOLESALERS, RETAILERS, OR USERS | 25TH | DEPARTMENT OF ADMINISTRATION, DIVISION OF TAXATION, MOTOR FUEL TAX SECTION - PROVIDENCE | TAX IS ON FIRST SALE WHERE USE IS KNOWN TO BE FOR INTERNAL COMBUSTION ENGINE. IF USE CANNOT BE DETERMINED INITIALLY, USER BECOMES LIABLE FOR TAX. TRANSIT USE IS EXEMPT. |
| SOUTH CAROLINA | | 13 | + LICENSED SELLER USERS, AND LICENSED WHOLESALE DISTRIBUTORS | 20TH | TAX COMMISSION, LICENSE TAX DIVISION - COLUMBIA | WHOLESALE SUPPLIER: TAX IS ON FIRST SALE WHEN USE IS KNOWN TO BE FOR INTERNAL COMBUSTION ENGINE. IF USE CANNOT BE DETERMINED, USER BECOMES LIABLE FOR TAX. SELLER USER: REPORTS FILED BY PERSONS SELLING FUEL ON WHICH TAX HAS BEEN PAID TO SUPPLIER AND PERSONS SELLING FUEL TO BE USED FOR PURPOSES OTHER THAN HIGHWAY USE. TRANSIT USE IS TAXED. |
| SOUTH DAKOTA | 5/ | 13 & 11 | + DEALERS OR LICENSED RESIDENT AND NONRESIDENT | 15TH | DEPARTMENT OF REVENUE, MOTOR FUEL TAX DIVISION - PIERRE | USER WHO DOES NOT MAINTAIN STORAGE FACILITIES, AND WHO PURCHASES FUEL FROM A LICENSED SPECIAL-FUEL DEALER FOR DELIVERY INTO A VEHICLE SUPPLY TANK, BUYS TAX-PAID FUEL AND NEED NOT HAVE A USER'S LICENSE. DEALER COLLECTS TAX WHEN FUEL IS DELIVERED TO VEHICLE TANK. TRANSIT USE IS TAXED. INDIAN TRIBE USE IS EXEMPT. |
| TENNESSEE | | 12 & 9 | + USERS | 25TH | DEPARTMENT OF REVENUE, PETROLEUM TAX DIVISION, SPECIAL FUEL SECTION - NASHVILLE | TRANSIT USE IS EXEMPT. |
| TEXAS | | 6.5 & 5 | + BONDED SUPPLIERS, BONDED DEALERS AND BONDED USERS | 25TH | CONTROLLER OF PUBLIC ACCOUNTS, FUELS TAX DIVISION - AUSTIN | DIESEL FUEL SALES TO BONDED SUPPLIERS, BONDED USERS, PREPAID USERS AND VERIFIED NON-TAXABLE USE TO PURCHASER NOT OWNING OR OPERATING DIESEL VEHICLES ARE EXEMPT. ALL SALES INTO VEHICLE FUEL SUPPLY TANKS ARE TAXABLE.<br>LIQUEFIED GAS SALES ARE TAX FREE EXCEPT SALES MADE TO MOTOR VEHICLES DISPLAYING OUT OF STATE LICENSE PLATES. ALL VEHICLES WITH TEXAS LICENSE PLATES MUST PREPAY TAX ANNUALLY.<br>DIESEL FUEL USED BY TRANSIT COMPANIES IS TAXED AT SIX CENTS PER GALLON. LIQUEFIED GAS POWERED TRANSIT VEHICLES MUST PREPAY ANNUALLY. |
| UTAH | 5/ | 11 | + USERS OR REFINERS | 25TH | TAX COMMISSION | TRUCK OPERATORS ARE LIABLE FOR TAX. RETAILERS ARE LIABLE FOR AUTOMOBILES. NO TAX ON PROPANE, METHANE, OR SYNTHETIC FUELS PRODUCED IN STATE. HOWEVER, THESE FUELS REQUIRE EXEMPTION CERTIFICATE. TRANSIT USE IS TAXED EXCEPT FOR PUBLICLY OWNED TRANSIT. |
| VERMONT | | 0 | (SEE REMARKS) | - | DEPARTMENT OF MOTOR VEHICLES - MONTPELIER | IN LIEU OF A GALLONAGE TAX, THE REGISTRATION FEE FOR NONGASOLINE-POWERED VEHICLES IS 1.75 TIMES THAT FOR A LIKE VEHICLE USING GASOLINE. |
| VIRGINIA | 5/ | 11 | SUPPLIERS (DISTRIBUTORS AND SOME USERS) | (8/) | DIVISION OF MOTOR VEHICLES, FUELS TAX DEPARTMENT - RICHMOND | SUPPLIER SELLS FUEL WHOLESALE AND RETAIL. USER ACQUIRING TAX-FREE FUEL IS LIABLE FOR THE TAX. USE IN TRUCKS OR COMBINATIONS OF MORE THAN TWO AXLES IS SUBJECT TO AN 11-CENT TAX. CERTAIN TRANSIT USE IS REFUNDED. |
| WASHINGTON | 5/ 6/ | 13.5 & 0 | + LICENSED USERS AND DEALERS | 25TH | DEPARTMENT OF LICENSING, PRORATE AND FUEL TAX DIVISION - OLYMPIA | TRUCKS USING SPECIAL FUEL (EXCEPT BUTANE OR PROPANE) PAY 12.5 PERCENT HIGHER GROSS WEIGHT FEES THAN TRUCKS USING GASOLINE, PLUS A $2 FLAT FEE THAT IS $1 OR LESS FOR GASOLINE VEHICLES. DIESEL AND L.P.G. INTERCITY BUSES PAY 20 CENTS PER HUNDRED MILES TRAVELED, WHEREAS GASOLINE BUSES PAY 15 CENTS. L.P.G. AND NATURAL GAS ARE EXEMPT AS NON-POLLUTING FUELS UNTIL JULY 1,1983, BUT VEHICLES USING THEM MUST PAY AN ANNUAL LICENSE FEE OF $50 TO $255 BASED ON TONNAGE. |
| WEST VIRGINIA | | 10.5 | PERSONS WHO FIRST RECEIVE FUEL IN STATE | LAST | TAX DEPARTMENT, DIVISION OF EXCISE AND LICENSE TAXES - CHARLESTON | A REFUND OF 6.0 CENTS PER GALLON FOR PURCHASES OF 25 GALLONS, OR MORE IS ALLOWED FOR TRANSIT USE. |
| WISCONSIN | | 13 | + WHOLESALERS, RETAILERS, OR USERS | 20TH | DEPARTMENT OF REVENUE - MADISON | TAX IS PAID BY PERSON WHO PLACES FUEL IN MOTOR-VEHICLE TANK OF THE USER. URBAN MASS TRANSIT USE BY COMMON CARRIERS IS EXCEPT. |
| WYOMING | | 0 | (SEE REMARKS) | 25TH | DEPARTMENT OF REVENUE AND TAXATION - CHEYENNE | IN LIEU OF THE GALLONAGE TAX THE USER PAYS 1.1 MILLS PER TON MILE, IN ADDITION TO 1.5 MILLS PER TON MILE FOR COMPENSATORY FEE. |
| PUERTO RICO | 5/ | 8 & 5 | WHOLESALE DISTRIBUTORS | (8/) | TREASURY DEPARTMENT, BUREAU OF EXCISE TAXES - SAN JUAN | |

1/ SPECIAL FUELS ARE MOTOR FUELS OTHER THAN GASOLINE AND GASOHOL, AND INCLUDE DIESEL FUEL AND LIQUEFIED PETROLEUM GASES. SEE MF-121 FOR GASOHOL AND SALES TAX INFORMATION.

2/ WHERE TWO TAX RATES ARE SHOWN FOR A STATE, THE FIRST RATE APPLIES TO DIESEL FUEL AND THE SECOND TO LIQUEFIED PETROLEUM GASES, SUCH AS BUTANE, PROPANE, ETC. ALSO SEE TABLE MF-121 FOR STATES WHICH HAVE "VARIABLE TAX RATES".

3/ DATE TAX IS DUE IN MONTH FOLLOWING MONTH OF RECEIPT OR SALE OF SPECIAL FUEL.

4/ LICENSING AND BONDING REQUIREMENTS ARE GIVEN IN TABLES MF-107, MF-108, AND MF-109. SPECIAL PROVISIONS FOR TAXATION OF MOTOR FUEL USED IN INTERSTATE OPERATION ARE SHOWN IN TABLE MF-104.

5/ IN THE FOLLOWING STATES AVIATION JET FUEL IS TAXED AT THE INDICATED RATES PER GALLON: ALABAMA, 0.9 CENT; MAINE AND PENNSYLVANIA, 1 CENT; MICHIGAN, 3 CENTS; NEBRASKA, 5 CENTS; OREGON, 0.5 CENTS; SOUTH DAKOTA, UTAH, AND VIRGINIA, 4 CENTS (0.25 CENTS IN VIRGINIA ON EXCESS OVER 100,000 GALLONS PER FISCAL YEAR); PUERTO RICO, 5 CENTS (3 CENTS COLLECTED BY THE TREASURY DEPARTMENT FROM WHOLESALE DISTRIBUTORS). IN CALIFORNIA, JET FUEL USED BY CARRIERS, MANUFACTURERS, REPAIRERS, THE FEDERAL GOVERNMENT, AND CERTAIN OTHERS IS EXEMPT FROM THE 2-CENT TAX. IN WASHINGTON, JET FUEL IS EXEMPT FROM THE 2-CENT TAX IF USED BY CARRIERS AND REFUNDED IF USED FOR TESTING OR TRAINING. IN ALASKA, MARINE FUEL IS TAXED AT 4 CENTS PER GALLON, JET FUEL AT 2.5 CENTS, AND OTHER NONHIGHWAY USE AT 2 CENTS.

6/ VARIABLE TAX RATE. RATE SHOWN IS AS OF OCTOBER 1, 1981. SEE TABLE MF-121 FOR BASIS OF TAX.

7/ THERE IS ALSO LEVIED A 3 PERCENT TAX ON THE RETAIL PRICE OF GASOLINE EXCLUDING THE STATE MOTOR FUEL TAX OF 7.5 CENTS. THE TAX IS LEVIED WHEN SOLD TO THE CONSUMER.

8/ TAX IS DUE IN APRIL, JULY, OCTOBER, AND JANUARY IN IDAHO, MAINE, NEW HAMPSHIRE, AND NEW MEXICO (APPLIES TO USERS ONLY IN MAINE AND NEW HAMPSHIRE). IN MASSACHUSETTS, THE MAY TAX IS DUE BY JUNE 20. IN MONTANA, USERS WITH TAX OF $10 OR LESS PER MONTH, AFTER APPLICATION, CAN FILE ANNUALLY BY JANUARY 25. IN NEVADA, TAX IS DUE LAST DAY OF MONTH FOLLOWING QUARTERLY PAYMENT PERIOD. IN NEW MEXICO, SOME USERS WITH TAX PAYMENTS OF $100 OR LESS PER YEAR CAN PAY ANNUALLY BY JANUARY 25. IN NEW YORK, RETURNS MUST BE POSTMARKED NO LATER THAN THIS DATE. THE DATE FOR THE FEBRUARY REPORT IS MARCH 20. IN VIRGINIA, THE TAX MUST BE RECEIVED ON THE FIFTH DAY, OR THE NEXT DIVISION BUSINESS DAY IF THE FIFTH IS NOT A WORKING DAY, OF THE SECOND MONTH. IN PUERTO RICO, 2 CENTS OF THE 5 CENTS TAX ON AVIATION FUEL MUST BE PAID TO THE PORTS AUTHORITY BY THE 10TH OF THE MONTH FOLLOWING SALE.

## FIGURE B-4

## 1979 STATE MOTOR-FUEL TAX INCREASES

| State | Rates (cents per gallon) | Remarks |
|---|---|---|
| Arkansas | 8.5 to 9.5 Gasoline | |
| | 10.0 to 11.5 | Diesel |
| Iowa | 8.5 to 10.0 Gasoline | |
| | 10.0 to 11.5 | Diesel |
| Michigan | 9.0 to 11.0 Gasoline | |
| | 7.0 to 9.0 Diesel | |
| Montana | 8.0 to 9.0 Gasoline | |
| | 10.0 to 11.0 | Diesel |
| Nebraska | 9.5 to 10.5 All Motor Fuel | |
| New Hampshire | 10.0 to 11.0 | All Motor Fuel |
| Pennsylvania | 9.0 to 11.0 All Motor Fuel | |
| South Carolina | 9.0 to 10.0 All Motor Fuel | |
| South Dakota | 8.0 to 9.0 All Motor Fuel | |
| Washington*/ | 11.0 to 12.0 | All Motor Fuel |

*/ Rate change via automatic adjustment mechanism.

Table MF-2, Highway Statistics, 1979, FHWA, Washington, DC.

FIGURE B-5

1980 STATE MOTOR-FUEL TAX INCREASES

| | |
|---|---|
| Alabama | Tax increased from 7 cents to 11 cents per gallon effective August 1, 1980. |
| Indiana* | Tax converted from a unit tax (8 cents) to 8 percent of average retail price before taxes. The tax has a ceiling of 12 cents in 1980, 14 cents in 1981, and 16 cents in 1982 and thereafter. The rate (determined twice a year by the Revenue Department) was set at 8.5 cents per gallon effective January 1, 1981. |
| Kentucky* | Tax converted from a unit tax (9 cents) to 9 percent of average wholesale price with a minimum of 9 cents per gallon. Tax may not exceed 13.5 The ratio is determined quarterly by the Department of Revenue. Tax set a 9 cents a gallon effective January 1, 1981. |
| Massachusetts* | Tax converted from a unit tax (8.5 cents) to 10 percent of average wholesale price. The rate initially set a 9.9 cents and was 9.8 cents effective January 1, 1981. |
| Minnesota | Tax increased from 9 cents to 11 cents per gallon effective May 1, 1980. |
| Nebraska* | Tax increased from 10.5 cents to 11.5 cents per gallon effective October 1, 1980. In addition, a 2-percent tax may be levied based on the average cost of gasoline to the State. The combined rate of 13.6 cents per gallon effective January 1, 1981. |
| New Mexico* | Tax increased from 7 cents to 8 cents per gallon effective July 1, 1980. The tax will automatically increase by 1 cent per gallon for each 10-cent increase in the average wholesale price of motor fuel, but cannot exceed 1 cent a year or a total tax of 11 cents a gallon. |
| South Carolina | Tax increased from 9 cents to 11 cents a gallon effective October 1, 1980. |
| South Dakota | Tax increased from 9 cents to 12 cents per gallon effective April 1, 1980. |

FIGURE B-5 (CONT.)

1980 STATE MOTOR-FUEL TAX INCREASES

| | |
|---|---|
| Virginia | Tax increased from 9 cents to 11 cents per gallon effective July 1, 1980. |
| Wisconsin | Tax increased from 7 cents to 9 cents per gallon effective May 1, 1980. |
| District of Columbia | Tax increased from 10 cents to 11 cents per gallon effective December 1, 1980. |

*Variable tax system

Source: National Governors Conference, Office of State Services, July 24, 1980, Washington, DC.

FIGURE B-6

1981 STATE MOTOR-FUEL TAX RATE CHANGES

| | |
|---|---|
| Arizona* | Effective January 1, 1982, the motor-fuel tax rate increased from 8 to 9.6 cents per gallon until January 1, 1983. Thereafter, the tax rate will equal 8 percent of the average retail selling price. (Note: Law later repealed.) |
| California | Effective January 1, 1983, the motor-fuel tax rate increases from 7 to 9 cents per gallon. A local optional penny per gallon authorized. |
| Colorado | Effective July 2, 1981, the motor-fuel tax rate increased from 7 to 9 cents per gallon; gasohol went up from 2 to 4 cents per gallon. |
| Delaware | Effective August 1, 1981, the motor-fuel tax rate increased from 9 to 11 cents per gallon. |
| District of Columbia** | Effective June 1, 1981, the motor-fuel tax rate increased 2 cents a gallon to 13 cents. The motor-fuel tax rate will be automatically adjusted each year, beginning in 1982, to reflect the change in the Consumer Price Index. |
| Idaho | Effective July 1, 1981, the motor-fuel tax rate increased from 9.5 to 11.5 cents per gallon. |
| Indiana*** | Effective June 1, 1981, the motor-fuel tax increased from 8.5 to 10.5 cents per gallon and remained in effect until December 31, 1981. Tax changed to 10 percent of selling price up to $1 and 8 percent for next 50 cents per gallon. Maximum of 14 cents per gallon. Rate set at 11.1 cents per gallon (January 1, 1982). |
| Iowa | Effective September 1, 1981, the motor-fuel tax rate increased from 10 to 13 cents per gallon. Gasohol increased to 6 cents until September 1983, thereafter to be the motor fuel prevailing rate. Diesel increased to 13.5 cents; to 15.5 cents July 1, 1982. |
| Kentucky** | 10.0 cents (January 1, 1982) |

FIGURE B-6 (CONT.)

1981 STATE MOTOR-FUEL TAX RATE CHANGES

| | |
|---|---|
| Massachusetts** | 11.1 cents (January 1, 1982) floor set for ad valorem tax |
| Minnesota | Effective June 1, 1981, the motor-fuel tax rate increased from 11 to 13 cents per gallon. |
| Nebraska** | 13.9 cents (August 30, 1981) |
| Nevada | Effective July 1, 1981, the motor-fuel tax increased to 10.5 cents per gallon. The rate increased to 12 cents on July 1, 1982. Gasohol increased to 9.5 cents per gallon July 1, 1981, and to 11 cents July 1, 1982. |
| New Hampshire | Effective July 1, 1981, the motor-fuel tax rate increased from 11 to 14 cents per gallon. The tax increase expires June 30, 1983; gasohol increased to 9 cents per gallon. |
| New Mexico** | 9.0 cents (July 1, 1981) |
| North Carolina | Effective July 1, 1981, the motor-fuel tax rate increased from 9 to 12 cents per gallon; gasohol increased from 8 to 12 cents per gallon. |
| Ohio* | Effective July 1, 1981, an "added motor-fuel tax" was imposed. By formula, the rate increased to 10.3 cents per gallon. |
| Oregon | Effective January 1, 1982, the motor-fuel tax rate increased from 7 to 8 cents per gallon. Further increases were approved but defeated by voters in May 1982: 9 cents (July 1, 1982), 10 cents (July 1, 1983), and 11 cents (July 1, 1984). |
| Pennsylvania* | Effective July 1, 1981, an Oil Company Franchise Tax was imposed at 35 mills per dollar on highway fuels and products sales. May add 2 cents to the price of motor fuel. |
| Rhode Island* | Effective June 1, 1981, the motor-fuel tax rate will be computed at 10 percent of the wholesale price of motor fuel, excluding Federal and State taxes. The minimum tax is 10 cents a gallon. Rate established at 12 cents per gallon (January 1, 1982). |

FIGURE B-6 (CONT.)

1981 STATE MOTOR-FUEL TAX RATE CHANGES

| | |
|---|---|
| South Carolina | Effective September 1, 1981, the motor-fuel fuel tax rate increased from 11 to 13 cents per gallon. |
| South Dakota | Effective April 1, 1981, an additional 1-cent per gallon tax was imposed which will run through March 31, 1984. The motor-fuel tax is 13 cents a gallon and gasohol was raised by 1 cent to 9 cents a gallon. The exemption of motor fuel from the State sales tax was extended. |
| Tennessee | Effective June 1, 1981, the motor-fuel tax rate increased 2 cents per gallon (7 to 9 cents). The diesel tax is 12 cents a gallon (June 1, 1981); LPG is 9 cents. |
| Utah | Effective July 1, 1981, the motor-fuel tax rate went up 2 cents to 11 cents a gallon. The gasohol tax is 5 cents less than the State motor-fuel tax rate. |
| Vermont | Effective June 1, 1981, the motor-fuel tax rate increased from 9 to 11 cents per gallon. |
| Washington*** | For 6 months (July 1 thru December 31, 1981) the motor-fuel tax rate was 13.5 cents per gallon. The maximum rate will be 16 cents per gallon (formally 12 cents); the minimum rate is 12 cents. The annual rate increase cannot exceed 2 cents per gallon. Rate set at 12 cents (January 1, 1982). |
| Wisconsin | Effective August 1, 1981, the motor-fuel tax rate increased from 9 to 13 cents per gallon. |

* New Variable Tax System.
** Rates changed by automatic rate adjustment system.
***Existing variable tax system given new maximum and minimum rates.

Source: State Tax Review, Commerce Clearing House.

FIGURE B-7

STATES WITH INDEXED*/ OR COMBINED UNIT AND INDEXED MOTOR FUEL TAXES AS OF JANUARY 1, 1984

District of Columbia

Indiana

Kentucky

Massachusetts

Michigan

Nebraska

New Mexico

Ohio

Rhode Island

*/ These rates refer to indexed fees used for highway purposes. Fourteen States also require a general sales tax on certain motor fuels which is not applied directly to highways.

Source: Federal Highway Administration, Highway Statistics, Table MF-121T, 1984.

# STATE MOTOR-FUEL TAXES AND RELATED RECEIPTS - 1982[1]

COMPILED FOR THE CALENDAR YEAR FROM REPORTS OF STATE AUTHORITIES AND OTHER SOURCES

(THOUSANDS OF DOLLARS)

TABLE MF-1
SEPTEMBER 1983

| STATE | TAX RATE ON DECEMBER 31 IN CENTS PER GALLON 2/ | | RECEIPTS FROM TAXATION OF MOTOR FUEL | | | | | | | OTHER RELATED RECEIPTS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GASOLINE | SPECIAL FUELS (DIESEL, BUTANE, ETC.) 3/ | GROSS TAX COLLECTIONS 4/ | DEDUCTIONS BY DISTRIBUTORS FOR EXPENSES | GROSS RECEIPTS BY STATE | REFUNDS PAID | NET RECEIPTS BY STATE | DEDICATED REVENUE FROM NONHIGHWAY GASOLINE 5/ | ADJUSTED NET GALLONAGE RECEIPTS | DISTRIBUTORS AND DEALERS LICENSES | INSPECTION FEES 6/ | FINES AND PENALTIES | MISCELLANEOUS RECEIPTS | TOTAL | ADJUSTED NET TOTAL RECEIPTS |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) |
| ALABAMA | 11 | 12 & 0 | 234,428 | 1,484 | 232,944 | 386 | 232,558 | 644 | 231,914 | 399 | 7,709 | - | 4,711 | 12,819 | 244,733 |
| ALASKA | 8 | 8 & 0 | 20,162 | - | 20,162 | 357 | 19,805 | 1,032 | 18,773 | - | - | - | 9 | 9 | 18,782 |
| ARIZONA | 10 | 10 | 134,152 | - | 134,152 | 2,585 | 131,567 | 1,504 | 130,063 | 56 | - | 339 | 2,312 | 2,707 | 132,770 |
| ARKANSAS | 9.5 | 10.5 & 7.5 | 130,283 | 2,678 | 127,605 | 31 | 127,574 | - | 127,574 | - | - | - | - | - | 127,574 |
| CALIFORNIA | 7 | 7 & 6 | 831,371 | - | 831,371 | - | 831,371 | 19,637 | 811,734 | 55 | - | - | 0 | 55 | 811,789 |
| COLORADO | 9 | 9 | 141,464 | 708 | 140,756 | 2,744 | 138,012 | - | 138,012 | - | - | - | 138 | 138 | 138,150 |
| CONNECTICUT | 11 | 11 | 152,606 | - | 152,606 | 840 | 151,766 | - | 151,766 | 52 | - | - | 2,308 | 2,440 | 154,206 |
| DELAWARE | 11 | 11 | 33,958 | - | 33,958 | 197 | 33,761 | - | 33,761 | 4 | - | 30 | - | 34 | 33,795 |
| DIST. OF COL. | 14 | 14 | 21,680 | - | 21,680 | - | 21,680 | - | 21,680 | 36 | - | 75 | - | 111 | 21,791 |
| FLORIDA | 8 | 8 | 427,552 | 2,495 | 425,057 | 5,787 | 419,270 | 2,509 | 416,761 | 52 | 6,046 | 404 | 286 | 6,788 | 423,549 |
| GEORGIA | 7.5 | 7.5 | 252,506 | 1,537 | 250,969 | 4,080 | 245,889 | - | 246,889 | 7 | - | 134 | 3,127 | 3,268 | 250,157 |
| HAWAII | 8.5 | 8.5 & 6 | 27,748 | - | 27,748 | 169 | 27,579 | 157 | 27,422 | - | - | - | - | - | 27,422 |
| IDAHO | 12.5 | 12.5 | 63,901 | 550 | 63,351 | 1,929 | 61,422 | 1,087 | 60,335 | - | - | 92 | - | 92 | 60,427 |
| ILLINOIS | 7.5 | 7.5 | 375,350 | - | 375,350 | 7,556 | 367,794 | 2,016 | 365,778 | - | - | - | 65 | 65 | 365,843 |
| INDIANA | 11.1 | 11.1 | 316,069 | - | 316,069 | 3,179 | 312,890 | 93 | 312,797 | 14 | 2,377 | 4,109 | - | 6,500 | 319,297 |
| IOWA | 13 | 15.9 & 13 | 190,853 | - | 190,853 | 15,510 | 175,343 | 1,767 | 173,576 | 2 | 24 | 139 | -1,579 | -1,414 | 172,162 |
| KANSAS | 8 | 10 & 7 | 123,616 | - | 123,616 | 6,225 | 117,391 | - | 117,391 | 21 | 154 | - | 24 | 199 | 117,590 |
| KENTUCKY 7/ | 10 | 10 | 200,699 | 2,108 | 198,591 | 1,137 | 197,454 | - | 197,454 | - | - | - | - | - | 197,454 |
| LOUISIANA | 8 | 9 | 197,740 | - | 197,740 | 5,385 | 192,355 | - | 192,355 | - | 805 | 151 | - | 956 | 193,311 |
| MAINE | 9 | 9 | 51,049 | - | 51,049 | 495 | 50,554 | 956 | 49,598 | - | 96 | - | - | 96 | 49,694 |
| MARYLAND | 11 | 11 | 211,218 | - | 211,218 | 3,104 | 208,114 | 1,088 | 207,026 | 942 | - | 317 | 8,252 | 9,511 | 216,537 |
| MASSACHUSETTS | 10.4 | 10.4 & 6.6 | 259,383 | - | 259,383 | 1,463 | 257,920 | 356 | 257,564 | 2,741 | - | - | - | 2,741 | 260,305 |
| MICHIGAN | 11 | 11 & 9 | 430,989 | - | 430,989 | 1,590 | 429,399 | 4,966 | 424,433 | 15 | - | - | - | [illegible] | 424,448 |
| MINNESOTA | 13 | 13 | 277,672 | - | 277,672 | 16,730 | 260,942 | 2,514 | 258,428 | 4 | 479 | 1 | 49 | 533 | 258,961 |
| MISSISSIPPI 8/ | 9 | 10 & 9 | 124,862 | - | 124,862 | 966 | 123,896 | 653 | 123,243 | - | 11 | 85 | 4,498 | 4,594 | 127,837 |
| MISSOURI | 7 | 7 | 195,167 | - | 195,167 | 4,595 | 190,572 | - | 190,572 | 3 | 256 | - | 772 | 1,031 | 191,603 |
| MONTANA | 9 | 11 & 0 | 50,386 | 313 | 50,073 | 2,549 | 47,524 | 246 | 47,278 | - | - | 266 | - | 266 | 47,544 |
| NEBRASKA | 14 | 14 | 123,994 | 1,280 | 122,714 | 6,541 | 116,173 | 199 | 115,974 | - | - | - | 14 | 14 | 115,988 |
| NEVADA | 12 | 12 | 63,576 | 660 | 62,916 | 783 | 62,133 | 632 | 61,501 | - | 287 | - | - | 287 | 61,788 |
| NEW HAMPSHIRE | 14 | 14 | 57,092 | - | 57,092 | 701 | 56,391 | 88 | 56,303 | 1,786 | - | 172 | 1,316 | 3,274 | 59,577 |
| NEW JERSEY | 8 | 8 & 4 | 289,563 | - | 289,563 | 1,263 | 288,300 | - | 288,300 | 69 | - | 933 | 16 | 1,018 | 289,318 |
| NEW MEXICO | 10 | 10 | 84,754 | - | 84,754 | 434 | 84,320 | 457 | 83,863 | 89 | - | 328 | 1,616 | 2,033 | 85,896 |
| NEW YORK | 8 | 10 & 8 | 458,386 | - | 458,386 | 3,980 | 454,406 | - | 454,406 | - | - | - | 7,950 | 7,950 | 462,356 |
| NORTH CAROLINA | 12 | 12 | 375,750 | - | 375,750 | 7,851 | 367,899 | - | 367,899 | - | 8,116 | 420 | 506 | 9,042 | 376,941 |
| NORTH DAKOTA | 8 | 8 | 37,923 | 790 | 37,133 | 3,270 | 33,863 | 109 | 33,754 | 2 | 108 | 27 | 6 | 143 | 33,897 |
| OHIO | 11.7 | 11.7 | 589,356 | - | 589,356 | 10,242 | 579,114 | 2,889 | 576,225 | - | - | - | - | - | 576,225 |
| OKLAHOMA | 6.5 | 6.5 | 132,841 | 2,691 | 130,150 | 10 | 130,140 | - | 130,140 | - | 1,543 | 452 | - | 1,995 | 132,135 |
| OREGON | 8 | 8 | 96,990 | - | 96,990 | 1,367 | 95,623 | 144 | 95,479 | - | - | 49 | 16 | 65 | 95,544 |
| PENNSYLVANIA | 11 | 11 | 716,616 | 4,369 | 712,247 | 3,516 | 708,731 | 75 | 708,656 | - | 8 | 1,630 | 10,221 | 11,859 | 720,515 |
| RHODE ISLAND | 11 | 11 | 43,065 | - | 43,065 | 235 | 42,830 | - | 42,830 | - | - | - | - | - | 42,830 |
| SOUTH CAROLINA | 13 | 13 | 223,422 | 1,472 | 221,950 | 2,226 | 219,724 | 854 | 218,870 | - | 3,819 | - | - | 3,819 | 222,689 |
| SOUTH DAKOTA | 13 | 13 | 60,948 | 501 | 60,447 | 5,739 | 54,708 | 357 | 54,351 | - | 80 | - | 499 | 579 | 54,930 |
| TENNESSEE | 9 | 12 & 9 | 261,226 | 2,165 | 259,061 | 5,589 | 253,472 | 2,497 | 250,975 | - | 27,413 | 223 | - | 27,636 | 278,611 |
| TEXAS | 5 | 6.5 & 5 | 512,108 | 8,307 | 503,801 | 2,825 | 500,976 | 2,247 | 498,729 | - | 135 | - | - | 135 | 498,864 |
| UTAH | 11 | 11 | 81,465 | - | 81,465 | 178 | 81,287 | 851 | 80,436 | - | - | 41 | 774 | 815 | 81,251 |
| VERMONT | 11 | 14 & 0 | 27,046 | - | 27,046 | - | 27,046 | 89 | 26,957 | 1,176 | - | - | 103 | 1,279 | 28,236 |
| VIRGINIA 7/ | 11 | 11 | 344,071 | 822 | 343,249 | 3,102 | 340,147 | 313 | 339,834 | - | - | 169 | 1 | 166 | 340,000 |
| WASHINGTON | 12 | 12 | 246,721 | - | 246,721 | 2,031 | 244,690 | 3,891 | 240,799 | - | - | - | 47 | 47 | 240,846 |
| WEST VIRGINIA | 10.5 | 10.5 | 99,073 | - | 99,073 | 521 | 98,552 | - | 98,552 | - | - | - | - | - | 98,552 |
| WISCONSIN | 13 | 13 | 299,614 | - | 299,614 | 12,569 | 287,045 | - | 287,045 | - | 906 | - | - | 906 | 287,951 |
| WYOMING | 8 | 0 | 39,210 | - | 39,210 | 1,154 | 38,056 | 312 | 37,744 | 4 | - | - | - | 4 | 37,748 |
| TOTAL | 9/ 9.07 | 9/ 9.62 | 10,741,674 | 34,930 | 10,706,744 | 165,716 | 10,541,028 | 57,229 | 10,483,799 | 7,529 | 60,372 | 10,582 | 48,137 | 126,620 | 10,610,419 |
| PERCENTAGE | - | - | 100.00 | 0.33 | 99.67 | 1.54 | 98.13 | 0.53 | 97.60 | - | - | - | - | - | - |

1/ THIS TABLE INCLUDES THE REVENUES FROM STATE TAXES ON ALL MOTOR-VEHICLE FUELS AND RELATED RECEIPTS IN CONNECTION WITH MOTOR-FUEL TAXATION AND ADMINISTRATION. IN MOST STATES, HOWEVER, THE TAX ON SPECIAL FUELS (FUELS OTHER THAN GASOLINE AND GASOHOL) IS APPLICABLE ONLY TO THE GALLONAGE USED ON THE HIGHWAYS. FOR THE FEW STATES THAT APPLY THE TAX TO ALL FUEL SOLD, THE REVENUE AND REFUNDS COVERING THE NONHIGHWAY PORTION OF THESE SPECIAL FUELS HAVE BEEN EXCLUDED. IN MOST STATES WHERE GASOHOL IS TAXED AT THE SAME RATE AS GASOLINE, RECEIPTS ARE INSEPARABLE IN THE RECORDS, AND IN SOME STATES WHERE IT IS FULLY EXEMPT IT MAY NOT BE REPORTED AT ALL.

2/ FOR TAX RATES AS OF JANUARY 1, 1982 AND RATE CHANGES DURING THE YEAR SEE TABLE MF-121T. STATES WITH VARIABLE TAX RATES ARE ALSO IDENTIFIED IN TABLE MF-121T.

3/ WHERE TWO TAX RATES ARE SHOWN FOR A STATE, THE FIRST APPLIES TO DIESEL FUEL AND THE SECOND TO LIQUEFIED PETROLEUM GASES. SOME STATES IMPOSE ADDITIONAL REGISTRATION FEES OR MILEAGE TAXES ON VEHICLES USING SPECIAL FUELS. SUCH ADDITIONAL FEES ARE IN LIEU OF GALLONAGE TAXES IN WYOMING AND WERE IN VERMONT UNTIL JULY 1, 1982 WHEN GALLONAGE TAX WENT INTO EFFECT.

4/ INCLUDES, IN SOME STATES, RECEIPTS IN THE FORM OF TAX CREDITS FOR REFUND CLAIMS ACCEPTED BY DISTRIBUTORS ACTING AS AGENTS OF THE STATE AND REFUND CREDITS TO USERS WHO ARE LICENSED AS DISTRIBUTORS.

5/ THESE ARE PROCEEDS FROM TAXES ON NONHIGHWAY USE OF GASOLINE WHICH ARE DEDICATED FOR THE IMPROVEMENT OF FACILITIES OTHER THAN HIGHWAYS AND ARE GENERALLY REVENUES FROM TAXES ON GASOLINE FOR AVIATION AND MARINE USE, BUT, IN SOME STATES, INCLUDE TAXES ON GASOLINE USED IN OFF-HIGHWAY RECREATIONAL VEHICLES AND SNOWMOBILES AND FOR CALIFORNIA INCLUDE THE TAX ON GASOLINE USED FOR AGRICULTURAL PURPOSES.

6/ FEES FOR INSPECTION OF MOTOR-VEHICLE FUEL. INSOFAR AS POSSIBLE, FEES FOR INSPECTION OF FUELS NOT USED ON THE HIGHWAYS HAVE BEEN ELIMINATED.

7/ VEHICLES WITH 3 OR MORE AXLES PAY A 2% SURTAX ON MOTOR FUEL PURCHASED IN KENTUCKY AND INTERSTATE PROPERTY (FREIGHT) VEHICLES WITH 3 OR MORE AXLES PAY A 2 CENTS PER GALLON SURTAX IN VIRGINIA.

8/ SPECIAL COUNTY TAXES OF 3 CENTS PER GALLON IN HANCOCK COUNTY, AND 2 CENTS PER GALLON IN HARRISON AND JACKSON COUNTIES, IMPOSED FOR SEA WALL PROTECTION, ARE NOT INCLUDED IN THIS TABLE. MOTOR-FUEL RECEIPTS ARE FOR 11 MONTHS BECAUSE OF LEGISLATED CHANGES IN REPORTING DATES FOR DISTRIBUTORS.

9/ WEIGHTED AVERAGE TAX RATE (SPECIAL FUELS RATE EXCLUDES VERMONT AND WYOMING). THE WEIGHTED AVERAGE RATE FOR ALL MOTOR FUEL WAS 9.11 CENTS PER GALLON.

Source: Highway Statistics, 1982

FIGURE B-8

### Other Revenue Sources

While motor fuels are the major source of revenues, various other user and non-user taxes also provide significant revenues for highways. Registration and associated fees provide the next most significant source of highway user revenues. Figure B-9 provides 1982 State revenue totals for various second and third structure taxes.

Non-user revenues contribute roughly thirty percent of total highway expenditures. These include general revenues and other sources. These non-user sources may include a variety of taxes, as shown in Figure B-10.

To achieve desired cost-allocation goals it is probably necessary to employ revenue sources other than fuels. The analyst is encouraged to look at the experiences of States with third structure taxes and to explore taxes that are more efficient, such as congestion and pollution charges.

## REVENUE ATTRIBUTION AND COST RESPONSIBILITY COMPARISONS

Revenue attribution is an essential element of user-charge design if the study is geared to achieving complex goals like efficient and equitable charges. To assure that these goals are met, and others such as total revenue needs for that matter, it is essential to compare cost responsibilities with potential user charge contributions for alternative user charge schemes. This is particularly important if changes to existing user-charge rates and structures are likely to depart significantly from past practices (if there are close similarities between past and proposed tax systems simple extrapolation might suffice).

To examine potential revenue contributions by vehicle class a systematic procedure must be adopted. This section elaborates on general approaches useful for estimating first, second and third structure taxes. Other revenue forms may require fairly detailed analyses and extensive judgment.

# STATE MOTOR-VEHICLE AND MOTOR-CARRIER TAX RECEIPTS - 1982[1]

COMPILED FOR THE [illegible] FROM REPORTS OF STATE AUTHORITIES AND OTHER SOURCES

(THOUSANDS OF DOLLARS)

TABLE MV-2
SEPTEMBER 1983

| STATE | REGISTRATION FEES 2/ — MOTOR VEHICLES — AUTOMOBILES (INCLUDING TAXICABS) | REGISTRATION FEES 2/ — MOTOR VEHICLES — BUSES | REGISTRATION FEES 2/ — MOTOR VEHICLES — TRUCKS AND TRUCK TRACTORS 3/ | REGISTRATION FEES 2/ — OTHER VEHICLES — TRAILERS | REGISTRATION FEES 2/ — OTHER VEHICLES — MOTOR-CYCLES | REGISTRATION FEES 2/ — TOTAL | OTHER FEES — DRIVERS LICENSES | OTHER FEES — CERTIFICATE OF TITLE FEES | OTHER FEES — SPECIAL TITLING TAXES 4/ | OTHER FEES — FINES AND PENALTIES | OTHER FEES — ESTIMATED SERVICE CHARGES, LOCAL COLLECTIONS 5/ | OTHER FEES — CARRIER GROSS RECEIPTS TAXES 6/ | OTHER FEES — MILEAGE, TON-MILE AND PASSENGER-MILE TAX | OTHER FEES — SPECIAL LICENSE FEES AND FRANCHISE TAXES 7/ — WEIGHT OR CAPACITY | OTHER FEES — SPECIAL LICENSE FEES AND FRANCHISE TAXES 7/ — FLAT RATE | OTHER FEES — CERTIFICATE OR PERMIT FEES 7/ | OTHER FEES — MISCEL-LANEOUS RECEIPTS LESS UNCLAS-SIFIED REFUNDS | TOTAL RECEIPTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALABAMA | 28,390 | 82 | 19,824 | 1,061 | 398 | 49,722 | 8,401 | 1,450 | - | 1,450 | 3,897 | - | 231 | - | - | 391 | 2,078 | 68,428 |
| ALASKA | 9,908 | 99 | 4,944 | 922 | 157 | 12,030 | 221 | 986 | - | 1,482 | 104 | - | - | 688 | - | 28 | 1,206 | 16,602 |
| ARIZONA | 12,550 | 9 | 18,726 | 1,600 | 881 | 30,766 | 3,878 | 3,541 | - | 4,436 | 151 | - | 22,179 | - | - | - | 11,835 | 76,786 |
| ARKANSAS | 25,728 | 12 | 27,067 | 2,988 | 170 | 55,959 | 6,623 | 733 | - | 47 | 1,317 | - | - | - | - | 1,334 | 11,370 | 77,383 |
| CALIFORNIA 8/ | 879,801 | 18,138 | 384,593 | 100,384 | 28,899 | 1,405,512 | 51,020 | - | - | - | - | 5,159 | - | - | - | 1,882 | 88,480 | 1,551,783 |
| COLORADO | 17,513 | 131 | 13,107 | 1,404 | 535 | 32,690 | 3,287 | 1,568 | - | 2,444 | 2,029 | - | 23,613 | - | - | 158 | 7,991 | 74,800 |
| CONNECTICUT | 9/ 48,666 | 1,082 | 14,743 | 993 | 605 | 63,089 | 12,416 | 2,652 | - | 44 | - | - | - | - | 3,121 | 58 | 8,575 | 89,992 |
| DELAWARE | 6,766 | 110 | 4,887 | 548 | 43 | 12,351 | 1,137 | 400 | 9,302 | 1,882 | - | - | - | - | - | - | 1,394 | 26,466 |
| DIST. OF COL. | 10,728 | 481 | 1,337 | 94 | 93 | 12,733 | 1,593 | 716 | 11,150 | - | 247 | - | - | - | 271 | - | 5,825 | 32,838 |
| FLORIDA | 142,735 | 433 | 55,172 | 18,482 | 2,169 | 218,991 | 12,825 | 10,204 | - | 168 | 9,573 | - | - | - | 3,208 | - | 19,755 | 274,724 |
| GEORGIA | 23,848 | 249 | 20,548 | 1,793 | 574 | 47,012 | 4,399 | 4,029 | - | - | 2,359 | - | - | - | 2,407 | 183 | 1,345 | 61,734 |
| HAWAII | 15,682 | 260 | 5,645 | 908 | 311 | 22,806 | 1,365 | 350 | - | 578 | - | - | - | 43 | - | - | 1,302 | 26,444 |
| IDAHO | 12,807 | 26 | 9,898 | 536 | 330 | 23,597 | 1,566 | 827 | - | 914 | - | - | 13,520 | - | - | 182 | 5,888 | 46,494 |
| ILLINOIS | 146,033 | 27 | 144,228 | 8,817 | 4,469 | 303,574 | 19,117 | 6,938 | - | 5,699 | 698 | - | - | - | 2,404 | - | 22,197 | 360,627 |
| INDIANA | 31,488 | 277 | 56,398 | 4,136 | 1,386 | 93,685 | 6,347 | 7,009 | - | - | 6,632 | - | - | - | 1,379 | 73 | 5,902 | 121,027 |
| IOWA | 70,000 | 108 | 59,780 | 3,428 | 1,585 | 134,895 | 5,865 | 1,522 | - | 122 | - | - | - | - | 248 | 438 | 14,189 | 157,279 |
| KANSAS | 21,698 | 366 | 39,226 | 1,914 | 1,072 | 64,276 | 3,057 | 2,157 | - | - | - | - | - | - | 2,231 | 135 | 5,711 | 77,867 |
| KENTUCKY | 20,589 | 10 | 26,843 | 1,086 | 289 | 48,817 | 7,474 | - | 101,729 | - | 4,690 | - | 5,233 | 164 | 11 | 2,706 | 6,781 | 177,688 |
| LOUISIANA | 9/ 10,274 | 291 | 20,669 | 2,607 | 165 | 34,006 | 6,419 | 6,686 | - | 450 | - | 5,329 | - | - | 2,725 | 241 | 12,720 | 68,876 |
| MAINE | 10,764 | 15 | 11,085 | 5,304 | 627 | 27,795 | 3,532 | 1,047 | - | 442 | - | - | - | - | 699 | 28 | 5,094 | 38,637 |
| MARYLAND | 53,112 | 261 | 26,286 | 1,932 | 736 | 82,327 | 7,937 | 2,136 | 148,820 | 1,679 | - | - | - | - | - | - | 10,331 | 253,238 |
| MASSACHUSETTS | 9/ 33,920 | 104 | 28,145 | 2,547 | 1,089 | 65,805 | 20,248 | 730 | - | - | - | - | - | - | 1,595 | 78 | 11,747 | 180,203 |
| MICHIGAN | 125,114 | 186 | 73,216 | 9,013 | 2,847 | 210,376 | 10,647 | 6,190 | - | - | - | - | - | - | 403 | 1,285 | 22,016 | 281,717 |
| MINNESOTA | 95,671 | 307 | 39,896 | 2,791 | 1,666 | 140,331 | 7,678 | 3,380 | - | 3,681 | - | - | - | - | - | 1,294 | 10,484 | 166,848 |
| MISSISSIPPI | 15,253 | 448 | 24,407 | 635 | 211 | 40,954 | 5,946 | 2,366 | - | 5,605 | - | - | - | - | 255 | 223 | 5,647 | 60,996 |
| MISSOURI | 47,518 | 262 | 46,169 | 2,504 | 599 | 97,452 | 4,153 | 6,572 | - | 3,178 | - | - | - | - | 2,510 | - | 6,213 | 120,070 |
| MONTANA | 3,986 | 60 | 10,038 | 2,005 | 331 | 16,420 | 1,256 | 498 | 4,726 | - | - | - | - | - | 967 | 42 | 3,166 | 27,878 |
| NEBRASKA | 12,987 | 191 | 26,165 | 528 | 249 | 40,120 | 3,197 | 2,147 | - | 1,157 | - | - | - | - | 513 | 70 | 2,738 | 49,942 |
| NEVADA | 25,835 | 81 | 11,277 | 1,583 | 593 | 39,369 | 1,405 | 1,204 | - | 223 | - | - | 6,056 | 834 | - | 335 | 7,148 | 86,874 |
| NEW HAMPSHIRE | 17,337 | 69 | 6,673 | 740 | 630 | 25,449 | 3,923 | 1,101 | - | 3,862 | - | - | - | - | 1,974 | 38 | 3,982 | 40,329 |
| NEW JERSEY | 139,495 | 925 | 89,583 | 3,362 | 1,030 | 204,395 | 23,852 | 10,205 | - | - | - | - | 304 | - | 1,567 | - | 28,544 | 268,067 |
| NEW MEXICO | 13,626 | 28 | 7,925 | 964 | 172 | 22,715 | 1,583 | 1,006 | 21,106 | - | - | - | 21,242 | - | - | 420 | 3,641 | 71,713 |
| NEW YORK | 185,711 | 1,261 | 48,394 | 5,462 | 1,290 | 242,118 | 13,660 | 7,409 | - | 1,961 | - | - | 42,779 | - | - | 3,964 | 27,948 | 339,839 |
| NORTH CAROLINA | 49,090 | 837 | 73,109 | 3,908 | 1,008 | 127,652 | 10,056 | 7,583 | - | 4,013 | - | - | - | - | - | - | 20,544 | 169,848 |
| NORTH DAKOTA | 12,567 | 44 | 13,498 | 567 | 345 | 27,021 | 947 | 620 | 2,123 | 341 | - | - | 329 | - | 1,073 | 29 | 4,199 | 36,682 |
| OHIO | 143,789 | 267 | 93,312 | 19,214 | 3,162 | 259,744 | 11,720 | 5,085 | - | 8,008 | 15,354 | - | 44,087 | 98 | 1,928 | 189 | 12,749 | 358,962 |
| OKLAHOMA | 105,606 | 49 | 40,843 | 13,285 | 1,231 | 161,014 | 8,796 | 1,495 | - | - | 6,959 | - | 137 | - | 1,403 | 168 | 9,116 | 189,088 |
| OREGON | 9/ 19,825 | 107 | 12,051 | 6,652 | 278 | 38,913 | 6,647 | 5,559 | - | 449 | - | - | 53,775 | 8,664 | 1,719 | 91 | 11,979 | 124,786 |
| PENNSYLVANIA | 147,144 | 958 | 123,902 | 5,398 | 2,904 | 280,303 | 39,836 | 32,503 | - | 14,318 | - | - | - | - | - | - | 53,126 | 420,086 |
| RHODE ISLAND | 8,119 | 7 | 3,610 | 177 | 280 | 12,193 | 2,640 | 955 | - | 3,386 | - | - | - | - | - | 871 | 1,824 | 21,869 |
| SOUTH CAROLINA | 15,169 | 209 | 26,210 | 721 | 60 | 42,369 | 2,112 | 2,112 | - | 323 | - | - | 852 | 89 | - | - | 11,991 | 59,840 |
| SOUTH DAKOTA | 9,321 | 80 | 15,155 | 1,003 | 283 | 25,842 | 879 | 651 | - | 151 | - | - | - | - | - | - | 1,121 | 28,644 |
| TENNESSEE | 48,466 | 431 | 49,592 | 2,111 | 682 | 98,282 | 9,028 | 3,212 | - | 1,167 | 2,745 | - | - | - | 2,334 | 137 | 1,780 | 118,689 |
| TEXAS | 161,155 | 996 | 174,439 | 14,270 | 1,778 | 352,638 | 27,512 | 11,852 | 527,333 | 899 | - | - | - | 256 | 2,202 | 451 | 39,923 | 963,866 |
| UTAH | 5,327 | 62 | 10,277 | 494 | 303 | 16,463 | 2,348 | 703 | - | 29 | - | - | 1,773 | - | - | - | 7,637 | 28,983 |
| VERMONT | 9,790 | 55 | 9,116 | 460 | 256 | 19,677 | 1,939 | 1,387 | 14,481 | - | - | - | - | - | - | 5,084 | -187 | 42,381 |
| VIRGINIA | 59,045 | 57 | 30,968 | 2,213 | 840 | 93,123 | 10,525 | 10,460 | 77,324 | 2,245 | - | - | - | - | - | 4,366 | 21,241 | 219,284 |
| WASHINGTON 8/ | 157,025 | 343 | 99,098 | 10,679 | 5,091 | 272,236 | 15,445 | 610 | - | 8,891 | 5,700 | 176 | 26 | 2,545 | 416 | 219 | 10,808 | 317,872 |
| WEST VIRGINIA | 22,352 | 3 | 17,248 | 1,037 | 339 | 40,979 | 5,062 | 3,757 | 53,569 | 68 | - | - | - | 1,341 | - | 4 | 6,947 | 111,727 |
| WISCONSIN | 48,549 | 274 | 70,649 | 2,446 | 1,004 | 122,922 | 12,039 | 4,570 | - | - | - | - | - | - | - | 2,884 | 15,115 | 157,834 |
| WYOMING | 4,189 | 42 | 5,728 | 2,121 | 109 | 12,189 | 234 | 701 | - | - | - | - | 13,299 | - | 2,161 | - | 6,396 | 34,980 |
| TOTAL | 3,332,158 | 27,871 | 2,212,699 | 279,818 | 73,151 | 5,925,697 | 433,792 | 191,552 | 971,663 | 85,792 | 63,255 | 10,664 | 249,435 | 11,689 | 41,724 | 29,856 | 621,156 | 8,636,275 |

1/ ROAD-USER REVENUES CONSIST PRIMARILY OF MOTOR-FUEL TAXES, SHOWN IN TABLE MF-1, AND MOTOR-VEHICLE AND MOTOR-CARRIER TAXES SHOWN IN THIS TABLE.

2/ WHERE THE REGISTRATION YEAR IS NOT MORE THAN ONE MONTH REMOVED FROM THE CALENDAR YEAR, REGISTRATION-YEAR RECEIPTS ARE GIVEN. WHERE THE REGISTRATION YEAR IS MORE THAN ONE MONTH REMOVED, CALENDAR-YEAR RECEIPTS ARE GIVEN.

3/ INCLUDES FEES FOR LIGHT TRUCKS AS REPORTED IN TABLE MV-9.

4/ SPECIAL TITLING TAXES IMPOSED UNDER GENERAL SALES TAX LEVIES ARE NOT INCLUDED.

5/ COUNTY OR LOCAL OFFICERS IN MANY STATES ARE ALLOWED SERVICE CHARGES FOR ISSUING REGISTRATIONS, OPERATORS' LICENSES, OR FOR RELATED SERVICES. SOME OF THESE CHARGES ARE INCLUDED WITH REGISTRATION AND OTHER FEES. THE AMOUNTS SHOWN IN THIS COLUMN ARE ESTIMATES OF SERVICE CHARGES THAT ARE COLLECTED AND RETAINED BY LOCAL OFFICIALS AND NOT REPORTED ELSEWHERE IN THIS TABLE.

6/ NUMEROUS STATES IMPOSE TAXES ON THE GROSS RECEIPTS OF MOTOR CARRIERS IN CONNECTION WITH GENERAL STATE SALES TAXES OR TAXES ON ALL TRANSPORTATION COMPANIES OR PUBLIC UTILITIES. THIS COLUMN INCLUDES ONLY THE PROCEEDS OF GROSS RECEIPTS TAXES REPORTED BY THE STATES AS SPECIAL TAXES ON MOTOR CARRIERS.

7/ IN GENERAL, THE PROCEEDS OF SPECIAL WEIGHT OR CAPACITY TAXES IMPOSED AT A FLAT RATE PER VEHICLE ARE INCLUDED UNDER SPECIAL LICENSE FEES AND FRANCHISE TAXES. APPLICATION OR FILING FEES REQUIRED FOR THE ISSUANCE OF CERTIFICATES OF CONVENIENCE AND NECESSITY TO COMMON CARRIERS, AND CORRESPONDING PERMITS TO CONTRACT AND OTHER MOTOR CARRIERS, ARE INCLUDED UNDER CERTIFICATE OR PERMIT FEES.

8/ PROPERTY TAXES FORMERLY LEVIED ON MOTOR VEHICLES HAVE BEEN REPLACED BY "VEHICLE LICENSE FEES" IN CALIFORNIA, AND BY "MOTOR VEHICLE EXCISE TAXES" IN WASHINGTON. BECAUSE OF THE ORIGIN OF THESE TAXES, THE ADMINISTRATIVE OFFICERS OF THE TWO STATES DO NOT CONSIDER THEM TO BE ROAD-USER TAXES. THE AMOUNTS INCLUDED WITH REGISTRATION FEES IN THIS TABLE ARE AS FOLLOWS: CALIFORNIA, AUTOMOBILES $557,202,445, BUSES $12,038,116, TRUCKS $305,590,267, TRAILERS $66,603,293, MOTORCYCLES $9,060,878; WASHINGTON, AUTOMOBILES $116,113,367, BUSES $277,557, TRUCKS $48,215,623, TRAILERS $5,706,299, MOTORCYCLES $2,709,929, DEALERS $53,085.

9/ CONNECTICUT, LOUISIANA, MASSACHUSETTS AND OREGON REGISTER AUTOMOBILES FOR TWO-YEAR PERIODS ON A STAGGERED MONTHLY BASIS.

Source: Highway Statistics, 1982

FIGURE B-9

FIGURE B-10

OTHER TAXES DEDICATED

TO HIGHWAYS — 1980

| STATE | SPECIAL TYPE OF TAX | AMOUNT 1980 | PERCENT TOTAL STATE HWY. REVENUE |
|---|---|---|---|
| ARIZONA | mineral leases | $ 854,192 | 0.4 |
| ARKANSAS | severance tax | 2,476,182 | |
| | mineral leases | 83,820 | 1.1 |
| KANSAS | mineral leases | 445,710 | 0.2 |
| KENTUCKY | coal severance tax | 33,194,680 | 6.5 |
| MARYLAND | corporate income tax | 5,366,270 | 1.4 |
| MASSACHUSETTS | cigarette tax | 17,600,000 | 4.4 |
| MISSISSIPPI | cigarette tax | 5,005,540 | 1.6 |
| MONTANA | mineral leases | 3,580,444 | |
| | coal tax | 1,786,708 | 7.0 |
| NEW MEXICO | severance tax | 20,314,705 | 13.7 |
| NORTH DAKOTA | gas and coal production tax | 4,580,022 | 6.7 |
| OKLAHOMA | oil severance tax | 28,988,239 | 6.7 |
| SOUTH DAKOTA | game and fish license | 221,525 | 0.3 |
| WYOMING | coal severance tax | 16,361,000 | |
| | mineral royalties (fed) | 39,603,000 | 58.6 |

Source: "State Highway Finance Analysis Schedule: FHWA Form PR-533," compiled from information submitted annually by States (September 1981). "Highway Statistics 1980," FHWA, 1982, Table SF-1.

These formulas are also useful to provide the estimates of direct impacts on highway users. Impact analyses are discussed in Chapter IV and Appendix C. Impact estimates for various groups provide valuable information on the economic incidence of the alternative systems. This analysis may be particularly useful if tax rates are to be changed without prior cost-allocation analysis and guidance.

## FIRST STRUCTURE TAXES

Registration and allied taxes are the principal first structure taxes. Each requires a slightly different estimating approach, depending on the form of the tax. Registration taxes levied either as a flat fee or as a graduated fee by vehicle class or weight are the simplest form to compute. These can be calculated using the formula:

$$T = F * t,$$

where $T$ = registration tax revenue

$F$ = fleet size

$t$ = registration tax rates.

Calculating excise on vehicle sales, registration fees and property taxes assessed on the vehicle value imposes more complexity on required data and methods. The general form for estimating these fees is

$$T = F * V * T,$$

where $V$ = average vehicle value (assessed or purchase priced) and other variables are as described above.

With property taxes assessed on the declining vehicle value over time, V may be estimated as

$$V_y = V_0 * (1-d)^y,$$

where superscript y refers to the vehicle's vintage
(0 represents new vehicles),
d is the depreciation rate
(often prescribed in revenue department rules),
and other variables are as above.

As an example, property or excise taxes levied on the assessed value of a five year old vehicle might be computed as follows. If the original assessed value is assumed to be $10,000 with a prescribed depreciation rate of 20 percent <u>per annum</u> and a tax rate of $25.00 per $1,000 valuation (i.e., 2.5%), then per vehicle assessments would be,

$$T = F * V_y * t \text{, or}$$
$$T = F * (V_0 * (1 - d)^y * t) \text{,}$$

For a single vehicle F = 1, so

$$T = \$10,000 * (1 - .2)^5 * 0.025$$
$$= \$10,000 * .32768 * .025$$
$$= \$81.92.$$

Total accumulated revenue by vehicle class is simply the product of tax revenues by vintage and fleet size.

## SECOND STRUCTURE TAXES

Taxes assessed on fuel or other items consumed with vehicle travel, such as tolls, can be estimated as follows:

$$T = VMT * CR * t$$

where VMT = vehicle miles of travel,
CR = consumption rate (e.g. gallons per mile or toll charge per mile),
and other variables are as above.

Separate assessments should be made for gasoline and diesel (and other special fuels) since the consumption rates are different. It should also be kept in mind that both consumption rates and mileages vary over time. These should be reflected in any forecasts. For example, to assess fuel taxes for a vehicle travelling 10,000 miles per annum with a fuel consumption rate of 20 miles per gallon (o.05 gallon per mile) and a tax rate of 10¢ per gallon, taxes are

$$T = 10{,}000 * 0.05 * \$0.1 = \$50.00.$$

Any other travel related tax can be estimated the same way. With some taxes the consumption per mile can only be roughly estimated, for example parking fees and special excises. These require some thought to define the proper consumption rate.

## THIRD STRUCTURE TAXES

Third structure taxes may include ton-mile, gross-weight distance, and axle-weight distance taxes, among others. These taxes vary with both vehicle characteristics (such as weight or capacity requirements) and distance traveled. Weight-distance taxes are often considered to have a perverse impact on pavement wear. Since the tax is on gross vehicle weight, and no explicit condition is imposed on particular axle loads which determine highway wear and tear, this tax appears to create an incentive to load axles too heavily. It is nevertheless suggested that this tax is less distorting than those which ignore either or both weight and distance. Axle-weight distance taxes, however, may provide the incentives desired by the policy-maker; that is, spreading loads over more axles.

A variety of third structure taxes are conceivable. Discussion here will be limited to weight-distance and axle-weight-distance taxes. Other possible forms might be ESAL-mile and PCE-mile taxes. (Both ESAL, equivalent single axle load; and PCE, passenger car equivalent, are discussed in the appendices to Chapter 2.) Various forms of graduated or differentiated taxes are possible as well.

Weight-distance taxes may be assessed on the gross vehicle weight (GVW), average operating weight, average loaded weight, tare weight or any other desired weight basis, and the estimated travel. The form shown is for a fixed rate tax, which can be assumed to represent only one tax bracket if a graduated scheme is of interest. The general form for revenues derived from these taxes is:

$$T = W * VMT * t ,$$

where W represents selected weight basis and other variables are as above.

If this tax were assessed on a vehicle with a declared gross weight of 80,000 pounds, estimated to travel 100,000 miles annually, and the tax rate was assumed to be 50¢ per thousand kip-miles,*/ the total tax per vehicle would be calculated as:

$$80 * 100 * \$0.5 = \$4000.00$$

An alternative tax, which would encourage the use of more axles per load, is the axle-weight-distance tax. Axle-weight-distance taxes are assessed on the weight-per-axle as follows,

$$T_A = W_A * VMT * t,$$

where $T_A$ is the tax revenue for the particular axle,
$W_A$ is the weight borne by the axle,
and the other variables are as above.

The total tax for the vehicle is the sum over all axles.

$$T = \sum T_A$$

This tax can be isolated to heavier vehicles by establishing axle weight thresholds below which the tax is not levied. This is often considered desirable given the conclusions of many transportation analysts that heavier vehicles cause more highway and road costs than can conveniently be collected through traditional, or simpler, tax sources and simultaneously provide correct charges by axle load.

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*/ Kip equals 1000 pounds.

As an example, it might be useful to calculate the tax on a typical eighteen-wheel combination (3S2). For this example assume a 3S2 rig travelling 100,000 miles annually, with a declared gross combination weight of 78,000 pounds and a tax rate of 50¢ per thousand kip-axle miles. Based on the Bridge Formula*/ assume the steering axle carries 10,000 pounds and the two sets of tandem axles carry an evenly distributed 34,000 pounds per set. Also assume a weight threshold of 9,000 pounds per axles below which no taxes are assessed; taxes estimated under these assumptions are:

| | | |
|---|---|---|
| steering axle - 1* (10-9) *100 x $.5 | = | $ 50 |
| drive axles - 2* (17-9) *100 x $.5 | = | $800 |
| trailer axles - 2* (17-9) *100 x $.5 | = | $800 |
| Total | | $1,650 |

If a third axle (tridem) were placed under the semi-trailer the annual tax on the combination would be reduced to $1200. (The rear axle set would be assessed $350 annually based on an average weight of 11,333 pounds each as opposed to 17,000 pounds above.) Assumptions of different weight distributions, different number of axles or graduation by axle-loads will yield different results.

The sum of revenues attributed by vehicle type over the entire fleet will provide an estimate or forecast of total highway tax revenues. For a variety of reasons historical estimates may not equal realized tax revenues. These reasons include tax evasion, errors in the data, possible exemptions and others. After carefully checking data and other correctable errors, one should calculate differences in estimated revenues versus receipts, by tax source, for some historical period. These ratios can provide the basis for estimating potential discrepancies in forecasts.

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*/ Public Law 97-424, January 6, 1983, Sec. 133, Section 127 of Title 23 of United States Code.

The formulas above were used for revenue attribution and impact analyses in the Federal Highway Cost Allocation Study. To provide for the numerous and repetitious test runs, necessary to devise a user-charge schedule that fit cost responsibilities, these formulas were incorporated in a set of computer programs with provisions made for easy entry of new user-charge rates and structures. In this way it was possible to fine-tune the user charge alternatives which match both individual and total responsibilities as well as allowing examination of both different user charge structures and rates.

## VEHICLE CLASSES

An essential step in the revenue and cost comparison is the definition of a set of vehicle classes, compatible with cost-allocation classes. Figure B-11 reviews vehicle classifications of eighteen recent cost-allocation studies. It shows that no uniformity exists in the number of classes, their definition, or even in the definition of "heavy" vehicle.

The equity of a highway user tax structure can be assessed most easily by comparing the total costs occasioned, by vehicle type, with the total revenues generated. Individual States vary in the definition of these vehicle types and the method of comparison. A few examples from previous State studies should suffice to show the various types of classes and comparisons.

The Oregon Motor Vehicle Cost Responsibility Study, 1980 is a fairly representative study. Figure B-12 shows the method used to allocate shares of the total highway budget to vehicle classes. Figure B-13 is the tabular version of these shares converted into a taxable unit, mills per mile. Figure B-14 shows the resulting tax schedule. Figure B-15 reflects the equity aspects - a comparison of cost responsibility and actual payments.

## FIGURE B-11

## VEHICLE CLASSES CONSIDERED IN RECENT STATE HIGHWAY COST ALLOCATION STUDIES

| State | Number of Classes | Where Does "Heavy Vehicle" Class Begin | How Many Heavy Vehicle Classes? | Class Internal Used in Heavy Vehicle Breakdown | Are Small Trucks Included With Autos In Lightest Class? |
|---|---|---|---|---|---|
| Arkansas | 24 | Trucks, 6001 lbs. | 21 | 4,000 lbs to 38,000; 40,000-52,000 56,000-64,000 68,000-72,000 2,000 lbs for 38,000-40,000 52,000-56,000 64,000-68,000 72,000-73,200 | No |
| California | 2 | Trucks, 8,001 lbs., 2 or more axles, 6 or more tires, or any vehicle over 10,000 lbs. | No breakdown given | No breakdown given | Yes |
| Florida | 7 | 2 and 3 axle single unit trucks with dual rear tires | 4 | 3 axle, 4 axle, and 5 axle tractor truck semi-trailer | No |
| Georgia | 7 | 2 and 3 axle single unit trucks with dual rear tires | 4 | 3 axle, 4 axle, and 5 axle tractor truck semi-trailer | No |
| Iowa | 2 | Straight trucks larger than pickups motor homes, buses | 1 | No breakdown given | Yes |
| Kentucky | 14 | Single unit, 2 axle 6 tire trucks | 10 | 4,000 - 11,280 lbs. | Yes |
| Michigan | 5 (24)1/ | Trucks and Combinations | 2 (20)1/ | 1,500-2,000 lbs. for trucks; 4,000, 6,000, 8,000, 10,000, 15,000 lbs. for combinations | No |

Source: Highway Cost Allocation Study, Working Paper Number 15. "State Highway Cost Allocation Methods." Florence Banks, U.S. Department of Transportation, FHWA, March, 1982.

FIGURE B-11 (CONT.)

VEHICLE CLASSES CONSIDERED IN RECENT STATE HIGHWAY COST ALLOCATION STUDIES

| State | Number of Classes | Where Does "Heavy Vehicle" Class Begin | How Many Heavy Vehicle Classes? | Class Internal Used in Heavy Vehicle Breakdown | Are Small Trucks Included With Autos In Lightest Class? |
|---|---|---|---|---|---|
| Minnesota | 11 | Trucks 9,000 lbs. and over; difficult to determine where heavy vehicle class begins --?? urban trucks, commercial trucks, Minnesota and non-Minnesota based trucks?? | Not stated | No breakdown given | No |
| Mississippi | 2 | 2 or more axles, at least 6 tires | Not stated | No breakdown given | No |
| Missouri | 15 2/ | Trucks, 6,001 lbs. | 13 | 6,000 lbs. units | No |
| New Mexico | 8 major types (24) 3/ | Combinations (?)<br>Single unit trucks (?) | 1 or 2<br>(?)<br>(19) or<br>(18) 3/ | 2,000 lbs. units, gross registered weight within "Trucks," "Combinations" and "Farm Vehicles" | No |
| Oregon | 2 (45 weight groups) | 6,000 lbs. | 3 (44) | Up to 16,000 lbs; 165,000 - 76,000 lbs; Over 76,000 lbs. (2,000 lbs intervals) | Yes |
| South Dakota | 2 | All trucks other than pickup trucks which were classified with automobiles in "light" category | 1 | No breakdown given | Yes |
| Virginia | 5 | 2 axle, 6 tire trucks (equivalent of 6,480 lbs.) | 4 | Not state in gross weight terms but in terms of axle number and/or tire number | Yes |
| Washington | 15 4/ | Single-unit, 2 axle/ 4 tire or 2 axle stages (?) | 9 or 11 inlcuding stages(?) | Not stated | No |

FIGURE B-11 (CONT.)

VEHICLE CLASSES CONSIDERED IN RECENT STATE HIGHWAY COST ALLOCATION STUDIES

| State | Number of Classes | Where Does "Heavy Vehicle" Class Begin | How Many Heavy Vehicle Classes? | Class Internal Used in Heavy Vehicle Breakdown | Are Small Trucks Included With Autos In Lightest Class? |
|---|---|---|---|---|---|
| Wisconsin | 14 5/ | Not available | Not available | 168 classes of axle configureations and weight groups. Weight intervals varied from 0 - 20,000 pound gross register weight, 6,000 pound intervals over 20,000 pounds. | No |
| Wyoming | 13 5/ | Trucks, empty weights 0-2,500 (?) | 10 | Empty weight:<br>2,500 lbs.—up to 2,500 lbs.<br>2,000 lbs.—2,501 - 6,500 lbs.<br>5,000 lbs.—6,501 - 36,500 lbs. | No |

1/ There are five major classes indicated in the Michigan study in computing incremental costs. These classes expand to a total of 24 when subdivisions by weight groups are made in assigning costs and in comparing user responsibilities with estimated tax payments.

2/ Although the study indicates 15 registration classes, there are actually 16 classes of vehicles. Buses are subdivided into two groups: commercial and school.

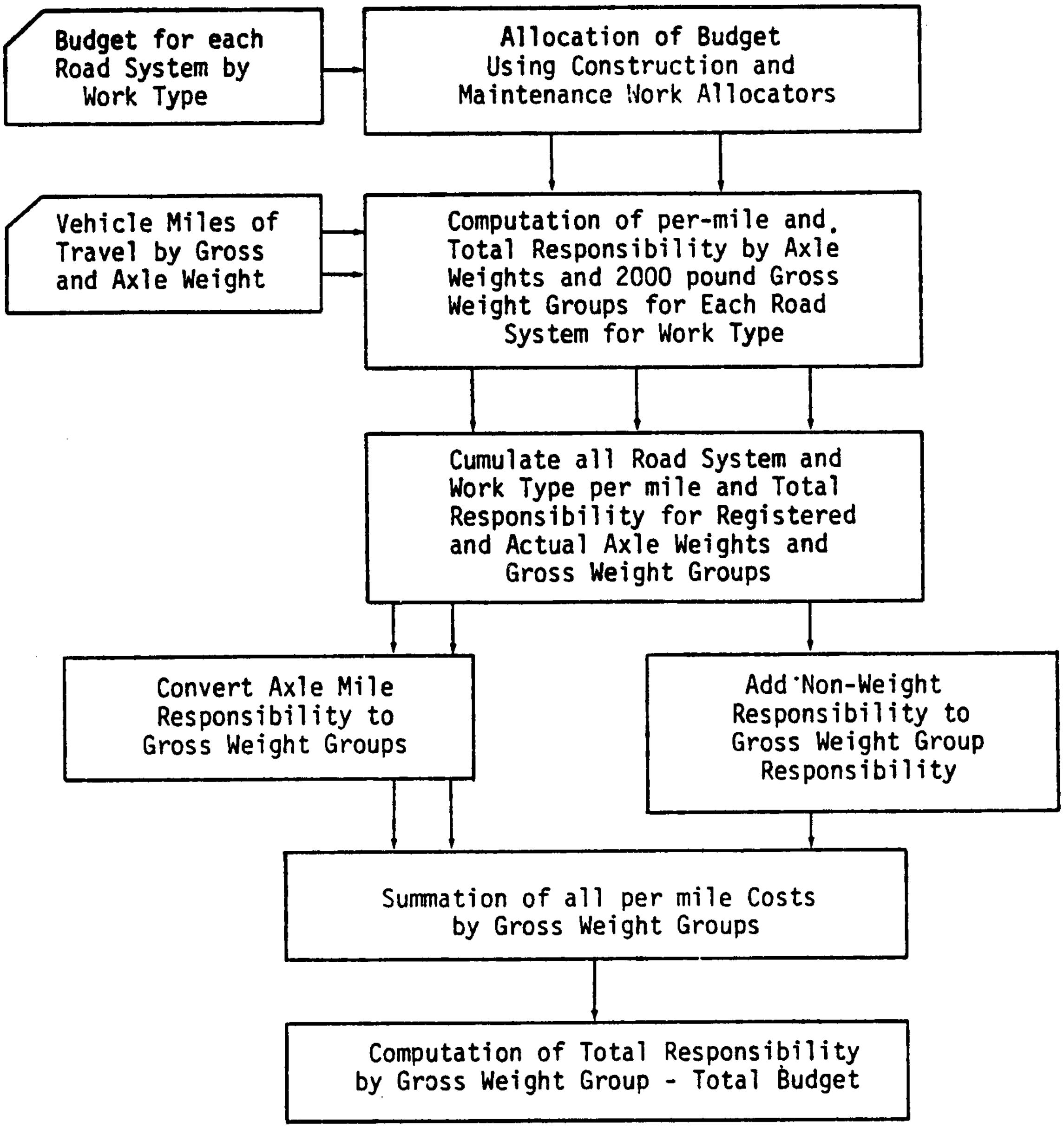
3/ In addition to automobiles, taxis, two classes of buses, pickups and panels, there are 6 gvw categories of single unit trucks, 8 gvw categories of combinations and 5 gvw categories of farm truck. Trucks and combinations are further subdivided into 2,000 lb. gvw units.

4/ The following classes are indicated: passenger cars, taxis, 2 axle stages, 3 axle stages, private buses, motorcycles, 3 groups of single unit trucks, 3 groups of tractor/semi-trailers, and 2 groups of truck/trailers and tractor trains. Actually, annual cost responsibility versus tax payment, by vehicle type, was shown for 241 individual vehicle types and registered gross vehicle weights.

5/ There are 3 major classes noted: passenger cars, commercial buses and trucks. Trucks are broken into 10 subcategories. No allocation is made to motorcycles or recreational vehicles.

FIGURE B-12

COST RESPONSIBILITY STUDY WORK FLOW




Source: Oregon study, 1980.

FIGURE B-13

TOTAL AND NET RESPONSIBILITY FOR OREGON'S CLASSES OF VEHICLES - BUDGET #1 - CURRENT EXPENDITURE LEVEL

(Biennium 1981-83)[1]

| Gross Vehicle Weight Group | TOTAL RESPONSIBILITY Dollars - $ | TOTAL RESPONSIBILITY Mills per Mile | NET RESPONSIBILITY[2] Dollars - $ | NET RESPONSIBILITY[2] Mills per Mile |
|---|---|---|---|---|
| Basic Vehicles (0- 6,000 lbs.) | $ 99,115,973 | 5.313 | $ 78,701,240 | 4.312 |
| 6,001- 8,000 lbs. | 376,323 | 12.706 | 91,412 | 12.368 |
| 8,001-10,000 lbs. | 1,127,323 | 13.541 | 539,747 | 11.546 |
| 10,001-12,000 lbs. | 745,480 | 14.343 | 451,021 | 11.884 |
| 12,001-14,000 lbs. | 489,523 | 15.368 | 303,318 | 12.212 |
| 14,001-16,000 lbs. | 443,736 | 16.390 | 259,515 | 12.266 |
| 16,001-18,000 lbs. | 619,730 | 18.078 | 344,463 | 13.908 |
| 18,001-20,000 lbs. | 330,544 | 19.635 | 154,812 | 12.520 |
| 20,001-22,000 lbs. | 968,874 | 20.517 | 144,033 | 13.004 |
| 22,001-24,000 lbs. | 890,792 | 21.448 | 238,381 | 13.333 |
| 24,001-26,000 lbs. | 670,026 | 23.088 | 226,776 | 13.850 |
| 26,001-28,000 lbs. | 1,479,826 | 24.203 | 544,427 | 16.405 |
| 28,001-30,000 lbs. | 1,489,292 | 26.430 | 277,363 | 18.222 |
| 30,001-32,000 lbs. | 1,239,008 | 27.589 | 161,317 | 19.447 |
| 32,001-34,000 lbs. | 314,880 | 29.420 | 126,084 | 21.527 |
| 34,001-36,000 lbs. | 654,406 | 30.881 | 394,343 | 23.073 |
| 36,001-38,000 lbs. | 212,893 | 31.652 | 113,759 | 23.557 |
| 38,001-40,000 lbs. | 349,136 | 32.408 | 202,047 | 23.031 |
| 40,001-42,000 lbs. | 578,960 | 33.719 | 214,815 | 20.946 |
| 42,001-44,000 lbs. | 4,154,980 | 34.763 | 3,451,139 | 31.993 |
| 44,001-46,000 lbs. | 2,146,741 | 38.198 | 1,582,693 | 32.533 |
| 46,001-48,000 lbs. | 747,397 | 38.820 | 477,177 | 31.198 |
| 48,001-50,000 lbs. | 1,565,884 | 41.545 | 1,179,559 | 35.525 |
| 50,001-52,000 lbs. | 410,327 | 43.862 | 2266,620 | 34.292 |
| 52,001-54,000 lbs. | 187,263 | 41.837 | 104,482 | 27.561 |
| 54,001-56,000 lbs. | 186,781 | 46.302 | 113,391 | 32.781 |
| 56,001-58,000 lbs. | 153,735 | 40.909 | 93,473 | 28.028 |
| 58,001-60,000 lbs. | 678,346 | 43.801 | 451,037 | 30.498 |
| 60,001-62,000 lbs. | 133,145 | 47.450 | 85,297 | 33.280 |
| 62,001-64,000 lbs. | 229,865 | 44.086 | 162,633 | 33.381 |
| 64,001-66,000 lbs. | 202,844 | 49.366 | 152,844 | 37.739 |
| 66,001-68,000 lbs. | 175,106 | 52.600 | 137,638 | 42.891 |
| 68,001-70,000 lbs. | 164,430 | 55.777 | 138,796 | 47.811 |
| 70,001-72,000 lbs. | 428,636 | 55.819 | 332,511 | 43.763 |
| 72,001-74,000 lbs. | 1,488,170 | 58.728 | 1,096,536 | 43.384 |
| 74,001-76,000 lbs. | 3,004,759 | 66.329 | 2,475,966 | 55.673 |
| 76,001-78,000 lbs. | 16,158,428 | 79.397 | 14,462,294 | 71.455 |
| 78,001-80,000 lbs. | 34,592,080 | 77.418 | 31,249,008 | 69.984 |
| 80,001-82,000 lbs. | 1,834,670 | 95.209 | 1,687,626 | 87.628 |
| 82,001-84,000 lbs. | 2,281,625 | 105.876 | 2,114,237 | 98.108 |
| 84,001-86,000 lbs. | 2,075,541 | 127.522 | 1,946,225 | 119.576 |
| 86,001-88,000 lbs. | 1,412,066 | 153.853 | 1,337,772 | 145.759 |
| 88,001-90,000 lbs. | 371,498 | 149.556 | 351,007 | 141.308 |
| 90,001 and over lbs. | 396,190 | 139.454 | 371,531 | 130.775 |
| Heavy Vehicle Total | $ 88,161,259 | 51.555 | $ 70,669,127 | 51.190 |
| TOTAL | $187,277,232 | 9.196 | $149,370,367 | 7.609 |

[1] The biennial expenditures are on an annual basis.

[2] Net responsibility is obtained after adjusting for payment of registration fees and reallocation of subsidies given to farm and exempt vehicles.

FIGURE B-14

RECOMMENDED AND ALTERNATE WEIGHT-MILE TAX SCHEDULES
FOR DIESEL-POWERED VEHICLES - BUDGET #1
(Mills per Mile)

| Gross Vehicle Wt. Group (lbs.) | Net Responsibility | Recommended Schedule | Alternate Schedule | Existing Statutory Schedule |
|---|---|---|---|---|
| Cars | 4.312 | ---- | ---- | |
| 0- 6,000 | ---- | 7.0 | 6.0 | 6.0 |
| 6,001- 8,000 | 12.368 | 10.0 | 7.5 | 8.0 |
| 8,001-10,000 | 11.546 | 12.0 | 9.0 | 9.5 |
| 10,001-12,000 | 11.884 | 13.0 | 10.5 | 11.5 |
| 12,001-14,000 | 12.212 | 14.0 | 12.0 | 13.5 |
| 14,001-16,000 | 12.266 | 15.0 | 13.0 | 15.5 |
| 16,001-18,000 | 13.908 | 16.0 | 14.0 | 17.5 |
| 18,001-20,000 | 12.520 | 17.0 | 15.0 | 19.5 |
| 20,001-22,000 | 13.004 | 18.0 | 16.0 | 21.0 |
| 22,001-24,000 | 13.333 | 19.0 | 17.5 | 23.5 |
| 24,001-26,000 | 13.850 | 20.0 | 19.0 | 25.0 |
| 26,001-28,000 | 16.405 | 21.0 | 20.5 | 26.5 |
| 28,001-30,000 | 18.222 | 22.0 | 22.0 | 28.5 |
| 30,001-32,000 | 19.447 | 23.5 | 23.5 | 30.5 |
| 32,001-34,000 | 21.527 | 25.0 | 25.0 | 32.5 |
| 34,001-36,000 | 23.073 | 26.5 | 26.5 | 34.0 |
| 36,001-38,000 | 23.557 | 28.0 | 28.0 | 35.5 |
| 38,001-40,000 | 23.031 | 30.0 | 30.0 | 37.5 |
| 40,001-42,000 | 20.946 | 32.0 | 32.0 | 39.0 |
| 42,001-44,000 | 31.993 | 34.0 | 34.0 | 40.5 |
| 44,001-46,000 | 32.533 | 35.0 | 36.0 | 42.5 |
| 46,001-48,000 | 31.198 | 36.0 | 38.0 | 44.5 |
| 48,001-50,000 | 35.525 | 37.0 | 40.0 | 46.0 |
| 50,001-52,000 | 34.292 | 38.0 | 42.0 | 48.0 |
| 52,001-54,000 | 27.561 | 39.0 | 44.0 | 50.0 |
| 54,001-56,000 | 32.781 | 40.0 | 46.0 | 52.0 |
| 56,001-58,000 | 28.028 | 41.0 | 48.0 | 53.5 |
| 58,001-60,000 | 30.498 | 42.0 | 50.0 | 54.5 |
| 60,001-62,000 | 33.280 | 44.0 | 52.0 | 55.5 |
| 62,001-64,000 | 33.381 | 46.0 | 54.0 | 57.0 |
| 64,001-66,000 | 37.739 | 48.0 | 56.0 | 58.0 |
| 66,001-68,000 | 42.891 | 50.5 | 58.0 | 59.0 |
| 68,001-70,000 | 47.811 | 53.5 | 60.0 | 60.0 |
| 70,001-72,000 | 43.763 | 56.5 | 62.0 | 61.5 |
| 72,001-74,000 | 43.384 | 59.5 | 64.0 | 62.0 |
| 74,001-76,000 | 55.673 | 63.0 | 66.0 | 63.0 |
| 76,001-78,000 | 71.455 | 66.5 | 68.0 | 64.0 |
| 78,001-80,000 | 69.984 | 70.5 | 70.0 | 65.0 |
| 80,001 & Over | | Add 4.0 Mills per ton above 80,000 lbs. | Add 2.0 Mills per ton above 80,000 lbs. | Add 1.0 Mills per ton above 80,000 lbs. |

## FIGURE B-15

## CROSS-SUBSIDIES IN HEAVY VEHICLE WEIGHT GROUPS
(Current Tax Rates)

| Weight Group (000 lbs.) | Net Responsibility | Actual Payments Based on Current Tax Rates | Difference* | % Difference |
|---|---|---|---|---|
| 0-16 | $ 1,645,013 | $ 1,602,919 | $ 42,094 | 2.56 |
| 16-76 | 15,504,412 | 21,312,408 | -5,807,996 | -37.46 |
| Over 76 | 53,519,702 | 46,807,664 | 6,712,038 | 12.54 |

| Weight Group (000 lbs.) | Total Adjusted Responsibility | Actual Payments Based on Current Tax Rates | Difference* | % Difference |
|---|---|---|---|---|
| 0-16 | $ 2,026,869 | $ 1,984,775 | $ 42,094 | 2.08 |
| 16-76 | 19,546,727 | 25,354,723 | -5,807,996 | -29.71 |
| Over 76 | 59,150,410 | 52,438,372 | 6,712,038 | 11.35 |

*Positive difference indicates <u>underpayment</u> relative to responsibility and negative difference indicates <u>overpayment</u> relative to responsibility.

Figure B-16 is from the Washington State Highway Cost Allocation Study (January 1977). It shows the cost/tax comparison as a ratio and at a more disaggregate level.

The 1972 State of New Mexico Cost Allocation Study is at a very fine level of disaggregation and shows the comparison as an absolute level. It also offers three different cost allocation methods. These are shown in Figure B-17.

The Maryland Cost Allocation Study, February 1982 offers disaggregate detail, two costing methods, and a distinction between the State highway system and the total highway system. The "costs" used were the actual expenditures for 1979-81 and estimated costs for the period 1982-4. Figures B-18 and B-19 show these results.

## RECIPROCITY AND PRORATION

Reciprocity and proration compacts facilitate the exchanges of user charges among States, where payments of user fees may be made in certain States while travel OCCURS in other States. These compacts act to smooth the differences between the revenue contributions from particular users and the wear and tear they impose on the road system for particular States. Detail on this subject is provided in the joint U.S. DOT and ICC publication, Uniform State Regulations.*/

*/ U.S. Department of Transportation and Interstate Commerce Commission, Uniform State Regulations: Motor Carrier Act of 1980, Section 19, Report to Congress, 1982.

FIGURE B-16

ANNUAL COST RESPONSIBILITY VS. ANNUAL TAX PAYMENT BY VEHICLE TYPE FOR CASE-3 (AVERAGE) PAVEMENT INCREMENTS -- JUNE 1976 BUDGET

| | | BASIC RESULTS | | | IMPACT OF UNIFORM TAX INCREASE[1] | | |
|---|---|---|---|---|---|---|---|
| | Annual Cost Responsibility | Annual Tax Payment | Annual Cost Less Tax | Ratio: Tax ÷ Cost | Annual Tax Payment | Annual Cost Less Tax | Ratio: Tax ÷ Cost |
| Passenger Cars | $ 94 | $ 64 | $ 30 | .68 | $ 91 | $ 3 | .97 |
| Taxis | 531 | 909 | (378) | 1.71 | 1,298 | (767) | 2.44 |
| Stages: | | | | | | | |
| 2-axle | 2,200 | 706 | 1,494 | .32 | 1,008 | 1,192 | .46 |
| 3-axle | 4,798 | 1,283 | 3,515 | .27 | 1,824 | 2,974 | .38 |
| Private Buses | 85 | 81 | 4 | .95 | 116 | (31) | 1.37 |
| Motorcycles | 31 | 18 | 13 | .58 | 26 | 5 | .84 |
| Single-Unit Trucks: | | | | | | | |
| 2-axle/4-tire | 69 | 63 | 6 | .91 | 90 | (21) | 1.30 |
| 2-axle/6-tire | 344 | 212 | 132 | .62 | 303 | 41 | .88 |
| 3-axle | 901 | 846 | 55 | .94 | 1,208 | (307) | 1.34 |
| Tractor/Semi-Trailers: | | | | | | | |
| 3-axle | 1,172 | 695 | 477 | .59 | 992 | 180 | .85 |
| 4-axle | 1,095 | 874 | 221 | .80 | 1,248 | (153) | 1.14 |
| 5-axle | 2,805 | 1,859 | 946 | .66 | 1,654 | 151 | .95 |
| Truck/Trailers: | | | | | | | |
| 4-axle | 3,016 | 1,725 | 1,291 | .57 | 2,418 | 598 | .80 |
| 5-axle | 4,467 | 2,083 | 2,384 | .47 | 2,974 | 1,493 | .67 |
| Tractor Trains | 2,927 | 1,898 | 1,029 | .65 | 2,710 | 217 | .93 |

( ) Indicates tax overpayment, i.e., tax payment exceeds cost responsibility.

1. Tax payments for all vehicle-types uniformly factored upward by multiplier equal to program cost ($328.2 million) divided by aggregate crisis forecast tax payment ($229.9).

Source: Washington State study.

FIGURE B-17

COMPARISON OF NET STATE USER RESPONSIBILITY AND NET STATE TAX PAYMENTS PER VEHICLE BY THE THREE COST ALLOCATION METHODS FOR SELECTED VEHICLES

| Vehicle Type and Gross Registered Weight | Net State Tax Payment (Credit) | Incremental Method | | Cost-Function Method | | Ton-Mile Method | |
|---|---|---|---|---|---|---|---|
| | | Net State User Responsibility | Balance | Net State User Responsibility | Balance | Net State User Responsibility | Balance |
| Automobiles | $ 71 | $ 109 | $ -38 | $ 105 | $ -34 | $ 63 | $ +8 |
| Taxi | 329 | 262 | +67 | 254 | +75 | 161 | +168 |
| Commerical Bus | 829 | 1,497 | -668 | 1,726 | -897 | 3,226 | -2,397 |
| Other Bus | 166 | 379 | -213 | 482 | -316 | 802 | -636 |
| Pickups and Panels | 64 | 126 | -62 | 115 | -51 | 61 | +3 |
| Single Unit Trucks | | | | | | | |
| 04 | 79 | 172 | -93 | 168 | -89 | 141 | -52 |
| 10 | 123 | 219 | -96 | 212 | -89 | 273 | -150 |
| 20 | 241 | 284 | -43 | 291 | -50 | 547 | -306 |
| 30 | 283 | 331 | -48 | 378 | -95 | 885 | -502 |
| 40 | 335 | 361 | -26 | 474 | -139 | 1,290 | -955 |
| 56 | 406 | 369 | +37 | 642 | -236 | 2,070 | -1,664 |
| Combinations | | | | | | | |
| 20 | 427 | 582 | -155 | 624 | -197 | 1,445 | -1,018 |
| 30 | 506 | 706 | -200 | 763 | -257 | 1,839 | -1,333 |
| 40 | 619 | 911 | -292 | 1,023 | -404 | 2,596 | -1,977 |
| 50 | 763 | 1,195 | -432 | 1,404 | -641 | 3,716 | -2,953 |
| 60 | 948 | 1,545 | -597 | 1,902 | -954 | 5,195 | -4,247 |
| 70 | 1,191 | 1,978 | -787 | 2,507 | -1,316 | 7,022 | -5,831 |
| 80 | 1,740 | 2,368 | -628 | 3,118 | -1,378 | 9,097 | -7,357 |
| 86.4 | 2,248 | 2,514 | -266 | 3,444 | -1,196 | 10,592 | -8,344 |
| Farm Trucks | | | | | | | |
| 08 | 53 | 64 | -11 | 67 | -14 | 78 | -25 |
| 20 | 91 | 101 | -10 | 112 | -21 | 220 | -129 |
| 40 | 165 | 191 | -26 | 338 | -223 | 1,001 | -836 |
| 50 | 208 | 240 | -32 | 599 | -391 | 1,638 | -1,430 |
| 56 | 237 | 270 | -33 | 750 | -513 | 2,098 | -1,861 |

Source: State of New Mexico Cost Allocation Study, 1972.

FIGURE B-18

COMPARISON OF PERCENT STATE USER PAYMENTS AND RESPONSIBILITIES
STATE HIGHWAY SYSTEM
1979-1984

| VEHICLE TYPE GROSS REGISTERED WEIGHT (POUNDS) | PERCENT OF STATE USER TAX PAYMENTS | PERCENT OF RESPONSIBILITY | | RATIO OF PERCENT REVENUES/RESPONSIBILITY | |
|---|---|---|---|---|---|
| | | INCREMENTAL | FEDERAL PRIMARY | INCREMENTAL | FEDERAL PRIMARY |
| Automobiles | 67.39 | 67.19 | 57.36 | 1.00 | 1.17 |
| Buses | 0.89 | 0.81 | 1.13 | 1.10 | 0.79 |
| Pickups/Vans (Less than 10,000) | 13.49 | 13.26 | 12.05 | 1.02 | 1.12 |
| SINGLE UNIT TRUCKS (Class E) | | | | | |
| 10,000 - 18,000 | 3.15 | 3.23 | 3.35 | 0.98 | 0.94 |
| 18,001 - 26,000 | 1.57 | 1.42 | 1.71 | 1.11 | 0.92 |
| 26,001 - 38,000 | 2.25 | 1.95 | 3.22 | 1.15 | 0.70 |
| 38,001 - 68,000 | 0.92 | 0.73 | 1.17 | 1.26 | 0.79 |
| SUB-TOTAL SINGLE UNITS | 7.89 | 7.33 | 9.45 | 1.08 | 0.83 |
| Dump Trucks - 40,000 | 0.23 | 0.15 | 0.38 | 1.53 | 0.61 |
| Dump Trucks - 65,000 | 1.86 | 1.33 | 3.31 | 1.40 | 0.56 |
| TOTAL SINGLE UNITS | 9.98 | 8.81 | 13.14 | 1.13 | 0.76 |
| TRUCK TRACTORS (Class F) | | | | | |
| 40,000 - 68,000 | 2.50 | 2.89 | 4.67 | 0.87 | 0.54 |
| 68,001 - 76,000 | 2.26 | 2.49 | 4.11 | 0.91 | 0.55 |
| 76,001 - 79,000 | 3.49 | 4.55 | 7.54 | 0.77 | 0.46 |
| TOTAL TRUCK TRACTORS | 8.25 | 9.93 | 16.32 | 0.83 | 0.51 |
| TOTAL ALL VEHICLES | 100.00 | 100.00 | 100.00 | | |

NOTE: A ratio of 1.00 indicates equity in user tax payments (payments equals responsibility).
A ratio of less than 1.00 indicates an underpayment of user taxes.

Source: Maryland Cost Allocation Study. February, 1982.

FIGURE B-19

## PERCENT OF TOTAL RESPONSIBILITY AND USER TAX PAYMENTS

| VEHICLE TYPE GROSS REGISTERED WEIGHT | PERCENT OF TOTAL USER RESPONSIBILITY | | | | PERCENT OF TOTAL STATE USER TAX PAYMENT |
|---|---|---|---|---|---|
| | ALL SYSTEMS | | STATE HIGHWAY SYSTEM | | |
| | INCREMENTAL | FEDERAL PRIMARY METHOD | INCREMENTAL | FEDERAL PRIMARY METHOD | |
| Automobiles | 71.26 | 61.56 | 67.19 | 57.36 | 67.39 |
| Buses | 1.06 | 2.31 | 0.81 | 1.13 | 0.89 |
| Pickups/Vans (Less Than 10,000) | 12.16 | 11.19 | 13.26 | 12.05 | 13.49 |
| Single Unit Trucks (Class E) | | | | | |
| 10,000 | 1.42 | 1.39 | 1.56 | 1.59 | 1.47 |
| 14,000 | 0.15 | 0.15 | 0.17 | 0.17 | 0.16 |
| 18,000 | 1.36 | 1.46 | 1.50 | 1.59 | 1.52 |
| 22,000 | 0.45 | 0.56 | 0.50 | 0.57 | 0.56 |
| 26,000 | 0.82 | 1.11 | 0.92 | 1.14 | 1.01 |
| 30,000 | 0.34 | 0.58 | 0.38 | 0.53 | 0.38 |
| 34,000 | 0.96 | 1.63 | 1.10 | 1.79 | 1.31 |
| 38,000 | 0.42 | 0.90 | 0.47 | 0.90 | 0.56 |
| 42,000 | 0.05 | 0.08 | 0.06 | 0.09 | 0.08 |
| 46,000 | 0.11 | 0.17 | 0.13 | 0.20 | 0.17 |
| 50,000 | 0.04 | 0.06 | 0.04 | 0.06 | 0.06 |
| 54,000 | 0.02 | 0.04 | 0.03 | 0.05 | 0.03 |
| 56,000 & Greater | 0.39 | 0.69 | 0.47 | 0.77 | 0.58 |
| SubTotal Single Units | 6.53 | 8.82 | 7.33 | 9.45 | 7.89 |
| Dump Truck-40,000 | 0.14 | 0.40 | 0.15 | 0.38 | 0.23 |
| Dump Truck-65,000 | 1.13 | 3.03 | 1.33 | 3.31 | 1.86 |
| TOTAL SINGLE UNIT | 7.80 | 12.25 | 8.81 | 13.14 | 9.98 |
| Truck Tractors (Class F) | | | | | |
| 40,000 | 0.15 | 0.25 | 0.19 | 0.22 | 0.16 |
| 44,000 | - | 0.01 | 0.01 | 0.01 | - |
| 48,000 | 0.02 | 0.03 | 0.02 | 0.04 | 0.01 |
| 52,000 | 0.33 | 0.57 | 0.40 | 0.65 | 0.33 |
| 56,000 | 0.13 | 0.25 | 0.15 | 0.27 | 0.12 |
| 60,000 | 0.09 | 0.16 | 0.12 | 0.19 | 0.11 |
| 64,000 | 0.05 | 0.08 | 0.06 | 0.10 | 0.06 |
| 68,000 | 1.63 | 2.95 | 1.94 | 3.19 | 1.71 |
| 72,000 | 0.04 | 0.08 | 0.05 | 0.08 | 0.04 |
| 76,000 | 2.04 | 3.58 | 2.44 | 4.03 | 2.22 |
| 79,000 | 3.24 | 4.73 | 4.55 | 7.54 | 3.49 |
| TOTAL TRUCK TRACTORS | 7.72 | 12.69 | 9.93 | 16.32 | 8.25 |
| TOTAL ALL VEHICLES | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Motor fuel taxes constitute the largest source of tax revenues at both the Federal and State levels. Also, as mentioned previously, these taxes have the attractive feature of being related to highway usage. For this reason there has been an effort to collect the tax, not only on fuel purchased in a given State, but even on fuel purchased outside if it is consumed in the State. There is close similarity in this to third structure taxes in terms of the motivation behind the tax, the need for mileage data in tax determination, and in the difficulties in administration and compliance which ensue.

A pragmatic principle in tax application as well as reciprocity agreements is to minimize collection and administration costs by collecting the tax from the fewest possible taxing stations or taxpayers. For gasoline this has worked successfully by taxing wholesale distributors. For special fuels such as diesel fuel this is not as feasible because much of the fuel is used for nonhighway purposes. Special fuels are taxed at the distributor level which results in additional costs and aggravation of numerous refund claims for nonhighway users. Figure B-3 earlier has shown that there is no uniformity in the States' approach to this problem. Special fuel tax is collected from distributors (wholesalers), dealers (retailers), licensed users, bonded users, users, user-dealers, bulk users, and licensed special-fuel suppliers.

There is no problem with motor fuel tax apportionment as long as the vehicle user buys the fuel and uses it in the same State. Interstate operations practically guarantee that vehicles consume some fuel in one State that has been purchased and taxed in another. This produces an inequity between highway costs imposed by the vehicle and its tax contributions. In terms of the pay as you go principle, the purchase State has received too much tax and the travel State too little. For autos and light trucks, it is generally assumed that these effects net out. For heavy trucks and other equipment with large fuel reserves, however, there has been a tendency to adopt fuel use taxes which provide tax contributions that conform to usage.

Most States have enacted legislation either to restrict the amount of fuel that a vehicle can carry tax-free from another State or to require reporting of consumption within the State and payment of a corresponding fuel tax. Compliance problems occur with the reporting and validation of fuel use. Such systems require permits and some level of bonding. It is necessary to identify each vehicle uniquely for taxing purposes, opening the door to evasion. Quarterly or monthly reports cause a paperwork burden and the recordkeeping requirements for the vehicle owner may be significant. Enforcement may require border checks, record audits, and even examination of a vehicle's fuel tanks. This is all costly and difficult to achieve.

The motivation behind the development of third structure taxes has been twofold. One intention has been to assign proper cost responsibility to heavier vehicles. Another, equally important, intention has been to extract proper payments from out-of-State users. This latter point has led to the concept and practice of reciprocity, which was intended to mitigate the difficulties caused by third structure taxes and which now encompasses first and second structure taxes as well. The following section will discuss the development and status of reciprocity arrangements.

Reciprocity arrangements may be divided into pre-IRP and IRP.[*/] Initially, these arrangements came about to avoid the burgeoning problem of each State registering each user, whether resident or not. The principles underlying reciprocity were a desire to avoid tax duplication and a belief that ease of interstate commerce outweighed any net gains or losses from non-resident use of a State's roads. The latter point is now in question, especially in bridge States,[**/] as tax revenues decline and maintenance costs soar. One of the basic problems in applying reciprocity

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*/ IRP refers to the International Registration Plan.

**/ States which have a high level of traffic passing through them.

has been that no two States have exactly the same tax structure; therefore a compromise has to be negotiated. Another problem is with third structure taxes. These are usually applied, in part, to extract payment from out-of-State users and they are not usually reciprocal. States without third structure taxes feel that their trucks are receiving unfair treatment if reciprocity is offered to foreign users. Sometimes this has led to a cancellation of registration fee reciprocity, a levying of retaliatory ("equalizing") third-structure taxes, or both. In fact, the current status of reciprocity agreements is that it rarely or never is granted on third structure taxes.

The initial reciprocity agreement is referred to as the Multistate Reciprocal Agreement (MRA) which was initiated in 1949 and now consists of fifteen member States. MRA allows full reciprocity of registration fees for vehicles that are registered in one of the member States. For-hire vehicles must also fulfill whatever State and Federal licensing requirements that apply.

A major problem associated with reciprocal agreements has been deciding which State should be the State of registration for a commercial vehicle. Obviously the residence of the owner and the place(s) of business of the firm may be in different States. The Multistate Reciprocal Agreement solves this through a "basing point" principle which states that all commercial vehicles must be based (maintained and operated from) at a place of business within one of the member States. This poses problems with vehicles that do not actually have a permanent base.

The western States have devised a different approach, partially licensing vehicles for each State in which they operate. This is called "proportional registration" or "proration." This approach avoids the problems of defining residence or base, allows States to collect registration fees from out of State commercial vehicles, and avoids tax duplication. There were two early multilateral compacts in existence that permitted the proration of registration fees and other motor vehicle taxes. These were the Uniform Vehicle Registration Proration and Reciprocity Agreement and the Midwest Vehicle Proration Compact.

Proportional registration has strong advantages. States gain tax payments from non-resident users without becoming involved in the quagmire of residence versus base of operations. Operators are freed from duplication of taxation and can operate under clearly written interstate requirements and privileges. Proration also is compatible with or without third structure taxes, allowing States taxing flexibility. It even generates the type of recordkeeping that is required for these types of taxes. However, it does not offer an easy solution to the inequity related to usage.

With western States using a prorated system of registration and eastern/southern States relying on reciprocity agreements, problems were experienced by registrants that traveled in both sections of the country. These problems led to the adoption in 1973 of the International Registration Plan (IRP).

Five basic principles are embodied in the IRP:

1. The assessment of a single, proportional registration fee for fleets of vehicles based on mileage traveled in member jurisdictions.
2. The issuance of one base State plate and cab card per vehicle.
3. Recognition of the registration by other member jurisdictions.
4. The granting of reciprocity to proportionally registered vehicles and to the continuance of reciprocity granted to those vehicles not eligible for proportioned registration under the agreement. Under the IRP definition, reciprocity means that an apportioned vehicle over 26,000 pounds, properly registered under the plan, is exempt from further registration by other member States.
5. To allow, with no exceptions, interstate and intrastate movements by proportionally registered vehicles.

By combining the UPRA features of prorated registration fees and the MRA flexibility of a single plate system, greater freedom of movement is achieved. A significant departure from the other agreements is the IRP base State revenue distribution concept. Under the IRP, a carrier registers vehicles in the base State. A base State is determined using three criteria:

1. Where the registrant has an established place of business (construed to mean a physical structure owned, leased, or rented by the fleet registrant, designated by a street number or road location and open during regular business hours; within which there is a phone listed in the name of the fleet registrant, a person conducting business and the operations records of the fleet).
2. Where mileage is accrued by the fleet.
3. Where operational records of the fleet are maintained or can be made available.

This definition allows for a greater degree of operational flexibility for the carrier without depriving the States of registration revenues. States can collect an equitable share of revenue because the IRP allows reporting and revenue collection to be based on 100 percent of the mileage, regardless of where it occcurs. In other words, mileage in non-IRP States is reported to and fees are usually collected by the base State. The non-IRP mileage is attributed to the base State, which is allowed to charge for such mileage on its own fee schedule. This revenue is retained by the base State. The carrier is paying to the base State registration fees based on

1. The percentage of in-State mileage * base State fee
2. The percentage of non-IRP mileage * base State fee
3. The percentage of mileage occurring in each IRP member jurisdiction * the jurisdiction's fee.

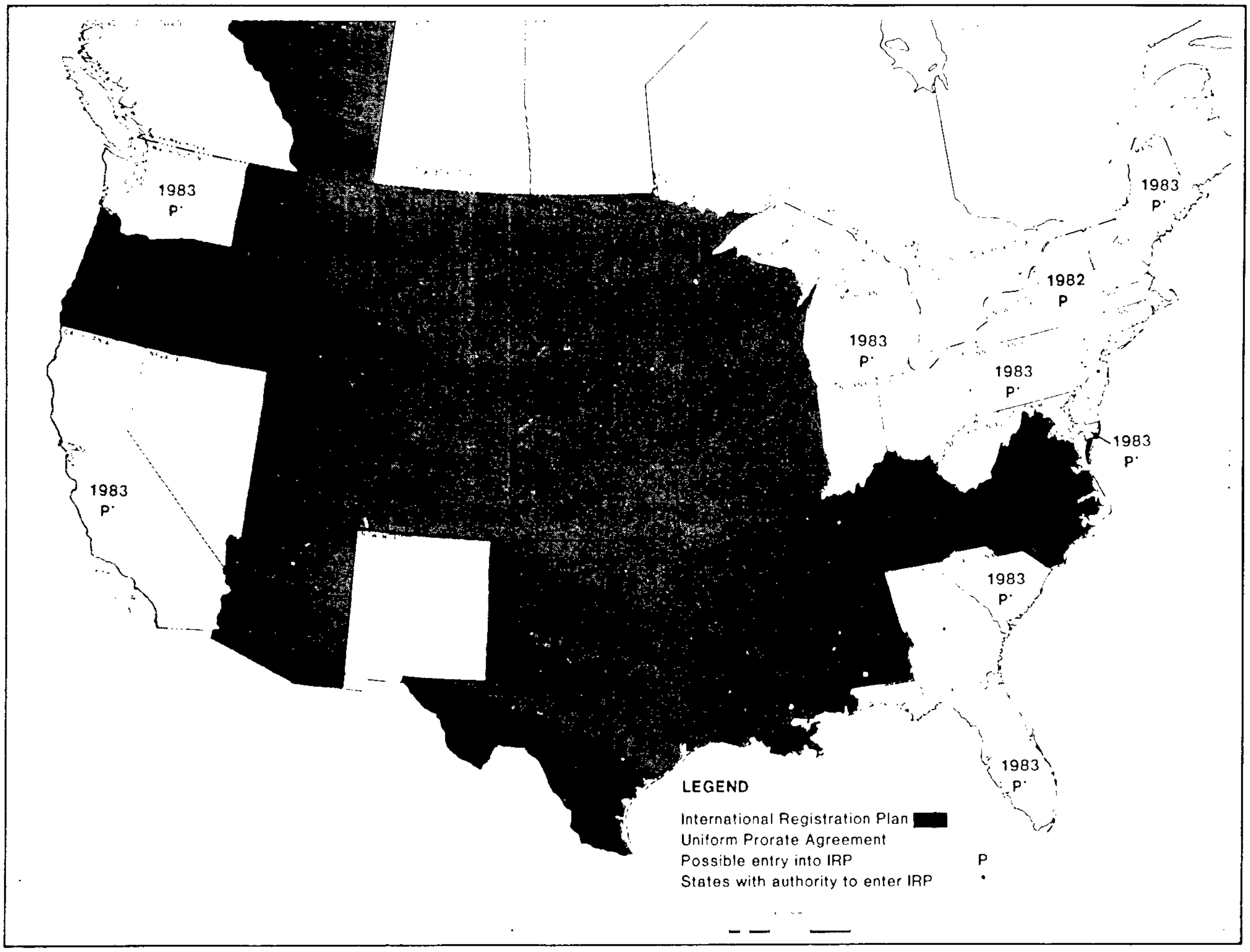
Some problems have occurred within the IRP. One is that not all member States collect fees for non-IRP mileage from home-based carriers. Another problem is with the mileage estimate - if estimated travel varies widely from actual, it is possible for a carrier to pay more or less than the intended fees.

All in all, IRP has attracted twenty-nine member States and one Canadian province. The IRP's wider acceptance has been due to several factors. Under apportionment, revenue is distributed to States with a greater degree of equity, in that every member State will receive a portion of its registration fee if a carrier registered under the IRP travels there. Under pure reciprocity this is not the case. In return, the carrier receives greater operational flexibility with a reduction in the number of registration filings. The single, apportioned license plate concept has eliminated the problem of multiple vehicle registration identifications and the administrative cost associated with them. Figures B-20 and B-21 show the States that are currently members of IRP as well as those with enabling legislation allowing them to join. IRP has, in large part, superseded the other compacts and seems likely, in time, to become the only significant multi-State compact. Figure B-22 shows a State by State catalog of the various reciprocity and proration agreements.

FIGURE B-20

INTERNATIONAL REGISTRATION PLAN - Membership Status

MAP OF IRP STATES




Source: International Registration Plan, American Association of Motor Vehicle Administrators, Appendix D, 4/1/82.

FIGURE B-21

ROSTER OF MEMBER JURISDICTIONS

| *JURISDICTION* | *DATE APPROVED* | *DATE OF ENTRY* |
|---|---|---|
| Kentucky | September 13, 1973 | September 13, 1973 |
| Tennessee | September 13, 1973 | September 13, 1973 |
| Missouri | September 13, 1973 | September 13, 1973 |
| Texas | September 13, 1973 | September 13, 1973 |
| Minnesota | September 13, 1973 | January 1, 1975 |
| Oregon | September 13, 1973 | January 1, 1975 |
| Nebraska | September 13, 1973 | January 1, 1975 |
| Utah | September 13, 1973 | January 1, 1975 |
| Colorado | September 13, 1973 | January 1, 1975 |
| Alberta | July 22, 1974 | January 1, 1975 |
| South Dakota | August 5, 1974 | January 1, 1975 |
| Mississippi | November 4, 1974 | November 1, 1975 |
| Virginia | February 24, 1975 | March 1, 1975 |
| Wyoming | July 14, 1975 | January 1, 1976 |
| Montana | October 10, 1975 | January 1, 1976 |
| Arkansas | October 10, 1975 | July 1, 1976 |
| Louisiana | December 1, 1975 | April 1, 1976 |
| Idaho | December 10, 1975 | January 1, 1976 |
| Illinois | July 7, 1976 | January 1, 1977 |
| North Carolina | July 16, 1976 | January 1, 1977 |
| Oklahoma | January 19, 1977 | January 1, 1978 |
| Wisconsin | May 23, 1977 | January 1, 1978 |
| Iowa | August 17, 1977 | January 1, 1978 |
| Alabama | September 5, 1979 | October 1, 1980 |
| Arizona | May 9, 1980 | January 1, 1981 |
| North Dakota | June 19, 1980 | January 1, 1981 |
| Kansas | July 9, 1980 | January 1, 1981 |
| Pennsylvania | September 15, 1982 | June 1, 1983 |
| Michigan | August 10, 1983 | March 1, 1985 |
| Florida | Application Pending | December 1, 1984 |

FIGURE B-22

# VEHICLE REGISTRATION RECIPROCITY AND PRORATION FOR-HIRE CARRIERS

| TRAVELING FROM \ STATES TRAVELING TO | ALABAMA | ALASKA | ARIZONA | ARKANSAS | CALIFORNIA | COLORADO | CONNECTICUT | DELAWARE | DIST. OF COLUMBIA | FLORIDA | GEORGIA | HAWAII | IDAHO | ILLINOIS | INDIANA | IOWA | KANSAS | KENTUCKY | LOUISIANA | MAINE | MARYLAND | MASSACHUSETTS | MICHIGAN | MINNESOTA | MISSISSIPPI | MISSOURI | MONTANA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALABAMA | | | I | I | $R^5$ | I | R | $R^1$ | $R^1$ | M | M | | I | I | $R^2$ | I | I | I | I | $R^1$ | M | $R^1$ | M | I | I | I | I |
| ALASKA | | | P | $R^1$ | P | P | $R^1$ | $R^2$ | $R^1$ | $R^1$ | | | P | P | $R^2$ | P | P | | $R^1$ | $R^1$ | $R^2$ | $R^1$ | $R^2$ | P | | P | P |
| ARIZONA | I | P | | I | P | I | | $R^2$ | $R^1$ | $R^2$ | $R^2$ | | I | I | $R^2$ | I | I | I | I | | $R^2$ | | | I | I | I | I |
| ARKANSAS | I | | I | | $R^5$ | I | $R^1$ | $R^1$ | $R^1$ | $R^1$ | $R^2$ | | I | I | $R^2$ | I | I | | I | $R^1$ | $R^2$ | $R^1$ | $R^1$ | I | I | I | I |
| CALIFORNIA | $R^1$ | P | P | $R^1$ | | P | $R^1$ | $R^1$ | $R^1$ | $R^1$ | $R^2$ | | P | P | $R^2$ | P | P | $R^5$ | $R^1$ | $R^1$ | $R^2$ | $R^1$ | $R^1$ | P | $R^1$ | P | P |
| COLORADO | I | P | I | I | P | | $R^1$ | $R^2$ | $R^1$ | $R^1$ | $R^2$ | | I | I | $R^2$ | I | I | I | I | $R^2$ | $R^2$ | $R^1$ | $R^1$ | I | I | I | I |
| CONNECTICUT | $R^1$ | | | $R^1$ | $R^5$ | $R^1$ | | $R^2$ | $R^1$ | $R^1$ | $R^1$ | | | $R_5^1$ | $R^2$ | $R^1$ | $R^1$ | $R^5$ | $R^1$ | $R^1$ | $R^2$ | $R^1$ | $R^1$ | $R^2$ | $R^1$ | $R^2$ | $R^2$ |
| DELAWARE | $R^1$ | | | $R^1$ | $R^2$ | $R^2$ | $R^1$ | | $R^1$ | $R^1$ | $R^1$ | | | $R_5^1$ | $R^2$ | $R^1$ | $R^1$ | $R^5$ | $R^1$ | $R^1$ | $R^2$ | $R^1$ | $R^1$ | $R^2$ | $R^1$ | $R^2$ | $R^2$ |
| DIST. OF COLUMBIA | $R^1$ | | | $R^1$ | $R^5$ | $R^2$ | $R^1$ | $R^2$ | | $R^1$ | $R^1$ | | | $R_5^1$ | $R^2$ | | $R^1$ | $R^5$ | $R^1$ | $R^1$ | $R^2$ | $R^1$ | $R^1$ | $R^2$ | $R^1$ | $R^2$ | $R^2$ |
| FLORIDA | M | | $R^4$ | $R^1$ | $R^5$ | $R^2$ | $R^1$ | $R^2$ | $R^1$ | | M | | | $R_5^1$ | $R^2$ | | $R^1$ | M | M | $R^1$ | M | $R^1$ | M | $R^2$ | M | M | $R^2$ |
| GEORGIA | M | | $R^4$ | $R^1$ | $R^5$ | $R^2$ | $R^1$ | $R^1$ | $R^1$ | M | | | | $R_5^1$ | $R^2$ | $R^1$ | $R^1$ | M | M | $R^2$ | M | $R^1$ | M | $R^2$ | M | M | $R^2$ |
| HAWAII | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| IDAHO | I | P | I | I | P | I | $R^1$ | $R^2$ | $R^1$ | $R^1$ | $R^2$ | | | I | $R^2$ | I | I | I | I | $R^1$ | $R^2$ | | | I | I | I | I |
| ILLINOIS | I | P | I | I | P | I | R | $R^1$ | $R^1$ | $R^1$ | $R^1$ | | I | | $R^2$ | I | I | I | I | $R^1$ | $R^1$ | $R^1$ | $R^1$ | I | I | I | I |
| INDIANA | M | | $R^4$ | $R^1$ | $R^5$ | $R^3$ | $R^1$ | $R^1$ | $R^1$ | M | M | | $R_3^1$ | $R^1$ | | $R^1$ | $R^1$ | M | M | $R^1$ | $R^1$ | $R^1$ | M | $R^2$ | M | M | $R^2$ |
| IOWA | I | P | I | I | P | I | $R^1$ | $R^1$ | $R^1$ | $R^1$ | $R^2$ | | I | I | $R^2$ | | I | I | I | $R^1$ | $R^1$ | $R^1$ | $R^1$ | I | I | I | I |
| KANSAS | I | P | I | I | P | I | $R^1$ | $R^2$ | $R^1$ | $R^1$ | $R^1$ | | I | I | $R^2$ | I | | I | I | $R^1$ | $R^1$ | $R^1$ | $R^1$ | I | I | I | I |
| KENTUCKY | | | I | I | $R^5$ | I | $R^1$ | $R^1$ | $R^1$ | M | M | | I | I | $R^2$ | I | I | | I | $R^1$ | M | $R^1$ | M | I | I | I | I |
| LOUISIANA | I | | I | I | $R^5$ | I | $R^1$ | $R^1$ | $R^1$ | M | M | | I | I | $R^2$ | I | I | I | | $R^1$ | M | $R^1$ | M | I | I | I | I |
| MAINE | $R^1$ | | | $R^1$ | $R^1$ | $R^2$ | $R^1$ | $R^2$ | $R^1$ | $R^1$ | $R^2$ | | | $R_5^1$ | $R^2$ | | $R^1$ | $R^5$ | $R^1$ | | $R^2$ | $R^1$ | $R^2$ | R | $R^2$ | $R^2$ | R |

| TRAVELING FROM \ STATES TRAVELING TO | NEBRASKA | NEVADA | NEW HAMPSHIRE | NEW JERSEY | NEW MEXICO | NEW YORK | NORTH CAROLINA | NORTH DAKOTA | OHIO | OKLAHOMA | OREGON | PENNSYLVANIA | RHODE ISLAND | SOUTH CAROLINA | SOUTH DAKOTA | TENNESSEE | TEXAS | UTAH | VERMONT | VIRGINIA | WASHINGTON | WEST VIRGINIA | WISCONSIN | WYOMING |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALABAMA | I | | $R^2$ | M | | $R^2$ | M | I | $R^1$ | I | I | $R^2$ | $R^1$ | M | I | I | I | I | | I | $R^1$ | M | I | I |
| ALASKA | P | P | $R^2$ | $R^2$ | P | $R^2$ | $R_3$ | P | | $R^4$ | P | $R^2$ | $R^2$ | $R^2$ | P | | | P | $R^2$ | | P | $R^2$ | $RS^1$ | P |
| ARIZONA | I | P | $R^2$ | | P | | I | I | $R^2$ | I | I | | $R^2$ | $R^2$ | I | I | I | I | | I | P | $R^2$ | I | I |
| ARKANSAS | I | | $R^2$ | $R^2$ | $R^4$ | | I | I | $R^1$ | I | I | $R^2$ | $R^1$ | $R^2$ | I | I | I | I | $R^2$ | I | $R^2$ | $R^2$ | I | I |
| CALIFORNIA | P | P | $R^2$ | $R^2$ | P | $R^2$ | $R_3$ | P | $R^2$ | $R^4$ | P | $R^2$ | $R^1$ | $R^2$ | P | $R_2^1$ | $R^4$ | P | | $P^2$ | P | $R^2$ | $R^1$ | P |
| COLORADO | I | P | $R^2$ | $R^2$ | P | $R^2$ | I | I | $R^2$ | I | I | $R^2$ | $R^1$ | $R^2$ | I | I | I | I | | I | P | $R^2$ | I | I |
| CONNECTICUT | $R^2$ | $R^2$ | $R^2$ | $R^2$ | | $R^2$ | $R_3^1$ | | $R^1$ | $R^2$ | $R^2$ | $R^2$ | $R^1$ | $R^2$ | $R^2$ | $R^5$ | $R^1$ | | | $R^2$ | $R^2$ | $R^2$ | $RS^1$ | $R^2$ |
| DELAWARE | $R^2$ | $R^2$ | $R^2$ | $R^2$ | | $R^2$ | $R_3^1$ | | $R^2$ | $R^2$ | $R^1$ | $R^2$ | $R^1$ | $R^2$ | | $R^5$ | $R^1$ | | | $R^2$ | $R^2$ | $R^2$ | $R^1$ | $R^1$ |
| DIST. OF COLUMBIA | $R^2$ | $R^2$ | $R^2$ | $R^2$ | | $R^2$ | $R_3^1$ | | $R^2$ | $R^2$ | $R^2$ | $R^2$ | $R^1$ | $R^2$ | $R^2$ | $R_2^1$ | $R^1$ | | $R^2$ | $R^2$ | $R^2$ | $R^2$ | $R^1$ | $R^2$ |
| FLORIDA | $R^2$ | $R^2$ | $R^2$ | M | $R^4$ | $R^2$ | M | M | $R^2$ | $R^2$ | $R^2$ | $R^2$ | $R^1$ | M | $R^2$ | M | $R^1$ | | $R^2$ | M | $R^2$ | M | $RS^1$ | $R^2$ |
| GEORGIA | $R^2$ | | $R^2$ | M | | $R^2$ | | M | M | $R^2$ | $R^2$ | $R^2$ | $R^2$ | $R^1$ | $R^2$ | $R^1$ | | | | M | $R^2$ | M | $R^1$ | $R^2$ |
| HAWAII | | | | | | | | | | | | | | | | | | | | | | | | |
| IDAHO | I | P | $R^2$ | | P | | I | I | $R^2$ | I | I | $R^2$ | | | I | I | I | I | | I | P | $R^2$ | I | I |
| ILLINOIS | I | P | $R^2$ | $R^2$ | P | $R^2$ | I | I | $R^2$ | I | I | $R^2$ | $R^2$ | $R^2$ | I | I | I | I | $R^2$ | I | P | $R^2$ | I | I |
| INDIANA | $R^2$ | $R^2$ | $R^2$ | M | $R^4$ | $R^2$ | M | M | $R^2$ | $R^2$ | $R^2$ | $R^2$ | $R^1$ | M | $R^2$ | M | $R^1$ | $R^1$ | | M | $R^2$ | $R^2$ | $R^1$ | $R^2$ |
| IOWA | I | R | $R^2$ | $R^2$ | P | $R^2$ | I | I | $R^2$ | I | I | $R^2$ | $R^1$ | $R^2$ | I | I | I | I | $R^2$ | I | P | $R^2$ | I | I |
| KANSAS | I | P | $R^2$ | $R^2$ | P | | I | I | $R^2$ | I | I | $R^2$ | $R^1$ | $R^2$ | I | I | I | I | | I | P | $R^2$ | I | I |
| KENTUCKY | I | $R^2$ | $R^2$ | M | $R^4$ | $R^2$ | I | I | $R^2$ | I | I | $R^2$ | $R^1$ | M | I | I | I | I | | I | $R^2$ | M | I | I |
| LOUISIANA | I | $R^2$ | $R^2$ | M | | $R^2$ | I | I | $R^2$ | I | I | $R^2$ | $R^1$ | M | I | I | I | I | | I | $R^2$ | M | I | I |
| MAINE | $R^2$ | | R | | | $R^2$ | $R_3^1$ | | $R^2$ | $R^2$ | $R^2$ | $R^2$ | $R^1$ | $R^2$ | $R^2$ | $R^2$ | $R^2$ | | | $R^2$ | $R^2$ | $R^2$ | $R^1$ | $R^2$ |

Source: Uniform State Regulations, Motor Carrier Act of 1980: Section 19. Report to Congress, U.S. Department of Transportation and the Interstate Commerce Commission, 1982.

## FIGURE B-22 (CONT.)

## VEHICLE REGISTRATION RECIPROCITY AND PRORATION FOR-HIRE CARRIERS

| TRAVELING FROM \ STATES TRAVELING TO | ALABAMA | ALASKA | ARIZONA | ARKANSAS | CALIFORNIA | COLORADO | CONNECTICUT | DELAWARE | DIST. OF COLUMBIA | FLORIDA | GEORGIA | HAWAII | IDAHO | ILLINOIS | INDIANA | IOWA | KANSAS | KENTUCKY | LOUISIANA | MAINE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MARYLAND | M | | | R[1] | R[5] | R[2] | R[1] | R[2] | R[1] | M | M | | | R5[1] | R[2] | R[2] | R[1] | M | M | R[1] |
| MASSACHUSETTS | R[1] | | | R[1] | R[5] | R[2] | R[1] | R[2] | R[1] | R[1] | R[2] | | | R5[1] | R[2] | R[1] | R[1] | R[5] | R[1] | R[1] |
| MICHIGAN | M | | | R[1] | R[5] | R[1] | R[1] | R[1] | R[1] | M | M | | | R5[1] | R[2] | R[1] | R[1] | M | M | R[1] |
| MINNESOTA | I | P | I | I | P | I | R[1] | R[1] | R[1] | R[1] | R[3] | | I | I | R[2] | I | I | I | I | R[1] |
| MISSISSIPPI | I | | I | I | R[5] | I | R[1] | R[1] | R[1] | M | M | | I | I | R[2] | I | I | I | I | R[2] |
| MISSOURI | I | P | I | I | P | I | R[1] | R[2] | R[1] | M | M | | I | I | R[2] | I | I | I | I | R[1] |
| MONTANA | I | P | I | I | P | I | R[1] | R[2] | R[1] | R[1] | R[2] | | I | I | R[2] | I | I | I | I | R[2] |
| NEBRASKA | I | P | I | I | P | I | R[1] | R[1] | R[1] | R[1] | R[3] | | I | I | R[2] | I | I | I | I | R[1] |
| NEVADA | | P | P | | P | P | R[1] | R[2] | R[1] | R[1] | R[2] | | P | P | R[2] | P | P | | R[1] | R[1] |
| NEW HAMPSHIRE | | | | R[1] | R[5] | R[2] | R[1] | R[2] | R[1] | R[1] | R[2] | | | R5[1] | R[2] | R[1] | R[1] | R[5] | R[1] | R[1] |
| NEW JERSEY | R[1] | | | R[1] | R[5] | R | R[1] | R[2] | R[1] | M | M | | | R5[1] | M | | R[1] | M | M | R[1] |
| NEW MEXICO | | P | P | | P | P | R[1] | R[2] | R[1] | R[1] | R[2] | | P | P | R[2] | P | P | | | |
| NEW YORK | R[1] | | | R[1] | R[5] | R[2] | R[1] | R[1] | R[1] | R[2] | R[2] | | | R[4] | R[2] | | | R[5] | R | R[1] |
| NORTH CAROLINA | I | | I | I | R[5] | I | R[1] | R[1] | R[1] | M | M | | I | I | R[2] | I | I | I | I | R[1] |
| NORTH DAKOTA | I | P | I | I | P | I | | R[2] | R[1] | M | M | | I | I | R[2] | I | I | I | I | R[3] |
| OHIO | R[1] | | | R[1] | R[5] | R[2] | R[1] | R[2] | R[1] | R[3] | R[2] | | | R[4] | R[2] | | | R[5] | R[1] | R[1] |
| OKLAHOMA | I | | I | I | R[4] | I | R[1] | R[1] | R[1] | R[1] | R[3] | | I | I | R[2] | I | I | I | I | R[1] |
| OREGON | I | P | I | I | P | I | R[1] | R[1] | R[1] | R[1] | R[2] | | I | I | R[2] | I | I | I | I | R[1] |
| PENNSYLVANIA | R[1] | | | R[1] | R[5] | R[2] | R[1] | R[2] | R[1] | R[1] | R[3] | | | R5[1] | R[2] | R[2] | R[1] | R[5] | R[1] | R[1] |
| RHODE ISLAND | | | R[4] | R[1] | R[4] | R[2] | R[1] | R[2] | R[1] | R[1] | R[3] | | | R5[1] | R[2] | R[1] | R[1] | R[5] | R[1] | R[1] |
| SOUTH CAROLINA | M | | R[4] | R[1] | R[5] | R[2] | R[1] | R[2] | R[1] | M | M | | | R5[1] | R[2] | | R[1] | M | M | R[1] |
| SOUTH DAKOTA | I | P | I | I | P | I | R[1] | R[2] | R[1] | R[1] | R[2] | | I | I | R[2] | I | I | I | I | R[1] |
| TENNESSEE | I | | I | I | R[4] | I | R[1] | R[1] | R[1] | M | M | | I | I | R[2] | I | I | I | I | R[1] |

| TRAVELING FROM \ STATES TRAVELING TO | MARYLAND | MASSACHUSETTS | MICHIGAN | MINNESOTA | MISSISSIPPI | MISSOURI | MONTANA | NEBRASKA | NEVADA | NEW HAMPSHIRE | NEW JERSEY | NEW MEXICO | NEW YORK | NORTH CAROLINA | NORTH DAKOTA | OHIO | OKLAHOMA | OREGON | PENNSYLVANIA | RHODE ISLAND | SOUTH CAROLINA | SOUTH DAKOTA | TENNESSEE | TEXAS | UTAH | VERMONT | VIRGINIA | WASHINGTON | WEST VIRGINIA | WISCONSIN | WYOMING |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MARYLAND | | R[1] | M | R[2] | M | M | | R[2] | R[2] | P[2] | M | | R[2] | M | M | R[2] | R[2] | R[2] | R[2] | R[1] | M | | M | R[1] | | | M | R[2] | M | R5[1] | |
| MASSACHUSETTS | R[2] | | R[1] | P[2] | R[1] | R[2] | R[2] | R[2] | R[2] | R[2] | R | | R[2] | R5[1] | | R[2] | R[2] | R[2] | R[2] | R[1] | R[2] | R[2] | R[5] | R[1] | | R[2] | R[2] | R[2] | R[2] | R5[1] | |
| MICHIGAN | M | R[1] | | R | M | M | R[2] | R[2] | | R[2] | M | | R[2] | M | M | R[2] | R[2] | R[2] | R[2] | R[1] | M | R[2] | M | R[1] | | R[2] | M | R[2] | M | R5[1] | |
| MINNESOTA | R[2] | R[1] | R[1] | | I | I | I | I | P | R[2] | R[2] | P | R[2] | I | I | R[2] | I | I | R[2] | R[1] | R[2] | I | I | I | I | | I | P | R[2] | I | I |
| MISSISSIPPI | M | R[1] | M | I | | I | I | I | | R[2] | M | R[4] | | I | I | R[2] | I | I | R[2] | R[2] | M | I | I | I | I | | I | R[2] | M | I | I |
| MISSOURI | M | R[1] | M | I | I | | I | I | P | R[2] | M | P | R[2] | I | I | R[2] | I | I | R[2] | R[1] | M | I | I | I | I | | I | P | M | I | I |
| MONTANA | R[2] | R[1] | R[4] | I | I | I | | I | P | R[2] | R[2] | P | R[2] | I | I | R[2] | I | I | R[2] | R[1] | R[2] | I | I | I | I | | I | P | R[2] | I | I |
| NEBRASKA | R[2] | R[1] | R[1] | I | I | I | I | | P | R[2] | R[2] | P | R[2] | I | I | R[2] | I | I | R[2] | R[1] | R[2] | I | I | I | I | | I | P | R[2] | I | I |
| NEVADA | R[2] | R[4] | | P | | P | P | P | | R[2] | | P | R[2] | R5[1] | P | R[2] | | P | R[2] | R[2] | R[2] | P | R[2] | P[4] | P | | R[2] | P | R[2] | R[4] | P |
| NEW HAMPSHIRE | R[3] | R[1] | R[1] | R[2] | R[2] | R[2] | R[2] | R[2] | R[2] | | | | R[2] | R5[1] | | R[2] | | R[2] | R[2] | R[1] | R[2] | P[2] | R | R[1] | | R[2] | R[2] | R[2] | R[2] | R5[1] | |
| NEW JERSEY | M | R[1] | M | R[2] | M | M | R[2] | R[2] | R[2] | R[2] | | | R[2] | M | M | R[2] | R[2] | R[2] | R[2] | P[1] | M | | M | R[1] | | | M | R[2] | M | R5[1] | R[2] |
| NEW MEXICO | R[2] | | | P | R[1] | P | P | P | P | R[3] | | | | R | P | R[2] | R[4] | | R[2] | R[2] | P | P | R[4] | R | P | | R[2] | P | R[2] | | P |
| NEW YORK | R[2] | R[1] | R[2] | | | R[2] | | | R[2] | R[2] | | | | R[5] | | R[2] | R[2] | R[2] | R[2] | R[1] | R[2] | | R[2] | R[1] | | | R[2] | R[4] | R[2] | R[4] | |
| NORTH CAROLINA | M | R[1] | M | I | I | I | I | I | R[2] | R[2] | M | | R[2] | | I | R[2] | I | | R[2] | R[1] | M | I | I | I | I | | I | R[2] | M | I | I |
| NORTH DAKOTA | M | R[1] | M | I | I | I | I | I | P | R[2] | M | P | R[2] | I | | R[2] | | | R[2] | R[2] | M | I | I | I | I | | I | P | M | I | I |
| OHIO | R[2] | R[1] | R[2] | | R[1] | R[2] | | | | R[2] | | | R[2] | R3[1] | | | R[2] | R[2] | R[2] | R[1] | R[2] | | R1[5] | R[2] | | | R[2] | R[4] | R[2] | R[4] | R[2] |
| OKLAHOMA | R[2] | R[2] | R[1] | I | I | I | I | I | | R[2] | R[2] | | | I | I | R[2] | | I | R[2] | R[2] | R[2] | I | I | I | I | | I | R[4] | R[2] | I | I |
| OREGON | R[5] | R[1] | R[2] | I | I | I | I | I | P | R[2] | | P | R[2] | I | I | R[2] | I | | R[2] | R[2] | R[2] | I | I | I | I | | I | P | R[2] | I | I |
| PENNSYLVANIA | R[2] | R[1] | R[1] | R[2] | R[1] | R[2] | R[2] | R[2] | R[2] | R[2] | R[2] | | R[2] | R3[1] | R | R[2] | R[2] | R[2] | | R[1] | R[2] | R[2] | R[5] | R[1] | | R[2] | R[2] | R[2] | R[2] | R5[1] | R[2] |
| RHODE ISLAND | R[2] | R[1] | R[2] | R[2] | | R[2] | R[2] | R[2] | R[2] | R[2] | R[2] | | R[2] | R[3] | | R[2] | R[2] | R[2] | R[2] | | R[2] | R[2] | R[2] | R[1] | | R[2] | R[2] | R[2] | R[2] | R5[1] | |
| SOUTH CAROLINA | M | R[1] | M | R[2] | M | M | R[2] | R[2] | R[2] | R[2] | M | | R[2] | M | M | R[2] | R[2] | R[2] | R[2] | R[1] | | R[2] | M | R[1] | | | M | R[2] | M | R5[1] | R[2] |
| SOUTH DAKOTA | R[2] | R[1] | R[1] | I | I | I | I | I | P | R[2] | R[2] | P | R[2] | I | I | R[2] | I | I | R[2] | R[2] | R[2] | | I | I | I | R[2] | I | P | R[2] | I | I |
| TENNESSEE | M | R[1] | M | I | I | I | I | I | R | R[2] | M | R[4] | R[2] | I | I | R[2] | I | I | R[2] | R[2] | M | I | | I | I | | I | R[2] | M | I | I |

FIGURE B-22 (CONT.)

# VEHICLE REGISTRATION RECIPROCITY AND PRORATION FOR-HIRE CARRIERS

STATES TRAVELING TO / TRAVELING FROM

| TRAVELING FROM | ALABAMA | ALASKA | ARIZONA | ARKANSAS | CALIFORNIA | COLORADO | CONNECTICUT | DELAWARE | DIST. OF COLUMBIA | FLORIDA | GEORGIA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TEXAS | I | | I | I | $R^4$ | I | $R^1$ | $R^1$ | $R^1$ | $R^1$ | $R^3$ |
| UTAH | I | P | I | I | P | I | $R^1$ | $R^1$ | $R^1$ | $R^1$ | $R^2$ |
| VERMONT | | | | | $R^5$ | R | $R^1$ | $R^1$ | $R^1$ | $R^1$ | $R^2$ |
| VIRGINIA | I | | I | I | $R^5$ | I | $R^1$ | $R^1$ | $R^1$ | M | M |
| WASHINGTON | $R^1$ | P | P | $R^4$ | P | P | $R^1$ | $R^2$ | $R^1$ | $R^1$ | $R^2$ |
| WEST VIRGINIA | M | | | $R^4$ | $R^5$ | R | $R^1$ | $R^1$ | $R^1$ | M | M |
| WISCONSIN | I | | I | I | $R^4$ | I | $R^1$ | $R^1$ | $R^1$ | $R^1$ | $R^3$ |
| WYOMING | I | P | I | I | P | I | $R^1$ | $R^1$ | $R^1$ | $R^1$ | $R^2$ |

| TRAVELING FROM | HAWAII | IDAHO | ILLINOIS | INDIANA | IOWA | KANSAS | KENTUCKY | LOUISIANA | MAINE | MARYLAND | MASSACHUSETTS | MICHIGAN | MINNESOTA | MISSISSIPPI | MISSOURI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEXAS | | I | I | $R^2$ | I | I | I | I | $R^1$ | $R^2$ | $R^1$ | $R^1$ | I | I | I |
| UTAH | | I | I | $R^2$ | I | I | I | I | $R^2$ | $R^2$ | | $R^1$ | I | I | I |
| VERMONT | | | R | $R^2$ | $R^1$ | $R^1$ | $R^1$ | $R^1$ | $R^1$ | $R^5$ | $R^1$ | $R^1$ | $R^2$ | | R |
| VIRGINIA | | I | I | $R^2$ | I | I | I | I | $R^1$ | M | $R^1$ | M | I | I | I |
| WASHINGTON | | P | P | $R^2$ | P | P | R | $R^1$ | $R^1$ | $R^2$ | $R^1$ | $R^2$ | R | | P |
| WEST VIRGINIA | | | R | $R^2$ | | $R^4$ | M | M | $R^1$ | M | $R^1$ | M | $R^2$ | M | M |
| WISCONSIN | | I | I | $R^2$ | I | I | I | I | $R^1$ | $R^1$ | $R^1$ | $R^1$ | I | I | I |
| WYOMING | | I | I | $R^2$ | I | I | I | I | $R^1$ | $R^2$ | $R^1$ | | I | I | I |

| TRAVELING FROM | MONTANA | NEBRASKA | NEVADA | NEW HAMPSHIRE | NEW JERSEY | NEW MEXICO | NEW YORK | NORTH CAROLINA | NORTH DAKOTA | OHIO | OKLAHOMA | OREGON | PENNSYLVANIA | RHODE ISLAND | SOUTH CAROLINA | SOUTH DAKOTA | TENNESSEE | TEXAS | UTAH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEXAS | I | I | | $R^2$ | R | $R^2$ | $R^2$ | I | I | $R^2$ | I | I | R | $R^1$ | R | I | I | | I |
| UTAH | I | I | P | $R^2$ | | $R^2$ | $R^2$ | I | I | $R^2$ | I | I | $R^2$ | $R^2$ | $R^2$ | I | I | I | |
| VERMONT | | $R^2$ | $R^2$ | R | | | $R^2$ | R | | $R^2$ | | R | R | R | R | R | R | $R^1$ | |
| VIRGINIA | I | I | R | $R^2$ | M | | $R^2$ | I | I | $R^2$ | I | I | $R^2$ | $R^1$ | M | I | I | I | I |
| WASHINGTON | P | P | P | $R^2$ | | P | $R^2$ | $R^4$ | P | $R^2$ | $R^4$ | P | $R^2$ | $R^1$ | R | R | R | $R^2$ | P |
| WEST VIRGINIA | $R^2$ | R | | R | M | | R | M | M | $R^2$ | $R^2$ | $R^2$ | R | $R^1$ | M | | M | $R^1$ | |
| WISCONSIN | I | I | $R^2$ | $R^2$ | $R^2$ | | $R^2$ | I | I | $R^2$ | I | I | $R^2$ | $R^2$ | $R^2$ | I | I | I | I |
| WYOMING | I | I | P | $R^2$ | R | P | $R^2$ | I | I | $R^2$ | I | I | $R^2$ | $R^2$ | $R^2$ | I | I | I | I |

| TRAVELING FROM | VERMONT | VIRGINIA | WASHINGTON | WEST VIRGINIA | WISCONSIN | WYOMING |
|---|---|---|---|---|---|---|
| TEXAS | [illegible] | I | $R^1$ | $R^2$ | I | I |
| UTAH | | I | P | $R^2$ | I | I |
| VERMONT | | $R^2$ | $R^2$ | $R^2$ | $R^5$ | |
| VIRGINIA | | | $R^2$ | M | I | I |
| WASHINGTON | | $R^2$ | | $R^2$ | $R^5$ | P |
| WEST VIRGINIA | | M | $R^2$ | | $R^5$ | $R^2$ |
| WISCONSIN | $R^2$ | I | $R^4$ | $R^2$ | | I |
| WYOMING | | I | P | $R^2$ | I | |

I = International Registration Plan
R = Reciprocity
M = Multistate Reciprocity Agreement
P = Uniform Proration and Reciprocity Agreement
$R^1$ = Reciprocity based on residence
$R^2$ = Reciprocity based on proper registration or licensed
$R^3$ = Vehicle must be based in jurisdiction of registration
$R^4$ = Registration must be prorated
$R^5$ = Reciprocity based on place of business

Source:

American Trucking Associations, Inc., Bulletin Advisory Service, Washington, D.C., Volumes I and II.

J. J. Keller & Associates, Inc., Trucking Permit Guide, Neenah, Wisconsin

FOOTNOTES

California: Reciprocity agreements with IRP States will change as of July 1, 1981, when California begins a pilot IRP program.

Georgia: Vehicles from Arizona, Colorado, Idaho, Nevada, New Mexico, New York, North Dakota, [illegible], Oregon, South Dakota, Utah, and Wyoming receive reciprocity but must pay a permit fee of $10 for each vehicle and a $10 round trip fee.

Illinois: Carriers operating into Illinois that are registered in more than one State must prorate mileage.

Maine: Grants only two trips per month to vehicles from Oklahoma and Texas.

Massachusetts: Vehicles properly licensed in Kentucky may make occasional trips into the State.

Minnesota: New York and Ohio carriers must pay retaliatory tax.

Mississippi: Reciprocity is extended to only one vehicle per fleet for New Mexico carriers.

Montana: Agreements do not cover non fleet vehicles for carriers from: Arizona, Georgia, Massachusetts, Maryland, Missouri, Vermont. Must purchase trip permits. Montana extends reciprocity to only private carriers from West Virginia.

New Hampshire: New York, Ohio, and Oregon carriers must pay a flat, annual fee per vehicle.

New Jersey: Retaliatory taxes must be paid if from the States of Arizona, Colorado, Connecticut, Idaho, Kansas, Kentucky, Maine, Mississippi, Nevada, New Hampshire, New Mexico, New York, Ohio, Oregon, Utah, Vermont, Virginia, Washington, and Wyoming.

Texas: Allows two trips per month under reciprocity.

The IRP and UPRA supersede existing reciprocal or other agreement between member jurisdictions. The IRP would take precedence over UPRA.

# APPENDIX C

## ESTIMATING IMPACTS OF CHANGES IN USER CHARGES AND TRUCK SIZE AND WEIGHT LIMITS

### PURPOSE AND SCOPE

The purpose of this appendix, which supplements Chapter IV of Volume I, is to describe methods used to estimate economic impacts on vehicles and highway users resulting from changes in either user charges or truck size and weight limits. The discussion of these methods is accompanied by hypothetical, but realistic, impact estimates which may suffice as approximate or typical estimates with which to gauge other analytical results, or as data for first-cut State-level analyses. The usefulness of the methods and estimates to the State analyst will depend on the similarity of the examples and the consistency of the methods with the State material.

This appendix provides a discussion of methods useful for estimating both the direct and indirect impacts of potential changes in user-tax structures and truck size and weight limits at the Federal or State level. Also, coverage is provided for all highway user groups, given data on their fleet mix and use characteristics. Since, however, the specific definition of groups, and consequently their fleet characteristics, is derived from the perspective of Federal studies rather than State studies, these groupings may need modification to be useful in specific State studies.

Except for a few brief references, the truck size and weight (TS&W) material is treated only in this volume (i.e., not in Volume I) because it is considered somewhat tangential to cost allocation. However, as noted in the TS&W section later in this appendix, changes in TS&W limits can serve as an alternative instrument for implementing cost-allocation study findings. Also, changes in size and weight limits, whether at the national or State level, can affect operating costs, and thus economic impacts and intermodal relationships.

It is the intent of this appendix to provide an overview of the types of impacts examined in the Final Report of the Federal Highway Cost Allocation Study and the Investigation of Truck Size and Weight Limits.[1/] The examples are not intended to represent either a reference manual or an exhaustive array of areas for investigation by every State. Those who have already worked on such studies or those who are familiar with such study needs may prefer to pursue entirely different lines of analysis.

The degree of sophistication demanded in impact studies is influenced by the available budget for the study, the magnitude of the proposed changes, and the specific interests of public and private groups. These studies can provide valuable insights into who will be affected, by how much, and when. Information derived from these studies may be essential to identify real economic problems as well as to refute exaggerated claims of potential impacts.

In the Federal studies the list of impacts examined, varying by study, included:

- Vehicle operating and ownership costs (exclusive of other transport costs)
- Total transportation costs
- Total fuel consumption
- Changes in fleet size and vehicle purchases
- Changes in VMT
- Impacts on transportation costs for specified groups of freight and passenger carriers
- Modal traffic diversions

- Rail carrier revenue loss/gain
- Motor carrier revenue loss/gain
- Axle load distributions
- Gross vehicle weight distributions
- Highway traffic
- Pavement and bridge costs
- Environmental (noise and air pollution)
- Highway safety
- Sales and profit impacts on other industries and groups likely to be sensitive to transportation cost changes
- Macro-economic impacts on GNP, prices, and employment

These impacts are not exhaustive but provide a broad array of the areas of potential government concern. They serve, also, to trace the linkage from the direct impacts through many indirect impacts and, ultimately, to the most obvious macro-economic changes.

## ESTIMATING IMPACTS FROM USER CHARGE CHANGES

Direct impacts from proposed user charge changes were estimated for the Federal study using a computer model developed for this study called the Highway User Tax/Cost Model (HUTCM). Indirect impacts were estimated by examining specific industry costs through the use of linked macro-economic and interindustry (I/O) models. Because of broad aggregation, many of the specific analyses described for the national level analysis may not be sufficient for State level analyses. These methods may, however, provide a reasonable outline on which to base a State study.

## IMPACTS ON HIGHWAY USERS

The most significant form of impacts from user charge changes are the costs to various user groups. Depending on the nature of the user group, the major cost categories are composed of most or all of the following cost elements:

| <u>OPERATING COSTS</u> | <u>OWNERSHIP COSTS</u> |
|---|---|
| Fuel | Annualized Purchase Costs plus Interest |
| Lubricating Oil | Registration Fees |
| Tires (Tubes, Tread rubber) | License Fees |
| Parts | Vehicle Weight Taxes |
| Maintenance | Insurance Costs |
| Garaging, Washing, Tolls, Parking fees, etc. | Fixed Terminal Area Costs (Trucking) |
| Taxes on any use-related items | |
| Labor (Commercial groups) | |
| Variable Terminal Area Costs (Trucking) | |

## VEHICLE CLASSES

The choice of vehicle classes is based on both the analytical and the reporting requirements of the study. Analytical requirements demand a more detailed classification scheme than that for reporting purposes. Reporting requirements generally dictate a conceptual scheme which conveys the broad implications of the tax proposals. Classification for analytical purposes imposes the need for enough detail to comprehend the variations in tax rates and structures and differences in vehicle characteristics.

In the past Federal studies on cost allocation and the associated impact analysis, thirty-eight vehicle classes were used for analytical purposes. These were established early in the cost allocation study in order to allow for flexibility to test alternative tax structures and rates, reflect existing or proposed tax exemptions and exclusions, and to account for significant variations in vehicle characteristics. In more recent work a more detailed classification was established to allow a coordinated analysis of impacts from changes in both user charges and truck size and weight limits. Figure C-1 provides the list of these vehicles. For reporting purposes ten summary vehicle classes might be chosen, similar to those shown in Figure C-2.

## USER GROUPS

In order to effectively assess economic consequences of changes in highway user taxes for any particular group it is important to describe the group's mix of vehicles, their typical annual utilization and other appropriate characteristics such as fuel consumption rates. It may be attractive to attempt to represent the impacts on a particular group by estimating changes for a "typical" vehicle. While this method is appealing for its simplicity, it can be very misleading. First, only in unusual situations would the vehicle type chosen to represent the typical vehicle reflect the weighted average of the group's vehicle fleet mix and use. Second, in the Federal

FIGURE C-1

DETAILED VEHICLE CLASSIFICATIONS

| Vehicle Class Number | Vehicle Description | Gross Vehicle Weight Intervals (000 pounds) |
|---|---|---|
| 1 | Small Automobiles | |
| 2 | Standard Automobiles | |
| 3 | Motorcycles & Motor Bikes | |
| 4 | School and Other Buses | |
| 5 | Transit Buses | |
| 6 | Intercity Buses | |
| 7 | Light Trucks (4 Tires) | |
| 8-11 | Two Axle Single-Unit Trucks (6 Tires) | (0-10, 10-26, 26-33, 33+) |
| 12-15 | Three or More Axle Single-Unit Trucks | (0-26, 26-33, 33-55, 55+) |
| 16-18 | Three Axle Semi-Combinations | (0-26, 26-33, 33+) |
| 19-21 | Four Axle Semi-Combinations | (0-33, 33-55, 55+) |
| 22-24 | Five Axle Semi-Combinations | (0-55, 55-80, 80+) |
| 25-27 | Six or More Axle Semi-Combinations | (0-55, 55-80, 80+) |
| 28-30 | Five & Six Axle Doubles, Triple Combinations | (0-55, 55-80, 80+) |
| 31-33 | Seven Axle Double Combinations | (0-55, 55-80, 80+) |
| 34-36 | Eight or More Axle Double Combinations | (0-55, 55-80, 80+) |
| 37-39 | Three or Four Axle Truck Combinations | (0-26, 26-33, 33+) |
| 40-41 | Five Axle Truck Combinations | (0-55, 55+) |
| 42-44 | Six or More Axle Truck Combinations, Truck Triples | (0-55, 55-80, 80+) |

FIGURE C-2

SUMMARY VEHICLE CLASSIFICATIONS

Small Automobiles

Standard Automobiles

Motorcycles

Buses

Light Trucks

Single Unit Trucks, 0-26,000 pounds GVW

Single Unit Trucks, 26,001+ pounds GVW

Combinations, 0-55,000 pounds GVW

Combinations, 55,001-80,000 pounds GVW

Combinations, 80,001+ pounds GVW

and State tax structures, tax rates vary by vehicle type. Some changes in the tax structure may reduce the burden on certain vehicle types while increasing the burden on others. A particular vehicle type may not reflect the weighted mix of these taxes. Third, impacts should account for likely price-induced behavioral adjustment in fleet size and use. Price elasticities are different between groups. It is therefore necessary to reflect the appropriate mix of vehicles and their utilization to assess costs and accurately reflect behavioral adjustments.

In addition to these reasons it is often more useful to describe impacts for economic entities (i.e. highway user groups or industries) than for vehicles. An analysis of the economic and financial consequences of tax alternatives on particular groups is an effective basis for argument in refuting exaggerated claims of damage derived from ad hoc estimates as are often used by groups with narrow interests.

A classification scheme which defines sixteen separate, but inclusive, user groups for national user-charge and TS&W studies is shown in Figure C-3. For each of these groups, vehicle fleet size and use characteristics were forecast in order to allow distinct impact analyses.

## CALCULATING PRICE ELASTICITIES

Following the 1973 petroleum embargo period, after which fuel prices rose dramatically, a significant body of literature focused on the analysis of travel elasticities with respect to changes in fuel prices. A good portion of this literature concentrates on household or light vehicle travel. The literature is sparse concerning price elasticities for for-hire groups and elasticities other than for fuel prices. It is, therefore, difficult to deduce from the published literature a comprehensive set of price elasticities necessary in the estimation of impacts. Several studies however, provide indications of overall trucking freight demand (i.e. sensitivity to freight rate) elasticities. These sources provided the foundation for the estimates used in the Federal studies.

FIGURE C-3

HIGHWAY USER GROUPS

Low Income Households
Medium Income Households
High Income Households
Taxi Operators
For-Hire Bus Operators
Farm and Ranch
Other Private Groups
State and Local Government
Federal Government
Utilities, Services and Construction
Local For-Hire Trucking
Long-Haul General Cargo Carriers
Long-Haul Special Commodity Carriers
Long-Haul Exempt Carriers
Long-Haul Private Freight Carriers
Other Long-Haul Private Carriers

A further difficulty evident when referring to the available literature is that the estimated elasticities refer to components of vehicle costs, such as changes in fuel price or vehicle purchase price elasticities, rather than the elasticities of changes in total operating costs, total ownership costs, or the total vehicle costs. Because Federal user charges affect an array of operating and ownership costs, not just one item such as fuel prices, it was necessary for study purposes to construct from the published estimates the elasticity estimates for these broader cost categories. For the purposes of the Federal impact analysis four sets of elasticities were contructed to account for changes in both VMT and vehicle ownership with respect to changes in either total operating costs or total ownership costs.

Estimates of the elasticities of VMT with respect to fuel price for autos and light vehicles are generally in the -0.15 to -0.35 range. These estimates imply that for a 10 percent increase in fuel prices, VMT will drop between 1.5 and 3.5 percent. Some estimates indicate that lower income households are more price sensitive than higher income households and that business is generally less price sensitive than private households. These estimates are usually of short-run elasticities. Since the model used in the Federal studies explicitly treats changes in fuel efficiency over time, the short-run estimates were considered appropriate.

The literature available concerning fuel price impacts on total vehicle ownership suggests median elasticity estimates in the range between -0.65 and -0.85. Fuel price impacts on new car sales are reported in a range between -0.2 and -1.0 in the short-run, with long run effects suggested to be less than -0.2. Study estimates of elasticities are reported in Figure C-4.

Several studies have reported elasticities of truck freight ton-miles ranging from -0.2 to -3.0, depending on the commodity and the availability of alternative modes. As a general conclusion it appears a reasonable estimate of the average ton-mile/rate elasticity is -1.0. Little is reported on the likely effects of cost changes on average loads, average length of haul or shipment sizes.

FIGURE C-4

STUDY PRICE ELASTICTY ESTIMATES

| Elasticity of: | Low Income Households | Mid Income Households | High Income Households | Trucking | Private Busing | Business Fleets | Government/ Transit |
|---|---|---|---|---|---|---|---|
| 1) VMT with respect to vehicle operating costs | -1.1 | -0.7 | -0.5 | -0.3 | -0.2 | -0.3 | -0.1 |
| 2) VMT with respect to vehicle ownership costs | -0.4 | -0.4 | -0.4 | -0.1 | -0.4 | -0.2 | -0.1 |
| 3) Vehicle ownership with respect to vehicle operating costs | -0.4 | -0.4 | -0.4 | -0.3 | -0.2 | -0.2 | -0.1 |
| 4) Vehicle ownership with respect to vehicle ownership costs | -0.5 | -0.5 | -0.5 | -0.1 | -0.4 | -0.2 | -0.1 |

As indicated above, the structure of the model used in the Federal studies requires elasticities in different forms from those generally reported in the literature. The derivation of these estimates requires several simplifying assumptions which allow simple computation of the necessary elasticity forms. Even if these assumptions are not totally accurate, given the level of cost changes implied by these analyses, the distortions will not be significant. Examples of the derivation of the elasticities needed for the analysis are shown below.

Four sets of elasticities used in the analysis of impacts will be referred to as $E_{m,o}$, $E_{m,a}$, $E_{v,o}$, and $E_{v,a}$, representing the elasticities of VMT with respect to operating costs, VMT with respect to annual (or ownership) costs, vehicle ownership with respect to operating costs and vehicle ownership with respect to annual cost, respectively. These can be represented symbolically in simplified forms, as:

$$E_{m,o} = \frac{\Delta VMT}{\Delta OC} \frac{OC}{VMT},$$

$$E_{m,a} = \frac{\Delta VMT}{\Delta AC} \frac{AC}{VMT},$$

$$E_{v,o} = \frac{\Delta V}{\Delta OC} \frac{OC}{V}, \text{ and}$$

$$E_{v,a} = \frac{\Delta V}{\Delta AC} \frac{AC}{V},$$

where, VMT represents vehicle miles of travel,
OC represents vehicle operating costs,
AC represents annual vehicle costs,
and V represents fleet size.

Elasticities of VMT with respect to operating costs, $E_{m,o}$, were generally derived from reported estimates of the elasticities of VMT with respect to fuel price, $E_{m,f}$, relying on the following relationship:

$$E_{m,o} = E_{m,f} / E_{o,f} ,$$

stating that the desired elasticity form, $E_{m,o}$, is the dividend of the VMT-fuel price elasticity divided by the elasticity of operating costs with respect to fuel price. This may be expressed symbolically as:

$$\frac{\Delta VMT}{\Delta OC} \frac{OC}{VMT} = \frac{\Delta VMT}{\Delta f} \frac{f}{VMT} / \frac{\Delta OC}{\Delta f} \frac{f}{OC} ,$$

where f represents fuel price and the other terms are as previously defined.

This expression reveals that the VMT/operating cost elasticities can be derived from VMT/fuel price elasticities if the relationship between operating costs and fuel prices is known. Operating costs per mile are likely to change by the same amount as the per mile change in fuel prices, since the consumption per mile of items like tires, maintenance and parts are not likely to change substantially when fuel prices change.

This means that $\frac{\Delta OC}{\Delta f} = 1$.

Therefore, $E_{o,f}$ reduces to the ratio of fuel price to total operating costs, or simply, $\frac{f}{OC}$.

These ratios were estimated from the output of the Highway User Tax/Cost Model.

Similar derivations may be made for the elasticities of vehicle ownership with respect to total annual costs using reported vehicle ownership/capital costs elasticities and the ratios of capital costs to total annual costs.

For trucking firms the derivation of study elasticities was based on aggregate ton-mile/rate elasticities, in a similar fashion to derivations above. From trucking rate elasticities, $E_{tm,r}$, the four sets of elasticities required in the study can be inferred. Given that

$$E_{tm,r} = \frac{\Delta TM}{\Delta r}\frac{r}{TM},$$

we can derive the VMT/operating cost elasticity, $E_{m,o}$, from the following sequence of terms:

$$E_{m,o} = \frac{\Delta TM}{\Delta r}\frac{r}{TM} * \frac{\Delta r}{\Delta OC}\frac{OC}{r} * \frac{\Delta VMT}{\Delta TM}\frac{TM}{VMT},$$

where the three terms are the ton-mile/rate elasticity, the rate/operating cost elasticity and the VMT/ton-mile elasticity. If it is reasonable to assume that the change in rates will be equal to the change in operating costs, i.e. increases in costs per ton-mile will be totally passed through as rate increases, and that the average load, i.e. TM/VMT, remains constant, then the two latter terms reduce to $\frac{OC}{r}$ and 1, respectively.

The desired elasticity can then be calculated as:

$$E_{m,o} = \frac{\Delta TM}{\Delta r}\frac{r}{TM} * \frac{OC}{r} * 1 = E_{tm,r} * \frac{OC}{r}.$$

Vehicle operating cost/rate ratios vary by carrier group and region.

The other required elasticities can be derived similarly. The additional assumption of constant annual vehicle capacity utilization, (i.e., $\frac{\Delta V}{\Delta TM}\frac{TM}{V} = TM/V$) , is required for estimates of $E_{v,o}$ and $E_{v,a}$.

These assumptions may not hold for large price changes but seem reasonable for the small price changes likely under the considered user-charge alternatives.

## VEHICLE COSTS AND USER-CHARGE CONTRIBUTIONS

In the Federal user-charge impact study, the highway cost allocation studies and in most State studies, the methods used to estimate user-charge revenues and vehicle costs by vehicle type or user group divide vehicle costs into a variable, VMT-related, operating-cost component and a fixed, or annually based, cost component. In these computations, variable costs and tax revenues from variable items are computed as a function of VMT. Fixed costs and annual taxes, like depreciation, registration fees, licenses, insurance and property taxes, are calculated as a function of the type of vehicle and the total number of vehicles in the fleet.

Stated simply, operating costs and related taxes can be calculated using the general equation:

$$OC_{iv} = VMT_{iv} * CR_{iv} * (P+t)_i$$

where, OC represents operating costs,
VMT represents vehicle miles of travel,
CR represents the appropriate consumption rate,
P represents an item's price, and
t represents the tax rate.

Subscripts i and v represent the particular item and vehicle class, respectively. Operating cost items include fuel, lubricating oil, tires, tubes, retreads, parts, maintenance, tolls, parking, and other items. Calculations of tax revenues on operating items, such as fuel, use the same formula with the tax rate only instead of the (P+t) term. The next section contains sample calculations.

Annual costs include depreciation and interest, registrations, licenses, insurance, property taxes and other items. For commercial vehicles terminal facilities, labor costs, etc., are included. Annual or fixed costs, denoted AC, can generally be estimated as a lump sum per vehicle based on particular vehicle characteristics. Depreciation and interest and registration fees, for instance, are likely to vary by vehicle type.

Annual depreciation and interest per vehicle may be estimated in a variety of ways. In the Federal study an annualizing factor, the capital recovery factor, was used to estimate these costs by vehicle type. The capital recovery factor is calculated as:

$$CRF = \frac{(1+r)^L * i}{(1+r)^L - 1},$$

where, CRF represents the capital recovery factor,

L represents the useful vehicle life,

r represents the interest or discount rate,

and i is the number of time periods.

Using this factor annual depreciation and interest may be calculated as:

$$AC_i = PV*(1-SR)*(CRF)+(SR*r) ,$$

where, AC represents annual costs per vehicle (including taxes and other costs).

PV represents the vehicle purchase price,

SR represents the salvage rate, and

subscript i, in this case, represents depreciation and interest only.

This calculation, using the CRF, incorporates a notion close to both the economic opportunity cost of capital and the likely annual costs of vehicle purchases. In the Federal user-charge-impact studies, because separate values for average vehicle life were available by user group and vehicle class and separate vehicle prices were available by vehicle type[2/], this calculation provided unique values by user group and vehicle type.

Other annual costs and annual taxes were estimated as a lump sum per vehicle. The total of these other values plus depreciation and interest yields the annual cost estimate for a particular vehicle class.

The sum of operating and annual costs represents total vehicle costs. The equation for estimating these costs can be represented as:

$$TC = \sum_{v} NV_v * (OC_{i,v} + AC_{i,v}),$$

where, TC represents total vehicle costs,
NV represents the total number of vehicles, and

The methods described in this section served as the basis of the Highway User Tax/Cost Model used in the Federal highway cost allocation study impact analysis and more recent work on a combined analysis of changes in user charges and TS&W limits. A more complete description of the information and methods used in this analysis is contained in TSC's, An Analysis of Alternative Highway User Charges, Highway User Tax/Cost Model Documentation.

Vehicle costs and Federal user charge forecasts for 1985 using this model are shown in Figures C-5 and C-6, for twelve vehicle classifications and two fuel types. Forecasts of average vehicle costs for twelve user groups, based on their expected vehicle fleet mix and use, are also shown in Figure C-7. Costs for these figures assume $1.75 per gallon of fuel (diesel and gasoline); other costs (converted to 1985 dollars) and consumption rates are shown in Figures V-6 and V-8 in Volume I.

FIGURE C-5

1985 GASOLINE-POWERED VEHICLE COSTS

| | | | | | Single Units | | Combination Trucks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING COSTS (¢/mile) | Sm Auto | Lg Auto | Motor-cycle | Small Trucks | 0-26K GVW | 26K+ GVW | 0-50K GVW | 50-70K GVW | 70-75K GVW | 75K+ GVW | Other Buses |
| Fuel | 7.1¢ | 11.7¢ | 3.7¢ | 12.7¢ | 25.3¢ | 31.2¢ | 34.5¢ | 41.8¢ | 44.0¢ | 41.8¢ | 23.9¢ |
| Oil | 0.4 | 0.5 | 0.6 | 0.5 | 0.8 | 1.0 | 1.1 | 1.4 | 1.5 | 1.4 | 0.7 |
| Tires | 0.4 | 1.0 | 0.6 | 1.1 | 1.1 | 1.5 | 1.6 | 2.5 | 3.1 | 3.3 | 2.6 |
| Parts & Accessories | 1.3 | 1.6 | 3.9 | 1.0 | 5.1 | 6.3 | 4.8 | 4.4 | 4.4 | 5.0 | 7.9 |
| Maintenance | 3.3 | 4.3 | 5.9 | 2.0 | 11.8 | 15.6 | 11.7 | 10.9 | 11.0 | 12.4 | 24.4 |
| Other | 4.3 | 4.4 | 4.3 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 |
| Total Operating Costs (¢/mile) | 16.8¢ | 23.5¢ | 19.0¢ | 21.6¢ | 48.6¢ | 60.0¢ | 58.1¢ | 65.4¢ | 68.4¢ | 68.3¢ | 63.9¢ |
| ANNUAL COSTS ($/year) | | | | | | | | | | | |
| Depreciation and Interest | $1545 | $1915 | $ 350 | $1150 | $2030 | $4440 | $5200 | $9220 | $ 9500 | $12100 | $ 8770 |
| Insurance, Registration, Fees | 280 | 375 | 400 | 940 | 2040 | 3950 | 3990 | 6290 | 8420 | 12370 | 2240 |
| Total Annual Costs ($/year) | $1825 | $2290 | $ 750 | $2090 | $4070 | $8390 | $9190 | $15510 | $17920 | $24470 | $11010 |
| Average Annual Miles per Vehicle | 9970 | 9970 | 2300 | 10600 | 11600 | 11600 | 14800 | 17890 | 21800 | 17700 | 7400 |
| Fleet Size (000) | 44395 | 61079 | 8167 | 33724 | 3064 | 784 | 117 | 50 | 4 | 2 | 419 |

FIGURE C-6

1985 DIESEL-POWERED VEHICLE COSTS

| | | | | Single-Units | | Combination Trucks | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sm Auto | Lg Auto | Small Trucks | 0-26K GVW | 26K+ GVW | 0-50K GVW | 50-70K GVW | 70-75K GVW | 75K+ GVW | Inter-city Buses | Other Buses |
| OPERATING COSTS (¢/mile) | | | | | | | | | | | |
| Fuel | 4.2¢ | 8.0¢ | 6.0¢ | 27.6¢ | 28.1¢ | 30.1¢ | 30.3¢ | 31.8¢ | 32.2¢ | 29.3¢ | 45.1¢ |
| Oil | 0.8 | 1.0 | 1.0 | 1.8 | 1.9 | 2.0 | 2.0 | 2.1 | 2.1 | 1.9 | 3.0 |
| Tires | 0.4 | 1.0 | 1.1 | 1.1 | 1.8 | 1.8 | 2.7 | 3.0 | 3.3 | 1.3 | 1.4 |
| Parts & Accessories | 1.3 | 1.6 | 1.0 | 2.5 | 4.3 | 2.3 | 2.4 | 2.3 | 2.3 | 2.0 | 2.1 |
| Maintenance | 3.3 | 4.0 | 2.1 | 6.4 | 10.5 | 5.7 | 6.0 | 5.7 | 5.5 | 19.2 | 46.5 |
| Other | 4.3 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 |
| Total Operating Cost (¢/mile) | 14.3¢ | 20.0¢ | 15.6¢ | 43.8¢ | 51.0¢ | 46.3¢ | 47.8¢ | 49.3¢ | 49.8¢ | 58.1¢ | 102.3 |
| ANNUAL COSTS ($/year) | | | | | | | | | | | |
| Depreciation and Interest | $1665 | $1880 | $1335 | $2790 | $ 8620 | $ 7430 | $12160 | $14190 | $15400 | $17660 | $13900 |
| Insurance, Registration, Fees | 280 | 340 | 1050 | 2190 | 4680 | 4190 | 7280 | 8830 | 12650 | 9680 | 9740 |
| Total Annual Costs ($/year) | $1945 | $2220 | $2385 | $4980 | $13300 | $11620 | $19440 | $23020 | $28050 | $27340 | $23640 |
| Average Annual Miles per Vehicle | 9970 | 9970 | 10600 | 17950 | 21200 | 41000 | 44800 | 63300 | 68250 | 55000 | 32250 |
| Fleet Size (000) | 2995 | 2770 | 1007 | 179 | 519 | 194 | 318 | 315 | 376 | 20 | 59 |

FIGURE C-7

1985 VEHICLE COSTS BY USER GROUP

| | Households High Income | Households Med Income | Households Low Income | Regulated Trucking | Local Trucking | Exempt Carriers | Private Trucking | Services, Construction | Owner-Operators | Private Busing | Auto Fleets, Rental/Lease | Government, Transit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OPERATING COSTS (¢/mile) | | | | | | | | | | | | |
| Fuel | 9.6¢ | 9.8¢ | 9.9¢ | 30.9¢ | 27.2¢ | 31.9¢ | 23.0¢ | 17.7¢ | 31.6¢ | 26.9¢ | 10.8¢ | 14.2¢ |
| Oil | 0.5 | 0.5 | 0.5 | 1.9 | 1.4 | 1.9 | 1.0 | 0.7 | 2.0 | 1.4 | 0.5 | 0.8 |
| Tires | 0.8 | 0.8 | 0.8 | 2.7 | 1.8 | 2.7 | 1.5 | 1.1 | 2.8 | 1.9 | 10.8 | 1.0 |
| Parts | 1.4 | 1.4 | 1.4 | 2.3 | 2.7 | 2.3 | 2.2 | 1.5 | 2.3 | 4.6 | 1.6 | 2.5 |
| Maintenance | 3.6 | 3.5 | 3.5 | 6.2 | 7.0 | 6.2 | 5.4 | 3.5 | 6.2 | 21.5 | 4.1 | 8.2 |
| Other | 4.3 | 4.3 | 4.3 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 |
| Total Operating Costs (¢/mile) | 20.2¢ | 20.3¢ | 20.4¢ | 48.4¢ | 44.5¢ | 49.4¢ | 37.5¢ | 28.9¢ | 49.3¢ | 60.7¢ | 22.2¢ | 31.1¢ |
| ANNUAL COSTS ($/year) | | | | | | | | | | | | |
| Depreciation & Interest | $2560 | $ 955 | $ 710 | $ 9420 | $ 4340 | $ 8560 | $ 2870 | $1540 | $ 9830 | $ 9680 | $3250 | $2960 |
| Insurance, Registration, Fees | 570 | 360 | 240 | 5900 | 3470 | 8940 | 2210 | 1620 | 10290 | 3010 | 630 | 1390 |
| Total Annual Costs ($/year) | $3130 | $1315 | $ 950 | $15320 | $ 7810 | $17500 | $ 5080 | $3160 | $20120 | $12690 | $3880 | $4350 |
| Average Annual Miles per Vehicle | 8750 | 8200 | 7400 | 49150 | 22650 | 50600 | 19150 | 11750 | 54250 | 10250 | 28450 | 11900 |
| Fleet Size (000) | 41518 | 52900 | 32425 | 431 | 443 | 88 | 3917 | 11179 | 213 | 196 | 13470 | 3779 |

Estimates of total Federal, State and Local highway user charges for each of these vehicle classes are shown in Figures C-8 and C-9. Federal user charges were estimated using the HUTCM model. State and local taxes were approximated from data in FHWA's Road User and Property Taxes, 1982.

Estimates of total vehicle costs and user charges by user group are the sum of charges for each type of vehicle in the user group's fleet. These costs and user charge estimates reflect the variations in usage among groups.

These estimates, for the most part, reflect forecasts for 1985 of national level data. Consequently, they very likely do not represent State level values. They are provided, rather, as approximations by which to gauge other estimates or for rough-cut analyses.

**CALCULATING TAX REVENUES**

As an example of tax revenue calculations employing the methods discussed in Chapter IV the following hypothetical calculations are provided, shown in Figure C-10.

Consider a hypothetical case of a proposed fuel tax increase from 8¢ per gallon to 12¢ per gallon. For a vehicle travelling an average of 10,000 miles per year with an average fuel economy of 18 miles per gallon, tax contributions would equal $44 per year in the base case and about $67 under the alternative case,

(10000 VMT/18 MPG) * $0.08 = $44.44, vs
(10000 VMT/18 MPG) * $0.12 = $66.66.

With 1.5 million such vehicles in the fleet, fuel taxes would equal $67 million in the base case and $100 million for the proposed tax. An alternative way of figuring these totals would be to use aggregate fleet VMT estimates of 15 billion VMT.

FIGURE C-8

ESTIMATED HIGHWAY USER CHARGES BY VEHICLE TYPE

GAS-POWERED VEHICLES

| | Sm Autos | Large Autos | Motor-cycles | Small Trucks | Single-Units 0-26K GVW | Single-Units 26K+ GVW | Combination Trucks 0-50K GVW | Combination Trucks 50-70K GVW | Combination Trucks 70-75K GVW | Combination Trucks 75K+ GVW | Other Buses |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STATE AND LOCAL | | | | | | | | | | | |
| Variable (¢/mile) | 0.5 | 0.8 | 0.2 | 0.8 | 1.7 | 2.1 | 2.3 | 2.8 | 2.9 | 2.8 | 1.6 |
| Fixed ($/year) | 71 | 172 | 21 | 83 | 335 | 685 | 915 | 1040 | 1650 | 1980 | 520 |
| FEDERAL | | | | | | | | | | | |
| Variable (¢/mile) | 0.3 | 0.6 | 0.2 | 0.6 | 1.1 | 1.5 | 1.7 | 2.1 | 2.3 | 2.2 | 0 |
| Fixed ($/year) | 0 | 0 | 0 | 0 | 0 | 90 | 260 | 940 | 1180 | 1460 | 0 |
| TOTAL | | | | | | | | | | | |
| Variable (¢/mile) | 0.8 | 1.4 | 0.4 | 1.4 | 2.8 | 3.6 | 4.0 | 4.9 | 5.2 | 5.0 | 1.6 |
| Fixed ($/year) | 71 | 172 | 21 | 83 | 335 | 775 | 1175 | 1980 | 2830 | 3440 | 520 |

Source: FHWA's <u>ROAD USER AND PROPERTY TAXES, 1982</u> and TSC Estimates.

FIGURE C-9

ESTIMATED HIGHWAY USER CHARGES BY VEHICLE TYPE

DIESEL POWERED VEHICLES

| | Sm Autos | Large Autos | Small Trucks | Single-Units 0-26K GVW | Single-Units 26K+ GVW | Combination Trucks 0-50K GVW | Combination Trucks 50-70K GVW | Combination Trucks 70-75K GVW | Combination Trucks 75K+ GVW | Inter-city Buses |
|---|---|---|---|---|---|---|---|---|---|---|
| STATE AND LOCAL | | | | | | | | | | |
| Variable (¢/mile) | 0.3 | 0.5 | 0.4 | 1.8 | 1.9 | 2.0 | 2.0 | 2.1 | 2.1 | 2.0 |
| Fixed ($/year) | 71 | 172 | 92 | 390 | 1000 | 910 | 1200 | 1815 | 2160 | 1715 |
| FEDERAL | | | | | | | | | | |
| Variable (¢/mile) | 0.2 | 0.4 | 0.3 | 1.4 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 | 0 |
| Fixed ($/year) | 0 | 0 | 0 | 0 | 550 | 650 | 1540 | 2010 | 2300 | 0 |
| TOTAL | | | | | | | | | | |
| Variable (¢/mile) | 0.5 | 0.9 | 0.7 | 3.2 | 3.5 | 3.7 | 3.8 | 4.0 | 4.1 | 2.0 |
| Fixed ($/year) | 71 | 172 | 92 | 390 | 1550 | 1560 | 2740 | 3825 | 4460 | 1715 |

Source: FHWA's ROAD USER AND PROPERTY TAXES, 1982 and TSC Estimates.

FIGURE C-10

HYPOTHETICAL IMPACT AND REVENUE CALCULATIONS

| | Base Case | Tax Alternative w/o Elasticities | Tax Alternative w/Elasticities |
|---|---|---|---|
| Miles per Vehicle | 10000 | 10000 | 9944 |
| Miles per Gallon | 18 | 18 | 18 |
| Fuel Consumption (Gallons/yr) | 556 | 556 | 552 |
| Tax Revenue per Vehicle | $44.44 | $66.66 | $66.29 |
| Vehicle Operating Costs ($/yr) | $ 2044 | $ 2067 | $ 2055 |
| Fleet Size (Millions) | 1.5 | 1.5 | 1.5 |
| | | —Change from Base Case— | |
| TOTAL TAX REVENUES (Millions) | $ 66.7 | $ 33.3 | $ 32.8 |
| TOTAL VEHICLE OPERATING COSTS (Millions) | $ 3066 | $ 33.3 | $ 17.4 |

To put these increases into perspective it may be useful to examine the relationship between the increases in taxes and total vehicle operating costs. For this example assume vehicle costs other than taxes equal 20¢ per mile. Under these assumptions vehicle operating costs would equal $2044 per year in the base case and $2067 in the alternative, an increase of 1.1 percent.

As a first approximation this method probably yields reasonable estimates. It, however, fails to account for likely price-induced changes in travel and vehicle ownership. This concept was discussed in the section on price elasticities.

The general formula for price elasticity can be expressed as,

$$E = \frac{\Delta Q}{\Delta P}\frac{P}{Q},$$

where, E represents elasticity,
Q represents quantity (for example VMT or number of vehicles) and
P represents price.

This formula can be applied in the impact analysis to estimate vehicle costs. Since we are interested in the likely change in VMT or travel, i.e. Q, we can rearrange the terms above as:

$$Q_a = E*\frac{\Delta P}{P} * Q_b.$$

To take this derivation one step further, the total quantity predicted for the alternative case is $Q_b + \Delta Q$, where $\Delta Q$ may be positive or negative depending on the sign of the elasticity and price change. Symbolically this is expressed as:

$$Q_b + \Delta Q = Q_b + E * \frac{\Delta P}{P} * Q_b = Q_b * \left[ 1 + E \frac{\Delta P}{P} \right]$$

If $VMT_b$ and $VMT_a$ are taken to represent VMT estimates before and after tax changes respectively, then

$$VMT_a = VMT_b + \Delta VMT, \text{ or}$$

$$VMT_a = VMT_b * (1 + E \frac{\Delta P}{P})$$

If the elasticity of VMT with respect to vehicle operating costs per mile is assumed to equal -0.5, calculations for the example above, where $VMT_b$ = 10000, P = 20.44¢ per vehicle mile, ΔP = (20.67 - 20.44) = 0.23¢, are

$$VMT_a = 10000 * (1 - 0.5 (\frac{0.23}{20.44})) = 9944 \text{ miles}$$

Fuel tax revenues for the alternative 12¢ tax rate will then equal:

$$T_a = (9944 \text{ miles/18 MPG}) * \$0.12 = \$66.29 \text{ per vehicle}$$

Total fuel tax revenues after accounting for elasticity effects would equal $99.4 million as opposed to $100 million above, a change of $32.8 million as opposed to $33.3 million. Similarly, average annual vehicle costs are $2055 after elasticity effects as opposed to $2067.

While these changes may not appear significant on the whole, impacts on all vehicle owners in this example would be overestimated by about $15 million annually or by about 48% (i.e., a change of $17.4 million as opposed to $33.3 million). Similar elasticity estimates should be made to account for fleet size changes when annual fixed costs change.

This example is intended to show that revenue estimates will not seriously differ with or without accounting for the elasticities of demand. However, impacts will be significantly overstated. Furthermore, the estimated changes in VMT, vehicle sales and fleet size allow calculation of indirect impacts, such as impacts on motor vehicle sales and services and the overall regional economy. The elasticity calculations provide the basis for estimates of the magnitudes of these indirect impacts.

### OTHER COSTS

Other costs, such as travel time for passengers and overhead and warehousing for trucking firms are discussed in Chapter IV.

## ESTIMATED IMPACTS

Two hypothetical tax cases have been set up to present typical impacts. These cases presume the national averages for the vehicle classes shown, with vehicle costs and user charges corresponding to those shown earlier in Figures C-5 and C-6. The tax alternatives presented should be interpreted as being in addition to existing taxes rather than substituting for existing ones.

The first case is a 10¢ per gallon fuel tax increase for both gasoline and diesel fuels by the twelve vehicle classes and two fuel types, shown in Figures C-11 and C-12. Larger or smaller increases would be roughly proportional, based on the relative tax rates. They are intended to serve as a guide for the range of likely impacts.

As can be seen, a 10¢ fuel tax increase would raise user-charge levels on various vehicles between 9 and 37 percent. Vehicle costs, on the other hand, rise between 0.1 and 2.0 percent. The reason is, in part, due to the fact that highway use taxes constitute only a small fraction of total vehicle costs for all groups and an even smaller fraction of a for-hire group's total transportation costs. Another

FIGURE C-11
ESTIMATED IMPACTS FROM 10¢ PER GALLON FUEL TAX INCREASE

| | Small Auto | Large Auto | Motor-cycle | Light Trucks | Single-Units 0-26K GVW | Single-Units 26K+ GVW | Combination Trucks 0-50K GVW | Combination Trucks 50-70K GVW | Combination Trucks 70-75K GVW | 75K+ GVW | Inter-city Buses | Other Buses |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GASOLINE-POWERED VEHICLES** | | | | | | | | | | | | |
| Changes in: User Charges ($/year) | $ 42 | $ 68 | $ 5 | $ 80 | $ 143 | $180 | $268 | $ 400 | $ 514 | $ 388 | - | $ 30 |
| Vehicle Costs* ($/year) | $ 31 | $ 48 | $ 4 | $ 66 | $ 140 | $179 | $268 | $ 400 | $ 514 | $ 388 | - | $ 30 |
| Percentage Change in: | | | | | | | | | | | | |
| Vehicle Costs* | 0.3% | 0.4% | 0.1% | 0.8% | 1.2% | 1.0% | 1.3% | 1.4% | 1.3% | 1.0% | - | 0.2% |
| VMT | -1.2% | -1.4% | -0.4% | -1.3% | -0.3% | -0.2% | -0.3% | -0.3% | -0.4% | -0.3% | - | - |
| Fleet Size | -0.6% | -0.6% | -0.2% | -0.6% | -0.2% | -0.2% | -0.3% | -0.4% | -0.4% | -0.3% | - | - |
| **DIESEL AND SPECIAL FUELS-POWERED VEHICLES** | | | | | | | | | | | | |
| Changes in: User Charges ($/year) | $ 18 | $ 39 | - | $ 41 | $ 274 | $337 | $725 | $ 802 | $1192 | $1304 | $1025 | - |
| Vehicle Costs ($/year) | $ 14 | $ 29 | - | $ 39 | $ 269 | $333 | $725 | $ 800 | $1184 | $1287 | $1015 | - |
| Percentage Change in: | | | | | | | | | | | | |
| Vehicle Costs* | 0.1% | 0.2% | - | 0.6% | 1.8% | 1.1% | 2.0% | 1.6% | 1.8% | 1.8% | 1.4% | - |
| VMT | -0.8% | -1.2% | - | -0.5% | -0.2% | -0.3% | -0.5% | -0.5% | -0.5% | -0.5% | -0.1% | - |
| Fleet Size | -0.4% | -0.5% | - | -0.3% | -0.2% | -0.3% | -0.5% | -0.4% | -0.4% | -0.4% | -0.5% | - |

*Vehicle cost changes are net after changes in VMT and fleet size.

FIGURE C-12
ESTIMATED IMPACTS ON USER GROUPS FROM 10¢ FUEL TAX INCREASE
(per vehicle)

| | Households High Income | Households Med Income | Households Low Income | Regulated Trucking | Local Trucking | Exempt Trucking | Private Carriers | Services, Construction | Owner-Operators | Private Busing | Fleet Operators | Government and Transit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Change in:** | | | | | | | | | | | | |
| User Charges ($/year) | $ 44 | $ 47 | $ 40 | $900 | $ 358 | $954 | $252 | $ 118 | $1117 | $ 169 | $172 | $ 7 |
| Vehicle Costs* ($/year) | $ 27 | $ 36 | $ 11 | $895 | $ 355 | $942 | $247 | $ 115 | $1112 | $ 165 | $148 | $ 7 |
| **Percentage Change in:** | | | | | | | | | | | | |
| Vehicle Costs* | 0.1% | 0.3% | -0.2% | 1.9% | 1.7% | 1.9% | 1.7% | 1.5% | 1.8% | 0.8% | 1.4% | 0.1% |
| VMT | -1.6% | -1.2% | -2.6% | -0.4% | -0.4% | -0.4% | -0.4% | -0.4% | -0.4% | -0.1% | -0.7% | - |
| Fleet Size | -0.6% | -0.6% | -0.6% | -0.4% | -0.3% | -0.4% | -0.3% | -0.3% | -0.4% | -0.1% | -0.3% | - |

*Vehicle costs are net after changes in VMT and fleet size.

reason is that, in response to price increases, highway users will travel less and choose to own fewer vehicles. In total it should be recognized that these charges are a small part of highway user costs and, as a consequence, generally result in small impacts.

For households the response entails direct travel and fleet reduction in reaction to the tax changes. With for-hire groups the reduction in fleet size and travel reflects both an effort to choose a more optimal mix of productive factors (e.g., labor vs trucks) and the consequence of reduced traffic demand, which results when tax-induced rate increases are passed through to shippers.

These changes in VMT and fleet size, also shown in Figures C-11 and C-12, are generally small, ranging between -0.1 and -2.6 percent. Noticeably smaller changes are shown among heavy truck classes, generally used in freight transportation services, reflecting the indirect nature of these adjustments via increased rates and reduced industry traffic demand.

Impacts resulting from the second hypothetical tax case, a third structure tax, are shown in Figures C-13 and C-14. The example shows a tax structure using a kip-axle-mile basis. In the example, the tax is computed at a rate of $1.00 per thousand kip-axle-miles, for axles weighing more than 9000 pounds (GVW basis). This tax, given its rate and structure, affects only combination trucks significantly. As can be seen by comparing these tables with the previous impact tables, the incidence of the $1.00 weight-distance tax rises more steeply for heavier vehicles, based on the 1985 fleet mix and use characteristics forecast for the Federal highway cost allocation study. Therefore, the heavy truck users, regulated and exempt carriers and independent owner-operators, face greater relative tax increases than medium truck users, most notably, local and private carriers and services, construction firms and utilities.

FIGURE C-13

ESTIMATED IMPACTS FROM WEIGHT-DISTANCE TAX*

| GASOLINE POWERED | Combination Trucks** 0-50K GVW | 50-70K GVW | 70-75K GVW | 75K+ GVW |
|---|---|---|---|---|
| Changes in: | | | | |
| User Charges ($/yr) | $ 34 | $ 350 | $538 | $ 480 |
| Vehicle Costs ($/yr)*** | $ 31 | $ 350 | $538 | $ 480 |
| Percentage Change in: | | | | |
| Vehicle Costs*** | 0.2% | 1.2% | 1.2% | 1.1% |
| VMT | - | -0.2% | -0.2% | -0.2% |
| Fleet Size | - | -0.2% | -0.2% | -0.2% |
| **DIESEL AND SPECIAL FUELS** | | | | |
| Changes in: | | | | |
| User Charges ($/yr) | $187 | $ 876 | $1924 | $2578 |
| Vehicle Costs ($/yr)*** | $186 | $ 866 | $1897 | $2534 |
| Percentage Change in: | | | | |
| Vehicle Costs*** | 0.6% | 1.9% | 3.1% | 3.6% |
| VMT | - | -0.4% | -0.7% | -0.9% |
| Fleet Size | - | -0.3% | -0.5% | -0.7% |

* Rate = $1.00 per 1000 kip-axle miles for axles greater than 9000 pounds.

** Trucks other than combinations showed no significant impacts.

*** Vehicle costs are net after changes in VMT and fleet size.

FIGURE C-14

ESTIMATED IMPACTS FROM WEIGHT-DISTANCE TAX*

| | Regulated Trucking | Local Trucking | Exempt Trucking | Private Trucking | Service, Construction | Owner-Operators |
|---|---|---|---|---|---|---|
| Changes in: | | | | | | |
| User Charges ($/yr) | $1196 | $223 | $1149 | $110 | $ 9 | $1363 |
| Vehicle Costs ($/yr)** | $1140 | $204 | $1086 | $100 | $ 8 | $1307 |
| Percentage Change in: | | | | | | |
| Vehicle Costs** | 2.7% | 1.1% | 2.4% | 0.8% | 0.2% | 2.6% |
| VMT | -0.4% | -0.1% | -0.4% | -0.1% | - | -0.5% |
| Fleet Size | -0.3% | - | -0.2% | - | - | -0.3% |

* Rate = $1.00 per 1000 kip-axle miles for axles greater than 9000 pounds

** Vehicle costs are net after changes in VMT and fleet size.

It is often suggested that the desired effect of this type of tax is to offer incentives to truckers to add more load-bearing axles, thereby reducing tax burden. As an example of the cost savings possible, annual taxes were computed for an eighteen wheel combination (3S2) travelling 100,000 miles per year with a gross combination weight of 78,000 pounds. Using the bridge formula[3/] the steering axle is assumed to carry 10,000 pounds and each tandem, 34,000 pounds. Further, it is assumed that the weight on the tandem axles is evenly distributed. The taxes estimated for this vehicle were compared with those for a configuration using three rear trailer axles (3S3), all other assumptions remaining the same. Figure C-15 shows the estimated tax payments per vehicle for the two combinations. The third rear axle would save taxes of $900 per year with a discounted present value of $3250, assuming 20 percent cost of capital and a seven-year useful life. This amount is probably enough to induce the adoption of an additional axle under many circumstances even given tire wear and maintenance considerations.

These examples are intended only as hypothetical cases, though possibly useful as rough estimates. The number of potential tax alternatives precludes providing a broader range of possible impacts.

FIGURE C-15

## WEIGHT-DISTANCE TAXES ON ALTERNATIVE COMBINATION TRUCK CONFIGURATIONS

**3S2**

| Axle | Tax Rate* | * | Axles | | Thousand pounds weight per axle over threshold | | Thousands of annual miles | = Tax |
|---|---|---|---|---|---|---|---|---|
| Steering | $1.00 | * | 1 | * | (10-9) | * | 100 | = $ 100 |
| Drive | $1.00 | * | 2 | * | (17-9) | * | 100 | = $1600 |
| Trailer | $1.00 | * | 2 | * | (17-9) | * | 100 | = $1600 |
| | | | | | | | Total | $3300 |

**3S3**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Steering | $1.00 | * | 1 | * | (10-9) | * | 100 | = $ 100 |
| Drive | $1.00 | * | 2 | * | (17-9) | * | 100 | = $1600 |
| Trailer | $1.00 | * | 3 | * | (11.3-9) | * | 100 | = $ 700 |
| | | | | | | | Total | $2400 |

TAX SAVINGS, 3S-3 vs 3S-2 = $900 per annum.
PRESENT VALUE at 20 percent per annum, 7 year life = $3250.

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*Rate = $1.00 per thousand kip-axle miles for axles greater than 9000 pounds gross weight.
A graduated tax would encourage even more advantageous load shifting.

## NON-HIGHWAY MODE IMPACTS

The boundaries of potential changes among non-highway modes are either the maximum rate/fare changes or the maximum traffic diversion. Maximum traffic diversion occurs if affected modes do not increase rates/fares when demand increases. Maximum revenue and profit increases occur if affected modes raise rates/fares on all competitive traffic to the level where total traffic carried remains the same as in the base case. The first case is likely in competitive markets; the second case is likely when the alternative mode has strong market control or where output is restricted. These two cases are represented in Figure C-16, referred to as CASE I and CASE II, respectively.

Total traffic diverted to an alternative mode, shown in CASE I as $(Q_1 - Q_0)$, can be calculated given estimates of the relative highway mode price change and the cross-price elasticity between the highway and affected mode, as follows:

$$Q_1 = Q_0 * (1 + E \frac{\Delta R}{R}),$$

where, Q is traffic level,

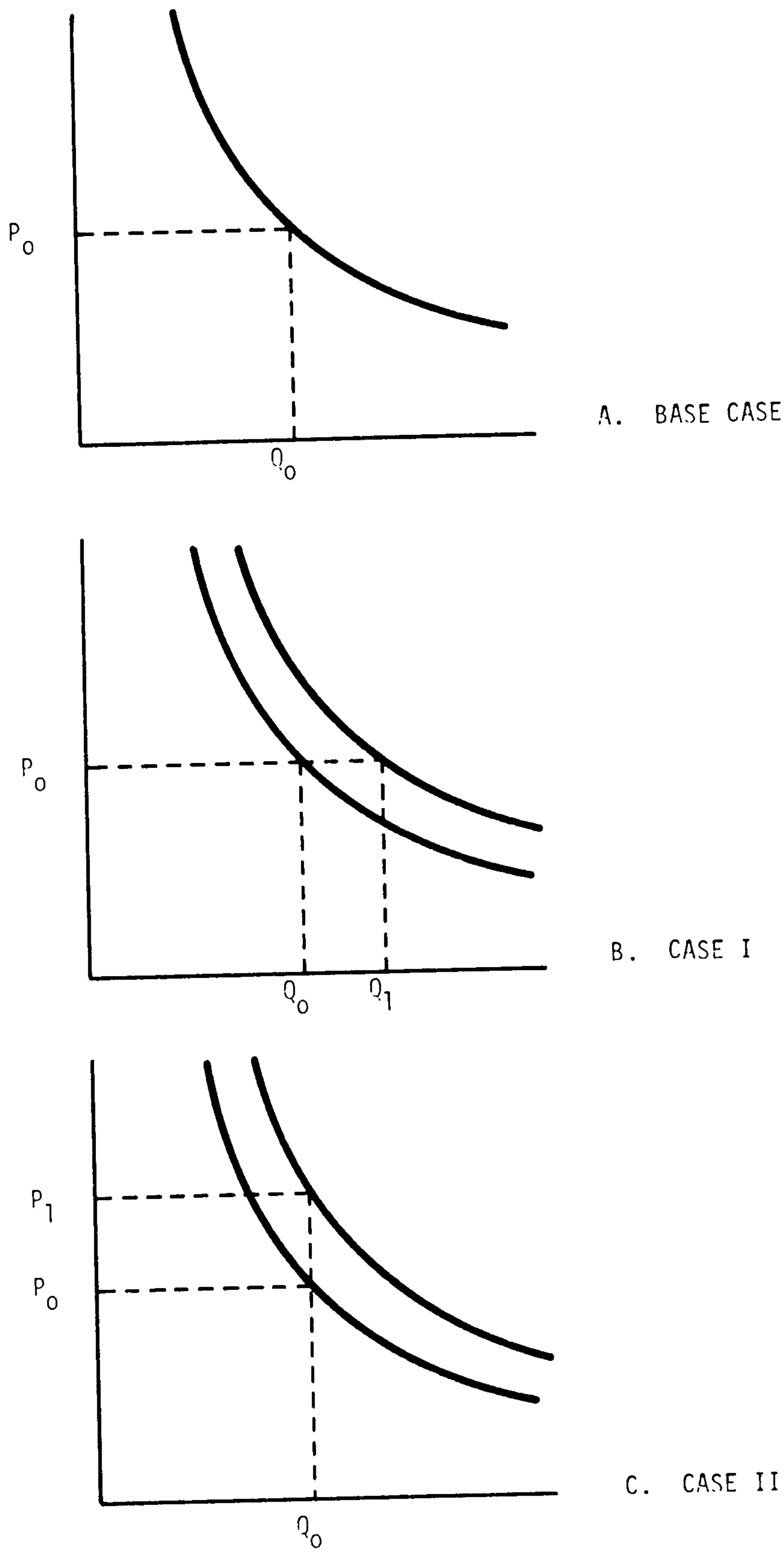
E represents cross-price elasticity,

$\Delta$ R/R is the relative rate change in the highway mode, and subscripts 1 and 0 represent tax alternative and base case, respectively.

This formula is similar to the one shown earlier for calculating VMT and fleet size changes for highway modes.

In the Federal studies a cross-price elasticity of 0.15 for the aggregate of rail traffic was used. Estimates made for the Federal study suggest that 18 percent of total national rail traffic is truck competitive. Implicitly, the combination of

FIGURE C-16
POTENTIAL NON-HIGHWAY MODE IMPACTS



these assumptions means that the cross-price elasticity on rail's truck competitive traffic is about 0.85, consistent with available disaggregate traffic demand studies.[4/]

Estimates of base case rail rates for truck competitive traffic, necessary to estimate CASE II revenue and profit changes, are roughly one-third of estimated truck rates, or about 13.3¢ per ton-mile in 1985 dollars. Clearly these are gross estimates which will vary by region, commodity, shipment size and shipment distance.

Changes in the levels of rail rates, shown as CASE II, in response to increased demand, depend on railroads' market power and the nature of their marginal cost of producing additional ton-miles. The exact nature of this response would be difficult to estimate.

The nature of the maximum potential rail rate increase depends on the way shippers and receivers perceive costs. Discussion in the literature on mode choice suggests that shippers are concerned with either relative or absolute price differences. Shippers' perceived shipment costs might be expressed as the sum of transportation costs plus some other costs, which might include service, carrying costs, and other costs. This expression for total shipment costs can be written:

$$SC = TC + OC,$$

where, SC represents total shipment costs,
TC represents transportation costs, and
OC represents other costs.

If shippers choose to distribute traffic on available modes until the costs are equated, i.e. they are indifferent between the alternatives, then the total perceived cost among modes would be equal. In the case of two modes, rail and truck for example, this might be expressed either as:

$SC_T = SC_R, \quad TC_T + OC_T = TC_R + OC_R$, or

$SC_T/SC_R = 1, \quad (TC_T + OC_T)/(TC_R + OC_R) = 1,$

depending on whether shippers are concerned with absolute or relative cost differences.

Tax-induced changes in truck price can be expressed as:

$$SC_T^* = TC_T + \Delta TC_T + OC_T$$

where, $SC_T^*$ represents total truck shipping costs after trucking price changes, and

$\Delta TC_T$ represents the level of trucking price change induced by tax or other changes.

The largest potential rail rate increase, assuming other shipping costs remain constant, is one of the same absolute level as the truck rate increase, i.e.,

$$\Delta TC_R = \Delta TC_T.$$

Since, under this extreme, traffic levels are assumed to remain constant at the base case levels, that is, rates will rise on all competitive traffic to the point where no new traffic is accepted, costs will likely remain constant. Therefore, profit and revenue changes will be equal, and can be estimated as the rate increase multiplied by rail's truck competitive traffic volume. This can be expressed as

$$\Delta P = \Delta R = TC_R * TM_R,$$

where, $\Delta P$ represents profit changes,

$\Delta R$ represents revenue change, and

TM represents rail's truck competitive ton-mile volume.

Truck rate changes need to be calculated if financial impacts on trucking firms are to be considered. These can be used to derive $\Delta TC_R$ (= $\Delta TC_T$). Estimating rail's truck competitive traffic volume presents a difficult problem. In the Federal user charge study, an analysis of traffic volumes recorded in the Bureau of Census' 1977 Commodity Transportation Survey served as the basis for determining rail's truck competitive traffic. This survey provides State level detail and is available for such analysis.

Tabulations shown in Summary Table IV-7 of the Survey define traffic by mode, shipment size and shipment distance. For the purpose of the Federal study traffic was defined as truck/rail competitive if both modes showed at least 10 percent of the total ton-miles in the weight/distance cell. Since the Survey contains estimates of manufactured goods only, a separate analysis of bulk shipments considered truck/rail competitive was also conducted. This analysis suggested that of rail's total traffic, 18 percent was truck competitive. Specific analysis would have to be conducted for each region to determine the correct competitive volumes.

Case I and Case II represent extreme positions which if, as is generally held, rail traffic is price inelastic, bound the possible outcomes. The likely response is probably between these extremes.

**MACROECONOMIC IMPACTS**

It should be kept in mind that if increases in taxes are matched by equal increases in expenditures on highways, broad regional impacts on economic activity and employment will likely be offsetting, where negative tax impacts are offset by positive expenditure impacts. It will, therefore, be necessary to focus analyses on individual economic sectors to describe impacts of specific concern and the impacts on overall State activity. Such an approach to an analysis of local economic impacts might rely on locally available interindustry models or detailed sectoral analyses.

## ESTIMATING IMPACTS OF TRUCK SIZE AND WEIGHT LIMIT CHANGES

### INTRODUCTION

Truck size and weight (TS&W) limit changes can be used to promote equity and/or economic efficiency in terms of the cost-allocation/tax-revenue ratios analyzed in cost-allocation studies. Thus TS&W limit changes can be viewed as another instrument for implementing cost-allocation findings, either in tandem with tax-structure changes or in place of them. For example, tax changes (especially increases) might be politically difficult (or impossible), or socially or economically undesirable; an impact analysis might show that tax increases would cause too much inflation, or unduly injure a segment of the population or another transport mode.

Changes in truck axle load limits, gross vehicle weight limits, and vehicle width and length limits, as well as previously prohibited multiple unit combinations, directly affect the payload carrying capacity of individual vehicles. Vehicle capacity changes affect total truck traffic (e.g., larger trucks mean fewer trips per given volume of freight shipments) as well as axle load and gross weight distributions. They also affect truck operator costs to transport a given volume of shipment. Motor carrier cost changes in turn may be reflected by changes in freight charges to both shippers and receivers. If highway freight service prices change significantly because of these changes in operating cost, the intermodal competitive relationships may be disturbed and some shift of markets between truck and rail modes may result. Modal shifts in turn cause additional changes to the truck traffic volume, axle load and gross weight distributions. Changes in each of the limits affects the various types of trucking operations differently.

Analytical methods and data used by the Federal studies of TS&W limits are documented and available to States on request. Data files and computer programs are being prepared at the DOT Transportation Computer Center for FHWA use in future national studies. Some of these data may be of interest for an individual State study and in some cases may serve as default values in the absence of State specific data. These will be available from FHWA, Office of Program and Policy Planning, Transportation and Socio-Economic Studies Division (HPP-10).

In general, analytical methods and data which are adequate for aggregate national level studies tend to be too coarse for specific regions or for individual States or markets. The measure of traffic volumes is different for the national and for State studies. The national studies use annual vehicle miles of travel (VMT) and annual payload ton-miles over the entire highway system. State studies use average daily traffic (ADT), and truck trips on a specific segment of highway. However, the variables considered in the national studies should be relevant and some of the intermediate data files may be helpful in estimating traffic changes on State highways if locally collected State or regional level data are insufficient.

The objective of a State study may be to project the likely impact on the State's own highway maintenance imposed by TS&W limit changes in other States. The State study may have to project a series of annual estimates which explicitly incorporate the period of transition from the old equilibrium to the new equilibrium vis-a-vis the TS&W limits. If this is the objective of a State study, then the rates of implementation of the various shifts must be estimated in addition to the estimated magnitude of the shifts. This may be more manageable in a State study with a limited scope and sharper focus than in a national study, assuming adequate data and study resources are available.

Certain elements of the national studies are relevant to State studies. One major consideration in the Federal TS&W study is the disaggregation of traffic within the State into intrastate traffic constrained by TS&W limits in the State of the study and interstate traffic constrained by limits in other States. Another consideration is the segregation of traffic impacts attributed to shifts of markets between modes from those attributed to shifts of truck traffic among gross weight groups and among truck types.

"Load shift" procedures in current use are applied to truck trip distributions rather than to the distributions of payload carried. Implicit in the current procedures, which evolved from past statistical studies, is the assumption that aggregate truck payload ton-miles grow with the increased limits. This growth is implied to come from either new demand induced by lower truck freight costs and/or diversions from rail attributed to lower truck freight rates. The procedures recommended here involve converting cumulative distributions of truck trips among operating gross weight intervals into payload distributions, then applying load shift procedures. After load shifts are estimated, the process is reversed by reconverting the shifted curve back to truck trips and axle loads distributions. In this way, aggregate payload is neither created nor destroyed in the shifting process. Growth in total truck transport demand and modal diversions should be treated explicitly and separately.

A third relevant matter in the national studies is the explicit segregation and separate treatment of size limit changes on volume-limited trucks and the impact of axle load and gross weight limit changes on weight-limited trucks. Previous load shift methods have treated only weight limit impacts. The approach in this study was to isolate the weight limited traffic by analyzing traffic only from the high end of the cumulative distribution of the weight curve.

## VEHICLE CAPACITY IMPACTS

Truck volume capacity is constrained by limits on the length, width and height of the cargo carrying unit. The weight capacity is constrained by limits on axle loads, number and configuration of axles, and gross vehicle weights. Each of these types of limits has different effects on each type of truck operator or highway user group. Short-haul truck operators, who seldom fill trucks either to the volume capacity or the weight capacity, are unlikely to change the frequency or pattern of trip making in response to limit changes except as an indirect consequence of substantial changes by other operators with whom they interchange traffic.

Trucks carrying low density cargoes ("balloon freight") will have little interest in increased axle loads or increased gross weight limits but will be quick to take advantage of increases in the volume capacity. Trucks servicing high-density-freight markets will have little interest in increased length, width or height limits (assuming they currently comply with axle load and gross weight limits). Axle load and/or gross weight limit increases will, however, increase the weight payload of trucks used in these services. Such shifting of activity among types, sizes and weights assumes the truck operators are unconstrained by their financial status, labor, or equipment availability, or competitive position.

It is advisable to segregate the total State traffic into two streams, using vehicle class and body type and/or commodity carried to differentiate the potentially volume constrained from the potentially weight constrained trucks. State level truck weight study (TWS) data may be used to classify all trucks using the appropriate codes. These codes are presented in Figure C-17. The TIUS body type bridge is Figure C-18. A minimum of three vehicle classes (e.g., single units, semi-trailer, and other combinations) and a maximum of 13, with a minimum of two body types (e.g., vans, other) and a maximum of ten, should suffice for these analyses.

Given a selection of vehicle classes and body types, a maximum value for volume capacity and maximum practical operating gross vehicle weight (MPOGVW) may be calculated for each vehicle class and body type subgroup under the old TS&W limits and then under the projected new limits. Effective payload capacity, however, depends on the physical attributes of the freight being transported. It is, therefore, necessary to establish relationships between truck body types and commodities carried. TWS data may be used to develop distributions of commodities among truck body types and/or vehicle classes among commodities. Such distributions for the State, for the nation as a whole, or for other areas with similar economic activity (or presently permitting use of the anticipated vehicle types) together with State level commodity flow data will support estimates of the demand for specific types of trucks.

FIGURE C-17

TRUCK CLASSIFICATION, CONFIGURATION SYMBOLS AND TWS CODES

| | SYSTEM VEHICLE CLASSIFICATION | CONFIGURATION SYMBOL | TWS VEHICLE CODE |
|---|---|---|---|
| 7 | Light Trucks<br>2 Axle, <10K GVW | 2S | 20,21 |
| 8 | Single-Unit Trucks<br>2 Axle, >10K GVW | 2D | 22 |
| 9 | Single-Unit Trucks<br>3 or More Azles | 3A, 4A, 5A, 6A, 7A, 8A | 23-28 |
| 10 | Tractor, Semi-Trailer<br>3 Axles | 2S1 | 321 |
| 11 | Tractor, Semi-Trailer<br>4 Axles | 2S2, 3S1 | 322, 327, 331 |
| 12 | 3 Axle Tractor, 2 Axle<br>Semi-Trailer | 3S2 | 332 |
| 13 | Other Tractor Semi-Trailer<br>5 or more Axles | 2S3, 2S4, 3S3, 3S4 | 323, 324, ≥333 but <40 |
| 14 | Tractor, Semi-Trailer<br>+ 1 or 2 Trailers,<br>5 or More Single Axles | 2S1-2, 2S1-2-2,<br>3S1-2-2, 3S1-2<br>3S2-1, 3S1-1, 2S1-1, 2S2-1 | 5212, 5312, ≥70 but <80<br><br>5222, 5213, 5321, 5311<br>5221. 5211 |
| 15 | Tractor, Semi-Trailer<br>+ Trailer, 7 Axles | 3S2-2, 2S2-3<br>3S3-1 | 5322, 5223, 5313, 5331 |
| 16 | Tractor, Semi-Trailer<br>+ Trailer, 8 or More Axles | 3S2-3, 3S2-4, 3S3-2<br>3S3-3, 3S3-4 | 5323, 5324, ≥5332 but<br><60 |
| 17 | Truck + Trailer<br>3 or 4 Axles | 2-1, 2-2, 3-1 | 421, 422, 431 |
| 18 | Truck + Trailer<br>5 Axles | 2-3, 3-2 | 423, 432 |
| 19 | Truck + 1 or 2<br>Trailers, 6 or More<br>Axles | 3-3, 3-4, 3-2-2,<br>3-3-2, 3-2-3, 3-3-3,<br>3-3-4, 3-4-3,3-4-4<br>2-2-2, 2-4 | 424, ≥433 but <50<br>≥ 60 but < 70<br>≥ 80 but < 90 |

## FIGURE C-18

## TI&U BODY TYPE BRIDGE

| | TI&U Code | TWS Code |
|---|---|---|
| 1 Pickup | 01, 02, 03 | 11, 12, 14, 15,61 |
| 2 Van | 11, 12, & 13 | 28, 31,32, 41, 54, 75 |
| 3 Reefer | 08 & 09 | 42, |
| 4 Moving | 10 | 43 |
| 5 Flat | 04, 05, 06, 07, & 17 | 21, 22, 23, 24, 25, 26, 27 |
| 6 Dump | 40 | 33, 34, 35 |
| 7 Tank | 50 & 60 | 51, 52 |
| 8 Utility | 14 | 13,53, 63, 73, 78 |
| 9 Auto | 18, 19 | 62, 64, 77 |
| 10 Other | 15, 16, 20, 30, 70 | 71, 72, 74, 76 |

Having segregated volume limited trucks from weight limited trucks, it is necessary to further segregate traffic streams constrained by the study-State's limits and those constrained by limits of other States. If the limits projected to change are the State's own limits, then all traffic currently constrained by these limits should be isolated from all other traffic. If a State is planning to raise limits which are presently lower than other States, its limits are most likely constraining both intrastrate and interstate volume-limited or weight-limited truck traffic within its boundaries. The study should therefore isolate such traffic. If a State is not planning to change its limits, but expects others to change theirs, then the study-State traffic, which must pass through the States with changes, either before or after entering the study-State, should be isolated.

If a State cannot identify such traffic via sample surveys of trucks operating within the State and/or shippers and receivers of interstate shipments in the State, then data from the U.S. DOT studies[5/] may be of some help in establishing rough estimates of the relevant traffic streams as a proportion of the total State traffic.

## TRUCK TRAFFIC IMPACTS

This section describes procedures developed for use in the Federal studies and offered here as a general guide for State analysts who may wish to develop analogous procedures. To make the discussion more applicable to a State study, the traffic measurement units have been changed from vehicle-miles of travel to truck trips, and the payload measurement units have been changed from ton-miles to tons.

The effects of changes in truck size and weight limits on truck traffic are generally measured in several dimensions. For the typical lane mile of each functional class of highway within the State, the total vehicles, the distribution of these vehicles by operating gross weight, the number of axles of each type and the distribution of these by load are projected. Given a projected base case for a forecast year as defined in Appendix D, traffic effects of the projected changes in TS&W limits are estimated by a procedure involving the shifting of aggregate vehicle payload by vehicle class and by body type among gross weight intervals, vehicle classes, highway functional classes and, if appropriate, among competing modes. The focus of all this shifting is the transportation demand, measured in tons of payload, the aggregate of which does not change for a given year's forecast. Modal diversions attributed to the TS&W limit changes are treated separately.

For example, if axle load limits and/or gross weight limits are increased, a portion of the cumulative distribution of payload tons is shifted to the right and the percent of total tons and the related truck trips for each vehicle class and body type must be recomputed for each operating gross vehicle weight interval. Only the portion of the curve representing the limit-constrained trucks is shifted. Empty truck trips related to the reduced trips of loaded trucks should be estimated and adjustments made to the truck trips in the weight intervals representing the empty trucks. This general procedure can be followed for each of four types of limit changes as indicated in the following four subsections.

**Average Payload Shift Among O.G.V.W. Intervals Attributed to Change in Weight Limits**

Average payload is the weighted average of loaded and empty weights. A change in axle load limits and/or gross vehicle weight limits will change the practical maximum gross vehicle weight (PMGVW). If one assumes a proportional change in the average empty weight of specific vehicle classes, the average payload of all truck activity which is weight-capacity limited would change in direct proportion to the change in the PMGVW.

One may also take the opposite extreme position by assuming that small changes in weight limits (e.g., 73,280 to 80,000 lb.) will not entail increased tare weight of the trucks involved. An intermediate position may be more accurate. One may assume an increase in tare weight less than the percentage increase in gross weight but greater than zero. In this case, average payload would increase less than proportionately to the increase in limits.

Non-weight limited truck activity would be unchanged by the new legal limits under either assumption except that empty mileage associated with the weight limited truck activity would be changed in proportion to the change in vehicle miles required to carry a given annual tonnage.

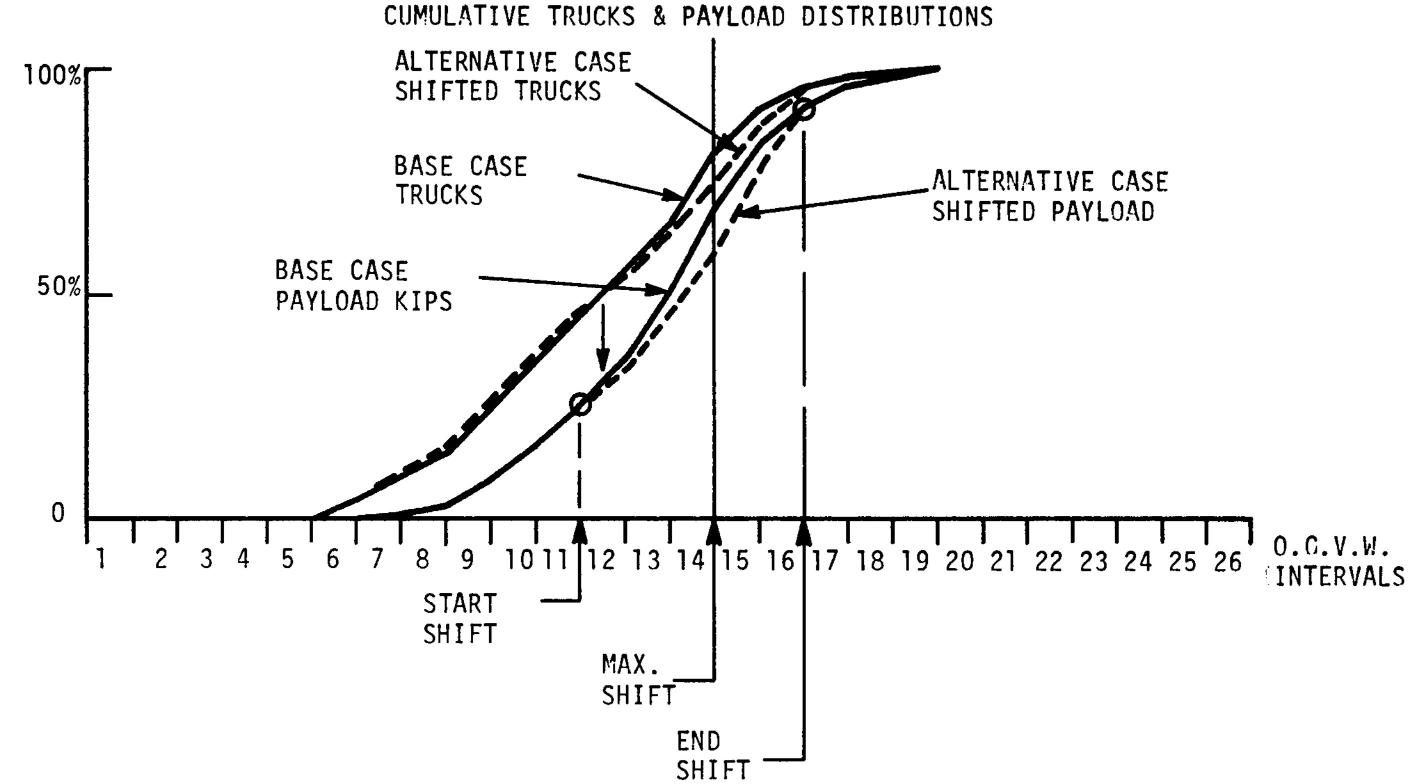
Figure C-19 describes, graphically, the general procedure for payload shift developed for FHWA use in national studies. It represents a modified version of the Texas State Department of Highways and Public Transportation approach which in turn is an expansion of the National Cooperative Highway Research Program Report #141 procedure. Figure C-20 provides some default values for these starting points. The specifics of the method are as follows:

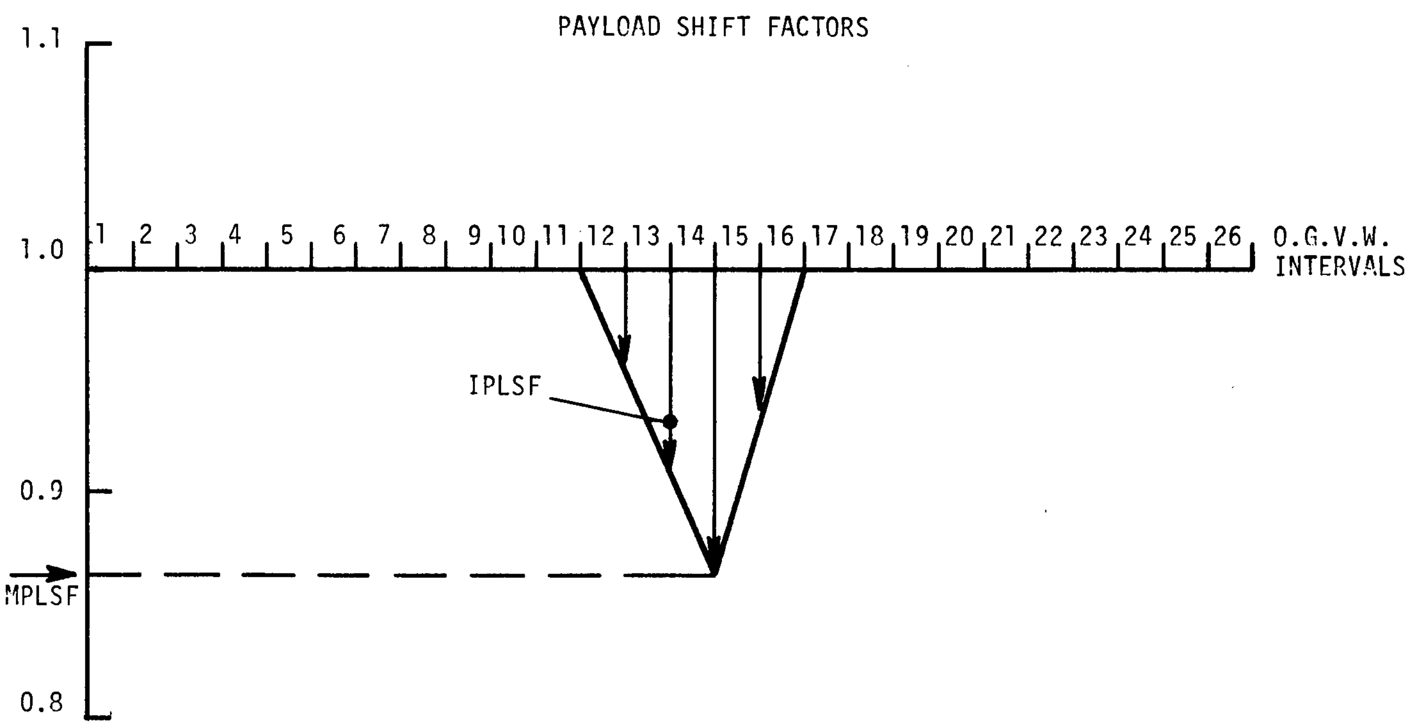
(a) Given a payload ton distribution among operating gross vehicle weight (O.G.V.W.) intervals, (each interval's value assigned to the midpoint of the interval) the following steps apply. Figure C-21 shows methods for estimating average payload for each interval used in the Federal studies.

   (1) Establish the interval start point (SGVW) of the payload shift. Ref. Figures C-19 and C-20

   (2) In order to provide for either of the above tare weight assumptions, the analyst/user has the option of two equations for the maximum

**FIGURE C-19**




MPLSF = MAXIMUM PAYLOAD SHIFT FACTOR = $\frac{\text{PRESENT PAYLOAD}}{\text{FUTURE PAYLOAD}}$

FIGURE C-20

DEFAULT VALUES FOR SGVWW & SGVWV

| Vehicle Class Code | Lower Limit of Interval in Which Cumulative % = SGVWW | SGVWV |
|---|---|---|
| 7 + 8 | 50 | 50 |
| 9 | 50 | 50 |
| 10 + 11 | 33 | 50 |
| 12 | 33 | 50 |
| 13 | 75 | 50 |
| 14 + 15 | 50 | 50 |
| 16 + 17 | 50 | 50 |
| 18 | 50 | 50 |

Where:

SGVWW = Start of GVW distribution load shift for weight limit changes.

SGVWV = Start of GVW distribution load shift for vehicle length and width limit changes.

## FIGURE C-21

ESTIMATING AVERAGE PAYLOAD WEIGHT BY VEHICLE CLASS AND O.G.V.W.

| DEFAULT EMPTY WEIGHT KIPS | VEHICLE CLASS CODE | | OPERATING GROSS VEHICLE WEIGHT | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | INTERVAL UPPER LIMIT KIPS | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 | 125 | 130 | > 130 |
| | | INTERVAL MIDPOINT KIPS | 8 | 12.5 | 17.5 | 22.5 | 27.5 | 32.5 | 37.5 | 42.5 | 47.5 | 52.5 | 57.5 | 62.5 | 67.5 | 72.5 | 77.5 | 82.5 | 87.5 | 92.5 | 97.5 | 102.5 | 107.5 | 112.5 | 117.5 | 122.5 | 127.5 | 140 |
| | | INTERVAL CODE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 4 | 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 34 | 13 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | 14 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 34 | 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 40 | 16 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | 17 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 40 | 19 | | | | | | | | | | | | | | | | | | | | | | | | | | | |

pay load shift factor. Equation #1 for the assumption that tare weight increases in proportion to the PMGVW increase and equation #2 for the assumption that tare weight remains essentially constant. Calculate the maximum payload shift factor (MPLSFW) by either equation #1 or #2.

Equation #1: $MPLSFW = \frac{PMGVWP}{PMGVWF}$; #2: $MPLSFW = \frac{PMGVWP - AEWP}{PMGVWF - AEWP}$

where:

MPLSFW = Maximum Payload Shift Factor for Weight Limit Changes

PMGVWP = Practical Maximum G.V.W. under Present Limits

PMGVWF = Practical Maximum G.V.W. under Future Limits.

AEWP = Average Empty Weight-Present

(3) Calculate the interval payload shift factor for each interval between the start point (SGVW) and the PMGVWP

$$IPLSFU = 1.0 - \frac{1.0 - MPLSFW}{NU} nu$$

where:

IPLSFU = interval payload shift factor for intervals below the PMGVWP

NU = The number of intervals between SGVW and PMGVWP

nu = The number of the interval from SGVW

(4) Calculate the interval payload shift factor for each interval between the PMGVWP and the end point (PMGVWF + 1 interval)

$$IPLSFO = MPLSFW + \frac{1.0 - MPLSFW}{NO} no$$

where:

IPLSFO = Interval shift factor for intervals above PMGVWP

NO = The number of intervals between PMGVWP and end point

no = The number of the interval from PMGVWP

(5) Multiply the midpoint value of each affected O.G.V.W. interval of the base case payload ton cumulative percent distribution by the appropriate IPLSF to produce the alternative case (payload shifted) cumulative percent distribution.

(6) Calculate new payload ton values for each O.G.V.W. interval affected by the alternative. Multiply the new interval percent by the base case total payload tons for the O.G.V.W intervals.

(7) Divide the payload tons in each interval by the average payload for each interval to produce the new truck trips in each cell. Do this for each highway class, vehicle class, and highway user group affected by the weight limit change.

New axle load distributions for the new TS&W limit case are calculated as in the Base Case defined in Appendix D.

(b) Adjust the truck trips in O.G.V.W cells below the S.G.V.W. for reduced empty trips for each vehicle class affected by the payload shift. Compute the difference between the base case truck trips above the SGVW and the alternative case truck trips above the SGVW. Multiply this difference by an appropriate empty/loaded ratio and subtract or add (as appropriate) this value from or to the truck trips in the lowest OGVW cell of the vehicle class.

**Payload Shift Among O.G.V.W. Intervals Attributed to Change in Vehicle Width or Length Limits**

A change in the width of trucks (e.g., 96" to 102") or length of cargo body (e.g., 45 ft. to 48 ft. trailers) also changes the practical maximum gross vehicle weight (PMGVW).[*] If, again, we assume only minor change in the average empty weight of specific vehicle classes, the average payload of all truck activity which is volume capacity limited would be changed in proportion to the change in allowed volume capacity of the vehicles. However, volume capacity increases are not obtained without vehicle tare weight penalty. The indications are that truck tare weight increases about one third as quickly as volume capacity increases for trailer lengths between 40 and 50 ft.[6] It can be assumed that similar proportional tare weight increases occur with width increases (unless more accurate estimates are available).

The following procedure can be used to estimate the shift in payload to higher gross weight vehicles attributed to volume capacity increases. The payload weight is estimated to increase proportionately with the increase in volume, assuming that the average payload density of the loaded freight remains constant. The national average value for general commodity shipments of 11-12 pounds per cubic foot may be used to calculate the volume-limited gross vehicle weight of the trucks under the present limits. This value may be replaced by a more accurate value, if known, for the commodities actually involved.

1. Isolate the traffic and body types that are affected in the base case payload ton distributions.
2. Given the payload ton distribution among O.G.V.W intervals (base case or weight limit alternative case).

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[*] If both size and weight limit changes are analyzed, the procedures outlined in the previous subsection and this subsection would be applied in sequence.

(a) Establish the interval start point (SGVW) of the payload shift and the end point (VLGVWF + 1 interval)

(b) Calculate the maximum payload shift factor (MPLSFV)

MPLSFV = (VLGVWP-AEWP) / (VLGVWP(TVCF/TVCP) - AEWP (1.0 + .333 * ((TVCF-TVCP) / TVCP)))

where:

MPLSFV = maximum payload shift factor for volume (length or width) limit change

TVCF = truck volume capacity under future limits

TVCP = truck volume capacity under present limits

AEWP = average empty weight present

VLGVWF = volume limited gross vehicle weight, future

VLGVWP = volume limited gross vehicle weight, present (computed at 12 $lbs/ft^3$)

(c) Calculate the interval payload shift factors as in (a)(3) and (a)(4) of the previous subsection on shifts attributed to change in weight limit.

(d) Calculate the new payload tons, truck trips and axle load distributions as (a) (5,6,7) of the previous subsection and Appendix D.

3. Adjust for empty trips per (b) of the previous subsection.

**Payload Shift Among Vehicle Classes Attributed to Change in Vehicle Class Prohibition**

Prohibition of specific vehicle classes (e.g., combinations with full trailers) often constrain motor carriers from using the lowest cost vehicle class in certain markets. Therefore removing such prohibitions should result in shifts to the formerly prohibited vehicles. The traffic impacts are different depending on whether the change in prohibition is or is not accompanied by gross weight limit changes. Specific examples of changes were considered in Federal studies rather than generic cases as used below.

Compute the shift as follows:

Compute the ratio of the transportation cost of pairs of vehicle classes that are likely alternatives for shorthaul and for longhaul traffic. Body types and commodities will be a function of the State's economic activities.

(1) For each body type affected, calculate the average transportation cost in dollars per ton-mile of payload for the base case operations.

(2) For each body type affected, calculate the average transportation cost under the alternative case (i.e., large combinations operating on the designated network).

(3) Calculate the base case payload tons associated with the vehicle classes and body types affected and multiply by the relative difference between the ratio of the base case cost and the new system cost and multiply by the elasticity value.

(4) Subtract the resultant value (the shifting payload tons) from the donating vehicle class and add to the receiving vehicle class.

(5) Factors for distributing the losses and gains among the donating and receiving vehicle classes and among their respective O.G.V.W. intervals should be estimated. Because there will likely be no State-specific base case distribution, another vehicle class in the State or the receiving vehicle class from some other State may be used as the source of a surrogate distribution.

(6) Truck trips for this alternative are calculated as in (a)(7) (in the previous section) and adjusted for empty trips as in (b) above of the subsection dealing with changes in weight limits.

### With No Change in Gross Weight Limit

When prohibitions against 65-foot doubles are eliminated, with no change in the gross weight limit, the increase in potential volume capacity may be realized only by carriers who transport low density freight shipments. In such cases, a shift of payload tons is likely from the largest volume capacity trucks permitted before the change to the newly permitted doubles. For short hauls, which are typical for intrastate traffic, the shift to doubles will be considerably less than for the longer hauls typical for interstate traffic. The shift will be greatest in those markets and for carrier services with the greatest savings in transportation cost between the present vehicle class and the newly permitted vehicle class. The magnitude of the shift may be estimated as a function of the difference in transport cost between vehicle classes and the price elasticity values for affected traffic (possibly derived from analysis of markets where such vehicles have been used).

In order for substantial shifts of short-haul traffic to take place among vehicle classes the change in restrictions must apply to the majority of principal arterials within the State. If the TS&W limit alternative being studied changes the restrictions only on certain highway classes serving only interstate traffic, it must be assumed that intrastate traffic shifts among vehicle classes will be relatively small, while the interstate traffic shift may be relatively large.

### With Change in Gross Weight Limit

When a prohibition against 65-foot doubles is eliminated in combination with a change in gross weight limit, the increase in volume capacity is accompanied by an increase in weight capacity, for example, when axles are added to the combination (e.g., tandem axles in lieu of single axles). The prohibition elimination must be uniform among highway classes or very little shift of short-haul traffic is likely. Calculation of the payload shift among vehicle classes is identical to that for shifts attributed to change in weight limits.

## With Change in Gross Weight and Length Limits

When restrictions on multiple unit combinations are liberalized, together with increases in overall length of the combination and with the gross vehicle weight controlled by the bridge formula,[7/] a substantial shift will occur from lower capacity combinations to the newly permitted higher capacity combinations. For example, a long-haul interstate network, using two and three unit combinations with total lengths of 110 feet, and gross weights controlled by Bridge Formula B, would probably include highway links attractive to both the long-haul of manufactures as well as the local or regional movement of heavy bulk commodities. In such cases some short-haul traffic shift from conventional semi-trailers to the newly permitted combinations would occur along with the associated shifts in traffic to highway classes designated as part of the new network. The magnitude of the shifts may be estimated as a function of the change in the relative cost of transporting commodities using the current and the new rigs. A price elasticity value may be estimated and used as suggested earlier.

## Payload Shift Among Highway Classes Attributed to Change in Limits Among Highway Classes

Given a base case highway class distribution of State level truck trips, shifts of long-haul and short-haul traffic among highway classes might occur in response to any changes in size or weight limits on specific classes of highway. A change in State regulation could involve one or more of the following:

(1) Prohibiting the use of specific highway classes by certain vehicle classes,

(2) Eliminating restrictions on certain vehicle classes from specific highway classes,

(3) Changing (either increasing or decreasing) size and/or gross weight and/or axle limits on specific classes of highways.

If one or more of these changes is sufficient to significantly affect the relative cost of operation among vehicle classes and body types and among highway classes within a State, then a shift of truck activity from the higher to the lower cost highway class will probably occur in proportion to the change in the relative cost.

The magnitude of the shift should be estimated separately for long haul and for short haul traffic as a function of the change in the relative cost of operating on two alternative classes. Price elasticity values may be used.

If the change is applied to only a small percentage of the route miles in a State, the price elasticity value for the short haul traffic should be modified to reflect the lower route availability for the larger trucks. An adjustment factor which reflects the proportion of the State highway mileage involved may be used. Using mileages shown in Highway Statistics, Table HM-20, calculate the ratio of the miles which have been changed to the total State miles, for all functional classes (except local). Apply this ratio to the price elasticity as an adjustment factor.

Compute the shift as follows:

(a) Compute the ratio of transportation cost ($/ton) via the alternative highway classes for each type of traffic.

  (1) For each vehicle class and body type affected, calculate the average transportation cost on the competing highway classes in dollars per payload ton. Divide the lower average cost by the larger average cost producing a ratio less than one. Do this for the Base Case.

  (2) Perform the same calculation for the alternative TS&W limit case.

(3) Divide the alternative case ratio of average costs by the base case ratio of average costs (x100) to obtain the percent change for each vehicle class affected.

(4) Multiply the total base case tons of each effected vehicle class by the percent (x 100) obtained in a(3) above. Subtract the shifting tons from the donor highway class and add the same tons to the receiving highway class for each affected vehicle class. Figures C-22 and C-23 provide examples of this calculation.

(b) The distribution of the gains and losses among O.G.V.W. intervals will probably remain unchanged as they shift highway classes in the case of vehicle class prohibition changes. In the case of changes in weight limits, a shift among O.G.V.W. will accompany the highway class shift, which means that this highway class shift must be preceeded by the shift among O.G.V.W. intervals.

(c) Adjust for empty trips in the lowest non-zero O.G.V.W. interval.

## HIGHWAY USER OPERATING COST AND TRANSPORT PRICE IMPACTS

Savings in operating costs of vehicles using an improved section of highway are generally presented to the decision makers as the economic benefit of a proposed improvement. For example, a straighter, flatter, smoother, higher speed segment of highway is projected to reduce the travel time, truck operator fuel costs, vehicle maintenance, and driver and other labor costs for each trip. Greater average speeds allow opportunity for more trips per year with the same truck and the smoother ride and reduction of congestion extends the life of the vehicle. All of these impacts mean a reduction in the vehicle operating costs per truckload of freight hauled.

## FIGURE C-22

## EXAMPLE OF HIGHWAY CLASS SHIFT

Given: (Hypothetical Data for Example Only)

1) Base case % distribution among highway classes of combination trucks.
2) Base case cost advantage of $1.00/payload ton of rural interstate highways over rural other principal arterials eliminated by increased size or weight limits on other principal arterials.
3) Price elasticity of unity.

Calculate:

1) Base case distribution of vehicle classes impacted by limit changes.
2) Calculate base case ratio of per payload ton cost on interstates and on other principal arterials.
3) Calculate alternative case ratio.
4) Calculate the percent change of the alternative ratio from the base case ratio.
5) Calculate the absolute value of the base case vehicles on the rural interstates.
6) Subtract this value from the rural interstates and add it to the rural other principal arterials.

FIGURE C-23

EXAMPLE OF HIGHWAY CLASS SHIFT

| | Base Case Vehicles x $10^3$ | % Shift | Vehicles Shifted | Alternative Case Vehicles x $10^3$ |
|---|---|---|---|---|
| Rural | | | | |
| 01 | 40.2 | 5.0% | -2.0 | 38.2 |
| 02 | 5.3 | - | +2.0 | 7.3 |
| 06 | 2.0 | - | 0 | 2.0 |
| 07 + 08 | 0.6 | - | 0 | 0.6 |
| Urban | | | | |
| 11 + 12 | 43.7 | - | 0 | 43.7 |
| 14 | 5.8 | - | 0 | 5.8 |
| 16 | 1.6 | - | 0 | 1.6 |
| 17 | 0.8 | - | 0 | 0.8 |
| TOTAL STATE | 100.0 | | | 100.0 |

Base case transport cost per payload ton

on interstate (01) $20.00

on non interstate principal arterials (02) $21.00

$$\text{Ratio} = \frac{20.00}{21.00} = 0.9524$$

Alternative case transport cost per payload ton

on interstates (01) $20.00

on non-interstate principal arterials (02) $20.00

$$\text{Ratio} = \frac{20.00}{20.00} = 1.0000$$

Ratio % change from base case = 5.0

In the same way, increasing truck payload capacity by increasing size and/or weight limits is expected to increase the total payload more than the fully allocated cost of the trip, thus decreasing the average total cost per unit transported.

In considering the added costs of providing the new segment of highway or the higher size and/or weight limits, the State study must include estimates of the aggregate cost reduction for all highway users and the aggregate increases in the State's total costs to provide the required highway quality (i.e., a cost/benefit analysis).

If the effect of the TS&W limit changes (e.g., axle load limit) is to reduce only the over-the-road (line-haul) operating costs, then these costs are all that need be analyzed to estimate the aggregate savings for truck operators. If limit changes affect terminal area costs of motor carriers (e.g., by use of doubles), then these costs must also be estimated. If the relative significance of the savings to transportation service users is to be estimated, total carrier system costs including overhead, general administrative costs, and returns or profits must also be estimated.

If the market is highly competitive, estimated truck operator cost reductions from TS&W limit change can be assumed to be "passed-through" in freight rates. Conversely, if competition is light or the profit margin for the service had been too small to justify new investment, then the cost savings attributed to the limit change may be in large part retained internally as a contribution to overhead and profits. In this latter case, the truck transportation prices to the transportation service users remain essentially unchanged.

After deciding on the scope of the proposed cost/price impact study and the variables to be included, the analyst is faced with the question of how to obtain the needed cost data. The most appropriate costs are those derived from the potentially affected truck operations within the State. Often the analyst is forced to obtain costs from a variety of "foreign" sources representing services that only vaguely resemble the truck operations under investigation. Regardless of the source, the level of detail must offer sensitivity to the size and weight limits and comprehensive representation of all affected cost elements.

A change in vehicle length and/or width may change the vehicle purchase price and, therefore, the vehicle ownership costs; it may change the aerodynamic drag and, therefore, fuel consumption. A change in the weight of the vehicle may affect the maximum practical payload weight to haul high density cargo, but may not significantly affect the per mile operating cost.

The cost difference attributed to a TS&W limit change should be calculated on the basis of the fully allocated (or long run average) cost to transport a given volume of freight in a given market. If certain cost elements are determined to be unchanged by the TS&W limit changes, then they are held constant while the affected elements are adjusted to reflect the new limits. If payloads are expected to shift among vehicle classes, then the costs of vehicle classes affected under the base case limits and under the projected limits should be estimated. If payloads are expected to shift among highway classes, then the costs of operation on the affected classes should be estimated. Costs may be computed on a vehicle mile basis and aggregate cost differences calculated as the product of the unit cost and the total vehicle miles involved. If shifts between vehicle types and/or between modes are to be estimated, the per mile costs must be divided by the payload weight to obtain a comparable per ton-mile cost.[8/]

## MODAL DIVERSIONS

Underlying the procedures outlined in this chapter for the analysis of truck size and weight limit changes is the assumption that aggregate freight trucking demand (ton-miles of freight shipments) remains constant, despite the many disaggregate redistributions of vehicle payloads among vehicle classes, operating gross vehicle weights and highway classes. The transport demand forecast for truck freight services may include a variety of assumptions about the trends in truck market share, vis-a-vis its modal competitors, attributed to factors other than TS&W limit changes. Isolation of the payload shift to (or from) truck from (or to) its modal competitors (primarily rail) attributable only to TS&W limit changes is a concomitant concept underlying these procedures.

The interest of a particular State study may be in the effects of TS&W limit changes on rail carriers (or other modes) serving the State, or it may be solely to obtain a more accurate estimate of highway traffic impacts. Several analytical options are available to the State analyst for estimating potential modal diversions attributable to size and weight limit changes. None of these options alone will provide fully satisfactory results, particularly at the State level. The choice will depend on the specifics of the State situation.

All the options involve two preliminary steps. The first is estimating the change in the price of the truck services attributed to the specific size and weight limit changes. The second is estimating the corresponding change in the price of the competing rail services. The latter may range from a rail price response equaling the reductions in truck prices in an attempt to retain market share to no change in current rail prices which risks loss of portions of the competitive traffic.

To some extent the choice of methods for estimating modal diversions depends upon the category of truck services affected by the specific truck size and weight limits and the level of concern over the modal diversions involved. Different methods are effective for short haul, intrastate transport of low unit value bulk commodities and other methods are effective for long haul, interstate transport of high unit value manufactured goods. Different levels of detail are needed for gross estimates of impacts on highway traffic as opposed to identification of specific traffic potentially diverted and the resultant revenue loss to particular carriers.

A rough estimate of potential State diversions available to the State analyst is found in the estimated regional diversions from the Federal DOT report[9/] for specific size and weight limit scenarios. If this approximation indicates that the issue is important enough to proceed with more detailed analyses, then the following procedures might be considered.

One approach is to isolate all truck operations with no significant modal competition from the total State level truck traffic and delete them from the analysis of modal diversion. These may be identified by commodity transported, by haul distance, by truck type or by payload level.

Another approach is to isolate the portion of each truck class for which there is substantial rail competition. The Truck Weight Study data for the study-State, and/or adjacent States, compared with data from the Federal Railroad Administration's one percent rail waybill sample[10/] will provide commodity and geographical detail for rail carriers serving the State. Absence of rail traffic for specific commodities with origins or destinations on rail lines serving the State will indicate a lack of rail competition. Data from the U.S. Bureau of the Census, Census of Transportation, Commodity Transportation Survey, also provide detail of commodities shipped by various modes. The proportion of each vehicle class that appears to have substantial rail competition, when applied to the State level annual total truck trips (average daily trips expanded to annual), provides an estimate of the truck trips susceptible to increase from rail diversions if the truck prices are reduced (or decrease if the truck prices are increased).

Having estimated the maximum potentially divertable traffic by these means, the analyst has several options for the final step:

a) Use the identified competitive traffic as a guide for detailed analysis of industries within the State and their inbound and outbound transport requirements. Use these results to estimate the current rail shipments which are divertable based on the estimated truck price reductions. Conversely, the analyst can estimate the truck traffic which might be diverted to rail if the truck prices are increased.

b) Use the identified competitive traffic as input to one of several proprietary shipper-mode choice models available through transportation management consultants.

c) Use the identified competitive traffic with commodity group and shipment size-specific elasticity parameters to calculate the increase in truck transport demand as a function of the change in truck price. This approach was used in the U.S. DOT studies.

The choice of methods will depend also upon whether intrastate traffic or interstate traffic is most likely to experience substantial modal diversions. If relatively short-haul, intrastate transport of large volumes of relatively low value shipments are involved, method (a) above is likely to produce the most accurate estimates. If the limit changes have their greatest impact on interstate, long haul traffic, then methods (b) and (c) are most appropriate. Method (b) offers the opportunity to tailor the analysis to the specific needs of the State study and (c) offers the lowest cost and quickest results. Method (c) can also be tailored to the specific State markets if appropriate elasticity parameters are developed.

## REFERENCES

## APPENDIX C


1. Final reports of the Secretary of Transportation to the United States Congress An Investigation of Truck Size and Weight Limits, August, 1981; Final Report on the Federal Highway Cost Allocation Study, May 1982. Persuant to the Surface Transportation Assistance Act of 1978.
2. Average vehicle life estimates were derived primarily from the U.S. Department of Commerce, Bureau of the Census, 1977 Census of Transportation: Truck Inventory and Use Survey and Department of Transportation's Nationwide Personal Transportation Survey, DOT and Motor Vehicle Manufacturers', Motor Vehicle Facts and Figures '79. Vehicle prices are contained in Sydec's, Transportation System Descriptors Used in Forecasting Federal Highway Revenues, June, 1981.
3. Note: The bridge formula is described in Public Law 97-424 Jan. 6, 1983, STAA 1982 Section 133.
4. See Freidlaender and Spady, Equity, Efficiency and Resource Allocation in the Rail and Regulated Trucking Industry, Center for Transportation Studies Report Number 79-4, Massachusetts Institute of Technology, 1979.
5. An Investigation of Truck Size and Weight Limits, Table 2-4, P-2-19, Tech. Sup. Vol. 4. Also, State level VMT by type of traffic and vehicle class, body type and highway user group, base case traffic from FHWA System of Analysis of Policy Options.
6. Ibid., Tech. Sup. Vol. 1, Appendix C
7. Public Law 97-424, Jan. 6, 1983, Sec. 133, Section 127 of Title 23 of United States Code.
8. Details of the methods used in the Federal studies are contained in the Technical Supplement, Volumes 2, 4 and 7 to the DOT TS&W report to Congress.
9. Op. Cit.
10. Interstate Commerce Commission/Federal Railroad Administration Rail Waybill Sample.

# APPENDIX D

## STUDY DATA REQUIREMENTS

The purpose of this appendix is to analyze the data needs of and forecasting methods related to truck size and weight limit changes, and to provide the analyst with references to regional data sources available from the Federal government and selected data items available from FHWA's updated analysis of user charge and truck size and weight limit alternatives. It supplements the discussion of data requirements and forecasts in Volume I, Chapter V.

This appendix has four sections: an analysis of the data needs and forecasting methods related to changes in truck size and weight limits, references for Federally-compiled regional data, data on axle weight observations for heavy vehicles, and vehicle fleet size characteristics and ownership. Figure D-1 lists data items and classifying variables thought to be useful for organizing the data collection effort. Figure D-2 lists items and variables appropriate for truck size and weight limit change impact analyses. Figures D-3 and D-4 show factors useful in forecasting weight and load distributions for size and weight limit changes. Figure D-5 contains data at a national level of average axle-loads for various truck configurations. Figure D-6 is a tabulation of data on fleet size and characteristics from ongoing FHWA research. These data are intended only to provide indications of certain value ranges and as a preliminary focus for the data gathering effort.

FIGURE D-1

STUDY DATA REQUIREMENTS

| | Truck Body Type | Commodity Group | Cost Element | Vehicle Fuel Type | Highway Class | Mode | User Group | Vehicle Class | Registered Weight Interval |
|---|---|---|---|---|---|---|---|---|---|
| Consumption Rates | | | X | X | | | X | X | X |
| ESALs | | | | | X | | | X | X |
| Vehicle Empty/Loaded Miles | X | | | | | | X | X | |
| Highway Costs | | | X | | X | | | | |
| Highway Mileage Inventory | | | | | X | | | | |
| Operating Gross Vehicle Weights | X | | | | | | X | | X |
| Payload Ton-Miles | X | X | | X | X | | X | X | X |
| Payload Density | X | X | | | | | | X | |
| PCE's | | | | | X | | | X | X |
| Prices | X | | X | X | | X | X | X | X |
| Price Elasticities | | | | | | X | X | | |
| Price Indices | | | X | X | X | | X | X | |
| Tax Payments | | | X | X | | | | X | X |
| Transport (and Vehicle) Costs | X | | X | X | | X | X | X | X |
| Vehicle Fleet Size | X | | | X | X | | X | X | X |
| Vehicle Miles of Travel | X | | | X | X | | X | X | X |
| Vehicle Volume Capacity | X | | | | | | | X | |

## TRUCK SIZE AND WEIGHT LIMIT CHANGES

The analyses of the effects of truck size and weight limit changes on highway traffic volumes, axle load distributions, highway user costs, transport prices and modal shares of freight shipments described in Appendix C involve the use of eleven separate data items. Figure D-2 displays a matrix of these elements and up to seven dimensions required for each. Each marked cell in the matrix represents the required dimension of the data called for in the methods outlined in Appendix C.

To allow focus of the available project resources on data items which must be State specific, such as vehicle counts per lane mile, commodity tonnage and vehicle axle configurations, data from the Federal studies may be used. These State-specific values may be derived from items such as vehicle volume capacity, vehicle empty weight and vehicle empty mileage ratios.

All data items should be defined by at least two dimensions. Where three or more dimensions are indicated on Figure D-2, the State analyst must judge the value to the project of gathering the additional data.

FIGURE D-2

DATA REQUIRED FOR TS&W LIMIT IMPACTS

| Dimension<br><br>Data Element | Vehicle Class | Body Type | Intra vs Inter State Traffic | High-way Class | High-way User Group | Com-modity Group | Weight Interval |
|---|---|---|---|---|---|---|---|
| Vehicles per mile | X | X | X | X | X | X | X |
| Vehicle Axle Configuration | X | X | | X | | | X |
| Vehicle Empty Weight | X | X | | | | | |
| Vehicle Empty Mileage Ratio | X | X | X | | X | | |
| Vehicle Volume Capacity | X | X | | | | | |
| P.M.G.V.W.* | X | X | | | | | |
| Commodity Tonnage | X | X | X | | | X | |
| Axle Share of O.G.V.W.** | X | X | | | | | X |
| Loaded Payload Density | X | X | | | X | | |
| Transportation Cost/Veh. Mile | X | X | | X | X | | |
| Price Elasticity | | | | | X | X | |

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* Vehicle Practical Maximum Gross Vehicle Weight

** Operating Gross Vehicle Weight

## FORECASTING VEHICLE GROSS WEIGHT AND AXLE LOAD DISTRIBUTION FOR TRUCK SIZE AND WEIGHT LIMIT CHANGES

The following section discusses several options for developing the detail of data used in the Federal study on changes in truck size and weight limits and suggests ways to apply these procedures at the State level.

Vehicle gross weight and axle load distributions may vary over time even if truck size and weight limits are not changed. The growth rates in particular markets which tend to use various classes of trucks may be quite different, tending to change the mix of vehicles over time. The volume of activity in given markets may increase sufficiently to warrant larger lot shipments in larger trucks than previously used. Product lines and materials used in manufacturing may significantly change the payload density of shipments causing significantly different loads on axles. Market forces such as these may affect only the intrastate traffic. On the other hand, such forces may affect the interstate traffic as well.

Different types of truck size and weight limit changes affect gross weight and axle load distributions for various traffic streams. It is thus necessary to disaggregate traffic streams into those sensitive to size limit changes which affect the volume capacity of trucks, and those sensitive to weight limit changes which affect the weight capacity. Traffic must also be divided into intrastate and interstate. Partitioning the State truck traffic into intrastate and interstate and segregating volume-limited and weight-limited traffic is therefore desirable before developing base year operating gross weight and axle load distributions.

The Federal forecast involves a base case and one or more alternative cases; the difference between the alternatives and the base case are taken to represent the potential effects of alternative policies or scenarios. In this approach, a decision must be made about what is to be held constant and what is to vary in each alternative. The base year truck size and weight limits may be held constant and alternative futures in market growth and/or fleet mix and equipment utilization may be treated as scenarios. Conversely, a constant market environment and fleet assignment may be projected while truck size and weight limits are changed to isolate the effects of alternative limits, as was done in the Federal studies.

In the Federal study, the base case forecast was established by holding constant the TS&W limits as well as the market assignments of the vehicle types and their capacity utilization rates. The base year operating gross vehicle weight (OGVW) distribution, the distribution of axle types and the distribution of operating gross weight among the axles may be developed by vehicle class and body type from the latest FHWA Truck Weight Study (TWS) data. Association of vehicle classes and body types with commodity/industry groups may be based on data from the TWS and the Bureau of Census' Truck Inventory and Use Survey. A given year's forecast, therefore, is the product of a projection of commodity groups shipped (tons or ton-miles) or truck trips (or truck miles) generated to transport the shipment and the distributions of the commodities among vehicle classes and body types.

When the base year distributions of commodities among vehicle classes and body types are held constant, the implied assumption is that the fleet mix servicing each commodity market will be relatively stable and the changes in the aggregate fleet mix will result only from the changes in the relative growth of the commodity markets. This was the approach taken in The Investigation of Truck Size and Weight Limit Changes and The Final Report on the Federal Highway Cost Allocation Study submitted to Congress in 1981 and 1982 respectively.

Gross vehicle weight distributions and axle load distributions may be obtained from the TWS data disaggregated by vehicle class and by body type. If no size and weight limit changes are projected, they may remain constant, allowing any projected changes in the number of trucks of each vehicle class and body type to translate into changes in the aggregate gross weight and axle load distributions. Procedures for forecasting changes in fleet size and mix of vehicle classes and body types were discussed above.

However, if size and weight limits are projected to change for either intrastate or the interstate traffic, a more complex procedure is required. In order to shift the truck payload among OGVW intervals and to maintain internal consistency between gross weight and axle loads, it is suggested that the axle load distributions be derived from the gross weight distributions for each vehicle class and body type, both before and after the payload shift. It is preferable to develop these distributions by functional highway class, but TWS data in most States is highly concentrated on two or three of the twelve highway classes, making its use impractical. The following procedure used for the Federal studies may be appropriate for a State study.

1) Divide the State total truck trips for each vehicle class and body type by the appropriate highway lane miles.

2) Distribute the average trucks per lane mile by vehicle class and body type among the OGVW intervals using the distributions derived from the latest TWS data.

3) For each vehicle class, body type and OGVW interval, calculate the average load on each of the axle types by applying the distribution of OGVW among the axle types derived from the TWS data.

4) Calculate the aggregate axle load applications per lane-mile for each axle type and weight interval, multiplying the number of trucks per lane mile for each truck class and OGVW cell by the number of axles of each type.

5) Combine the average axle loads of 3) with the axle load applications of 4) to produce a distribution of lane-mile axle loadings for each type of axle. This is an aggregate distribution of all truck traffic on the highway lane.

Truck activity is not uniform among functional highway classes. Data suitable to accurately quantify the distribution of the various vehicles among the functional highway classes for individual States is very sparse. However, some general observations may be made from the data that is available. Medium and heavy duty single unit trucks represent a small and fairly uniform percent of the total traffic stream in all highway classes (slightly less in urban than in rural). Combination trucks are about evenly distributed between rural and urban highways, while light single units tend to follow the non-truck vehicle pattern where two thirds to three quarters of their respective activity is on urban roads.

Figure D-3 shows the percent of the total traffic stream represented by combination trucks, single unit trucks and non-truck vehicles for each of eight functional highway class groupings. Activity on local roads and streets has been excluded. Figure D-4 shows the percent distribution of each vehicle class among the highway classes. Each exhibit also shows the percent distribution by highway design type. Multilane highways are obviously the most attractive routes for all trucks, but 20% of the single unit truck and 10% of the combination activity are on two lane roads which, in certain cases, must be more than just collectors and

FIGURE D-3
PERCENT OF TOTAL TRAFFIC STREAM

| | | NON-TRUCKS* % | S.U. TRUCKS % | COMBINATIONS % |
|---|---|---|---|---|
| By Functional Highway Class | | | | |
| RURAL | | | | |
| 01** | Interstate | 79.0 | 3.1 | 17.9 |
| 02 | Other Principal Arterial | 87.4 | 3.6 | 9.0 |
| 06 | Minor Arterial | 91.2 | 3.8 | 5.0 |
| 07 + 08 | Collectors | 88.4 | 5.1 | 6.5 |
| URBAN | | | | |
| 11 + 12 | Interstate + Freeway | 89.1 | 2.7 | 8.2 |
| 14 | Other Principal Arterial | 94.2 | 2.6 | 3.1 |
| 16 | Minor Arterial | 96.3 | 2.1 | 1.6 |
| 17 | Collectors | 95.4 | 2.8 | 1.9 |
| By Highway Design Type | | | | |
| RURAL | | | | |
| Freeway + Expressway | | 79.3 | 3.1 | 17.6 |
| Other Multilane | | 84.5 | 6.8 | 8.8 |
| Two Lane | | 88.7 | 3.9 | 7.4 |
| URBAN | | | | |
| Freeway + Expressway | | 90.3 | 2.6 | 7.1 |
| Other Multilane | | 94.5 | 2.8 | 2.8 |
| Two Lane | | 95.0 | 2.6 | 2.4 |

Source: HPMS Vehicle Classification Case Study, August 1982.

* Includes cars, motorcycles, buses and other two-axle, four-tired vehicles.

** Highway Performance Monitoring System codes.

FIGURE D-4

VEHICLE DISTRIBUTION BY FUNCTIONAL HIGHWAY CLASS

| | | NON-TRUCKS* % | S.U. TRUCKS % | COMBINATIONS % |
|---|---|---|---|---|
| By Functional Highway Class | | | | |
| RURAL | | | | |
| 01** | Interstate | 16.6 | 20.9 | 40.2 |
| 02 | Other Principal Arterial | 5.0 | 6.5 | 5.3 |
| 06 | Minor Arterial | 3.5 | 4.4 | 2.0 |
| 07 + 08 | Collectors | 0.8 | 1.5 | 0.6 |
| URBAN | | | | |
| 11 + 12 | Interstate + Freeway | 44.3 | 42.8 | 43.7 |
| 14 | Other Principal Arterial | 16.4 | 14.1 | 5.8 |
| 16 | Minor Arterial | 9.3 | 6.2 | 1.6 |
| 17 | Collectors | 4.1 | 3.6 | 0.8 |
| | | 100.0 | 100.0 | 100.0 |
| By Highway Design Type | | | | |
| RURAL + URBAN | | | | |
| Freeway + Expressway | | 72.1 | 71.2 | 86.9 |
| Other Multilane | | 9.2 | 8.5 | 2.9 |
| Two Lane | | 18.7 | 20.3 | 10.2 |
| | | 100.0 | 100.0 | 100.0 |
| Total Vehicles Counted | | 10,566,794 | 287,430 | 854,932 |

Source: HPMS Vehicle Classification Case Study, August, 1982.

* Includes cars, motorcycles, buses and other 2 axle, four-tired vehicles.

** Highway Performance Monitoring System codes.

minor arterials. The data used for these exhibits represent the aggregate of nearly 12 million vehicles counted at 139 sites in five geographically dispersed States. The sites were distributed among functional highway classes roughly in proportion to the total vehicle VMT with a minimum of two sites for each class, one for less than 10% trucks and one for more than 10% trucks (15% on rural Interstates). That data, although limited geographically, provides a more representative sample of traffic across highway classes than the TWS data submitted to FHWA by each of the individual States.

A detailed review of the 1980-1981 data files indicates the inadequacy of functional highway class coverage in the States that have collected vehicle counts and/or weights. Truck traffic counts and truck weighings are heavily concentrated on two classes of roads - the Rural Principal Arterials (HPMS Codes 01 & 02). Of the 50 thousand hourly vehicle count records obtained in 1980 and 1981,*/ 69% were taken from stations on these two functional classes. Of the 146 thousand trucks weighed in 1980 and 1981, 75% were weighed at stations on these two functional classes.

These sample distributions seem to be out of balance by at least a factor of two relative to the truck traffic distribution, if the case study data is anywhere close to representative. Data collected on urban roads, minor arterials and collectors have provided some records but not in proportion to their apparent traffic volume.

If it is not possible for a State to obtain representative sample counts and weightings across functional highway classes in sufficient number to permit differentiation of gross weight and axle load distributions, then surrogate distributions must be generated.

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*/ None were collected on either rural local roads or urban streets.

The State analysts may differentiate among the few classes available in their State in developing gross weight and axle load distributions and speculate on how representative these few are of the other classes. Alternatively, the data from neighboring States may be aggregated with data from the home State.

If there is no need to project a future shift in gross weight distribution and/or load distribution, then 30 to 40 truck weight records may be adequate to obtain average operating gross weight and average axle loads by axle type for a few major vehicle classes. However, if shift estimates are required, then several hundred observations will be required to develop the distribution curves required as a basis for load shifting procedures outlined in Appendix C.

Records may be selected from two or more recent years and several neighboring States or States having similar vehicle types and commodities transported. It is suggested that aggregations for weight distributions may be developed without consideration for highway functional class if the distributions are by vehicle class, body type and/or commodity carried. Traffic volume by highway class may be developed by random selection of equal numbers of records for each class of highway. The sample size will be dictated by the smallest number available for any one class after the appropriate States and years have been aggregated. The hourly count of trucks by vehicle class and body type by highway class will be about as representative as existing data permits. Application of the gross weight and axle load distributions by vehicle class and body type to the traffic volume estimates of these same vehicle catagories will generate the appropriate aggregate gross weight and axle load distribution, before and after the load shift, as outlined in Appendix C.

## REGIONAL DATA SOURCES

This part of Appendix D lists some sources for region- or State-specific data. The entries list the government or other agency that publishes the data, the title of the series, the frequency of the data—annual, quarterly or monthly—the coverage of the series (fifty States, census regions, etc.), the starting date of series availability and some sample variables.

U.S. DEPARTMENT OF AGRICULTURE

Economic and Statistics Service

Cash Receipts from Farm Marketings—Annual—from "Economic Indicators of the Farm Sector" and advance tables—Fifty States beginning in 1947--Cash receipts from farm marketings, including CCC loans

U.S. DEPARTMENT OF COMMERCE

Bureau of Economic Analysis

Personal Income—Annual—from "Survey of Current Business," advance tables, tapes—U.S. total, the fifty States, generally beginning in 1958; total personal income is available for all MSA's beginning in 1965--Wages and salaries available by major sectors of the economy, transfer payments, earnings by place of work and by place of residence

Personal Income—Quarterly—from "Survey of Current Business," and advance tables—U.S. total, the fifty States, generally beginning in 1958--total labor and proprietors' income, wage and salary disbursements

Disposable Personal Income—Annual—from "Survey of Current Business" and unpublished tables—U.S. total, the fifty States, and the District of Columbia, generally from 1958—Disposable personal income

Bureau of Industrial Economics

Nonresidential Construction Authorized—Monthly—from "Construction Review"—U.S. total, fifty States, and the District of Columbia, generally beginning in 1968—total value of private nonresidential construction authorized

Bureau of the Census

Current Business Reports Retail Sales—Monthly—from "Monthly Retail Trade, Sales and Inventories," Tables 4, 5, 6, 7, 8—Selected regions, States, and MSA's, generally starting in 1976—Estimated Monthly Retail Sales by Kind of Business for Regions (for the four Census regions); Estimated Monthly Retail Sales by Kind of Business for Geographic Divisions (for the nine Census regions); Estimated Monthly Retail Sales by Selected Kinds of Business for Specified Large States; Estimated Monthly Retail Sales by Selected Kinds of Business for Specified Areas and Cities

Current Population Reports—Population and Households—Annual—from "P25: Population· Estimates and Projections"—U.S. total, Census regions, fifty States, and the District of Columbia; resident population also available for all MSA's—total resident pouplation by State by MSA

Family Money Income—Annual—from "P60: Consumer Income"—Four Census regions, from 1953

State Government Finances—Annual fiscal year—"State Government Finances" and "State Government Tax Collections" released in advance--U.S. total and fifty States, generally from 1951—Taxes, Intergovernmental revenue, Total Expenditure by Type and Function

Local Government Finances—Annual fiscal year—from "Governmental Finances"—U.S. total, the fifty States, and the District of Columbia, generally from 1961 forward—Total general revenue, Direct General Expenditure by Function

Quarterly Tax Revenue—from "Quarterly Summary of State and Local Tax Revenue"—For the U.S. total, the fifty States, and the District of Columbia, generally starting in 1961—Tax Collections

U.S. DEPARTMENT OF LABOR

Bureau of Labor Statistics

Consumer Price Indices—Monthly and bimonthly—from "The Consumer Price Index" and news release—Consumer price index, all items, all urban consumers

Hours and Earnings—Annual hours and earnings data are available for all fifty States and the Washington, DC MSA. Series are from the annual "Employment and Earnings, States and Areas," with preliminary updates released in the May issue of "Employment and Earnings."—Average hourly earnings of production workers in manufacturing

Civilian Labor Force and Unemployment--Monthly labor force data are available for all fifty States, the District of Columbia, and selected metropolitan statistical areas--Data supplied by State employment security agencies and the U.S. Bureau of Labor Statistics (BLS)--Civilian labor force, Number employed, Number unemployed, Unemployment Rate

Employment--Annual employment series by major standard industrial classification (SIC) are available for the fifty States, and the District of Columbia--from "Employment and Earnings, States and Areas," published annually by the Bureau of Labor Statistics and from the May issue of "Employment and Earnings"--Nonagricultural wage and salary

## U.S. DEPARTMENT OF TRANSPORTATION

### Federal Highway Administration

Motor Vehicle Registrations and Licenses--Annual--from "Highway Statistics" and advance releases--U.S. total, the fifty States, and the District of Columbia, generally starting in 1945--Registrations (buses, automobiles, trucks), Drivers' Licenses in Force

## HEAVY TRUCK AXLE WEIGHTS

Average truck axle weights, for all but light trucks, from the 1979 through 1982 FHWA Truck Weight Study files are shown in the following tables. These data include the first five axles per vehicle, with standard deviation for corresponding axles shown to the right of the tables. The first axle is the steering axle. The remaining four axles may be a single, part of a tandem set or some other axle group, depending on the rig's configuration. These data are from selected records in the sample; where data appeared erroneous or nonsensical they were deleted.

As can be inferred from the standard deviations to the right of the table, axle-weights cluster fairly closely about the mean values. Very little variance from these values was detected when the data were grouped by gross registered weight categories, therefore for a compact presentation all registered weight groups were combined. The more interesting classifying variables were included: body type and the for-hire/private split.

The sample provided by States to FHWA does not allow sufficient detail for complete State or regional detail. Furthermore, the Truck Weight Study does not provide a reliable statistical basis for judging these values by all road systems, locations, or other categories. It has not been designed as a representative sample, rather as selected observations. It is nevertheless, the best estimate of axle weights available. If there is a consistent bias, it appears to be that the axle weights shown are low, possibly due to heavy vehicles bypassing scales.

These data should be used with care and replaced by State-gathered data wherever possible. In selecting sample sites for gathering State data it is important to get representative coverage of road systems, locations throughout the State, time of day, day of week, and season, since these and other variables affect traffic observations, highway costs and other things of importance to State analysts.

FIGURE D-5

HEAVY TRUCK AXLE WEIGHTS, MEAND AND STANDARD DEVIATIONS
BASED ON 1979-1982 TRUCK WEIGHT STUDY FILES

| BODY TYPE | USER GROUP | AVERAGE LOADS AXLE 1 | AXLE 2 | AXLE 3 | AXLE 4 | AXLE 5 | STD. DEV. OF LOADS AXLE 1 | AXLE 2 | AXLE 3 | AXLE 4 | AXLE 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VEHICLE TYPE: | | 3-AXLE | TRACTOR | TRAILER | | | | | | | |
| FLAT | FOR-HIRE | 7,909 | 12,523 | 10,912 | 0 | 0 | 1,727 | 3,695 | 4,033 | 0 | 0 |
| FLAT | PRIVATE | 7,908 | 13,130 | 11,697 | 0 | 0 | 2,366 | 4,350 | 4,563 | 0 | 0 |
| MOVER | FOR-HIRE | 8,319 | 13,039 | 11,548 | 0 | 0 | 1,715 | 3,268 | 3,003 | 0 | 0 |
| MOVER | PRIVATE | 8,493 | 12,618 | 11,231 | 0 | 0 | 1,516 | 2,382 | 3,035 | 0 | 0 |
| REEFER | FOR-HIRE | 8,254 | 13,464 | 10,113 | 0 | 0 | 1,397 | 3,056 | 3,579 | 0 | 0 |
| REEFER | PRIVATE | 8,344 | 14,262 | 10,493 | 0 | 0 | 1,812 | 3,598 | 3,766 | 0 | 0 |
| VAN | FOR-HIRE | 7,768 | 11,352 | 9,527 | 0 | 0 | 2,705 | 4,019 | 4,272 | 0 | 0 |
| VAN | PRIVATE | 7,956 | 12,434 | 10,725 | 0 | 0 | 2,797 | 3,222 | 3,537 | 0 | 0 |
| VEHICLE TYPE: | | 4-AXLE | TRACTOR | TRAILER | | | | | | | |
| AUTO | FOR-HIRE | 10,125 | 15,388 | 9,006 | 8,865 | 0 | 2,305 | 3,665 | 2,313 | 2,775 | 0 |
| AUTO | PRIVATE | 9,159 | 13,452 | 7,448 | 7,441 | 0 | 1,630 | 3,625 | 2,636 | 2,605 | 0 |
| DUMP | PRIVATE | 8,227 | 19,442 | 16,715 | 16,331 | 0 | 1,685 | 4,128 | 4,478 | 4,285 | 0 |
| FLAT | FOR-HIRE | 8,152 | 13,618 | 9,599 | 9,361 | 0 | 1,829 | 4,005 | 3,893 | 3,852 | 0 |
| FLAT | PRIVATE | 7,796 | 14,058 | 9,922 | 10,024 | 0 | 1,708 | 4,583 | 4,322 | 5,751 | 0 |
| MOVER | FOR-HIRE | 9,023 | 14,350 | 9,151 | 9,118 | 0 | 1,131 | 3,187 | 2,533 | 2,593 | 0 |
| MOVER | PRIVATE | 8,906 | 14,086 | 8,824 | 8,445 | 0 | 1,266 | 3,383 | 2,898 | 2,877 | 0 |
| REEFER | FOR-HIRE | 8,953 | 16,031 | 10,163 | 9,879 | 0 | 1,779 | 3,844 | 4,237 | 4,296 | 0 |
| REEFER | PRIVATE | 8,227 | 16,428 | 9,744 | 9,685 | 0 | 1,381 | 4,999 | 3,853 | 3,885 | 0 |
| TANK | PRIVATE | 8,392 | 18,949 | 15,908 | 16,705 | 0 | 2,153 | 6,319 | 5,143 | 5,090 | 0 |
| VAN | FOR-HIRE | 8,757 | 13,719 | 8,720 | 8,440 | 0 | 2,321 | 3,862 | 3,438 | 3,399 | 0 |
| VAN | PRIVATE | 8,541 | 13,829 | 8,711 | 8,591 | 0 | 1,459 | 4,037 | 3,438 | 3,405 | 0 |
| VEHICLE TYPE: | | 5-AXLE | TRACTOR | TRAILER | | | | | | | |
| AUTO | FOR-HIRE | 10,262 | 11,225 | 13,954 | 10,997 | 10,745 | 1,888 | 3,705 | 3,044 | 2,670 | 2,522 |
| AUTO | PRIVATE | 10,568 | 12,010 | 13,335 | 10,528 | 10,602 | 7,287 | 3,661 | 3,022 | 2,673 | 2,479 |
| DUMP | FOR-HIRE | 9,423 | 15,410 | 15,094 | 15,703 | 15,813 | 1,674 | 3,138 | 2,924 | 3,964 | 3,933 |
| DUMP | PRIVATE | 9,228 | 15,760 | 15,230 | 16,626 | 16,492 | 1,811 | 3,219 | 3,203 | 4,182 | 4,088 |
| FLAT | FOR-HIRE | 9,789 | 14,390 | 13,860 | 13,694 | 13,498 | 1,611 | 3,296 | 3,292 | 4,055 | 3,976 |
| FLAT | PRIVATE | 9,578 | 14,149 | 13,639 | 13,455 | 13,500 | 2,074 | 3,726 | 3,662 | 4,456 | 4,431 |
| MOVER | FOR-HIRE | 9,613 | 10,338 | 9,793 | 10,023 | 10,138 | 1,468 | 2,596 | 2,525 | 2,889 | 2,961 |
| MOVER | PRIVATE | 9,343 | 9,921 | 9,718 | 9,477 | 9,434 | 1,274 | 2,780 | 2,807 | 3,376 | 3,191 |
| OTHER | FOR-HIRE | 9,768 | 13,038 | 13,003 | 12,163 | 12,674 | 1,720 | 3,849 | 3,764 | 4,697 | 4,576 |
| OTHER | PRIVATE | 9,539 | 13,920 | 13,984 | 13,420 | 13,887 | 1,828 | 3,381 | 3,763 | 4,649 | 4,911 |
| REEFER | FOR-HIRE | 9,867 | 14,988 | 14,493 | 13,470 | 13,435 | 1,607 | 2,851 | 2,859 | 3,755 | 3,662 |
| REEFER | PRIVATE | 9,678 | 14,353 | 14,016 | 12,576 | 12,685 | 1,429 | 3,241 | 3,269 | 4,239 | 4,162 |
| TANK | FOR-HIRE | 9,701 | 15,316 | 14,725 | 14,622 | 14,620 | 1,406 | 4,085 | 3,621 | 4,452 | 4,557 |
| TANK | PRIVATE | 9,689 | 15,750 | 15,337 | 15,007 | 15,354 | 1,549 | 3,793 | 4,190 | 4,300 | 4,449 |
| VAN | FOR-HIRE | 9,690 | 12,693 | 12,107 | 11,476 | 11,633 | 1,390 | 3,441 | 3,376 | 4,178 | 4,322 |
| VAN | PRIVATE | 9,572 | 13,023 | 12,417 | 11,475 | 11,677 | 2,381 | 3,814 | 3,753 | 4,442 | 4,546 |

VEHICLE TYPE: 4-AXLE TRUCK TRAILER

HEAVY TRUCK AXLE WEIGHTS, MEANO AND STANDARD DEVIATIONS
BASED ON 1979-1982 TRUCK WEIGHT STUDY FILES

| BODY TYPE | USER GROUP | AVERAGE LOADS AXLE 1 | AXLE 2 | AXLE 3 | AXLE 4 | AXLE 5 | STD. DEV. OF LOADS AXLE 1 | AXLE 2 | AXLE 3 | AXLE 4 | AXLE 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FLAT | FOR-HIRE | 5,317 | 8,320 | 6,530 | 5,463 | 0 | 2,158 | 3,254 | 3,108 | 2,931 | 0 |
| FLAT | PRIVATE | 5,763 | 10,233 | 5,922 | 5,741 | 0 | 2,242 | 3,437 | 3,526 | 3,244 | 0 |
| VEHICLE TYPE: 5-AXLE TRUCK TRAILER | | | | | | | | | | | |
| AUTO | FOR-HIRE | 9,807 | 12,421 | 13,505 | 11,165 | 9,967 | 1,906 | 2,296 | 2,920 | 3,157 | 2,992 |
| DUMP | FOR-HIRE | 13,426 | 14,652 | 14,245 | 14,643 | 13,853 | 2,691 | 2,404 | 2,295 | 2,886 | 2,842 |
| DUMP | PRIVATE | 12,660 | 14,487 | 14,150 | 14,210 | 13,803 | 3,457 | 3,785 | 3,574 | 3,998 | 4,197 |
| FLAT | FOR-HIRE | 10,917 | 14,157 | 12,976 | 13,517 | 13,073 | 2,865 | 3,361 | 4,267 | 5,075 | 5,264 |
| FLAT | PRIVATE | 10,371 | 12,675 | 11,876 | 12,137 | 11,766 | 3,837 | 4,089 | 4,894 | 5,465 | 5,834 |
| TANK | FOR-HIRE | 11,409 | 15,853 | 15,582 | 17,487 | 17,067 | 1,758 | 2,890 | 2,923 | 4,137 | 4,247 |
| TANK | PRIVATE | 11,029 | 16,147 | 15,947 | 18,343 | 18,017 | 1,667 | 2,702 | 2,546 | 3,732 | 3,793 |
| VAN | FOR-HIRE | 9,768 | 11,976 | 12,290 | 11,724 | 11,649 | 1,904 | 3,842 | 3,583 | 4,071 | 4,000 |
| VEHICLE TYPE: 5-AXLE TRACTOR SEMITRAILER TRAILER | | | | | | | | | | | |
| FLAT | FOR-HIRE | 8,948 | 16,624 | 15,784 | 14,689 | 14,473 | 1,133 | 3,259 | 4,706 | 4,297 | 4,468 |
| FLAT | PRIVATE | 8,738 | 16,324 | 14,779 | 13,997 | 14,010 | 1,168 | 4,727 | 4,816 | 4,730 | 4,650 |
| VAN | FOR-HIRE | 9,556 | 14,816 | 14,810 | 11,036 | 10,541 | 1,131 | 3,024 | 4,994 | 3,663 | 3,558 |
| VAN | PRIVATE | 9,280 | 14,607 | 13,042 | 10,666 | 10,702 | 1,056 | 2,959 | 3,898 | 3,339 | 3,515 |
| VEHICLE TYPE: 2-AXLE HEAVY TRUCK | | | | | | | | | | | |
| DUMP | FOR-HIRE | 7,035 | 14,411 | 0 | 0 | 0 | 1,934 | 6,115 | 0 | 0 | 0 |
| DUMP | PRIVATE | 6,880 | 15,494 | 0 | 0 | 0 | 2,105 | 6,056 | 0 | 0 | 0 |
| FLAT | FOR-HIRE | 7,271 | 12,389 | 0 | 0 | 0 | 2,413 | 4,855 | 0 | 0 | 0 |
| FLAT | PRIVATE | 6,760 | 11,931 | 0 | 0 | 0 | 3,218 | 5,427 | 0 | 0 | 0 |
| MOVER | FOR-HIRE | 7,980 | 12,794 | 0 | 0 | 0 | 1,996 | 4,050 | 0 | 0 | 0 |
| MOVER | PRIVATE | 7,012 | 11,957 | 0 | 0 | 0 | 1,979 | 3,897 | 0 | 0 | 0 |
| OTHER | PRIVATE | 8,020 | 14,712 | 0 | 0 | 0 | 3,085 | 5,556 | 0 | 0 | 0 |
| REEFER | FOR-HIRE | 8,163 | 11,823 | 0 | 0 | 0 | 2,067 | 3,546 | 0 | 0 | 0 |
| REEFER | PRIVATE | 8,300 | 12,773 | 0 | 0 | 0 | 2,318 | 4,299 | 0 | 0 | 0 |
| TANK | FOR-HIRE | 7,976 | 14,318 | 0 | 0 | 0 | 2,317 | 4,906 | 0 | 0 | 0 |
| TANK | PRIVATE | 7,910 | 14,744 | 0 | 0 | 0 | 3,104 | 4,562 | 0 | 0 | 0 |
| UTILITY | PRIVATE | 6,112 | 11,536 | 0 | 0 | 0 | 2,640 | 5,058 | 0 | 0 | 0 |
| VAN | FOR-HIRE | 7,624 | 11,276 | 0 | 0 | 0 | 2,312 | 3,962 | 0 | 0 | 0 |
| VAN | PRIVATE | 7,544 | 11,908 | 0 | 0 | 0 | 2,486 | 4,617 | 0 | 0 | 0 |
| VEHICLE TYPE: 3-AXLE TRUCK | | | | | | | | | | | |
| DUMP | FOR-HIRE | 13,145 | 15,796 | 15,449 | 0 | 0 | 3,456 | 5,445 | 5,779 | 0 | 0 |
| DUMP | PRIVATE | 12,612 | 17,678 | 17,700 | 0 | 0 | 3,613 | 6,148 | 6,124 | 0 | 0 |
| FLAT | FOR-HIRE | 11,592 | 12,925 | 12,170 | 0 | 0 | 3,853 | 4,432 | 4,618 | 0 | 0 |
| FLAT | PRIVATE | 10,467 | 12,678 | 12,264 | 0 | 0 | 3,351 | 4,717 | 4,904 | 0 | 0 |
| OTHER | FOR-HIRE | 13,124 | 13,729 | 13,032 | 0 | 0 | 3,540 | 4,550 | 4,146 | 0 | 0 |
| OTHER | PRIVATE | 13,353 | 15,000 | 14,725 | 0 | 0 | 4,302 | 5,193 | 5,168 | 0 | 0 |
| REEFER | FOR-HIRE | 10,256 | 10,753 | 9,731 | 0 | 0 | 2,497 | 3,157 | 3,294 | 0 | 0 |
| REEFER | PRIVATE | 10,425 | 10,693 | 9,766 | 0 | 0 | 2,641 | 3,649 | 3,397 | 0 | 0 |

FIGURE D-5 (cont.)

HEAVY TRUCK AXLE WEIGHTS, MEAND AND STANDARD DEVIATIONS
BASED ON 1979-1982 TRUCK WEIGHT STUDY FILES

| BODY TYPE | USER GROUP | AVERAGE LOADS AXLE 1 | AXLE 2 | AXLE 3 | AXLE 4 | AXLE 5 | STD. DEV. OF LOADS AXLE 1 | AXLE 2 | AXLE 3 | AXLE 4 | AXLE 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TANK | FOR-HIRE | 11,251 | 12,714 | 12,329 | 0 | 0 | 2,750 | 4,062 | 3,957 | 0 | 0 |
| TANK | PRIVATE | 11,460 | 13,363 | 12,753 | 0 | 0 | 3,311 | 4,861 | 5,946 | 0 | 0 |
| VAN | FOR-HIRE | 9,262 | 10,708 | 9,593 | 0 | 0 | 2,861 | 3,701 | 4,517 | 0 | 0 |
| VAN | PRIVATE | 9,833 | 11,342 | 10,531 | 0 | 0 | 2,669 | 3,947 | 5,500 | 0 | 0 |
| VEHICLE TYPE: | 4-AXLE TRUCK | | | | | | | | | | |
| DUMP | FOR-HIRE | 14,931 | 12,325 | 16,408 | 16,769 | 0 | 3,656 | 4,457 | 5,324 | 6,420 | 0 |
| DUMP | PRIVATE | 15,156 | 11,162 | 19,541 | 15,864 | 0 | 4,036 | 6,743 | 5,478 | 5,874 | 0 |
| FLAT | PRIVATE | 13,299 | 14,821 | 16,235 | 13,323 | 0 | 2,992 | 6,548 | 5,364 | 6,281 | 0 |
| OTHER | PRIVATE | 16,136 | 11,443 | 15,898 | 12,962 | 0 | 5,765 | 5,886 | 11,060 | 7,266 | 0 |

FIGURE D-5 (cont.)

# VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP

The data in the following tables were compiled from FHWA's, Highway Statistics, 1982, the 1977 Census of Transportation Nationwide Personal Transportation Survey and Truck Inventory and User Survey, Truck Weight Studies for 1979 through 1982, and the 1977 ICC study, Empty/Loaded Truck Miles on Interstate Highways During 1976. These various sources were used to compile statistics felt to be reasonably representative for 1982. The data should be used only for comparative purposes and to provide rough estimates with which to gauge other data sources. The analyst should not be surprised to find values from any number of sources diverging from those shown in the tables.

There are twelve sets of tables; the first is national level, which includes all trucks used in interstate freight hauling; these are not included in the other regions because there is no good way of assigning them particular travel locations. The remaining eleven tables are for the various regions specified in the sixth column of the tables.

For each table, the first column discribes the vehicle type, the second column indicates the gross registered weight interval, the third shows fuel type, the fourth identifies the user groups, the fifth provides the principal commodity carried, the seventh through tenth show the fleet size, average miles per gallon, annual average miles per vehicle, and average tons carried per vehicle - adjusted for empty miles. The definitions of the table mnemonics are provided below.

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP

Key for Figure D-6

| Vehicle | Description |
|---|---|
| Small car | Automobiles with gross vehicle weight under 3000 pounds |
| Big car | All other automobiles |
| Cycle | Motorcycles and motorbikes |
| IC-Bus | Intercity bus |
| Trans-Bus | Transit bus |
| Other Bus | School buses and other buses |
| SU 2A 4T | Single-unit, two-axle, four-tire truck |
| SU 2A 6T | Single-unit, two-axle, six-tire truck |
| SU 3A | Single-unit, three-axle or more, truck |
| Comb 34A | Combination vehicle, three or four axle |
| Comb 56A | Combination, five or more axles |
| Doubles | Combination with two or more trailers or semi-trailers |

| Capacity | Definition |
|---|---|
| All | All weights of vehicle |
| 00-10 | Less than 10000 pounds gross vehicle weight (GVW) |
| LT 26 | Less than 26000 pounds GVW |
| GT 26 | Greater than 26000 pounds GVW |
| 26-33 | Between 26001 and 33000 pounds GVW |
| 33-55 | Between 33001 and 55000 pounds GVW |
| GT 55 | Greater than 55000 pounds GVW |
| | (Other weight groups are similarly defined) |

Key for Figure D-6 (cont.)

| User Group | Definition |
|---|---|
| HIGHINC | Households with annual incomes greater that $20000 (1977 $) |
| MIDINC | Households with income between $10001 and $20000 (1977 $) |
| LOWINC | Households with incomes of $10000 or less (1977 $) |
| TAXI | Taxi operators |
| PRIVATE | Private businesses or institutions |
| FED-GOV | Federal Government |
| S&L-GOV | State and Local Government |
| FHBUS | For-hire bus company |
| FARM | Farm or ranch |
| U, S & C | Utilities, Services, and Construction |
| LOCAL-FH | Local for-hire firms |
| IC-GEN | Intercity freight hauler, general freight |
| IC-SPEC | Intercity freight hauler, special commodities |
| IC-PRIV | Intercity freight hauler, private |
| OWNER-OP | Owner Operator |

Commodity descriptions are taken from the Truck Inventory and Use Survey categories. These tables are assembled from data intended to represent the national fleet profile. It may be necessary to gather data for State studies. The broad classifications used to describe these data lead to a large degree of ambiguity, therefore, they should be interpreted with care.

FIGURE D-6

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SMALL_CAR | | | | ALL | | 30,206,205 | 20.7 | 8,868 | 0.0 |
| SMALL_CAR | ALL | GAS | HIGHINC | ALL | | 7,837,508 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | MIDINC | ALL | | 10,017,300 | 20.4 | 9,114 | 0.0 |
| SMALL_CAR | ALL | GAS | LOWINC | ALL | | 7,017,105 | 20.0 | 7,159 | 0.0 |
| SMALL_CAR | ALL | GAS | TAXI | ALL | | 8,704 | 15.4 | 40,622 | 0.0 |
| SMALL_CAR | ALL | GAS | PRIVATE | ALL | | 4,498,060 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | FED_GOV | ALL | | 3,101 | 20.8 | 10,663 | 0.0 |
| SMALL_CAR | ALL | GAS | S&L_GOV | ALL | | 30,251 | 20.8 | 10,663 | 0.0 |
| SMALL_CAR | ALL | DIESEL | TAXI | ALL | | 1,523 | 24.8 | 42,826 | 0.0 |
| SMALL_CAR | ALL | DIESEL | PRIVATE | ALL | | 786,820 | 33.3 | 10,057 | 0.0 |
| SMALL_CAR | ALL | DIESEL | S&L_GOV | ALL | | 5,292 | 33.3 | 11,242 | 0.0 |
| BIG_CAR | | | | ALL | | 93,491,607 | 15.5 | 9,263 | 0.0 |
| BIG_CAR | ALL | GAS | HIGHINC | ALL | | 26,007,401 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | MIDINC | ALL | | 30,985,138 | 15.4 | 9,085 | 0.0 |
| BIG_CAR | ALL | GAS | LOWINC | ALL | | 20,410,790 | 15.3 | 7,122 | 0.0 |
| BIG_CAR | ALL | GAS | TAXI | ALL | | 209,019 | 15.4 | 40,622 | 0.0 |
| BIG_CAR | ALL | GAS | PRIVATE | ALL | | 14,006,188 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | FED_GOV | ALL | | 74,458 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | GAS | S&L_GOV | ALL | | 726,424 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | DIESEL | TAXI | ALL | | 14,925 | 24.8 | 42,826 | 0.0 |
| BIG_CAR | ALL | DIESEL | PRIVATE | ALL | | 1,000,079 | 24.8 | 10,803 | 0.0 |
| BIG_CAR | ALL | DIESEL | FED_GOV | ALL | | 5,317 | 24.8 | 11,242 | 0.0 |
| BIG_CAR | ALL | DIESEL | S&L_GOV | ALL | | 51,869 | 24.8 | 11,242 | 0.0 |
| CYCLE | | | | ALL | | 6,623,999 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | HIGHINC | ALL | | 2,714,561 | 50.0 | 2,013 | 0.0 |
| CYCLE | ALL | GAS | MIDINC | ALL | | 2,727,738 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | LOWINC | ALL | | 1,146,441 | 50.0 | 2,909 | 0.0 |
| CYCLE | ALL | GAS | S&L_GOV | ALL | | 34,928 | 50.0 | 2,279 | 0.0 |
| IC_BUS | | | | ALL | | 18,242 | 5.9 | 61,142 | 0.0 |
| IC_BUS | ALL | DIESEL | FHBUS | ALL | | 18,242 | 5.9 | 61,142 | 0.0 |
| TRANS_BUS | | | | ALL | | 47,306 | 3.8 | 35,910 | 0.0 |
| TRANS_BUS | ALL | DIESEL | FHBUS | ALL | | 47,306 | 3.8 | 35,910 | 0.0 |
| OTHER_BUS | | | | ALL | | 432,177 | 7.3 | 7,413 | 0.0 |
| OTHER_BUS | ALL | GAS | FHBUS | ALL | | 14,694 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | PRIVATE | ALL | | 139,724 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | FED_GOV | ALL | | 2,272 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | S&L_GOV | ALL | | 266,521 | 7.4 | 7,396 | 0.0 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| OTHER_BUS | ALL | DIESEL | FHBUS | ALL | | 8,967 | 7.2 | 8,238 | 0.0 |
| SU_2A_4T | | | | ALL | | 28,039,654 | 14.0 | 10,583 | 0.1 |
| SU_2A_4T | 00-10 | GAS | HIGHINC | ALL | | 5,726,856 | 14.4 | 11,161 | 0.0 |
| SU_2A_4T | 00-10 | GAS | MIDINC | ALL | | 8,285,220 | 14.7 | 10,375 | 0.0 |
| SU_2A_4T | 00-10 | GAS | LOWINC | ALL | | 5,098,573 | 14.7 | 8,358 | 0.0 |
| SU_2A_4T | 00-10 | GAS | FED_GOV | ALL | | 219,894 | 13.9 | 6,424 | 0.4 |
| SU_2A_4T | 00-10 | GAS | S&L_GOV | ALL | | 835,970 | 13.9 | 6,424 | 0.4 |
| SU_2A_4T | 00-10 | GAS | OTHER | ALL | | 7,397,593 | 12.7 | 12,031 | 0.4 |
| SU_2A_4T | 00-10 | DIESEL | HIGHINC | ALL | | 68,509 | 18.1 | 15,641 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | MIDINC | ALL | | 99,115 | 18.4 | 14,539 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | LOWINC | ALL | | 60,993 | 18.4 | 11,713 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | OTHER | ALL | | 246,930 | 15.8 | 21,164 | 0.5 |
| SU_2A_6T | | | | ALL | | 5,035,085 | 7.1 | 12,626 | 0.7 |
| SU_2A_6T | LT 26 | GAS | OTHER | ALL | | 4,109,845 | 7.4 | 11,535 | 0.4 |
| SU_2A_6T | LT 26 | DIESEL | FED_GOV | ALL | | 1,346 | 8.4 | 20,092 | 0.5 |
| SU_2A_6T | LT 26 | DIESEL | S&L_GOV | ALL | | 61,786 | 8.4 | 20,092 | 0.5 |
| SU_2A_6T | LT 26 | DIESEL | OTHER | ALL | | 48,782 | 10.9 | 22,821 | 0.4 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | ALL | | 127,136 | 5.1 | 16,432 | 1.6 |
| SU_2A_6T | GT 26 | GAS | FARM | ALL | | 176,091 | 6.1 | 5,564 | 1.9 |
| SU_2A_6T | GT 26 | GAS | U,S & C | ALL | | 64,669 | 5.1 | 11,502 | 1.9 |
| SU_2A_6T | GT 26 | GAS | LOCAL_FH | ALL | | 27,131 | 5.0 | 17,407 | 1.8 |
| SU_2A_6T | GT 26 | GAS | IC_SPEC | ALL | | 5,058 | 5.1 | 31,834 | 1.6 |
| SU_2A_6T | GT 26 | GAS | IC_PRIV | ALL | | 45,714 | 5.5 | 26,294 | 1.5 |
| SU_2A_6T | GT 26 | GAS | OWNER_OP | ALL | | 8,824 | 5.5 | 19,633 | 1.9 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | ALL | | 132,567 | 6.0 | 17,080 | 1.6 |
| SU_2A_6T | GT 26 | DIESEL | FARM | ALL | | 17,232 | 3.7 | 6,796 | 2.1 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | ALL | | 65,990 | 6.4 | 14,005 | 1.9 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | ALL | | 48,780 | 7.0 | 19,598 | 1.8 |
| SU_2A_6T | GT 26 | DIESEL | IC_GEN | ALL | | 3,860 | 7.0 | 44,187 | 1.9 |
| SU_2A_6T | GT 26 | DIESEL | IC_SPEC | ALL | | 11,528 | 6.0 | 46,025 | 1.7 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | ALL | | 68,264 | 7.5 | 38,634 | 1.6 |
| SU_2A_6T | GT 26 | DIESEL | OWNER_OP | ALL | | 8,033 | 6.7 | 30,715 | 2.2 |
| SU_3A | | | | ALL | | 961,636 | 5.0 | 19,042 | 4.3 |
| SU_3A | LT 26 | GAS | OTHER | ALL | | 181,867 | 6.6 | 11,635 | 1.9 |
| SU_3A | LT 26 | DIESEL | OTHER | ALL | | 3,092 | 7.2 | 27,025 | 2.4 |
| SU_3A | 26-33 | GAS | PRIVATE | ALL | | 6,944 | 5.0 | 13,646 | 2.8 |
| SU_3A | 26-33 | GAS | FARM | ALL | | 15,069 | 5.9 | 4,865 | 2.5 |
| SU_3A | 26-33 | GAS | U,S & C | ALL | | 5,301 | 4.5 | 11,877 | 3.0 |
| SU_3A | 26-33 | GAS | LOCAL_FH | ALL | | 2,493 | 5.4 | 15,521 | 2.3 |
| SU_3A | 26-33 | GAS | IC_PRIV | ALL | | 3,405 | 5.6 | 22,141 | 2.2 |
| SU_3A | 26-33 | DIESEL | PRIVATE | ALL | | 13,238 | 5.0 | 24,763 | 1.5 |
| SU_3A | 26-33 | DIESEL | FARM | ALL | | 6,100 | 5.5 | 9,780 | 3.0 |
| SU_3A | 26-33 | DIESEL | U,S & C | ALL | | 30,407 | 5.4 | 13,444 | 2.6 |
| SU_3A | 26-33 | DIESEL | LOCAL_FH | ALL | | 11,313 | 5.7 | 14,430 | 2.6 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_3A | 26-33 | DIESEL | IC_SPEC | ALL | | 3,521 | 5.2 | 25,853 | 2.1 |
| SU_3A | 26-33 | DIESEL | IC_PRIV | ALL | | 11,438 | 6.2 | 39,049 | 1.3 |
| SU_3A | 26-33 | DIESEL | OWNER_OP | ALL | | 2,980 | 6.3 | 21,384 | 2.4 |
| SU_3A | 33-55 | GAS | PRIVATE | ALL | | 10,515 | 4.0 | 15,155 | 2.9 |
| SU_3A | 33-55 | GAS | FARM | ALL | | 18,818 | 4.6 | 8,102 | 2.5 |
| SU_3A | 33-55 | GAS | U,S & C | ALL | | 12,609 | 4.0 | 15,033 | 4.0 |
| SU_3A | 33-55 | GAS | LOCAL_FH | ALL | | 6,008 | 4.3 | 21,554 | 3.6 |
| SU_3A | 33-55 | GAS | IC_PRIV | ALL | | 5,621 | 4.5 | 28,479 | 2.3 |
| SU_3A | 33-55 | GAS | OWNER_OP | ALL | | 2,977 | 3.9 | 24,448 | 3.8 |
| SU_3A | 33-55 | DIESEL | PRIVATE | ALL | | 38,671 | 5.1 | 18,241 | 3.1 |
| SU_3A | 33-55 | DIESEL | FARM | ALL | | 10,097 | 5.8 | 13,132 | 3.0 |
| SU_3A | 33-55 | DIESEL | FED_GOV | ALL | | 12,080 | 4.5 | 14,600 | 2.5 |
| SU_3A | 33-55 | DIESEL | S&L_GOV | ALL | | 105,868 | 4.5 | 14,600 | 2.5 |
| SU_3A | 33-55 | DIESEL | U,S & C | ALL | | 73,912 | 4.7 | 17,741 | 2.9 |
| SU_3A | 33-55 | DIESEL | LOCAL_FH | ALL | | 25,431 | 5.2 | 29,079 | 3.4 |
| SU_3A | 33-55 | DIESEL | IC_SPEC | ALL | | 4,378 | 5.7 | 39,766 | 2.9 |
| SU_3A | 33-55 | DIESEL | IC_PRIV | ALL | | 20,806 | 5.6 | 38,318 | 2.4 |
| SU_3A | 33-55 | DIESEL | OWNER_OP | ALL | | 11,451 | 5.5 | 28,429 | 3.9 |
| SU_3A | GT 55 | GAS | PRIVATE | ALL | | 10,398 | 3.6 | 20,346 | 7.3 |
| SU_3A | GT 55 | GAS | FARM | ALL | | 17,870 | 5.0 | 3,318 | 6.0 |
| SU_3A | GT 55 | GAS | U,S & C | ALL | | 19,554 | 4.2 | 10,187 | 8.3 |
| SU_3A | GT 55 | GAS | LOCAL_FH | ALL | | 5,325 | 4.0 | 26,548 | 8.9 |
| SU_3A | GT 55 | GAS | IC_SPEC | ALL | | 1,652 | 4.1 | 26,822 | 6.1 |
| SU_3A | GT 55 | GAS | IC_PRIV | ALL | | 5,776 | 5.4 | 17,328 | 10.2 |
| SU_3A | GT 55 | GAS | OWNER_OP | ALL | | 7,393 | 3.8 | 19,338 | 9.1 |
| SU_3A | GT 55 | DIESEL | PRIVATE | ALL | | 39,521 | 4.5 | 19,926 | 7.6 |
| SU_3A | GT 55 | DIESEL | FARM | ALL | | 6,348 | 5.3 | 17,815 | 6.5 |
| SU_3A | GT 55 | DIESEL | U,S & C | ALL | | 74,707 | 4.7 | 15,460 | 7.4 |
| SU_3A | GT 55 | DIESEL | LOCAL_FH | ALL | | 35,128 | 5.0 | 26,886 | 8.9 |
| SU_3A | GT 55 | DIESEL | IC_GEN | ALL | | 4,543 | 4.8 | 78,155 | 5.4 |
| SU_3A | GT 55 | DIESEL | IC_SPEC | ALL | | 15,004 | 4.8 | 55,499 | 4.9 |
| SU_3A | GT 55 | DIESEL | IC_EXEMP | ALL | | 2,433 | 4.9 | 66,596 | 4.0 |
| SU_3A | GT 55 | DIESEL | IC_PRIV | ALL | | 23,473 | 5.2 | 41,976 | 5.4 |
| SU_3A | GT 55 | DIESEL | OWNER_OP | ALL | | 31,797 | 4.7 | 33,015 | 7.3 |
| | | | | | | | | | |
| COMB_34A | | | | ALL | | 412,047 | 5.3 | 31,006 | 3.1 |
| COMB_34A | LT 33 | GAS | PRIVATE | ALL | | 2,116 | 5.3 | 14,561 | 2.0 |
| COMB_34A | LT 33 | GAS | FARM | ALL | | 1,845 | 7.4 | 8,459 | 2.5 |
| COMB_34A | LT 33 | GAS | U,S & C | ALL | | 1,416 | 6.1 | 8,809 | 2.3 |
| COMB_34A | LT 33 | GAS | LOCAL_FH | ALL | | 3,008 | 4.9 | 16,888 | 1.6 |
| COMB_34A | LT 33 | GAS | IC_PRIV | ALL | | 1,657 | 5.5 | 23,538 | 1.9 |
| COMB_34A | LT 33 | DIESEL | PRIVATE | ALL | | 4,376 | 7.9 | 17,682 | 1.9 |
| COMB_34A | LT 33 | DIESEL | FARM | ALL | | 4,417 | 6.8 | 8,850 | 1.9 |
| COMB_34A | LT 33 | DIESEL | U,S & C | ALL | | 3,779 | 7.1 | 7,227 | 2.7 |
| COMB_34A | LT 33 | DIESEL | LOCAL_FH | ALL | | 7,184 | 7.3 | 18,903 | 1.8 |
| COMB_34A | LT 33 | DIESEL | IC_GEN | ALL | | 1,699 | 7.1 | 74,951 | 1.4 |
| COMB_34A | LT 33 | DIESEL | IC_SPEC | ALL | | 1,450 | 6.9 | 43,812 | 2.6 |
| COMB_34A | LT 33 | DIESEL | IC_PRIV | ALL | | 12,731 | 7.3 | 55,264 | 1.8 |
| COMB_34A | LT 33 | DIESEL | OWNER_OP | ALL | | 3,083 | 3.6 | 43,865 | 2.1 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| COMB_34A | 33-55 | GAS | PRIVATE | ALL | | 4,734 | 4.1 | 14,186 | 2.5 |
| COMB_34A | 33-55 | GAS | FARM | ALL | | 1,862 | 5.6 | 7,002 | 3.1 |
| COMB_34A | 33-55 | GAS | U,S & C | ALL | | 1,821 | 4.8 | 7,361 | 2.8 |
| COMB_34A | 33-55 | GAS | LOCAL_FH | ALL | | 10,941 | 4.1 | 17,371 | 2.5 |
| COMB_34A | 33-55 | GAS | IC_PRIV | ALL | | 3,037 | 4.7 | 21,128 | 2.7 |
| COMB_34A | 33-55 | GAS | OWNER_OP | ALL | | 1,010 | 4.9 | 26,270 | 2.6 |
| COMB_34A | 33-55 | DIESEL | PRIVATE | ALL | | 11,573 | 5.6 | 22,856 | 2.6 |
| COMB_34A | 33-55 | DIESEL | FARM | ALL | | 2,125 | 5.1 | 23,159 | 1.8 |
| COMB_34A | 33-55 | DIESEL | S&L_GOV | ALL | | 24,650 | 5.0 | 13,419 | 2.1 |
| COMB_34A | 33-55 | DIESEL | U,S & C | ALL | | 4,038 | 5.8 | 10,038 | 3.3 |
| COMB_34A | 33-55 | DIESEL | LOCAL_FH | ALL | | 21,972 | 5.3 | 20,025 | 2.6 |
| COMB_34A | 33-55 | DIESEL | IC_GEN | ALL | | 5,132 | 5.7 | 41,525 | 2.7 |
| COMB_34A | 33-55 | DIESEL | IC_SPEC | ALL | | 10,921 | 5.4 | 51,067 | 2.6 |
| COMB_34A | 33-55 | DIESEL | IC_PRIV | ALL | | 22,302 | 5.6 | 53,965 | 2.5 |
| COMB_34A | 33-55 | DIESEL | OWNER_OP | ALL | | 9,131 | 4.8 | 54,124 | 3.2 |
| COMB_34A | GT 55 | GAS | PRIVATE | ALL | | 3,150 | 4.5 | 12,720 | 4.1 |
| COMB_34A | GT 55 | GAS | FARM | ALL | | 2,068 | 5.1 | 8,069 | 4.3 |
| COMB_34A | GT 55 | GAS | U,S & C | ALL | | 1,308 | 5.1 | 11,088 | 4.8 |
| COMB_34A | GT 55 | GAS | LOCAL_FH | ALL | | 4,765 | 3.1 | 14,312 | 3.5 |
| COMB_34A | GT 55 | GAS | IC_PRIV | ALL | | 2,782 | 4.9 | 25,573 | 3.5 |
| COMB_34A | GT 55 | DIESEL | PRIVATE | ALL | | 13,285 | 5.2 | 27,111 | 4.2 |
| COMB_34A | GT 55 | DIESEL | FARM | ALL | | 5,653 | 4.9 | 17,966 | 4.7 |
| COMB_34A | GT 55 | DIESEL | FED_GOV | ALL | | 3,452 | 5.1 | 13,497 | 3.4 |
| COMB_34A | GT 55 | DIESEL | S&L_GOV | ALL | | 78,619 | 5.1 | 13,497 | 3.4 |
| COMB_34A | GT 55 | DIESEL | U,S & C | ALL | | 4,847 | 5.9 | 15,066 | 5.2 |
| COMB_34A | GT 55 | DIESEL | LOCAL_FH | ALL | | 19,655 | 5.3 | 25,210 | 4.1 |
| COMB_34A | GT 55 | DIESEL | IC_GEN | ALL | | 9,096 | 5.3 | 65,062 | 3.6 |
| COMB_34A | GT 55 | DIESEL | IC_SPEC | ALL | | 20,099 | 5.9 | 60,143 | 3.7 |
| COMB_34A | GT 55 | DIESEL | IC_EXEMP | ALL | | 3,275 | 4.8 | 59,764 | 3.4 |
| COMB_34A | GT 55 | DIESEL | IC_PRIV | ALL | | 38,801 | 5.1 | 56,925 | 3.6 |
| COMB_34A | GT 55 | DIESEL | OWNER_OP | ALL | | 10,816 | 5.1 | 50,405 | 3.9 |
| | | | | | | | | | |
| COMB_56A | | | | ALL | | 750,091 | 4.7 | 56,522 | 7.4 |
| COMB_56A | LT 55 | GAS | PRIVATE | ALL | | 1,289 | 4.1 | 16,062 | 4.8 |
| COMB_56A | LT 55 | GAS | FARM | ALL | | 1,169 | 4.9 | 6,375 | 6.4 |
| COMB_56A | LT 55 | GAS | LOCAL_FH | ALL | | 1,013 | 4.2 | 15,059 | 5.7 |
| COMB_56A | LT 55 | GAS | IC_PRIV | ALL | | 1,446 | 4.8 | 22,663 | 5.8 |
| COMB_56A | LT 55 | DIESEL | PRIVATE | ALL | | 7,633 | 4.9 | 22,362 | 6.4 |
| COMB_56A | LT 55 | DIESEL | FARM | ALL | | 3,495 | 5.3 | 10,800 | 5.9 |
| COMB_56A | LT 55 | DIESEL | U,S & C | ALL | | 6,259 | 5.1 | 13,852 | 6.4 |
| COMB_56A | LT 55 | DIESEL | LOCAL_FH | ALL | | 7,028 | 4.9 | 27,687 | 5.5 |
| COMB_56A | LT 55 | DIESEL | IC_GEN | ALL | | 2,117 | 4.7 | 53,163 | 5.2 |
| COMB_56A | LT 55 | DIESEL | IC_SPEC | ALL | | 6,989 | 4.8 | 66,888 | 5.2 |
| COMB_56A | LT 55 | DIESEL | IC_EXEMP | ALL | | 4,165 | 4.9 | 98,762 | 5.4 |
| COMB_56A | LT 55 | DIESEL | IC_PRIV | ALL | | 18,752 | 4.9 | 54,732 | 5.9 |
| COMB_56A | LT 55 | DIESEL | OWNER_OP | ALL | | 11,550 | 4.6 | 62,761 | 5.5 |
| COMB_56A | GT 55 | GAS | PRIVATE | ALL | | 1,981 | 4.2 | 12,187 | 7.5 |
| COMB_56A | GT 55 | GAS | FARM | ALL | | 1,146 | 4.1 | 4,020 | 7.6 |
| COMB_56A | GT 55 | GAS | U,S & C | ALL | | 1,556 | 4.5 | 11,256 | 8.5 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| COMB_56A | GT 55 | GAS | LOCAL_FH | ALL | | 3,045 | 3.7 | 19,698 | 7.2 |
| COMB_56A | GT 55 | GAS | IC_PRIV | ALL | | 3,186 | 3.5 | 23,676 | 7.5 |
| COMB_56A | GT 55 | DIESEL | PRIVATE | ALL | | 31,876 | 4.8 | 35,794 | 7.9 |
| COMB_56A | GT 55 | DIESEL | FARM | ALL | | 9,849 | 4.9 | 20,454 | 8.1 |
| COMB_56A | GT 55 | DIESEL | S&L_GOV | ALL | | 94,104 | 4.7 | 13,497 | 7.3 |
| COMB_56A | GT 55 | DIESEL | U.S & C | ALL | | 33,333 | 4.8 | 22,401 | 9.2 |
| COMB_56A | GT 55 | DIESEL | LOCAL_FH | ALL | | 43,948 | 4.7 | 33,720 | 7.7 |
| COMB_56A | GT 55 | DIESEL | IC_GEN | ALL | | 50,075 | 4.8 | 102,714 | 8.2 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | ALL | | 119,008 | 4.8 | 74,468 | 7.3 |
| COMB_56A | GT 55 | DIESEL | IC_EXEMP | ALL | | 32,641 | 4.6 | 80,602 | 7.5 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | ALL | | 149,432 | 4.7 | 66,198 | 7.4 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | ALL | | 97,729 | 4.5 | 75,829 | 7.6 |
| DOUBLES | | | | ALL | | 47,262 | 4.6 | 62,452 | 8.8 |
| DOUBLES | LT 55 | DIESEL | LOCAL_FH | ALL | | 1,091 | 4.4 | 28,347 | 8.4 |
| DOUBLES | LT 55 | DIESEL | IC_PRIV | ALL | | 1,188 | 4.5 | 49,002 | 7.1 |
| DOUBLES | GT 55 | DIESEL | PRIVATE | ALL | | 2,444 | 5.1 | 46,643 | 8.2 |
| DOUBLES | GT 55 | DIESEL | FARM | ALL | | 1,447 | 5.1 | 17,406 | 9.7 |
| DOUBLES | GT 55 | DIESEL | U.S & C | ALL | | 1,304 | 4.8 | 47,746 | 9.6 |
| DOUBLES | GT 55 | DIESEL | LOCAL_FH | ALL | | 5,443 | 4.6 | 32,964 | 8.7 |
| DOUBLES | GT 55 | DIESEL | IC_GEN | ALL | | 6,412 | 4.2 | 115,683 | 8.4 |
| DOUBLES | GT 55 | DIESEL | IC_SPEC | ALL | | 9,152 | 4.7 | 60,799 | 8.9 |
| DOUBLES | GT 55 | DIESEL | IC_EXEMP | ALL | | 5,135 | 4.9 | 81,317 | 9.7 |
| DOUBLES | GT 55 | DIESEL | IC_PRIV | ALL | | 6,937 | 4.8 | 60,928 | 8.6 |
| DOUBLES | GT 55 | DIESEL | OWNER_OP | ALL | | 1,810 | 4.5 | 50,773 | 9.4 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SMALL_CAR | | | | ALL | NEW_ENGL | 1,753,135 | 20.7 | 8,867 | 0.0 |
| SMALL_CAR | ALL | GAS | HIGHINC | PERSONAL | NEW_ENGL | 455,085 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | MIDINC | PERSONAL | NEW_ENGL | 581,654 | 20.4 | 9,114 | 0.0 |
| SMALL_CAR | ALL | GAS | LOWINC | PERSONAL | NEW_ENGL | 407,448 | 20.0 | 7,159 | 0.0 |
| SMALL_CAR | ALL | GAS | PRIVATE | NON_FRGT | NEW_ENGL | 261,180 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | S&L_GOV | NON_FRGT | NEW_ENGL | 1,135 | 20.8 | 10,663 | 0.0 |
| SMALL_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | NEW_ENGL | 45,687 | 33.3 | 10,050 | 0.0 |
| BIG_CAR | | | | ALL | NEW_ENGL | 5,411,336 | 15.5 | 9,258 | 0.0 |
| BIG_CAR | ALL | GAS | HIGHINC | PERSONAL | NEW_ENGL | 1,510,119 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | MIDINC | PERSONAL | NEW_ENGL | 1,799,152 | 15.4 | 9,085 | 0.0 |
| BIG_CAR | ALL | GAS | LOWINC | PERSONAL | NEW_ENGL | 1,185,152 | 15.3 | 7,122 | 0.0 |
| BIG_CAR | ALL | GAS | TAXI | NON_FRGT | NEW_ENGL | 12,137 | 15.4 | 40,622 | 0.0 |
| BIG_CAR | ALL | GAS | PRIVATE | NON_FRGT | NEW_ENGL | 813,269 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | FED_GOV | NON_FRGT | NEW_ENGL | 3,144 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | GAS | S&L_GOV | NON_FRGT | NEW_ENGL | 27,256 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | NEW_ENGL | 58,070 | 24.8 | 10,803 | 0.0 |
| BIG_CAR | ALL | DIESEL | S&L_GOV | NON_FRGT | NEW_ENGL | 1,946 | 24.8 | 11,242 | 0.0 |
| CYCLE | | | | ALL | NEW_ENGL | 400,820 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | HIGHINC | PERSONAL | NEW_ENGL | 164,942 | 50.0 | 2,013 | 0.0 |
| CYCLE | ALL | GAS | MIDINC | PERSONAL | NEW_ENGL | 165,742 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | LOWINC | PERSONAL | NEW_ENGL | 69,660 | 50.0 | 2,908 | 0.0 |
| IC_BUS | | | | ALL | NEW_ENGL | 1,177 | 5.9 | 61,142 | 0.0 |
| IC_BUS | ALL | DIESEL | FHBUS | NON_FRGT | NEW_ENGL | 1,177 | 5.9 | 61,142 | 0.0 |
| TRANS_BUS | | | | ALL | NEW_ENGL | 3,052 | 3.8 | 35,910 | 0.0 |
| TRANS_BUS | ALL | DIESEL | FHBUS | NON_FRGT | NEW_ENGL | 3,052 | 3.8 | 35,910 | 0.0 |
| OTHER_BUS | | | | ALL | NEW_ENGL | 19,748 | 7.3 | 7,424 | 0.0 |
| OTHER_BUS | ALL | GAS | PRIVATE | NON_FRGT | NEW_ENGL | 14,689 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | S&L_GOV | NON_FRGT | NEW_ENGL | 3,771 | 7.4 | 7,396 | 0.0 |
| SU_2A_4T | | | | ALL | NEW_ENGL | 874,355 | 13.1 | 10,889 | 0.0 |
| SU_2A_4T | 00-10 | GAS | HIGHINC | PERSONAL | NEW_ENGL | 173,864 | 13.3 | 11,564 | 0.0 |
| SU_2A_4T | 00-10 | GAS | MIDINC | PERSONAL | NEW_ENGL | 251,534 | 13.5 | 10,750 | 0.0 |
| SU_2A_4T | 00-10 | GAS | LOWINC | PERSONAL | NEW_ENGL | 154,789 | 13.5 | 8,660 | 0.0 |
| SU_2A_4T | 00-10 | GAS | FED_GOV | NON_FRGT | NEW_ENGL | 10,251 | 13.9 | 6,424 | 0.1 |
| SU_2A_4T | 00-10 | GAS | S&L_GOV | NON_FRGT | NEW_ENGL | 42,992 | 13.9 | 6,424 | 0.1 |
| SU_2A_4T | 00-10 | GAS | OTHER | ALL | NEW_ENGL | 235,810 | 12.4 | 13,028 | 0.1 |

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_2A_4T | 00-10 | DIESEL | OTHER | ALL | NEW_ENGL | 4,607 | 16.2 | 10,137 | 0.1 |
| SU_2A_6T | | | | ALL | NEW_ENGL | 208,067 | 6.0 | 11,929 | 0.8 |
| SU_2A_6T | LT 26 | GAS | OTHER | ALL | NEW_ENGL | 153,115 | 6.7 | 10,752 | 0.4 |
| SU_2A_6T | LT 26 | DIESEL | S&L_GOV | NON_FRGT | NEW_ENGL | 3,178 | 8.4 | 20,092 | 0.5 |
| SU_2A_6T | LT 26 | DIESEL | OTHER | ALL | NEW_ENGL | 5,087 | 8.8 | 10,909 | 0.4 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FOOD | NEW_ENGL | 2,178 | 3.8 | 16,415 | 1.5 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | PETROLEUM | NEW_ENGL | 2,704 | 3.8 | 12,416 | 1.8 |
| SU_2A_6T | GT 26 | GAS | FARM | FARM | NEW_ENGL | 1,095 | 5.5 | 10,497 | 1.8 |
| SU_2A_6T | GT 26 | GAS | U,S & C | BUILDING | NEW_ENGL | 2,707 | 5.4 | 11,553 | 2.3 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | FOOD | NEW_ENGL | 1,468 | 2.3 | 21,535 | 1.4 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | PETROLEUM | NEW_ENGL | 9,241 | 4.9 | 10,891 | 2.0 |
| SU_2A_6T | GT 26 | DIESEL | FARM | FARM | NEW_ENGL | 1,134 | 1.1 | 17,397 | 1.8 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | BUILDING | NEW_ENGL | 4,111 | 6.4 | 9,223 | 2.5 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | NON_FRGT | NEW_ENGL | 1,693 | 5.7 | 14,335 | 1.8 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | MIXED | NEW_ENGL | 1,722 | 8.2 | 23,826 | 1.6 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | NON_FRGT | NEW_ENGL | 1,055 | 9.6 | 20,202 | 1.5 |
| SU_3A | | | | ALL | NEW_ENGL | 49,707 | 5.4 | 18,775 | 6.2 |
| SU_3A | LT 26 | GAS | OTHER | ALL | NEW_ENGL | 7,252 | 10.7 | 34,373 | 3.2 |
| SU_3A | 26-33 | DIESEL | PRIVATE | PETROLEUM | NEW_ENGL | 1,038 | 8.0 | 10,995 | 3.7 |
| SU_3A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | NEW_ENGL | 5,445 | 4.5 | 14,600 | 3.9 |
| SU_3A | 33-55 | DIESEL | U,S & C | BUILDING | NEW_ENGL | 1,032 | 5.7 | 15,939 | 6.1 |
| SU_3A | GT 55 | GAS | U,S & C | BUILDING | NEW_ENGL | 1,216 | 4.5 | 8,947 | 11.2 |
| SU_3A | GT 55 | DIESEL | U,S & C | BUILDING | NEW_ENGL | 8,885 | 5.3 | 12,953 | 9.9 |
| SU_3A | GT 55 | DIESEL | LOCAL_FH | BUILDING | NEW_ENGL | 2,260 | 6.4 | 16,191 | 10.9 |
| SU_3A | GT 55 | DIESEL | IC_PRIV | BUILDING | NEW_ENGL | 1,694 | 5.2 | 13,959 | 9.8 |
| SU_3A | GT 55 | DIESEL | OWNER_OP | BUILDING | NEW_ENGL | 3,197 | 4.5 | 12,934 | 10.8 |
| COMB_34A | | | | ALL | NEW_ENGL | 17,589 | 5.2 | 28,559 | 3.0 |
| COMB_34A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | NEW_ENGL | 2,855 | 5.1 | 13,497 | 3.2 |
| COMB_34A | GT 55 | DIESEL | LOCAL_FH | MIXED | NEW_ENGL | 2,293 | 5.4 | 23,754 | 3.2 |
| COMB_56A | | | | ALL | NEW_ENGL | 23,950 | 4.4 | 39,628 | 7.6 |
| COMB_56A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | NEW_ENGL | 3,417 | 4.7 | 13,497 | 7.4 |
| COMB_56A | GT 55 | DIESEL | U,S & C | BUILDING | NEW_ENGL | 7,273 | 4.2 | 12,076 | 9.6 |
| COMB_56A | GT 55 | DIESEL | IC_GEN | MIXED | NEW_ENGL | 1,248 | 4.8 | 103,152 | 8.1 |
| DOUBLES | | | | ALL | NEW_ENGL | 120 | 4.6 | 92,068 | 11.2 |

FIGURE D-6 (cont.)

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SMALL_CAR | | | | ALL | MID_ATL | 4,099,816 | 20.7 | 8,868 | 0.0 |
| SMALL_CAR | ALL | GAS | HIGHINC | PERSONAL | MID_ATL | 1,063,717 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | MIDINC | PERSONAL | MID_ATL | 1,359,562 | 20.4 | 9,114 | 0.0 |
| SMALL_CAR | ALL | GAS | LOWINC | PERSONAL | MID_ATL | 952,371 | 20.0 | 7,159 | 0.0 |
| SMALL_CAR | ALL | GAS | TAXI | NON_FRGT | MID_ATL | 1,181 | 15.4 | 40,622 | 0.0 |
| SMALL_CAR | ALL | GAS | PRIVATE | NON_FRGT | MID_ATL | 610,483 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | S&L_GOV | NON_FRGT | MID_ATL | 4,267 | 20.8 | 10,663 | 0.0 |
| SMALL_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | MID_ATL | 106,788 | 33.3 | 10,059 | 0.0 |
| BIG_CAR | | | | ALL | MID_ATL | 12,692,937 | 15.5 | 9,263 | 0.0 |
| BIG_CAR | ALL | GAS | HIGHINC | PERSONAL | MID_ATL | 3,529,760 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | MIDINC | PERSONAL | MID_ATL | 4,205,345 | 15.4 | 9,085 | 0.0 |
| BIG_CAR | ALL | GAS | LOWINC | PERSONAL | MID_ATL | 2,770,180 | 15.3 | 7,122 | 0.0 |
| BIG_CAR | ALL | GAS | TAXI | NON_FRGT | MID_ATL | 28,368 | 15.4 | 40,622 | 0.0 |
| BIG_CAR | ALL | GAS | PRIVATE | NON_FRGT | MID_ATL | 1,900,939 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | FED_GOV | NON_FRGT | MID_ATL | 10,095 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | GAS | S&L_GOV | NON_FRGT | MID_ATL | 102,455 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | DIESEL | TAXI | NON_FRGT | MID_ATL | 2,026 | 24.8 | 42,826 | 0.0 |
| BIG_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | MID_ATL | 135,732 | 24.8 | 10,803 | 0.0 |
| BIG_CAR | ALL | DIESEL | S&L_GOV | NON_FRGT | MID_ATL | 7,316 | 24.8 | 11,242 | 0.0 |
| CYCLE | | | | ALL | MID_ATL | 592,634 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | HIGHINC | PERSONAL | MID_ATL | 242,448 | 50.0 | 2,013 | 0.0 |
| CYCLE | ALL | GAS | MIDINC | PERSONAL | MID_ATL | 243,625 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | LOWINC | PERSONAL | MID_ATL | 102,393 | 50.0 | 2,908 | 0.0 |
| CYCLE | ALL | GAS | S&L_GOV | NON_FRGT | MID_ATL | 4,156 | 50.0 | 2,279 | 0.0 |
| IC_BUS | | | | ALL | MID_ATL | 4,177 | 5.9 | 61,142 | 0.0 |
| IC_BUS | ALL | DIESEL | FHBUS | NON_FRGT | MID_ATL | 4,177 | 5.9 | 61,142 | 0.0 |
| TRANS_BUS | | | | ALL | MID_ATL | 19,833 | 3.8 | 35,910 | 0.0 |
| TRANS_BUS | ALL | DIESEL | FHBUS | NON_FRGT | MID_ATL | 19,833 | 3.8 | 35,910 | 0.0 |
| OTHER_BUS | | | | ALL | MID_ATL | 51,936 | 7.3 | 7,441 | 0.0 |
| OTHER_BUS | ALL | GAS | FHBUS | NON_FRGT | MID_ATL | 1,857 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | PRIVATE | NON_FRGT | MID_ATL | 25,027 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | S&L_GOV | NON_FRGT | MID_ATL | 22,170 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | DIESEL | FHBUS | NON_FRGT | MID_ATL | 2,796 | 7.2 | 8,238 | 0.0 |
| SU_2A_4T | | | | ALL | MID_ATL | 2,058,686 | 13.7 | 9,757 | 0.1 |
| SU_2A_4T | 00-10 | GAS | HIGHINC | PERSONAL | MID_ATL | 405,367 | 14.5 | 10,689 | 0.0 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_2A_4T | 00-10 | GAS | MIDINC | PERSONAL | MID_ATL | 586,457 | 14.8 | 9,936 | 0.0 |
| SU_2A_4T | 00-10 | GAS | LOWINC | PERSONAL | MID_ATL | 360,895 | 14.8 | 8,004 | 0.0 |
| SU_2A_4T | 00-10 | GAS | FED_GOV | NON_FRGT | MID_ATL | 26,126 | 13.9 | 6,424 | 0.2 |
| SU_2A_4T | 00-10 | GAS | S&L_GOV | NON_FRGT | MID_ATL | 122,064 | 13.9 | 6,424 | 0.2 |
| SU_2A_4T | 00-10 | GAS | OTHER | ALL | MID_ATL | 555,888 | 11.8 | 10,909 | 0.2 |
| SU_2A_4T | 00-10 | DIESEL | OTHER | ALL | MID_ATL | 1,137 | 12.0 | 18,430 | 0.2 |
| SU_2A_6T | | | | ALL | MID_ATL | 522,756 | 6.9 | 12,774 | 0.8 |
| SU_2A_6T | LT 26 | GAS | OTHER | ALL | MID_ATL | 391,405 | 7.2 | 11,575 | 0.4 |
| SU_2A_6T | LT 26 | DIESEL | S&L_GOV | NON_FRGT | MID_ATL | 9,022 | 8.4 | 20,092 | 0.5 |
| SU_2A_6T | LT 26 | DIESEL | OTHER | ALL | MID_ATL | 1,848 | 9.4 | 16,212 | 0.4 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FARM | MID_ATL | 1,498 | 5.2 | 15,642 | 1.4 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FOOD | MID_ATL | 6,007 | 4.9 | 14,664 | 1.4 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | BUILDING | MID_ATL | 1,232 | 5.9 | 12,759 | 2.2 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | PETROLEUM | MID_ATL | 4,108 | 4.4 | 9,903 | 1.9 |
| SU_2A_6T | GT 26 | GAS | FARM | FARM | MID_ATL | 6,297 | 5.7 | 9,132 | 1.8 |
| SU_2A_6T | GT 26 | GAS | U.S & C | BUILDING | MID_ATL | 4,035 | 5.3 | 8,422 | 2.5 |
| SU_2A_6T | GT 26 | GAS | U.S & C | NON_FRGT | MID_ATL | 3,494 | 4.7 | 10,483 | 1.5 |
| SU_2A_6T | GT 26 | GAS | LOCAL_FH | MIXED | MID_ATL | 1,171 | 4.9 | 15,954 | 1.7 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | FARM | MID_ATL | 1,987 | 5.7 | 27,912 | 1.2 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | FOOD | MID_ATL | 11,997 | 6.4 | 16,484 | 1.3 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | BUILDING | MID_ATL | 3,676 | 6.8 | 19,429 | 2.0 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | PAPER | MID_ATL | 2,902 | 7.9 | 14,266 | 1.5 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | CHEMICAL | MID_ATL | 1,296 | 7.3 | 17,416 | 1.5 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | PETROLEUM | MID_ATL | 14,263 | 6.6 | 16,970 | 1.9 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | MACHINERY | MID_ATL | 1,525 | 7.4 | 17,514 | 1.7 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | NON_FRGT | MID_ATL | 1,532 | 9.2 | 2,131 | 2.3 |
| SU_2A_6T | GT 26 | DIESEL | FARM | CHEMICAL | MID_ATL | 1,054 | 6.9 | 6,302 | 1.8 |
| SU_2A_6T | GT 26 | DIESEL | U.S & C | BUILDING | MID_ATL | 3,865 | 8.7 | 6,420 | 2.4 |
| SU_2A_6T | GT 26 | DIESEL | U.S & C | NON_FRGT | MID_ATL | 4,242 | 6.1 | 16,664 | 2.1 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | FOOD | MID_ATL | 2,773 | 8.8 | 10,751 | 1.5 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | PAPER | MID_ATL | 1,405 | 11.3 | 19,472 | 1.7 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | MIXED | MID_ATL | 6,498 | 6.8 | 12,562 | 1.6 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | FARM | MID_ATL | 1,553 | 6.9 | 34,213 | 1.8 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | FOOD | MID_ATL | 1,632 | 7.9 | 42,754 | 1.2 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | BUILDING | MID_ATL | 1,002 | 5.8 | 47,349 | 1.8 |
| SU_2A_6T | GT 26 | DIESEL | OWNER_OP | HHG | MID_ATL | 1,111 | 9.2 | 22,788 | 1.5 |
| SU_3A | | | | ALL | MID_ATL | 106,446 | 4.7 | 19,235 | 6.8 |
| SU_3A | LT 26 | GAS | OTHER | ALL | MID_ATL | 11,950 | 7.4 | 10,961 | 2.8 |
| SU_3A | 26-33 | DIESEL | LOCAL_FH | NON_FRGT | MID_ATL | 1,251 | 8.1 | 1,206 | 3.8 |
| SU_3A | 33-55 | DIESEL | PRIVATE | FOOD | MID_ATL | 1,871 | 6.2 | 29,931 | 3.2 |
| SU_3A | 33-55 | DIESEL | PRIVATE | BUILDING | MID_ATL | 1,053 | 5.9 | 17,795 | 4.6 |
| SU_3A | 33-55 | DIESEL | FED_GOV | NON_FRGT | MID_ATL | 1,281 | 4.5 | 14,600 | 4.1 |
| SU_3A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | MID_ATL | 15,458 | 4.5 | 14,600 | 4.1 |
| SU_3A | 33-55 | DIESEL | U.S & C | BUILDING | MID_ATL | 2,582 | 6.2 | 11,194 | 6.4 |
| SU_3A | 33-55 | DIESEL | U.S & C | NON_FRGT | MID_ATL | 3,331 | 4.7 | 16,319 | 4.1 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_3A | 33-55 | DIESEL | OWNER_OP | BUILDING | MID_ATL | 1,015 | 5.4 | 21,616 | 6.8 |
| SU_3A | GT 55 | GAS | PRIVATE | MINING | MID_ATL | 2,107 | 2.4 | 19,429 | 11.4 |
| SU_3A | GT 55 | GAS | U,S & C | BUILDING | MID_ATL | 3,789 | 4.4 | 6,546 | 9.9 |
| SU_3A | GT 55 | DIESEL | PRIVATE | BUILDING | MID_ATL | 2,394 | 4.2 | 11,828 | 9.3 |
| SU_3A | GT 55 | DIESEL | PRIVATE | PETROLEUM | MID_ATL | 2,203 | 4.3 | 19,743 | 7.5 |
| SU_3A | GT 55 | DIESEL | PRIVATE | NON_FRGT | MID_ATL | 1,060 | 4.1 | 6,762 | 8.6 |
| SU_3A | GT 55 | DIESEL | U,S & C | BUILDING | MID_ATL | 10,345 | 4.4 | 12,378 | 9.4 |
| SU_3A | GT 55 | DIESEL | U,S & C | NON_FRGT | MID_ATL | 1,530 | 5.3 | 13,254 | 8.0 |
| SU_3A | GT 55 | DIESEL | LOCAL_FH | FARM | MID_ATL | 1,256 | 6.3 | 65,652 | 9.5 |
| SU_3A | GT 55 | DIESEL | LOCAL_FH | MINING | MID_ATL | 1,763 | 4.9 | 31,616 | 11.4 |
| SU_3A | GT 55 | DIESEL | LOCAL_FH | BUILDING | MID_ATL | 2,996 | 5.1 | 22,632 | 10.6 |
| SU_3A | GT 55 | DIESEL | IC_PRIV | BUILDING | MID_ATL | 1,188 | 4.9 | 19,329 | 7.6 |
| SU_3A | GT 55 | DIESEL | OWNER_OP | MINING | MID_ATL | 3,944 | 4.5 | 36,958 | 11.0 |
| SU_3A | GT 55 | DIESEL | OWNER_OP | BUILDING | MID_ATL | 2,536 | 5.3 | 17,169 | 10.9 |
| | | | | | | | | | |
| COMB_34A | | | | ALL | MID_ATL | 42,989 | 5.3 | 31,176 | 3.1 |
| COMB_34A | 33-55 | GAS | LOCAL_FH | MIXED | MID_ATL | 1,084 | 3.7 | 17,323 | 2.6 |
| COMB_34A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | MID_ATL | 1,354 | 5.0 | 13,419 | 2.3 |
| COMB_34A | 33-55 | DIESEL | LOCAL_FH | MIXED | MID_ATL | 2,832 | 5.3 | 15,645 | 2.9 |
| COMB_34A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | MID_ATL | 4,319 | 5.1 | 13,497 | 3.5 |
| COMB_34A | GT 55 | DIESEL | LOCAL_FH | MIXED | MID_ATL | 3,316 | 5.2 | 26,648 | 3.5 |
| COMB_34A | GT 55 | DIESEL | IC_GEN | MIXED | MID_ATL | 1,390 | 5.3 | 65,139 | 3.6 |
| | | | | | | | | | |
| COMB_56A | | | | ALL | MID_ATL | 65,018 | 4.7 | 59,468 | 7.4 |
| COMB_56A | GT 55 | DIESEL | PRIVATE | PETROLEUM | MID_ATL | 1,497 | 4.8 | 29,785 | 7.6 |
| COMB_56A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | MID_ATL | 5,170 | 4.7 | 13,497 | 7.2 |
| COMB_56A | GT 55 | DIESEL | LOCAL_FH | MIXED | MID_ATL | 1,464 | 4.9 | 16,950 | 7.3 |
| COMB_56A | GT 55 | DIESEL | IC_GEN | MIXED | MID_ATL | 6,106 | 4.8 | 103,152 | 8.1 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | FOOD | MID_ATL | 1,580 | 4.5 | 87,514 | 6.2 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | BUILDING | MID_ATL | 1,861 | 5.1 | 71,769 | 8.0 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | CHEMICAL | MID_ATL | 1,003 | 5.0 | 72,695 | 9.0 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | PETROLEUM | MID_ATL | 1,626 | 4.9 | 72,446 | 7.8 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | MIXED | MID_ATL | 1,374 | 4.7 | 80,936 | 7.0 |
| COMB_56A | GT 55 | DIESEL | IC_EXEMP | FARM | MID_ATL | 1,131 | 4.9 | 79,625 | 7.5 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FOOD | MID_ATL | 2,922 | 4.6 | 66,972 | 6.4 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | BUILDING | MID_ATL | 1,320 | 4.4 | 56,221 | 7.9 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | CHEMICAL | MID_ATL | 1,356 | 5.1 | 60,543 | 7.2 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | PETROLEUM | MID_ATL | 1,658 | 5.0 | 75,753 | 8.3 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FARM | MID_ATL | 1,603 | 4.4 | 79,864 | 7.8 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FOOD | MID_ATL | 1,433 | 4.5 | 89,430 | 6.2 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | BUILDING | MID_ATL | 1,254 | 4.7 | 55,824 | 8.4 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | MIXED | MID_ATL | 1,926 | 4.6 | 71,563 | 7.7 |
| | | | | | | | | | |
| DOUBLES | | | | ALL | MID_ATL | 534 | 4.5 | 72,528 | 10.1 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SMALL_CAR | | | | ALL | SO_ATL | 1,773,908 | 20.7 | 8,869 | 0.0 |
| SMALL_CAR | ALL | GAS | HIGHINC | PERSONAL | SO_ATL | 459,266 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | MIDINC | PERSONAL | SO_ATL | 586,999 | 20.4 | 9,114 | 0.0 |
| SMALL_CAR | ALL | GAS | LOWINC | PERSONAL | SO_ATL | 411,192 | 20.0 | 7,159 | 0.0 |
| SMALL_CAR | ALL | GAS | PRIVATE | NON_FRGT | SO_ATL | 263,580 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | S&L_GOV | NON_FRGT | SO_ATL | 2,465 | 20.8 | 10,663 | 0.0 |
| SMALL_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | SO_ATL | 46,106 | 33.3 | 10,050 | 0.0 |
| BIG_CAR | | | | ALL | SO_ATL | 5,497,507 | 15.5 | 9,268 | 0.0 |
| BIG_CAR | ALL | GAS | HIGHINC | PERSONAL | SO_ATL | 1,523,995 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | MIDINC | PERSONAL | SO_ATL | 1,815,683 | 15.4 | 9,085 | 0.0 |
| BIG_CAR | ALL | GAS | LOWINC | PERSONAL | SO_ATL | 1,196,042 | 15.3 | 7,122 | 0.0 |
| BIG_CAR | ALL | GAS | TAXI | NON_FRGT | SO_ATL | 12,248 | 15.4 | 40,622 | 0.0 |
| BIG_CAR | ALL | GAS | PRIVATE | NON_FRGT | SO_ATL | 820,742 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | FED_GOV | NON_FRGT | SO_ATL | 5,517 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | GAS | S&L_GOV | NON_FRGT | SO_ATL | 59,183 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | SO_ATL | 58,603 | 24.8 | 10,803 | 0.0 |
| BIG_CAR | ALL | DIESEL | S&L_GOV | NON_FRGT | SO_ATL | 4,226 | 24.8 | 11,242 | 0.0 |
| CYCLE | | | | ALL | SO_ATL | 245,493 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | HIGHINC | PERSONAL | SO_ATL | 100,467 | 50.0 | 2,013 | 0.0 |
| CYCLE | ALL | GAS | MIDINC | PERSONAL | SO_ATL | 100,954 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | LOWINC | PERSONAL | SO_ATL | 42,430 | 50.0 | 2,908 | 0.0 |
| CYCLE | ALL | GAS | S&L_GOV | NON_FRGT | SO_ATL | 1,479 | 50.0 | 2,279 | 0.0 |
| IC_BUS | | | | ALL | SO_ATL | 1,544 | 5.9 | 61,142 | 0.0 |
| IC_BUS | ALL | DIESEL | FHBUS | NON_FRGT | SO_ATL | 1,544 | 5.9 | 61,142 | 0.0 |
| TRANS_BUS | | | | ALL | SO_ATL | 4,003 | 3.8 | 35,910 | 0.0 |
| TRANS_BUS | ALL | DIESEL | FHBUS | NON_FRGT | SO_ATL | 4,003 | 3.8 | 35,910 | 0.0 |
| OTHER_BUS | | | | ALL | SO_ATL | 25,585 | 7.3 | 7,411 | 0.0 |
| OTHER_BUS | ALL | GAS | PRIVATE | NON_FRGT | SO_ATL | 4,203 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | S&L_GOV | NON_FRGT | SO_ATL | 20,267 | 7.4 | 7,396 | 0.0 |
| SU_2A_4T | | | | ALL | SO_ATL | 1,280,119 | 14.6 | 10,414 | 0.0 |
| SU_2A_4T | 00-10 | GAS | HIGHINC | PERSONAL | SO_ATL | 290,803 | 14.9 | 11,355 | 0.0 |
| SU_2A_4T | 00-10 | GAS | MIDINC | PERSONAL | SO_ATL | 420,713 | 15.2 | 10,555 | 0.0 |
| SU_2A_4T | 00-10 | GAS | LOWINC | PERSONAL | SO_ATL | 258,899 | 15.2 | 8,503 | 0.0 |
| SU_2A_4T | 00-10 | GAS | FED_GOV | NON_FRGT | SO_ATL | 12,479 | 13.9 | 6,424 | 0.2 |
| SU_2A_4T | 00-10 | GAS | S&L_GOV | NON_FRGT | SO_ATL | 40,711 | 13.9 | 6,424 | 0.2 |

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_2A_4T | 00-10 | GAS | OTHER | ALL | SO_ATL | 245,005 | 12.9 | 11,993 | 0.2 |
| SU_2A_4T | 00-10 | DIESEL | HIGHINC | PERSONAL | SO_ATL | 2,065 | 19.5 | 4,914 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | MIDINC | PERSONAL | SO_ATL | 2,988 | 19.9 | 4,567 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | LOWINC | PERSONAL | SO_ATL | 1,839 | 19.9 | 3,680 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | OTHER | ALL | SO_ATL | 4,616 | 24.4 | 16,629 | 0.2 |
| SU_2A_6T | | | | ALL | SO_ATL | 293,964 | 7.8 | 13,233 | 0.7 |
| SU_2A_6T | LT 26 | GAS | OTHER | ALL | SO_ATL | 240,748 | 8.5 | 12,283 | 0.4 |
| SU_2A_6T | LT 26 | DIESEL | S&L_GOV | NON_FRGT | SO_ATL | 3,009 | 8.4 | 20,092 | 0.6 |
| SU_2A_6T | LT 26 | DIESEL | OTHER | ALL | SO_ATL | 2,001 | 9.3 | 23,754 | 0.4 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FOOD | SO_ATL | 3,807 | 5.2 | 16,094 | 1.6 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | PETROLEUM | SO_ATL | 1,591 | 5.0 | 17,789 | 2.1 |
| SU_2A_6T | GT 26 | GAS | FARM | FARM | SO_ATL | 7,351 | 6.8 | 4,073 | 2.2 |
| SU_2A_6T | GT 26 | GAS | U,S & C | BUILDING | SO_ATL | 2,421 | 5.1 | 11,290 | 2.3 |
| SU_2A_6T | GT 26 | GAS | U,S & C | NON_FRGT | SO_ATL | 1,259 | 5.1 | 12,317 | 1.9 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | FOOD | SO_ATL | 1,589 | 8.9 | 15,248 | 1.5 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | PETROLEUM | SO_ATL | 2,166 | 8.0 | 13,729 | 2.4 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | BUILDING | SO_ATL | 1,118 | 4.7 | 17,327 | 2.8 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | NON_FRGT | SO_ATL | 1,145 | 9.0 | 44,156 | 1.7 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | MIXED | SO_ATL | 3,662 | 3.5 | 14,949 | 1.7 |
| SU_3A | | | | ALL | SO_ATL | 55,599 | 4.9 | 20,356 | 7.0 |
| SU_3A | LT 26 | GAS | OTHER | ALL | SO_ATL | 3,776 | 6.6 | 10,613 | 2.4 |
| SU_3A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | SO_ATL | 5,156 | 4.5 | 14,600 | 3.7 |
| SU_3A | 33-55 | DIESEL | U,S & C | BUILDING | SO_ATL | 1,609 | 5.0 | 18,425 | 5.7 |
| SU_3A | GT 55 | GAS | U,S & C | BUILDING | SO_ATL | 1,014 | 3.3 | 7,943 | 8.6 |
| SU_3A | GT 55 | DIESEL | PRIVATE | MINING | SO_ATL | 1,127 | 6.5 | 16,391 | 10.7 |
| SU_3A | GT 55 | DIESEL | PRIVATE | BUILDING | SO_ATL | 2,395 | 4.4 | 12,939 | 8.7 |
| SU_3A | GT 55 | DIESEL | U,S & C | BUILDING | SO_ATL | 6,376 | 4.8 | 16,852 | 9.0 |
| SU_3A | GT 55 | DIESEL | LOCAL_FH | MINING | SO_ATL | 3,677 | 4.4 | 26,201 | 10.7 |
| SU_3A | GT 55 | DIESEL | LOCAL_FH | BUILDING | SO_ATL | 2,034 | 4.6 | 37,617 | 10.7 |
| SU_3A | GT 55 | DIESEL | IC_SPEC | MINING | SO_ATL | 1,122 | 4.1 | 20,828 | 10.7 |
| SU_3A | GT 55 | DIESEL | OWNER_OP | BUILDING | SO_ATL | 1,576 | 4.7 | 26,096 | 9.5 |
| COMB_34A | | | | ALL | SO_ATL | 19,873 | 5.4 | 32,661 | 3.2 |
| COMB_34A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | SO_ATL | 2,543 | 5.1 | 13,497 | 3.6 |
| COMB_34A | GT 55 | DIESEL | LOCAL_FH | MIXED | SO_ATL | 1,277 | 5.5 | 19,831 | 3.6 |
| COMB_56A | | | | ALL | SO_ATL | 32,643 | 4.8 | 59,621 | 7.2 |
| COMB_56A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | SO_ATL | 3,044 | 4.7 | 13,497 | 7.0 |
| COMB_56A | GT 55 | DIESEL | IC_GEN | MIXED | SO_ATL | 2,858 | 4.8 | 103,153 | 8.1 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | BUILDING | SO_ATL | 1,109 | 4.8 | 71,060 | 8.1 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FOOD | SO_ATL | 2,092 | 4.7 | 62,949 | 6.3 |
| DOUBLES | | | | ALL | SO_ATL | 177 | 4.5 | 55,034 | 8.7 |

FIGURE D-6 (cont.)

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SMALL_CAR | | | | ALL | SO_EAST | 3,576,051 | 20.7 | 8,868 | 0.0 |
| SMALL_CAR | ALL | GAS | HIGHINC | PERSONAL | SO_EAST | 927,811 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | MIDINC | PERSONAL | SO_EAST | 1,185,857 | 20.4 | 9,114 | 0.0 |
| SMALL_CAR | ALL | GAS | LOWINC | PERSONAL | SO_EAST | 830,691 | 20.0 | 7,159 | 0.0 |
| SMALL_CAR | ALL | GAS | TAXI | NON_FRGT | SO_EAST | 1,030 | 15.4 | 40,622 | 0.0 |
| SMALL_CAR | ALL | GAS | PRIVATE | NON_FRGT | SO_EAST | 532,484 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | S&L_GOV | NON_FRGT | SO_EAST | 3,830 | 20.8 | 10,663 | 0.0 |
| SMALL_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | SO_EAST | 93,144 | 33.3 | 10,050 | 0.0 |
| | | | | | | | | | |
| BIG_CAR | | | | ALL | SO_EAST | 11,072,290 | 15.5 | 9,264 | 0.0 |
| BIG_CAR | ALL | GAS | HIGHINC | PERSONAL | SO_EAST | 3,078,780 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | MIDINC | PERSONAL | SO_EAST | 3,668,049 | 15.4 | 9,085 | 0.0 |
| BIG_CAR | ALL | GAS | LOWINC | PERSONAL | SO_EAST | 2,416,248 | 15.3 | 7,122 | 0.0 |
| BIG_CAR | ALL | GAS | TAXI | NON_FRGT | SO_EAST | 24,744 | 15.4 | 40,622 | 0.0 |
| BIG_CAR | ALL | GAS | PRIVATE | NON_FRGT | SO_EAST | 1,658,065 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | FED_GOV | NON_FRGT | SO_EAST | 7,194 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | GAS | S&L_GOV | NON_FRGT | SO_EAST | 91,973 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | DIESEL | TAXI | NON_FRGT | SO_EAST | 1,767 | 24.8 | 42,826 | 0.0 |
| BIG_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | SO_EAST | 118,390 | 24.8 | 10,803 | 0.0 |
| BIG_CAR | ALL | DIESEL | S&L_GOV | NON_FRGT | SO_EAST | 6,567 | 24.8 | 11,242 | 0.0 |
| | | | | | | | | | |
| CYCLE | | | | ALL | SO_EAST | 556,656 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | HIGHINC | PERSONAL | SO_EAST | 227,258 | 50.0 | 2,013 | 0.0 |
| CYCLE | ALL | GAS | MIDINC | PERSONAL | SO_EAST | 228,361 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | LOWINC | PERSONAL | SO_EAST | 95,978 | 50.0 | 2,908 | 0.0 |
| CYCLE | ALL | GAS | S&L_GOV | NON_FRGT | SO_EAST | 5,035 | 50.0 | 2,279 | 0.0 |
| | | | | | | | | | |
| IC_BUS | | | | ALL | SO_EAST | 1,290 | 5.9 | 61,142 | 0.0 |
| IC_BUS | ALL | DIESEL | FHBUS | NON_FRGT | SO_EAST | 1,290 | 5.9 | 61,142 | 0.0 |
| | | | | | | | | | |
| TRANS_BUS | | | | ALL | SO_EAST | 3,346 | 3.8 | 35,910 | 0.0 |
| TRANS_BUS | ALL | DIESEL | FHBUS | NON_FRGT | SO_EAST | 3,346 | 3.8 | 35,910 | 0.0 |
| | | | | | | | | | |
| OTHER_BUS | | | | ALL | SO_EAST | 67,562 | 7.3 | 7,403 | 0.0 |
| OTHER_BUS | ALL | GAS | PRIVATE | NON_FRGT | SO_EAST | 12,354 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | S&L_GOV | NON_FRGT | SO_EAST | 54,028 | 7.4 | 7,396 | 0.0 |
| | | | | | | | | | |
| SU_2A_4T | | | | ALL | SO_EAST | 2,957,108 | 14.8 | 10,826 | 0.1 |
| SU_2A_4T | 00-10 | GAS | HIGHINC | PERSONAL | SO_EAST | 597,850 | 15.1 | 11,627 | 0.0 |
| SU_2A_4T | 00-10 | GAS | MIDINC | PERSONAL | SO_EAST | 864,928 | 15.4 | 10,808 | 0.0 |
| SU_2A_4T | 00-10 | GAS | LOWINC | PERSONAL | SO_EAST | 532,261 | 15.4 | 8,707 | 0.0 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_2A_4T | 00-10 | GAS | FED_GOV | NON_FRGT | SO_EAST | 18,714 | 13.9 | 6,424 | 0.2 |
| SU_2A_4T | 00-10 | GAS | S&L_GOV | NON_FRGT | SO_EAST | 114,629 | 13.9 | 6,424 | 0.2 |
| SU_2A_4T | 00-10 | GAS | OTHER | ALL | SO_EAST | 774,116 | 13.6 | 12,282 | 0.2 |
| SU_2A_4T | 00-10 | DIESEL | HIGHINC | PERSONAL | SO_EAST | 10,485 | 24.3 | 12,493 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | MIDINC | PERSONAL | SO_EAST | 15,169 | 24.8 | 11,613 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | LOWINC | PERSONAL | SO_EAST | 9,335 | 24.8 | 9,356 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | OTHER | ALL | SO_EAST | 19,622 | 16.5 | 16,459 | 0.2 |
| | | | | | | | | | |
| SU_2A_6T | | | | ALL | SO_EAST | 522,994 | 7.0 | 14,002 | 0.6 |
| SU_2A_6T | LT 26 | GAS | OTHER | ALL | SO_EAST | 442,151 | 6.9 | 12,239 | 0.4 |
| SU_2A_6T | LT 26 | DIESEL | S&L_GOV | NON_FRGT | SO_EAST | 8,472 | 8.4 | 20,092 | 0.4 |
| SU_2A_6T | LT 26 | DIESEL | OTHER | ALL | SO_EAST | 10,201 | 10.9 | 44,440 | 0.5 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FOOD | SO_EAST | 7,814 | 5.0 | 19,255 | 1.3 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | BUILDING | SO_EAST | 1,099 | 5.9 | 24,889 | 1.8 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | CHEMICAL | SO_EAST | 1,118 | 5.1 | 15,241 | 1.8 |
| SU_2A_6T | GT 26 | GAS | FARM | FARM | SO_EAST | 12,277 | 7.0 | 6,306 | 1.7 |
| SU_2A_6T | GT 26 | GAS | U,S & C | BUILDING | SO_EAST | 2,219 | 6.6 | 13,497 | 2.2 |
| SU_2A_6T | GT 26 | GAS | U,S & C | NON_FRGT | SO_EAST | 1,599 | 5.3 | 19,228 | 1.4 |
| SU_2A_6T | GT 26 | GAS | IC_PRIV | FOOD | SO_EAST | 1,402 | 5.3 | 35,881 | 1.3 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | PETROLEUM | SO_EAST | 2,458 | 6.0 | 10,925 | 1.7 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | PETROLEUM | SO_EAST | 3,248 | 8.6 | 12,886 | 1.6 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | NON_FRGT | SO_EAST | 1,235 | 5.5 | 3,221 | 2.0 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | HHG | SO_EAST | 1,518 | 8.1 | 70,039 | 1.2 |
| SU_2A_6T | GT 26 | DIESEL | IC_SPEC | CHEMICAL | SO_EAST | 1,021 | 7.7 | 17,429 | 1.7 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | FOOD | SO_EAST | 2,097 | 7.9 | 42,642 | 1.3 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | PETROLEUM | SO_EAST | 1,457 | 7.1 | 17,970 | 1.6 |
| | | | | | | | | | |
| SU_3A | | | | ALL | SO_EAST | 81,923 | 5.1 | 19,634 | 4.5 |
| SU_3A | LT 26 | GAS | OTHER | ALL | SO_EAST | 18,157 | 6.5 | 9,686 | 2.6 |
| SU_3A | 26-33 | DIESEL | U,S & C | BUILDING | SO_EAST | 3,080 | 4.4 | 11,475 | 3.6 |
| SU_3A | 26-33 | DIESEL | LOCAL_FH | NON_FRGT | SO_EAST | 1,028 | 6.4 | 11,004 | 3.0 |
| SU_3A | 33-55 | DIESEL | PRIVATE | BUILDING | SO_EAST | 2,777 | 4.8 | 20,620 | 3.7 |
| SU_3A | 33-55 | DIESEL | FARM | FARM | SO_EAST | 1,014 | 5.3 | 15,929 | 3.5 |
| SU_3A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | SO_EAST | 14,517 | 4.5 | 14,600 | 3.3 |
| SU_3A | 33-55 | DIESEL | U,S & C | BUILDING | SO_EAST | 6,207 | 5.0 | 20,780 | 4.3 |
| SU_3A | GT 55 | GAS | U,S & C | BUILDING | SO_EAST | 1,253 | 4.2 | 16,462 | 10.2 |
| SU_3A | GT 55 | DIESEL | PRIVATE | BUILDING | SO_EAST | 1,925 | 5.0 | 19,736 | 7.5 |
| SU_3A | GT 55 | DIESEL | U,S & C | BUILDING | SO_EAST | 2,640 | 5.6 | 14,189 | 8.5 |
| SU_3A | GT 55 | DIESEL | U,S & C | NON_FPGT | SO_EAST | 1,860 | 3.7 | 17,328 | 7.7 |
| SU_3A | GT 55 | DIESEL | OWNER_OP | BUILDING | SO_EAST | 1,238 | 5.2 | 17,571 | 7.6 |
| | | | | | | | | | |
| COMB_34A | | | | ALL | SO_EAST | 58,659 | 5.4 | 31,418 | 4.0 |
| COMB_34A | LT 33 | DIESEL | IC_PRIV | FOOD | SO_EAST | 1,145 | 7.2 | 60,395 | 2.0 |
| COMB_34A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | SO_EAST | 4,579 | 5.0 | 13,419 | 3.2 |
| COMB_34A | 33-55 | DIESEL | LOCAL_FH | MIXED | SO_EAST | 1,134 | 6.1 | 17,457 | 3.8 |
| COMB_34A | GT 55 | DIESEL | FARM | FARM | SO_EAST | 2,353 | 4.8 | 20,284 | 5.3 |
| COMB_34A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | SO_EAST | 14,603 | 5.1 | 13,497 | 4.5 |

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| COMB_34A | GT 55 | DIESEL | LOCAL_FH | MIXED | SO_EAST | 1,157 | 5.8 | 15,216 | 4.5 |
| COMB_34A | GT 55 | DIESEL | IC_GEN | MIXED | SO_EAST | 1,103 | 5.3 | 65,139 | 3.6 |
| COMB_34A | GT 55 | DIESEL | IC_PRIV | FOOD | SO_EAST | 1,277 | 5.1 | 68,022 | 3.3 |
| COMB_56A | | | | ALL | SO_EAST | 78,272 | 4.7 | 54,964 | 7.5 |
| COMB_56A | GT 55 | DIESEL | FARM | FARM | SO_EAST | 1,156 | 5.0 | 29,524 | 9.3 |
| COMB_56A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | SO_EAST | 17,489 | 4.7 | 13,497 | 7.9 |
| COMB_56A | GT 55 | DIESEL | LOCAL_FH | MIXED | SO_EAST | 1,712 | 4.9 | 48,282 | 7.7 |
| COMB_56A | GT 55 | DIESEL | IC_GEN | MIXED | SO_EAST | 4,780 | 4.8 | 103,154 | 8.3 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | FOOD | SO_EAST | 1,626 | 4.6 | 85,507 | 6.4 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | BUILDING | SO_EAST | 1,105 | 4.9 | 76,360 | 8.0 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | PETROLEUM | SO_EAST | 1,789 | 5.0 | 68,986 | 8.0 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | MIXED | SO_EAST | 1,262 | 4.7 | 81,018 | 7.1 |
| COMB_56A | GT 55 | DIESEL | IC_EXEMP | FARM | SO_EAST | 1,857 | 4.6 | 76,298 | 7.0 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FARM | SO_EAST | 2,262 | 4.8 | 73,642 | 7.5 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FOREST | SO_EAST | 1,015 | 4.8 | 46,417 | 8.8 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FOOD | SO_EAST | 4,742 | 4.6 | 68,665 | 6.9 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | BUILDING | SO_EAST | 1,578 | 4.5 | 56,451 | 8.7 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | CHEMICAL | SO_EAST | 1,234 | 4.9 | 77,163 | 7.4 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | PETROLEUM | SO_EAST | 2,101 | 5.0 | 76,692 | 9.2 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FARM | SO_EAST | 2,386 | 4.5 | 86,703 | 7.7 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FOOD | SO_EAST | 1,246 | 4.4 | 92,059 | 6.2 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | MIXED | SO_EAST | 1,519 | 4.7 | 77,351 | 7.8 |
| DOUBLES | | | | ALL | SO_EAST | 47 | 4.6 | 80,269 | 11.1 |

FIGURE D-6 (cont.)

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SMALL_CAR | | | | ALL | E_NO_CENTR | 5,643,928 | 20.7 | 8,868 | 0.0 |
| SMALL_CAR | ALL | GAS | HIGHINC | PERSONAL | E_NO_CENTR | 1,464,908 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | MIDINC | PERSONAL | E_NO_CENTR | 1,872,333 | 20.4 | 9,114 | 0.0 |
| SMALL_CAR | ALL | GAS | LOWINC | PERSONAL | E_NO_CENTR | 1,311,567 | 20.0 | 7,159 | 0.0 |
| SMALL_CAR | ALL | GAS | TAXI | NON_FRGT | E_NO_CENTR | 1,627 | 15.4 | 40,622 | 0.0 |
| SMALL_CAR | ALL | GAS | PRIVATE | NON_FRGT | E_NO_CENTR | 840,732 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | S&L_GOV | NON_FRGT | E_NO_CENTR | 4,261 | 20.8 | 10,663 | 0.0 |
| SMALL_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | E_NO_CENTR | 147,065 | 33.3 | 10,059 | 0.0 |
| BIG_CAR | | | | ALL | E_NO_CENTR | 17,432,623 | 15.5 | 9,259 | 0.0 |
| BIG_CAR | ALL | GAS | HIGHINC | PERSONAL | E_NO_CENTR | 4,861,042 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | MIDINC | PERSONAL | E_NO_CENTR | 5,791,431 | 15.4 | 9,085 | 0.0 |
| BIG_CAR | ALL | GAS | LOWINC | PERSONAL | E_NO_CENTR | 3,814,980 | 15.3 | 7,122 | 0.0 |
| BIG_CAR | ALL | GAS | TAXI | NON_FRGT | E_NO_CENTR | 39,068 | 15.4 | 40,622 | 0.0 |
| BIG_CAR | ALL | GAS | PRIVATE | NON_FRGT | E_NO_CENTR | 2,617,896 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | FED_GOV | NON_FRGT | E_NO_CENTR | 8,273 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | GAS | S&L_GOV | NON_FRGT | E_NO_CENTR | 102,322 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | DIESEL | TAXI | NON_FRGT | E_NO_CENTR | 2,790 | 24.8 | 42,826 | 0.0 |
| BIG_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | E_NO_CENTR | 186,925 | 24.8 | 10,803 | 0.0 |
| BIG_CAR | ALL | DIESEL | S&L_GOV | NON_FRGT | E_NO_CENTR | 7,306 | 24.8 | 11,242 | 0.0 |
| CYCLE | | | | ALL | E_NO_CENTR | 1,362,604 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | HIGHINC | PERSONAL | E_NO_CENTR | 563,061 | 50.0 | 2,013 | 0.0 |
| CYCLE | ALL | GAS | MIDINC | PERSONAL | E_NO_CENTR | 562,780 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | LOWINC | PERSONAL | E_NO_CENTR | 236,531 | 50.0 | 2,908 | 0.0 |
| CYCLE | ALL | GAS | S&L_GOV | NON_FRGT | E_NO_CENTR | 3,227 | 50.0 | 2,279 | 0.0 |
| IC_BUS | | | | ALL | E_NO_CENTR | 3,744 | 5.9 | 61,142 | 0.0 |
| IC_BUS | ALL | DIESEL | FHBUS | NON_FRGT | E_NO_CENTR | 3,744 | 5.9 | 61,142 | 0.0 |
| TRANS_BUS | | | | ALL | E_NO_CENTR | 9,710 | 3.8 | 35,910 | 0.0 |
| TRANS_BUS | ALL | DIESEL | FHBUS | NON_FRGT | E_NO_CENTR | 9,710 | 3.8 | 35,910 | 0.0 |
| OTHER_BUS | | | | ALL | E_NO_CENTR | 76,487 | 7.3 | 7,417 | 0.0 |
| OTHER_BUS | ALL | GAS | FHBUS | NON_FRGT | E_NO_CENTR | 4,126 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | PRIVATE | NON_FRGT | E_NO_CENTR | 31,020 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | S&L_GOV | NON_FRGT | E_NO_CENTR | 39,325 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | DIESEL | FHBUS | NON_FRGT | E_NO_CENTR | 1,920 | 7.2 | 8,238 | 0.0 |
| SU_2A_4T | | | | ALL | E_NO_CENTR | 3,998,311 | 13.5 | 10,708 | 0.1 |
| SU_2A_4T | 00-10 | GAS | HIGHINC | PERSONAL | E_NO_CENTR | 803,176 | 14.0 | 11,468 | 0.0 |

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
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| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_2A_4T | 00-10 | GAS | MIDINC | PERSONAL | E_NO_CENTR | 1,161,989 | 14.3 | 10,660 | 0.0 |
| SU_2A_4T | 00-10 | GAS | LOWINC | PERSONAL | E_NO_CENTR | 715,061 | 14.3 | 9,588 | 0.0 |
| SU_2A_4T | 00-10 | GAS | FED_GOV | NON_FRGT | E_NO_CENTR | 23,764 | 13.9 | 6,424 | 0.3 |
| SU_2A_4T | 00-10 | GAS | S&L_GOV | NON_FRGT | E_NO_CENTR | 118,186 | 13.9 | 6,424 | 0.3 |
| SU_2A_4T | 00-10 | GAS | OTHER | ALL | E_NO_CENTR | 1,154,366 | 12.3 | 12,076 | 0.3 |
| SU_2A_4T | 00-10 | DIESEL | HIGHINC | PERSONAL | E_NO_CENTR | 3,554 | 22.5 | 6,142 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | MIDINC | PERSONAL | E_NO_CENTR | 5,142 | 23.0 | 5,709 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | LOWINC | PERSONAL | E_NO_CENTR | 3,164 | 23.0 | 4,599 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | OTHER | ALL | E_NO_CENTR | 9,918 | 16.3 | 15,825 | 0.3 |
| | | | | | | | | | |
| SU_2A_6T | | | | ALL | E_NO_CENTR | 726,667 | 7.0 | 13,064 | 0.6 |
| SU_2A_6T | LT 26 | GAS | OTHER | ALL | E_NO_CENTR | 569,393 | 7.3 | 11,902 | 0.3 |
| SU_2A_6T | LT 26 | DIESEL | S&L_GOV | NON_FRGT | E_NO_CENTR | 8,735 | 8.4 | 20,092 | 0.3 |
| SU_2A_6T | LT 26 | DIESEL | OTHER | ALL | E_NO_CENTR | 2,707 | 7.9 | 19,253 | 0.4 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FARM | E_NO_CENTR | 2,226 | 5.2 | 27,504 | 1.4 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FOOD | E_NO_CENTR | 10,004 | 5.1 | 16,434 | 1.2 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | BUILDING | E_NO_CENTR | 3,076 | 6.1 | 14,168 | 1.6 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | CHEMICAL | E_NO_CENTR | 1,054 | 4.8 | 14,877 | 1.1 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | PETROLEUM | E_NO_CENTR | 2,714 | 5.1 | 17,385 | 1.5 |
| SU_2A_6T | GT 26 | GAS | FARM | FARM | E_NO_CENTR | 34,995 | 6.1 | 5,609 | 1.7 |
| SU_2A_6T | GT 26 | GAS | U,S & C | BUILDING | E_NO_CENTR | 6,434 | 5.8 | 9,729 | 1.9 |
| SU_2A_6T | GT 26 | GAS | U,S & C | NON_FRGT | E_NO_CENTR | 3,628 | 4.2 | 12,145 | 1.2 |
| SU_2A_6T | GT 26 | GAS | LOCAL_FH | FARM | E_NO_CENTR | 2,838 | 5.6 | 20,197 | 1.7 |
| SU_2A_6T | GT 26 | GAS | IC_PRIV | FARM | E_NO_CENTR | 1,890 | 6.2 | 23,462 | 1.5 |
| SU_2A_6T | GT 26 | GAS | IC_PRIV | FOOD | E_NO_CENTR | 2,127 | 5.1 | 33,775 | 1.2 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | FOOD | E_NO_CENTR | 5,113 | 9.2 | 25,407 | 1.0 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | BUILDING | E_NO_CENTR | 1,571 | 7.8 | 25,665 | 1.4 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | PETROLEUM | E_NO_CENTR | 10,692 | 5.3 | 16,034 | 1.5 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | MACHINERY | E_NO_CENTR | 1,027 | 4.8 | 12,976 | 1.6 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | MIXED | E_NO_CENTR | 1,350 | 8.8 | 52,658 | 1.3 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | NON_FRGT | E_NO_CENTR | 1,057 | 7.3 | 15,340 | 2.3 |
| SU_2A_6T | GT 26 | DIESEL | FARM | FARM | E_NO_CENTR | 4,028 | 8.6 | 9,286 | 2.1 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | BUILDING | E_NO_CENTR | 3,399 | 6.2 | 11,901 | 2.1 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | PETROLEUM | E_NO_CENTR | 1,673 | 6.3 | 14,039 | 1.5 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | FARM | E_NO_CENTR | 1,817 | 9.3 | 9,847 | 2.1 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | HHG | E_NO_CENTR | 1,189 | 7.1 | 26,532 | 2.2 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | MIXED | E_NO_CENTR | 4,447 | 7.5 | 14,685 | 1.4 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | FOOD | E_NO_CENTR | 3,551 | 7.9 | 42,674 | 1.2 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | PETROLEUM | E_NO_CENTR | 1,309 | 7.4 | 27,952 | 1.6 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | FAB_METAL | E_NO_CENTR | 1,336 | 8.1 | 13,563 | 1.8 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | MACHINERY | E_NO_CENTR | 1,022 | 11.6 | 25,009 | 1.5 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | NON_FRGT | E_NO_CENTR | 1,153 | 6.3 | 42,181 | 1.3 |
| | | | | | | | | | |
| SU_3A | | | | ALL | E_NO_CENTR | 169,832 | 5.0 | 19,173 | 3.9 |
| SU_3A | LT 26 | GAS | OTHER | ALL | E_NO_CENTR | 25,377 | 6.8 | 10,461 | 1.5 |
| SU_3A | 26-33 | GAS | FARM | FARM | E_NO_CENTR | 2,421 | 7.1 | 4,394 | 2.3 |
| SU_3A | 26-33 | DIESEL | PRIVATE | FOOD | E_NO_CENTR | 1,522 | 4.4 | 120,045 | 3.8 |

FIGURE D-6 (cont.)

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
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| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_3A | 26-33 | DIESEL | FARM | FARM | E_NO_CENTR | 1,473 | 10.4 | 5,002 | 2.3 |
| SU_3A | 33-55 | GAS | FARM | FARM | E_NO_CENTR | 2,376 | 4.7 | 9,453 | 2.8 |
| SU_3A | 33-55 | GAS | U,S & C | BUILDING | E_NO_CENTR | 2,594 | 3.7 | 13,199 | 3.5 |
| SU_3A | 33-55 | DIESEL | PRIVATE | BUILDING | E_NO_CENTR | 1,622 | 4.5 | 13,243 | 2.3 |
| SU_3A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | E_NO_CENTR | 14,967 | 4.5 | 14,600 | 1.8 |
| SU_3A | 33-55 | DIESEL | U,S & C | BUILDING | E_NO_CENTR | 9,347 | 5.4 | 15,837 | 3.1 |
| SU_3A | 33-55 | DIESEL | U,S & C | NON_FRGT | E_NO_CENTR | 3,280 | 5.0 | 23,132 | 1.9 |
| SU_3A | 33-55 | DIESEL | LOCAL_FH | BUILDING | E_NO_CENTR | 2,899 | 5.9 | 24,315 | 4.2 |
| SU_3A | 33-55 | DIESEL | OWNER_OP | BUILDING | E_NO_CENTR | 1,654 | 5.8 | 23,946 | 4.3 |
| SU_3A | GT 55 | GAS | FARM | FARM | E_NO_CENTR | 13,994 | 5.1 | 3,696 | 6.1 |
| SU_3A | GT 55 | GAS | U,S & C | BUILDING | E_NO_CENTR | 5,404 | 4.0 | 13,130 | 6.5 |
| SU_3A | GT 55 | GAS | OWNER_OP | BUILDING | E_NO_CENTR | 1,076 | 3.3 | 24,875 | 7.8 |
| SU_3A | GT 55 | DIESEL | PRIVATE | MINING | E_NO_CENTR | 1,170 | 4.3 | 21,129 | 7.8 |
| SU_3A | GT 55 | DIESEL | PRIVATE | BUILDING | E_NO_CENTR | 5,933 | 4.0 | 14,719 | 6.4 |
| SU_3A | GT 55 | DIESEL | FARM | FARM | E_NO_CENTR | 1,672 | 5.5 | 13,273 | 4.9 |
| SU_3A | GT 55 | DIESEL | U,S & C | MINING | E_NO_CENTR | 1,245 | 3.8 | 8,534 | 7.8 |
| SU_3A | GT 55 | DIESEL | U,S & C | BUILDING | E_NO_CENTR | 14,156 | 4.5 | 14,465 | 5.7 |
| SU_3A | GT 55 | DIESEL | U,S & C | NON_FRGT | E_NO_CENTR | 1,051 | 8.5 | 35,319 | 5.0 |
| SU_3A | GT 55 | DIESEL | LOCAL_FH | BUILDING | E_NO_CENTR | 4,982 | 5.1 | 31,279 | 7.8 |
| SU_3A | GT 55 | DIESEL | IC_GEN | MIXED | E_NO_CENTR | 1,130 | 4.8 | 78,155 | 5.3 |
| SU_3A | GT 55 | DIESEL | IC_PRIV | BUILDING | E_NO_CENTR | 1,180 | 5.7 | 39,256 | 5.5 |
| SU_3A | GT 55 | DIESEL | OWNER_OP | BUILDING | E_NO_CENTR | 4,948 | 4.9 | 27,190 | 7.3 |
| | | | | | | | | | |
| COMB_34A | | | | ALL | E_NO_CENTR | 66,890 | 5.2 | 35,167 | 2.8 |
| COMB_34A | LT 33 | DIESEL | IC_PRIV | FOOD | E_NO_CENTR | 1,000 | 7.1 | 81,394 | 1.8 |
| COMB_34A | 33-55 | GAS | LOCAL_FH | MIXED | E_NO_CENTR | 2,306 | 3.8 | 16,532 | 2.3 |
| COMB_34A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | E_NO_CENTR | 2,331 | 5.0 | 13,419 | 2.0 |
| COMB_34A | 33-55 | DIESEL | LOCAL_FH | MIXED | E_NO_CENTR | 4,372 | 4.4 | 18,990 | 2.2 |
| COMB_34A | 33-55 | DIESEL | IC_GEN | MIXED | E_NO_CENTR | 1,120 | 5.7 | 41,819 | 2.7 |
| COMB_34A | 33-55 | DIESEL | IC_PRIV | FOOD | E_NO_CENTR | 1,204 | 5.6 | 66,892 | 2.0 |
| COMB_34A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | E_NO_CENTR | 7,435 | 5.1 | 13,497 | 3.0 |
| COMB_34A | GT 55 | DIESEL | LOCAL_FH | MIXED | E_NO_CENTR | 1,742 | 5.2 | 22,980 | 3.0 |
| COMB_34A | GT 55 | DIESEL | IC_GEN | MIXED | E_NO_CENTR | 1,983 | 5.3 | 65,139 | 3.6 |
| COMB_34A | GT 55 | DIESEL | IC_SPEC | HHG | E_NO_CENTR | 1,506 | 5.2 | 47,668 | 3.0 |
| COMB_34A | GT 55 | DIESEL | IC_PRIV | FOOD | E_NO_CENTR | 1,216 | 5.0 | 65,549 | 2.7 |
| | | | | | | | | | |
| COMB_56A | | | | ALL | E_NO_CENTR | 139,366 | 4.7 | 59,531 | 7.2 |
| COMB_56A | GT 55 | DIESEL | PRIVATE | FOOD | E_NO_CENTR | 1,911 | 4.7 | 32,424 | 5.9 |
| COMB_56A | GT 55 | DIESEL | PRIVATE | PETROLEUM | E_NO_CENTR | 1,047 | 4.8 | 55,582 | 7.2 |
| COMB_56A | GT 55 | DIESEL | FARM | FARM | E_NO_CENTR | 1,747 | 4.9 | 14,175 | 7.4 |
| COMB_56A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | E_NO_CENTR | 8,899 | 4.7 | 13,497 | 6.1 |
| COMB_56A | GT 55 | DIESEL | U,S & C | BUILDING | E_NO_CENTR | 7,724 | 4.9 | 26,288 | 10.8 |
| COMB_56A | GT 55 | DIESEL | LOCAL_FH | FARM | E_NO_CENTR | 1,456 | 5.6 | 32,672 | 6.6 |
| COMB_56A | GT 55 | DIESEL | LOCAL_FH | BUILDING | E_NO_CENTR | 1,740 | 4.0 | 29,905 | 8.4 |
| COMB_56A | GT 55 | DIESEL | LOCAL_FH | MIXED | E_NO_CENTR | 4,136 | 4.6 | 24,927 | 6.1 |
| COMB_56A | GT 55 | DIESEL | IC_GEN | MIXED | E_NO_CENTR | 12,129 | 4.8 | 103,120 | 8.1 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | FARM | E_NO_CENTR | 2,508 | 4.8 | 80,009 | 7.0 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | FOREST | E_NO_CENTR | 1,069 | 4.5 | 58,305 | 8.3 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
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| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| COMB_56A | GT 55 | DIESEL | IC_SPEC | FOOD | E_NO_CENTR | 3,248 | 4.5 | 89,279 | 6.1 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | BUILDING | E_NO_CENTR | 3,573 | 4.8 | 71,898 | 7.8 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | PAPER | E_NO_CENTR | 1,111 | 4.6 | 77,985 | 6.8 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | CHEMICAL | E_NO_CENTR | 1,825 | 5.1 | 72,370 | 7.7 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | PETROLEUM | E_NO_CENTR | 3,659 | 4.9 | 74,434 | 7.6 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | PR_METAL | E_NO_CENTR | 1,218 | 4.7 | 59,055 | 8.1 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | TRASP_EQ | E_NO_CENTR | 1,097 | 5.0 | 69,111 | 4.0 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | MIXED | E_NO_CENTR | 3,001 | 4.7 | 79,916 | 6.8 |
| COMB_56A | GT 55 | DIESEL | IC_EXEMP | FARM | E_NO_CENTR | 4,129 | 4.5 | 83,385 | 7.2 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FARM | E_NO_CENTR | 2,566 | 4.9 | 58,459 | 7.4 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FOREST | E_NO_CENTR | 1,740 | 4.8 | 46,388 | 8.5 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FOOD | E_NO_CENTR | 5,896 | 4.6 | 69,444 | 6.2 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | BUILDING | E_NO_CENTR | 2,622 | 4.5 | 56,310 | 7.6 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | CHEMICAL | E_NO_CENTR | 2,114 | 4.9 | 75,323 | 7.0 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | PETROLEUM | E_NO_CENTR | 2,594 | 4.9 | 77,446 | 7.9 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FARM | E_NO_CENTR | 3,817 | 4.5 | 85,029 | 7.9 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | MINING | E_NO_CENTR | 1,022 | 5.2 | 53,836 | 7.2 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FOOD | E_NO_CENTR | 2,687 | 4.4 | 92,814 | 6.1 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | BUILDING | E_NO_CENTR | 3,415 | 4.7 | 55,418 | 8.1 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | HHG | E_NO_CENTR | 1,085 | 5.2 | 65,859 | 3.4 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | PR_METAL | E_NO_CENTR | 1,686 | 4.7 | 64,628 | 7.9 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | MIXED | E_NO_CENTR | 3,566 | 4.6 | 79,315 | 7.6 |
| DOUBLES | | | | ALL | E_NO_CENTR | 9,173 | 4.5 | 72,633 | 8.5 |
| DOUBLES | GT 55 | DIESEL | IC_GEN | MIXED | E_NO_CENTR | 2,209 | 4.2 | 116,946 | 8.1 |
| DOUBLES | GT 55 | DIESEL | IC_SPEC | FARM | E_NO_CENTR | 1,494 | 5.1 | 55,73. | 8.5 |

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SMALL_CAR | | | | ALL | E_SO_CENTR | 1,980,544 | 20.7 | 8,867 | 0.0 |
| SMALL_CAR | ALL | GAS | HIGHINC | PERSONAL | E_SO_CENTR | 514,124 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | MIDINC | PERSONAL | E_SO_CENTR | 657,114 | 20.4 | 9,114 | 0.0 |
| SMALL_CAR | ALL | GAS | LOWINC | PERSONAL | E_SO_CENTR | 460,307 | 20.0 | 7,159 | 0.0 |
| SMALL_CAR | ALL | GAS | PRIVATE | NON_FRGT | E_SO_CENTR | 295,063 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | S&L_GOV | NON_FRGT | E_SO_CENTR | 1,179 | 20.8 | 10,663 | 0.0 |
| SMALL_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | E_SO_CENTR | 51,614 | 33.3 | 10,050 | 0.0 |
| BIG_CAR | | | | ALL | E_SO_CENTR | 6,112,715 | 15.5 | 9,258 | 0.0 |
| BIG_CAR | ALL | GAS | HIGHINC | PERSONAL | E_SO_CENTR | 1,706,031 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | MIDINC | PERSONAL | E_SO_CENTR | 2,032,560 | 15.4 | 9,085 | 0.0 |
| BIG_CAR | ALL | GAS | LOWINC | PERSONAL | E_SO_CENTR | 1,338,905 | 15.3 | 7,122 | 0.0 |
| BIG_CAR | ALL | GAS | TAXI | NON_FRGT | E_SO_CENTR | 13,711 | 15.4 | 40,622 | 0.0 |
| BIG_CAR | ALL | GAS | PRIVATE | NON_FRGT | E_SO_CENTR | 918,777 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | FED_GOV | NON_FRGT | E_SO_CENTR | 5,417 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | GAS | S&L_GOV | NON_FRGT | E_SO_CENTR | 28,322 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | E_SO_CENTR | 65,603 | 24.8 | 10,803 | 0.0 |
| BIG_CAR | ALL | DIESEL | S&L_GOV | NON_FRGT | E_SO_CENTR | 2,022 | 24.8 | 11,242 | 0.0 |
| CYCLE | | | | ALL | E_SO_CENTR | 275,926 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | HIGHINC | PERSONAL | E_SO_CENTR | 113,244 | 50.0 | 2,013 | 0.0 |
| CYCLE | ALL | GAS | MIDINC | PERSONAL | E_SO_CENTR | 113,793 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | LOWINC | PERSONAL | E_SO_CENTR | 47,826 | 50.0 | 2,908 | 0.0 |
| CYCLE | ALL | GAS | S&L_GOV | NON_FRGT | E_SO_CENTR | 1,052 | 50.0 | 2,279 | 0.0 |
| IC_BUS | | | | ALL | E_SO_CENTR | 887 | 5.9 | 61,142 | 0.0 |
| TRANS_BUS | | | | ALL | E_SO_CENTR | 2,301 | 3.8 | 35,910 | 0.0 |
| TRANS_BUS | ALL | DIESEL | FHBUS | NON_FRGT | E_SO_CENTR | 2,301 | 3.8 | 35,910 | 0.0 |
| OTHER_BUS | | | | ALL | E_SO_CENTR | 30,480 | 7.3 | 7,407 | 0.0 |
| OTHER_BUS | ALL | GAS | PRIVATE | NON_FRGT | E_SO_CENTR | 4,629 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | S&L_GOV | NON_FRGT | E_SO_CENTR | 24,777 | 7.4 | 7,396 | 0.0 |
| SU_2A_4T | | | | ALL | E_SO_CENTR | 2,243,962 | 14.3 | 10,471 | 0.1 |
| SU_2A_4T | 00-10 | GAS | HIGHINC | PERSONAL | E_SO_CENTR | 457,178 | 14.4 | 10,844 | 0.0 |
| SU_2A_4T | 00-10 | GAS | MIDINC | PERSONAL | E_SO_CENTR | 661,414 | 14.7 | 10,080 | 0.0 |
| SU_2A_4T | 00-10 | GAS | LOWINC | PERSONAL | E_SO_CENTR | 407,022 | 14.7 | 8,121 | 0.0 |
| SU_2A_4T | 00-10 | GAS | FED_GOV | NON_FRGT | E_SO_CENTR | 15,231 | 13.9 | 6,424 | 0.3 |
| SU_2A_4T | 00-10 | GAS | S&L_GOV | NON_FRGT | E_SO_CENTR | 58,731 | 13.9 | 6,424 | 0.3 |
| SU_2A_4T | 00-10 | GAS | OTHER | ALL | E_SO_CENTR | 603,573 | 13.4 | 11,653 | 0.3 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_2A_4T | 00-10 | DIESEL | HIGHINC | PERSONAL | E_SO_CENTR | 6,188 | 18.3 | 19,951 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | MIDINC | PERSONAL | E_SO_CENTR | 8,952 | 18.7 | 18,545 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | LOWINC | PERSONAL | E_SO_CENTR | 5,509 | 18.7 | 14,940 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | OTHER | ALL | E_SO_CENTR | 20,165 | 16.5 | 33,989 | 0.3 |
| | | | | | | | | | |
| SU_2A_6T | | | | ALL | E_SO_CENTR | 341,704 | 7.0 | 12,618 | 0.9 |
| SU_2A_6T | LT 26 | GAS | OTHER | ALL | E_SO_CENTR | 261,423 | 7.4 | 11,620 | 0.5 |
| SU_2A_6T | LT 26 | DIESEL | S&L_GOV | NON_FRGT | E_SO_CENTR | 4,341 | 8.4 | 20,092 | 0.6 |
| SU_2A_6T | LT 26 | DIESEL | OTHER | ALL | E_SO_CENTR | 4,065 | 8.2 | 9,007 | 0.6 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FOREST | E_SO_CENTR | 2,709 | 3.6 | 10,617 | 2.1 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FOOD | E_SO_CENTR | 5,516 | 4.5 | 18,839 | 1.4 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | BUILDING | E_SO_CENTR | 1,610 | 6.3 | 19,849 | 2.1 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | PETROLEUM | E_SO_CENTR | 1,393 | 6.8 | 21,268 | 1.9 |
| SU_2A_6T | GT 26 | GAS | FARM | FARM | E_SO_CENTR | 22,701 | 6.8 | 4,975 | 1.9 |
| SU_2A_6T | GT 26 | GAS | U.S & C | BUILDING | E_SO_CENTR | 3,575 | 6.1 | 13,065 | 2.4 |
| SU_2A_6T | GT 26 | GAS | U.S & C | NON_FRGT | E_SO_CENTR | 1,627 | 5.9 | 9,843 | 1.7 |
| SU_2A_6T | GT 26 | GAS | LOCAL_FH | MIXED | E_SO_CENTR | 1,052 | 5.1 | 15,147 | 1.7 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | PETROLEUM | E_SO_CENTR | 2,669 | 5.4 | 10,798 | 1.9 |
| SU_2A_6T | GT 26 | DIESEL | FARM | FARM | E_SO_CENTR | 1,259 | 4.6 | 1,000 | 1.9 |
| SU_2A_6T | GT 26 | DIESEL | U.S & C | BUILDING | E_SO_CENTR | 1,090 | 5.0 | 17,774 | 2.8 |
| SU_2A_6T | GT 26 | DIESEL | U.S & C | PETROLEUM | E_SO_CENTR | 2,399 | 8.1 | 17,319 | 1.9 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | FOOD | E_SO_CENTR | 1,509 | 7.9 | 42,712 | 1.3 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | ELECTRIC | E_SO_CENTR | 1,089 | 9.9 | 51,531 | 1.6 |
| | | | | | | | | | |
| SU_3A | | | | ALL | E_SO_CENTR | 71,909 | 4.9 | 20,602 | 7.3 |
| SU_3A | LT 26 | GAS | OTHER | ALL | E_SO_CENTR | 13,177 | 5.8 | 11,168 | 3.9 |
| SU_3A | 26-33 | DIESEL | FARM | FARM | E_SO_CENTR | 1,040 | 5.7 | 10,833 | 4.3 |
| SU_3A | 33-55 | DIESEL | FED_GOV | NON_FRGT | E_SO_CENTR | 1,835 | 4.5 | 14,600 | 4.6 |
| SU_3A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | E_SO_CENTR | 7,438 | 4.5 | 14,600 | 4.6 |
| SU_3A | 33-55 | DIESEL | U.S & C | BUILDING | E_SO_CENTR | 1,269 | 5.4 | 15,289 | 5.5 |
| SU_3A | 33-55 | DIESEL | LOCAL_FH | MINING | E_SO_CENTR | 1,113 | 5.9 | 25,125 | 7.1 |
| SU_3A | GT 55 | GAS | PRIVATE | MINING | E_SO_CENTR | 1,070 | 4.2 | 49,852 | 12.3 |
| SU_3A | GT 55 | GAS | U.S & C | BUILDING | E_SO_CENTR | 1,450 | 3.9 | 10,284 | 8.8 |
| SU_3A | GT 55 | GAS | LOCAL_FH | BUILDING | E_SO_CENTR | 1,342 | 4.6 | 32,935 | 11.5 |
| SU_3A | GT 55 | GAS | OWNER_OP | BUILDING | E_SO_CENTR | 1,872 | 6.9 | 13,847 | 12.3 |
| SU_3A | GT 55 | DIESEL | PRIVATE | MINING | E_SO_CENTR | 2,583 | 4.9 | 26,831 | 12.3 |
| SU_3A | GT 55 | DIESEL | PRIVATE | BUILDING | E_SO_CENTR | 3,880 | 4.2 | 10,989 | 8.9 |
| SU_3A | GT 55 | DIESEL | U.S & C | BUILDING | E_SO_CENTR | 3,468 | 4.6 | 19,231 | 9.7 |
| SU_3A | GT 55 | DIESEL | LOCAL_FH | MINING | E_SO_CENTR | 1,144 | 4.3 | 31,616 | 10.8 |
| SU_3A | GT 55 | DIESEL | OWNER_OP | BUILDING | E_SO_CENTR | 1,847 | 4.3 | 18,974 | 11.7 |
| | | | | | | | | | |
| COMB_34A | | | | ALL | E_SO_CENTR | 25,048 | 5.3 | 37,471 | 3.1 |
| COMB_34A | 33-55 | DIESEL | LOCAL_FH | MIXED | E_SO_CENTR | 1,183 | 6.4 | 26,457 | 2.5 |
| | | | | | | | | | |
| COMB_56A | | | | ALL | E_SO_CENTR | 50,079 | 4.7 | 63,749 | 7.6 |
| COMB_56A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | E_SO_CENTR | 1,120 | 4.7 | 13,497 | 8.1 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| COMB_56A | GT 55 | DIESEL | IC_GEN | MIXED | E_SO_CENTR | 4,223 | 4.8 | 103,153 | 8.1 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | FOOD | E_SO_CENTR | 1,149 | 4.5 | 90,182 | 6.2 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | BUILDING | E_SO_CENTR | 1,564 | 4.9 | 73,154 | 8.4 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | PETROLEUM | E_SO_CENTR | 1,251 | 4.9 | 72,452 | 7.8 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | MIXED | E_SO_CENTR | 1,057 | 4.7 | 80,940 | 6.9 |
| COMB_56A | GT 55 | DIESEL | IC_EXEMP | FARM | E_SO_CENTR | 1,193 | 4.4 | 77,560 | 7.8 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FARM | E_SO_CENTR | 1,321 | 4.8 | 70,880 | 8.3 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FOOD | E_SO_CENTR | 2,829 | 4.6 | 76,077 | 6.7 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | BUILDING | E_SO_CENTR | 1,126 | 4.7 | 66,067 | 8.6 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | PETROLEUM | E_SO_CENTR | 1,286 | 5.0 | 72,211 | 8.0 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FARM | E_SO_CENTR | 1,679 | 4.6 | 86,910 | 8.2 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FOOD | E_SO_CENTR | 1,005 | 4.4 | 92,362 | 6.1 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | MIXED | E_SO_CENTR | 1,381 | 4.5 | 81,047 | 7.9 |
| DOUBLES | | | | ALL | E_SO_CENTR | 385 | 4.5 | 40,378 | 7.9 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SMALL_CAR | | | | ALL | W_NO_CENTR | 2,301,537 | 20.7 | 8,867 | 0.0 |
| SMALL_CAR | ALL | GAS | HIGHINC | PERSONAL | W_NO_CENTR | 597,444 | 20.9 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | MIDINC | PERSONAL | W_NO_CENTR | 763,606 | 20.4 | 9,114 | 0.0 |
| SMALL_CAR | ALL | GAS | LOWINC | PERSONAL | W_NO_CENTR | 534,905 | 20.9 | 7,159 | 0.0 |
| SMALL_CAR | ALL | GAS | PRIVATE | NON_FRGT | W_NO_CENTR | 342,882 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | S&L_GOV | NON_FRGT | W_NO_CENTR | 1,423 | 20.8 | 10,663 | 0.0 |
| SMALL_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | W_NO_CENTR | 59,978 | 33.3 | 10,050 | 0.0 |
| BIG_CAR | | | | ALL | W_NO_CENTR | 7,103,876 | 15.5 | 9,258 | 0.0 |
| BIG_CAR | ALL | GAS | HIGHINC | PERSONAL | W_NO_CENTR | 1,982,512 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | MIDINC | PERSONAL | W_NO_CENTR | 2,361,959 | 15.4 | 9,085 | 0.0 |
| BIG_CAR | ALL | GAS | LOWINC | PERSONAL | W_NO_CENTR | 1,555,889 | 15.3 | 7,122 | 0.0 |
| BIG_CAR | ALL | GAS | TAXI | NON_FRGT | W_NO_CENTR | 15,933 | 15.4 | 40,622 | 0.0 |
| BIG_CAR | ALL | GAS | PRIVATE | NON_FRGT | W_NO_CENTR | 1,067,674 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | FED_GOV | NON_FRGT | W_NO_CENTR | 5,523 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | GAS | S&L_GOV | NON_FRGT | W_NO_CENTR | 34,177 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | DIESEL | TAXI | NON_FRGT | W_NO_CENTR | 1,138 | 24.8 | 42,826 | 0.0 |
| BIG_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | W_NO_CENTR | 76,235 | 24.8 | 10,803 | 0.0 |
| BIG_CAR | ALL | DIESEL | S&L_GOV | NON_FRGT | W_NO_CENTR | 2,440 | 24.8 | 11,242 | 0.0 |
| CYCLE | | | | ALL | W_NO_CENTR | 886,173 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | HIGHINC | PERSONAL | W_NO_CENTR | 364,194 | 50.0 | 2,013 | 0.0 |
| CYCLE | ALL | GAS | MIDINC | PERSONAL | W_NO_CENTR | 365,962 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | LOWINC | PERSONAL | W_NO_CENTR | 153,810 | 50.0 | 2,908 | 0.0 |
| CYCLE | ALL | GAS | S&L_GOV | NON_FRGT | W_NO_CENTR | 2,193 | 50.0 | 2,279 | 0.0 |
| IC_BUS | | | | ALL | W_NO_CENTR | 905 | 5.9 | 61,142 | 0.0 |
| TRANS_BUS | | | | ALL | W_NO_CENTR | 2,346 | 3.8 | 35,910 | 0.0 |
| TRANS_BUS | ALL | DIESEL | FHBUS | NON_FRGT | W_NO_CENTR | 2,346 | 3.8 | 35,910 | 0.0 |
| OTHER_BUS | | | | ALL | W_NO_CENTR | 36,808 | 7.3 | 7,405 | 0.0 |
| OTHER_BUS | ALL | GAS | PRIVATE | NON_FRGT | W_NO_CENTR | 8,528 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | S&L_GOV | NON_FRGT | W_NO_CENTR | 27,403 | 7.4 | 7,396 | 0.0 |
| SU_2A_4T | | | | ALL | W_NO_CENTR | 2,763,103 | 13.4 | 9,579 | 0.1 |
| SU_2A_4T | 00-10 | GAS | HIGHINC | PERSONAL | W_NO_CENTR | 488,168 | 13.9 | 10,332 | 0.0 |
| SU_2A_4T | 00-10 | GAS | MIDINC | PERSONAL | W_NO_CENTR | 706,248 | 14.2 | 9,604 | 0.0 |
| SU_2A_4T | 00-10 | GAS | LOWINC | PERSONAL | W_NO_CENTR | 434,612 | 14.2 | 7,737 | 0.0 |
| SU_2A_4T | 00-10 | GAS | FED_GOV | NON_FRGT | W_NO_CENTR | 15,240 | 13.9 | 6,424 | 0.2 |
| SU_2A_4T | 00-10 | GAS | S&L_GOV | NON_FRGT | W_NO_CENTR | 56,607 | 13.9 | 6,424 | 0.2 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_2A_4T | 00-10 | GAS | OTHER | ALL | W_NO_CENTR | 1,022,470 | 12.5 | 10,212 | 0.2 |
| SU_2A_4T | 00-10 | DIESEL | HIGHINC | PERSONAL | W_NO_CENTR | 4,463 | 16.8 | 6,445 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | MIDINC | PERSONAL | W_NO_CENTR | 6,457 | 17.1 | 5,991 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | LOWINC | PERSONAL | W_NO_CENTR | 3,974 | 17.1 | 4,826 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | OTHER | ALL | W_NO_CENTR | 24,863 | 12.5 | 11,659 | 0.2 |
| SU_2A_6T | | | | ALL | W_NO_CENTR | 855,672 | 7.4 | 9,640 | 0.9 |
| SU_2A_6T | LT 26 | GAS | OTHER | ALL | W_NO_CENTR | 703,538 | 8.1 | 8,672 | 0.5 |
| SU_2A_6T | LT 26 | DIESEL | S&L_GOV | NON_FRGT | W_NO_CENTR | 4,184 | 8.4 | 20,092 | 0.7 |
| SU_2A_6T | LT 26 | DIESEL | OTHER | ALL | W_NO_CENTR | 1,963 | 8.3 | 19,849 | 0.6 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FARM | W_NO_CENTR | 2,479 | 5.8 | 13,340 | 2.2 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FOOD | W_NO_CENTR | 5,423 | 5.3 | 17,396 | 1.7 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | BUILDING | W_NO_CENTR | 1,710 | 5.4 | 10,335 | 2.4 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FETROLEUM | W_NO_CENTR | 3,240 | 5.0 | 18,014 | 2.1 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | NON_FRGT | W_NO_CENTR | 1,147 | 6.8 | 10,426 | 2.1 |
| SU_2A_6T | GT 26 | GAS | FARM | FARM | W_NO_CENTR | 62,308 | 5.9 | 4,920 | 2.1 |
| SU_2A_6T | GT 26 | GAS | FARM | CHEMICAL | W_NO_CENTR | 1,174 | 5.3 | 7,527 | 2.2 |
| SU_2A_6T | GT 26 | GAS | U,S & C | BUILDING | W_NO_CENTR | 3,782 | 5.8 | 13,438 | 2.5 |
| SU_2A_6T | GT 26 | GAS | U,S & C | NON_FRGT | W_NO_CENTR | 3,351 | 3.4 | 14,280 | 1.8 |
| SU_2A_6T | GT 26 | GAS | LOCAL_FH | FARM | W_NO_CENTR | 1,884 | 5.3 | 21,616 | 2.2 |
| SU_2A_6T | GT 26 | GAS | IC_PRIV | FARM | W_NO_CENTR | 1,122 | 5.3 | 23,105 | 1.7 |
| SU_2A_6T | GT 26 | GAS | IC_PRIV | FOOD | W_NO_CENTR | 1,463 | 4.9 | 35,824 | 1.4 |
| SU_2A_6T | GT 26 | GAS | IC_PRIV | BUILDING | W_NO_CENTR | 1,046 | 6.1 | 14,602 | 2.1 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | FOOD | W_NO_CENTR | 2,989 | 8.2 | 5,392 | 1.9 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | PETROLEUM | W_NO_CENTR | 9,748 | 3.5 | 12,422 | 2.1 |
| SU_2A_6T | GT 26 | DIESEL | FARM | FARM | W_NO_CENTR | 4,016 | 8.9 | 2,644 | 2.1 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | BUILDING | W_NO_CENTR | 1,399 | 6.4 | 15,482 | 3.0 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | PETROLEUM | W_NO_CENTR | 2,107 | 4.6 | 7,847 | 2.1 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | NON_FRGT | W_NO_CENTR | 2,342 | 7.1 | 5,173 | 1.8 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | FARM | W_NO_CENTR | 2,307 | 8.1 | 58,022 | 2.1 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | MIXED | W_NO_CENTR | 1,679 | 8.3 | 27,460 | 1.8 |
| SU_2A_6T | GT 26 | DIESEL | IC_SPEC | HHG | W_NO_CENTR | 1,914 | 5.8 | 75,028 | 1.7 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | FOOD | W_NO_CENTR | 2,389 | 7.9 | 42,550 | 1.3 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | PETROLEUM | W_NO_CENTR | 1,669 | 6.5 | 18,655 | 1.8 |
| SU_2A_6T | GT 26 | DIESEL | OWNER_OP | FURNITURE | W_NO_CENTR | 1,670 | 7.5 | 44,821 | 1.7 |
| SU_3A | | | | ALL | W_NO_CENTR | 128,931 | 5.1 | 17,122 | 3.0 |
| SU_3A | LT 26 | GAS | OTHER | ALL | W_NO_CENTR | 39,750 | 5.6 | 9,818 | 1.3 |
| SU_3A | 26-33 | GAS | FARM | FARM | W_NO_CENTR | 7,670 | 5.5 | 5,219 | 2.1 |
| SU_3A | 26-33 | DIESEL | PRIVATE | FOREST | W_NO_CENTR | 1,342 | 6.9 | 2,001 | 2.0 |
| SU_3A | 26-33 | DIESEL | PRIVATE | PETROLEUM | W_NO_CENTR | 1,514 | 6.4 | 15,006 | 1.5 |
| SU_3A | 26-33 | DIESEL | U,S & C | BUILDING | W_NO_CENTR | 1,473 | 5.8 | 28,010 | 3.6 |
| SU_3A | 26-33 | DIESEL | LOCAL_FH | BUILDING | W_NO_CENTR | 1,473 | 6.9 | 34,013 | 3.6 |
| SU_3A | 33-55 | GAS | FARM | FARM | W_NO_CENTR | 10,001 | 4.6 | 7,430 | 2.2 |
| SU_3A | 33-55 | GAS | U,S & C | BUILDING | W_NO_CENTR | 1,615 | 3.8 | 12,370 | 3.4 |
| SU_3A | 33-55 | GAS | LOCAL_FH | FARM | W_NO_CENTR | 1,060 | 4.6 | 22,600 | 2.2 |
| SU_3A | 33-55 | DIESEL | FRIVATE | BUILDING | W_NO_CENTR | 2,624 | 4.8 | 13,453 | 1.8 |
| SU_3A | 33-55 | DIESEL | FARM | FARM | W_NO_CENTR | 1,578 | 6.3 | 13,353 | 1.9 |

FIGURE D-6 (cont.)

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_3A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | W_NO_CENTR | 7,169 | 4.5 | 14,600 | 1.5 |
| SU_3A | 33-55 | DIESEL | U.S & C | BUILDING | W_NO_CENTR | 6,020 | 4.7 | 14,257 | 2.0 |
| SU_3A | 33-55 | DIESEL | LOCAL_FH | FARM | W_NO_CENTR | 1,045 | 6.5 | 49,373 | 1.7 |
| SU_3A | GT 55 | GAS | FARM | FARM | W_NO_CENTR | 3,074 | 4.5 | 1,422 | 5.1 |
| SU_3A | GT 55 | DIESEL | U.S & C | BUILDING | W_NO_CENTR | 5,568 | 5.1 | 21,133 | 6.1 |
| SU_3A | GT 55 | DIESEL | LOCAL_FH | BUILDING | W_NO_CENTR | 1,039 | 6.3 | 20,468 | 6.9 |
| | | | | | | | | | |
| COMB_34A | | | | ALL | W_NO_CENTR | 43,234 | 5.3 | 32,355 | 3.0 |
| COMB_34A | LT 33 | DIESEL | U.S & C | MACHINERY | W_NO_CENTR | 1,178 | 6.7 | 11,913 | 2.7 |
| COMB_34A | 33-55 | GAS | LOCAL_FH | MIXED | W_NO_CENTR | 1,764 | 4.2 | 13,736 | 2.2 |
| COMB_34A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | W_NO_CENTR | 2,763 | 5.0 | 13,419 | 2.0 |
| COMB_34A | 33-55 | DIESEL | LOCAL_FH | MIXED | W_NO_CENTR | 1,008 | 5.0 | 14,876 | 2.1 |
| COMB_34A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | W_NO_CENTR | 8,814 | 5.1 | 13,497 | 3.1 |
| COMB_34A | GT 55 | DIESEL | IC_PRIV | FARM | W_NO_CENTR | 1,077 | 5.0 | 49,135 | 4.0 |
| | | | | | | | | | |
| COMB_56A | | | | ALL | W_NO_CENTR | 88,395 | 4.7 | 60,130 | 7.5 |
| COMB_56A | GT 55 | DIESEL | FARM | FARM | W_NO_CENTR | 1,157 | 4.7 | 21,397 | 9.7 |
| COMB_56A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | W_NO_CENTR | 10,549 | 4.7 | 13,497 | 7.4 |
| COMB_56A | GT 55 | DIESEL | LOCAL_FH | MIXED | W_NO_CENTR | 1,930 | 4.8 | 22,449 | 7.7 |
| COMB_56A | GT 55 | DIESEL | IC_GEN | MIXED | W_NO_CENTR | 5,276 | 4.8 | 103,136 | 9.1 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | FARM | W_NO_CENTR | 1,795 | 4.6 | 87,097 | 7.9 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | FOOD | W_NO_CENTR | 1,784 | 4.5 | 90,100 | 6.2 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | BUILDING | W_NO_CENTR | 1,691 | 4.9 | 71,342 | 8.0 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | CHEMICAL | W_NO_CENTR | 1,028 | 5.1 | 72,432 | 7.8 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | PETROLEUM | W_NO_CENTR | 1,941 | 4.9 | 72,466 | 7.7 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | MIXED | W_NO_CENTR | 1,640 | 4.7 | 80,948 | 6.9 |
| COMB_56A | GT 55 | DIESEL | IC_EXEMP | FARM | W_NO_CENTR | 6,478 | 4.5 | 81,612 | 9.3 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FARM | W_NO_CENTR | 2,923 | 4.8 | 58,016 | 9.0 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FOREST | W_NO_CENTR | 1,180 | 4.8 | 46,361 | 5.7 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FOOD | W_NO_CENTR | 4,295 | 4.6 | 67,325 | 6.4 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | BUILDING | W_NO_CENTR | 2,002 | 4.5 | 53,980 | 8.4 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | CHEMICAL | W_NO_CENTR | 1,193 | 4.9 | 75,296 | 7.2 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | PETROLEUM | W_NO_CENTR | 1,898 | 5.0 | 68,841 | 8.0 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | MACHINERY | W_NO_CENTR | 1,145 | 5.0 | 53,705 | 9.1 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FARM | W_NO_CENTR | 3,969 | 4.5 | 84,246 | 8.3 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FOOD | W_NO_CENTR | 1,602 | 4.4 | 92,263 | 6.1 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | MIXED | W_NO_CENTR | 1,681 | 4.6 | 82,641 | 7.6 |
| | | | | | | | | | |
| DOUBLES | | | | ALL | W_NO_CENTR | 4,553 | 4.7 | 71,335 | 8.6 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SMALL_CAR | | | | ALL | W_SO_CENTR | 3,055,831 | 20.7 | 8,869 | 0.0 |
| SMALL_CAR | ALL | GAS | HIGHINC | PERSONAL | W_SO_CENTR | 792,455 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | MIDINC | PERSONAL | W_SO_CENTR | 1,012,855 | 20.4 | 9,114 | 0.0 |
| SMALL_CAR | ALL | GAS | LOWINC | PERSONAL | W_SO_CENTR | 709,504 | 20.0 | 7,159 | 0.0 |
| SMALL_CAR | ALL | GAS | PRIVATE | NON_FRGT | W_SO_CENTR | 454,802 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | S&L_GOV | NON_FRGT | W_SO_CENTR | 4,497 | 20.8 | 10,663 | 0.0 |
| SMALL_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | W_SO_CENTR | 79,556 | 33.3 | 10,050 | 0.0 |
| | | | | | | | | | |
| BIG_CAR | | | | ALL | W_SO_CENTR | 9,489,412 | 15.5 | 9,268 | 0.0 |
| BIG_CAR | ALL | GAS | HIGHINC | PERSONAL | W_SO_CENTR | 2,629,624 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | MIDINC | PERSONAL | W_SO_CENTR | 3,132,926 | 15.4 | 9,085 | 0.0 |
| BIG_CAR | ALL | GAS | LOWINC | PERSONAL | W_SO_CENTR | 2,063,747 | 15.3 | 7,122 | 0.0 |
| BIG_CAR | ALL | GAS | TAXI | NON_FRGT | W_SO_CENTR | 21,134 | 15.4 | 40,622 | 0.0 |
| BIG_CAR | ALL | GAS | PRIVATE | NON_FRGT | W_SO_CENTR | 1,416,174 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | FED_GOV | NON_FRGT | W_SO_CENTR | 6,981 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | GAS | S&L_GOV | NON_FRGT | W_SO_CENTR | 107,988 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | DIESEL | TAXI | NON_FRGT | W_SO_CENTR | 1,509 | 24.8 | 42,826 | 0.0 |
| BIG_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | W_SO_CENTR | 101,119 | 24.8 | 10,803 | 0.0 |
| BIG_CAR | ALL | DIESEL | S&L_GOV | NON_FRGT | W_SO_CENTR | 7,711 | 24.8 | 11,242 | 0.0 |
| | | | | | | | | | |
| CYCLE | | | | ALL | W_SO_CENTR | 640,237 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | HIGHINC | PERSONAL | W_SO_CENTR | 261,963 | 50.0 | 2,013 | 0.0 |
| CYCLE | ALL | GAS | MIDINC | PERSONAL | W_SO_CENTR | 263,235 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | LOWINC | PERSONAL | W_SO_CENTR | 110,635 | 50.0 | 2,908 | 0.0 |
| CYCLE | ALL | GAS | S&L_GOV | NON_FRGT | W_SO_CENTR | 4,394 | 50.0 | 2,279 | 0.0 |
| | | | | | | | | | |
| IC_BUS | | | | ALL | W_SO_CENTR | 806 | 5.9 | 61,142 | 0.0 |
| | | | | | | | | | |
| TRANS_BUS | | | | ALL | W_SO_CENTR | 2,089 | 3.8 | 35,910 | 0.0 |
| TRANS_BUS | ALL | DIESEL | FHBUS | NON_FRGT | W_SO_CENTR | 2,089 | 3.8 | 35,910 | 0.0 |
| | | | | | | | | | |
| OTHER_BUS | | | | ALL | W_SO_CENTR | 68,721 | 7.3 | 7,400 | 0.0 |
| OTHER_BUS | ALL | GAS | PRIVATE | NON_FRGT | W_SO_CENTR | 27,041 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | S&L_GOV | NON_FRGT | W_SO_CENTR | 40,280 | 7.4 | 7,396 | 0.0 |
| | | | | | | | | | |
| SU_2A_4T | | | | ALL | W_SO_CENTR | 4,198,625 | 13.6 | 11,688 | 0.3 |
| SU_2A_4T | 00-10 | GAS | HIGHINC | PERSONAL | W_SO_CENTR | 810,257 | 13.8 | 11,712 | 0.0 |
| SU_2A_4T | 00-10 | GAS | MIDINC | PERSONAL | W_SO_CENTR | 1,172,224 | 14.1 | 10,887 | 0.0 |
| SU_2A_4T | 00-10 | GAS | LOWINC | PERSONAL | W_SO_CENTR | 721,365 | 14.1 | 8,770 | 0.0 |
| SU_2A_4T | 00-10 | GAS | FED_GOV | NON_FRGT | W_SO_CENTR | 22,017 | 13.9 | 6,424 | 0.8 |
| SU_2A_4T | 00-10 | GAS | S&L_GOV | NON_FRGT | W_SO_CENTR | 124,189 | 13.9 | 6,424 | 0.8 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_2A_4T | 00-10 | GAS | OTHER | ALL | W_SO_CENTR | 1,204,117 | 12.5 | 14,068 | 0.8 |
| SU_2A_4T | 00-10 | DIESEL | HIGHINC | PERSONAL | W_SO_CENTR | 18,513 | 17.1 | 23,803 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | MIDINC | PERSONAL | W_SO_CENTR | 26,784 | 17.5 | 22,125 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | LOWINC | PERSONAL | W_SO_CENTR | 16,482 | 17.5 | 17,825 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | OTHER | ALL | W_SO_CENTR | 82,675 | 17.5 | 15,588 | 0.8 |
| SU_2A_6T | | | | ALL | W_SO_CENTR | 572,398 | 7.1 | 14,813 | 0.5 |
| SU_2A_6T | LT 26 | GAS | OTHER | ALL | W_SO_CENTR | 507,949 | 7.3 | 13,730 | 0.3 |
| SU_2A_6T | LT 26 | DIESEL | S&L_GOV | NON_FRGT | W_SO_CENTR | 9,179 | 8.4 | 20,092 | 0.3 |
| SU_2A_6T | LT 26 | DIESEL | OTHER | ALL | W_SO_CENTR | 3,489 | 9.7 | 20,218 | 0.3 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FOOD | W_SO_CENTR | 3,809 | 4.6 | 21,832 | 1.2 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | BUILDING | W_SO_CENTR | 1,187 | 5.8 | 20,983 | 1.8 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | OTHER | W_SO_CENTR | 1,353 | 5.1 | 15,743 | 1.5 |
| SU_2A_6T | GT 26 | GAS | FARM | FARM | W_SO_CENTR | 3,466 | 5.3 | 5,530 | 1.7 |
| SU_2A_6T | GT 26 | GAS | U,S & C | BUILDING | W_SO_CENTR | 1,319 | 4.8 | 12,702 | 2.0 |
| SU_2A_6T | GT 26 | GAS | U,S & C | NON_FRGT | W_SO_CENTR | 1,958 | 4.6 | 10,207 | 1.4 |
| SU_2A_6T | GT 26 | GAS | IC_PRIV | FARM | W_SO_CENTR | 1,064 | 5.7 | 20,422 | 1.5 |
| SU_2A_6T | GT 26 | GAS | IC_PRIV | FOOD | W_SO_CENTR | 1,476 | 5.0 | 34,122 | 1.3 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | PETROLEUM | W_SO_CENTR | 2,353 | 9.8 | 35,787 | 1.5 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | NON_FRGT | W_SO_CENTR | 3,708 | 5.7 | 10,150 | 1.6 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | BUILDING | W_SO_CENTR | 6,511 | 7.3 | 20,051 | 1.6 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | CHEMICAL | W_SO_CENTR | 1,165 | 5.2 | 30,011 | 1.6 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | PETROLEUM | W_SO_CENTR | 2,019 | 5.8 | 25,009 | 1.5 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | OTHER | W_SO_CENTR | 1,310 | 8.1 | 20,365 | 1.6 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | FOOD | W_SO_CENTR | 2,466 | 7.9 | 42,577 | 1.3 |
| SU_3A | | | | ALL | W_SO_CENTR | 106,247 | 5.0 | 20,187 | 2.2 |
| SU_3A | LT 26 | GAS | OTHER | ALL | W_SO_CENTR | 27,974 | 6.5 | 12,371 | 1.0 |
| SU_3A | 26-33 | DIESEL | U,S & C | BUILDING | W_SO_CENTR | 5,147 | 5.2 | 8,690 | 2.2 |
| SU_3A | 33-55 | GAS | FARM | FARM | W_SO_CENTR | 1,147 | 4.3 | 10,461 | 1.3 |
| SU_3A | 33-55 | DIESEL | PRIVATE | BUILDING | W_SO_CENTR | 5,509 | 5.1 | 16,894 | 1.4 |
| SU_3A | 33-55 | DIESEL | PRIVATE | NON_FRGT | W_SO_CENTR | 1,091 | 5.4 | 14,329 | 1.6 |
| SU_3A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | W_SO_CENTR | 15,727 | 4.5 | 14,600 | 0.7 |
| SU_3A | 33-55 | DIESEL | U,S & C | BUILDING | W_SO_CENTR | 9,545 | 3.9 | 23,239 | 1.4 |
| SU_3A | 33-55 | DIESEL | U,S & C | NON_FRGT | W_SO_CENTR | 1,016 | 4.5 | 39,488 | 0.7 |
| SU_3A | 33-55 | DIESEL | LOCAL_FH | BUILDING | W_SO_CENTR | 1,171 | 5.9 | 39,645 | 3.0 |
| SU_3A | 33-55 | DIESEL | IC_PRIV | NON_FRGT | W_SO_CENTR | 1,091 | 4.9 | 21,293 | 1.3 |
| SU_3A | GT 55 | DIESEL | U,S & C | BUILDING | W_SO_CENTR | 2,331 | 4.6 | 12,615 | 3.9 |
| COMB_34A | | | | ALL | W_SO_CENTR | 55,397 | 5.0 | 29,467 | 3.2 |
| COMB_34A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | W_SO_CENTR | 3,933 | 5.0 | 13,419 | 1.8 |
| COMB_34A | 33-55 | DIESEL | LOCAL_FH | MIXED | W_SO_CENTR | 1,435 | 5.6 | 21,616 | 2.2 |
| COMB_34A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | W_SO_CENTR | 12,544 | 5.1 | 13,497 | 3.2 |
| COMB_56A | | | | ALL | W_SO_CENTR | 108,780 | 4.7 | 54,626 | 7.2 |
| COMB_56A | LT 55 | DIESEL | FARM | FARM | W_SO_CENTR | 1,148 | 5.6 | 7,170 | 5.9 |

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| COMB_56A | GT 55 | DIESEL | FARM | FARM | W_SO_CENTR | 1,697 | 5.3 | 30,897 | 7.0 |
| COMB_56A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | W_SO_CENTR | 15,015 | 4.7 | 13,497 | 6.1 |
| COMB_56A | GT 55 | DIESEL | U,S & C | BUILDING | W_SO_CENTR | 1,774 | 5.1 | 58,721 | 7.8 |
| COMB_56A | GT 55 | DIESEL | LOCAL_FH | MIXED | W_SO_CENTR | 2,258 | 4.7 | 28,902 | 6.0 |
| COMB_56A | GT 55 | DIESEL | IC_GEN | MIXED | W_SO_CENTR | 5,343 | 4.8 | 103,119 | 8.3 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | FARM | W_SO_CENTR | 1,443 | 4.7 | 82,827 | 7.7 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | FOOD | W_SO_CENTR | 1,680 | 4.5 | 90,172 | 6.4 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | BUILDING | W_SO_CENTR | 2,519 | 4.9 | 81,124 | 8.0 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | CHEMICAL | W_SO_CENTR | 1,117 | 5.1 | 67,716 | 8.0 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | PETROLEUM | W_SO_CENTR | 2,737 | 4.6 | 75,849 | 7.5 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | MIXED | W_SO_CENTR | 1,546 | 4.7 | 80,929 | 7.1 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | NON_FRGT | W_SO_CENTR | 1,294 | 4.3 | 39,522 | 5.9 |
| COMB_56A | GT 55 | DIESEL | IC_EXEMP | FARM | W_SO_CENTR | 2,657 | 4.5 | 80,346 | 7.1 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FARM | W_SO_CENTR | 2,412 | 4.7 | 58,584 | 7.6 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FOREST | W_SO_CENTR | 1,224 | 4.8 | 46,361 | 9.0 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FOOD | W_SO_CENTR | 4,787 | 4.7 | 75,384 | 6.3 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | BUILDING | W_SO_CENTR | 2,753 | 4.6 | 57,004 | 7.7 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | CHEMICAL | W_SO_CENTR | 2,049 | 4.9 | 62,615 | 7.3 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | PETROLEUM | W_SO_CENTR | 1,756 | 5.0 | 77,622 | 8.3 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | MACHINERY | W_SO_CENTR | 1,546 | 3.8 | 47,234 | 8.3 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | NON_FRGT | W_SO_CENTR | 1,084 | 4.9 | 59,117 | 7.0 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FARM | W_SO_CENTR | 3,421 | 4.4 | 94,959 | 7.8 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FOOD | W_SO_CENTR | 1,676 | 4.5 | 86,419 | 6.3 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | BUILDING | W_SO_CENTR | 2,231 | 4.7 | 66,831 | 7.7 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | MIXED | W_SO_CENTR | 1,642 | 4.6 | 82,522 | 7.8 |
| DOUBLES | | | | ALL | W_SO_CENTR | 5,720 | 4.6 | 74,647 | 8.2 |
| DOUBLES | GT 55 | DIESEL | IC_GEN | MIXED | W_SO_CENTR | 1,216 | 4.2 | 113,311 | 7.7 |
| DOUBLES | GT 55 | DIESEL | IC_SPEC | FARM | W_SO_CENTR | 1,036 | 5.1 | 55,300 | 8.5 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SMALL_CAR | | | | ALL | MOUNTAIN | 1,619,251 | 20.7 | 8,869 | 0.0 |
| SMALL_CAR | ALL | GAS | HIGHINC | PERSONAL | MOUNTAIN | 420,069 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | MIDINC | PERSONAL | MOUNTAIN | 536,900 | 20.4 | 9,114 | 0.0 |
| SMALL_CAR | ALL | GAS | LOWINC | PERSONAL | MOUNTAIN | 376,097 | 20.0 | 7,159 | 0.0 |
| SMALL_CAR | ALL | GAS | PRIVATE | NON_FRGT | MOUNTAIN | 241,084 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | S&L_GOV | NON_FRGT | MOUNTAIN | 1,662 | 20.8 | 10,663 | 0.0 |
| SMALL_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | MOUNTAIN | 42,171 | 33.3 | 10,050 | 0.0 |
| BIG_CAR | | | | ALL | MOUNTAIN | 5,017,062 | 15.5 | 9,265 | 0.0 |
| BIG_CAR | ALL | GAS | HIGHINC | PERSONAL | MOUNTAIN | 1,393,925 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | MIDINC | PERSONAL | MOUNTAIN | 1,660,718 | 15.4 | 9,085 | 0.0 |
| BIG_CAR | ALL | GAS | LOWINC | PERSONAL | MOUNTAIN | 1,093,962 | 15.3 | 7,122 | 0.0 |
| BIG_CAR | ALL | GAS | TAXI | NON_FRGT | MOUNTAIN | 11,203 | 15.4 | 40,622 | 0.0 |
| BIG_CAR | ALL | GAS | PRIVATE | NON_FRGT | MOUNTAIN | 750,693 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | FED_GOV | NON_FRGT | MOUNTAIN | 8,784 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | GAS | S&L_GOV | NON_FRGT | MOUNTAIN | 39,900 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | MOUNTAIN | 53,601 | 24.8 | 10,803 | 0.0 |
| BIG_CAR | ALL | DIESEL | S&L_GOV | NON_FRGT | MOUNTAIN | 2,849 | 24.8 | 11,242 | 0.0 |
| CYCLE | | | | ALL | MOUNTAIN | 549,584 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | HIGHINC | PERSONAL | MOUNTAIN | 225,594 | 50.0 | 2,013 | 0.0 |
| CYCLE | ALL | GAS | MIDINC | PERSONAL | MOUNTAIN | 226,689 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | LOWINC | PERSONAL | MOUNTAIN | 95,275 | 50.0 | 2,908 | 0.0 |
| CYCLE | ALL | GAS | S&L_GOV | NON_FRGT | MOUNTAIN | 1,983 | 50.0 | 2,279 | 0.0 |
| IC_BUS | | | | ALL | MOUNTAIN | 918 | 5.9 | 61,142 | 0.0 |
| TRANS_BUS | | | | ALL | MOUNTAIN | 2,381 | 3.8 | 35,910 | 0.0 |
| TRANS_BUS | ALL | DIESEL | FHBUS | NON_FRGT | MOUNTAIN | 2,381 | 3.8 | 35,910 | 0.0 |
| OTHER_BUS | | | | ALL | MOUNTAIN | 18,047 | 7.3 | 7,411 | 0.0 |
| OTHER_BUS | ALL | GAS | PRIVATE | NON_FRGT | MOUNTAIN | 4,432 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | S&L_GOV | NON_FRGT | MOUNTAIN | 11,788 | 7.4 | 7,396 | 0.0 |
| SU_2A_4T | | | | ALL | MOUNTAIN | 2,647,988 | 14.3 | 9,881 | 0.1 |
| SU_2A_4T | 00-10 | GAS | HIGHINC | PERSONAL | MOUNTAIN | 589,916 | 14.4 | 10,224 | 0.0 |
| SU_2A_4T | 00-10 | GAS | MIDINC | PERSONAL | MOUNTAIN | 853,450 | 14.7 | 9,504 | 0.0 |
| SU_2A_4T | 00-10 | GAS | LOWINC | PERSONAL | MOUNTAIN | 525,198 | 14.7 | 7,657 | 0.0 |
| SU_2A_4T | 00-10 | GAS | FED_GOV | NON_FRGT | MOUNTAIN | 32,767 | 13.9 | 6,424 | 0.4 |
| SU_2A_4T | 00-10 | GAS | S&L_GOV | NON_FRGT | MOUNTAIN | 44,789 | 13.9 | 6,424 | 0.4 |
| SU_2A_4T | 00-10 | GAS | OTHER | ALL | MOUNTAIN | 550,474 | 13.2 | 11,830 | 0.4 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_2A_4T | 00-10 | DIESEL | HIGHINC | PERSONAL | MOUNTAIN | 11,427 | 17.6 | 14,904 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | MIDINC | PERSONAL | MOUNTAIN | 16,532 | 18.0 | 13,854 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | LOWINC | PERSONAL | MOUNTAIN | 10,173 | 18.0 | 11,161 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | OTHER | ALL | MOUNTAIN | 13,263 | 19.1 | 35,989 | 0.4 |
| | | | | | | | | | |
| SU_2A_6T | | | | ALL | MOUNTAIN | 354,027 | 7.3 | 11,737 | 0.7 |
| SU_2A_6T | LT 26 | GAS | OTHER | ALL | MOUNTAIN | 293,057 | 7.5 | 10,570 | 0.5 |
| SU_2A_6T | LT 26 | DIESEL | S&L_GOV | NON_FRGT | MOUNTAIN | 3,310 | 8.4 | 20,092 | 0.6 |
| SU_2A_6T | LT 26 | DIESEL | OTHER | ALL | MOUNTAIN | 6,330 | 14.3 | 18,147 | 0.2 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FOOD | MOUNTAIN | 2,100 | 5.1 | 17,478 | 1.5 |
| SU_2A_6T | GT 26 | GAS | FARM | FARM | MOUNTAIN | 9,760 | 6.1 | 6,706 | 2.0 |
| SU_2A_6T | GT 26 | GAS | U,S & C | BUILDING | MOUNTAIN | 2,300 | 6.4 | 7,705 | 2.1 |
| SU_2A_6T | GT 26 | GAS | IC_PRIV | FARM | MOUNTAIN | 1,536 | 5.7 | 18,573 | 1.6 |
| SU_2A_6T | GT 26 | GAS | IC_PRIV | FOOD | MOUNTAIN | 1,044 | 4.8 | 34,896 | 1.3 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | FOOD | MOUNTAIN | 1,545 | 7.5 | 12,297 | 1.1 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | PETROLEUM | MOUNTAIN | 2,564 | 7.5 | 18,673 | 1.9 |
| SU_2A_6T | GT 26 | DIESEL | FARM | FARM | MOUNTAIN | 3,069 | 6.8 | 6,864 | 2.1 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | BUILDING | MOUNTAIN | 1,841 | 5.6 | 12,688 | 2.6 |
| SU_2A_6T | GT 26 | DIESEL | U,S & C | NON_FRGT | MOUNTAIN | 2,069 | 7.7 | 5,086 | 1.0 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | FOOD | MOUNTAIN | 1,810 | 7.9 | 42,457 | 1.3 |
| | | | | | | | | | |
| SU_3A | | | | ALL | MOUNTAIN | 82,145 | 5.0 | 17,055 | 3.1 |
| SU_3A | LT 26 | GAS | OTHER | ALL | MOUNTAIN | 14,738 | 6.1 | 8,518 | 1.3 |
| SU_3A | 26-33 | GAS | FARM | FARM | MOUNTAIN | 1,036 | 6.4 | 3,787 | 2.1 |
| SU_3A | 26-33 | DIESEL | PRIVATE | PETROLEUM | MOUNTAIN | 1,164 | 5.5 | 17,274 | 1.5 |
| SU_3A | 26-33 | DIESEL | PRIVATE | OTHER | MOUNTAIN | 1,297 | 5.8 | 15,529 | 2.2 |
| SU_3A | 26-33 | DIESEL | FARM | FARM | MOUNTAIN | 1,775 | 4.7 | 16,573 | 2.1 |
| SU_3A | 26-33 | DIESEL | U,S & C | BUILDING | MOUNTAIN | 2,922 | 5.9 | 12,243 | 3.0 |
| SU_3A | 26-33 | DIESEL | LOCAL_FH | NON_FRGT | MOUNTAIN | 1,066 | 3.3 | 9,399 | 1.4 |
| SU_3A | 33-55 | GAS | FARM | FARM | MOUNTAIN | 1,373 | 4.8 | 6,492 | 2.4 |
| SU_3A | 33-55 | DIESEL | PRIVATE | BUILDING | MOUNTAIN | 1,732 | 3.9 | 14,869 | 1.7 |
| SU_3A | 33-55 | DIESEL | FARM | FARM | MOUNTAIN | 2,292 | 7.2 | 8,223 | 2.2 |
| SU_3A | 33-55 | DIESEL | FED_GOV | NON_FRGT | MOUNTAIN | 2,833 | 4.5 | 14,600 | 1.6 |
| SU_3A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | MOUNTAIN | 5,672 | 4.5 | 14,600 | 1.6 |
| SU_3A | 33-55 | DIESEL | U,S & C | BUILDING | MOUNTAIN | 4,581 | 5.0 | 14,121 | 2.8 |
| SU_3A | 33-55 | DIESEL | U,S & C | NON_FRGT | MOUNTAIN | 1,573 | 5.1 | 19,185 | 1.8 |
| SU_3A | 33-55 | DIESEL | LOCAL_FH | BUILDING | MOUNTAIN | 1,189 | 5.1 | 21,340 | 4.0 |
| SU_3A | GT 55 | DIESEL | PRIVATE | BUILDING | MOUNTAIN | 1,190 | 4.3 | 20,476 | 5.2 |
| SU_3A | GT 55 | DIESEL | FARM | FARM | MOUNTAIN | 1,171 | 5.3 | 6,845 | 4.7 |
| SU_3A | GT 55 | DIESEL | U,S & C | BUILDING | MOUNTAIN | 6,450 | 4.5 | 15,649 | 5.8 |
| | | | | | | | | | |
| COMB_34A | | | | ALL | MOUNTAIN | 27,685 | 5.3 | 30,309 | 3.2 |
| COMB_34A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | MOUNTAIN | 1,920 | 5.0 | 13,419 | 2.5 |
| COMB_34A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | MOUNTAIN | 6,124 | 5.1 | 13,497 | 3.8 |
| | | | | | | | | | |
| COMB_56A | | | | ALL | MOUNTAIN | 68,230 | 4.7 | 61,100 | 7.5 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| COMB_56A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | MOUNTAIN | 7,331 | 4.7 | 13,497 | 7.7 |
| COMB_56A | GT 55 | DIESEL | U.S & C | BUILDING | MOUNTAIN | 1,317 | 4.8 | 29,630 | 8.9 |
| COMB_56A | GT 55 | DIESEL | IC_GEN | MIXED | MOUNTAIN | 4,879 | 4.8 | 103,130 | 9.3 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | FARM | MOUNTAIN | 1,079 | 4.7 | 75,047 | 7.3 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | FOOD | MOUNTAIN | 1,481 | 4.5 | 90,179 | 6.3 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | BUILDING | MOUNTAIN | 1,618 | 4.7 | 74,806 | 6.3 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | PETROLEUM | MOUNTAIN | 1,750 | 4.9 | 68,769 | 7.9 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | MIXED | MOUNTAIN | 1,362 | 4.7 | 80,937 | 7.1 |
| COMB_56A | GT 55 | DIESEL | IC_EXEMP | FARM | MOUNTAIN | 3,841 | 4.6 | 69,310 | 7.9 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FARM | MOUNTAIN | 2,356 | 4.7 | 61,203 | 7.8 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FOOD | MOUNTAIN | 4,191 | 4.6 | 72,003 | 6.6 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | BUILDING | MOUNTAIN | 1,898 | 3.7 | 59,163 | 8.5 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | PETROLEUM | MOUNTAIN | 1,318 | 4.9 | 78,841 | 8.5 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FARM | MOUNTAIN | 3,258 | 4.4 | 91,595 | 8.2 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FOOD | MOUNTAIN | 1,334 | 4.4 | 92,344 | 6.2 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | MIXED | MOUNTAIN | 1,487 | 4.6 | 82,443 | 7.8 |
| DOUBLES | | | | ALL | MOUNTAIN | 6,711 | 4.6 | 67,287 | 9.0 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SMALL_CAR | | | | ALL | PACIFIC | 4,229,920 | 20.7 | 8,869 | 0.0 |
| SMALL_CAR | ALL | GAS | HIGHINC | PERSONAL | PACIFIC | 1,097,234 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | MIDINC | PERSONAL | PACIFIC | 1,402,400 | 20.4 | 9,114 | 0.0 |
| SMALL_CAR | ALL | GAS | LOWINC | PERSONAL | PACIFIC | 982,380 | 20.0 | 7,159 | 0.0 |
| SMALL_CAR | ALL | GAS | TAXI | NON_FRGT | PACIFIC | 1,219 | 15.4 | 40,622 | 0.0 |
| SMALL_CAR | ALL | GAS | PRIVATE | NON_FRGT | PACIFIC | 629,719 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | S&L_GOV | NON_FRGT | PACIFIC | 5,094 | 20.8 | 10,663 | 0.0 |
| SMALL_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | PACIFIC | 110,153 | 33.3 | 10,059 | 0.0 |
| BIG_CAR | | | | ALL | PACIFIC | 13,113,078 | 15.5 | 9,266 | 0.0 |
| BIG_CAR | ALL | GAS | HIGHINC | PERSONAL | PACIFIC | 3,640,980 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | MIDINC | PERSONAL | PACIFIC | 4,337,852 | 15.4 | 9,085 | 0.0 |
| BIG_CAR | ALL | GAS | LOWINC | PERSONAL | PACIFIC | 2,857,466 | 15.3 | 7,122 | 0.0 |
| BIG_CAR | ALL | GAS | TAXI | NON_FRGT | PACIFIC | 29,262 | 15.4 | 40,622 | 0.0 |
| BIG_CAR | ALL | GAS | PRIVATE | NON_FRGT | PACIFIC | 1,960,836 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | FED_GOV | NON_FRGT | PACIFIC | 12,627 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | GAS | S&L_GOV | NON_FRGT | PACIFIC | 122,320 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | DIESEL | TAXI | NON_FRGT | PACIFIC | 2,089 | 24.8 | 42,826 | 0.0 |
| BIG_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | PACIFIC | 140,009 | 24.8 | 10,803 | 0.0 |
| BIG_CAR | ALL | DIESEL | S&L_GOV | NON_FRGT | PACIFIC | 8,734 | 24.8 | 11,242 | 0.0 |
| CYCLE | | | | ALL | PACIFIC | 1,095,379 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | HIGHINC | PERSONAL | PACIFIC | 446,917 | 50.0 | 2,013 | 0.0 |
| CYCLE | ALL | GAS | MIDINC | PERSONAL | PACIFIC | 449,087 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | LOWINC | PERSONAL | PACIFIC | 188,747 | 50.0 | 2,908 | 0.0 |
| CYCLE | ALL | GAS | S&L_GOV | NON_FRGT | PACIFIC | 10,588 | 50.0 | 2,279 | 0.0 |
| IC_BUS | | | | ALL | PACIFIC | 2,341 | 5.9 | 61,142 | 0.0 |
| IC_BUS | ALL | DIESEL | FHBUS | NON_FRGT | PACIFIC | 2,341 | 5.9 | 61,142 | 0.0 |
| TRANS_BUS | | | | ALL | PACIFIC | 6,070 | 3.8 | 35,910 | 0.0 |
| TRANS_BUS | ALL | DIESEL | FHBUS | NON_FRGT | PACIFIC | 6,070 | 3.8 | 35,910 | 0.0 |
| OTHER_BUS | | | | ALL | PACIFIC | 33,965 | 7.3 | 7,418 | 0.0 |
| OTHER_BUS | ALL | GAS | FHBUS | NON_FRGT | PACIFIC | 3,791 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | PRIVATE | NON_FRGT | PACIFIC | 6,796 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | S&L_GOV | NON_FRGT | PACIFIC | 22,220 | 7.4 | 7,396 | 0.0 |
| SU_2A_4T | | | | ALL | PACIFIC | 4,812,525 | 14.6 | 10,748 | 0.2 |
| SU_2A_4T | 00-10 | GAS | HIGHINC | PERSONAL | PACIFIC | 1,067,517 | 15.0 | 11,356 | 0.0 |
| SU_2A_4T | 00-10 | GAS | MIDINC | PERSONAL | PACIFIC | 1,544,410 | 15.4 | 10,556 | 0.0 |

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_2A_4T | 00-10 | GAS | LOWINC | PERSONAL | PACIFIC | 950,402 | 15.4 | 8,594 | 0.0 |
| SU_2A_4T | 00-10 | GAS | FED_GOV | NON_FRGT | PACIFIC | 40,405 | 13.9 | 6,424 | 0.6 |
| SU_2A_4T | 00-10 | GAS | S&L_GOV | NON_FRGT | PACIFIC | 106,773 | 13.9 | 6,424 | 0.6 |
| SU_2A_4T | 00-10 | GAS | OTHER | ALL | PACIFIC | 1,007,416 | 13.1 | 12,039 | 0.6 |
| SU_2A_4T | 00-10 | DIESEL | HIGHINC | PERSONAL | PACIFIC | 9,955 | 17.8 | 11,785 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | MIDINC | PERSONAL | PACIFIC | 14,402 | 18.2 | 10,955 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | LOWINC | PERSONAL | PACIFIC | 8,863 | 18.2 | 8,825 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | OTHER | ALL | PACIFIC | 62,383 | 13.9 | 28,694 | 0.6 |
| SU_2A_6T | | | | ALL | PACIFIC | 609,485 | 7.2 | 13,555 | 0.5 |
| SU_2A_6T | LT 26 | GAS | OTHER | ALL | PACIFIC | 526,696 | 7.3 | 12,730 | 0.4 |
| SU_2A_6T | LT 26 | DIESEL | S&L_GOV | NON_FRGT | PACIFIC | 7,892 | 8.4 | 20,092 | 0.4 |
| SU_2A_6T | LT 26 | DIESEL | OTHER | ALL | PACIFIC | 10,657 | 14.6 | 19,551 | 0.3 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | FOOD | PACIFIC | 3,652 | 5.8 | 14,535 | 1.2 |
| SU_2A_6T | GT 26 | GAS | PRIVATE | PETROLEUM | PACIFIC | 1,098 | 4.1 | 18,744 | 1.6 |
| SU_2A_6T | GT 26 | GAS | FARM | FARM | PACIFIC | 6,897 | 6.1 | 4,709 | 1.8 |
| SU_2A_6T | GT 26 | GAS | U.S & C | BUILDING | PACIFIC | 2,201 | 6.2 | 8,709 | 1.8 |
| SU_2A_6T | GT 26 | GAS | U.S & C | NON_FRGT | PACIFIC | 3,038 | 3.7 | 8,694 | 1.5 |
| SU_2A_6T | GT 26 | GAS | IC_PRIV | FOOD | PACIFIC | 1,029 | 5.2 | 33,408 | 1.3 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | FOOD | PACIFIC | 2,530 | 6.4 | 13,056 | 1.1 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | PAPER | PACIFIC | 5,403 | 5.2 | 39,758 | 1.4 |
| SU_2A_6T | GT 26 | DIESEL | PRIVATE | PETROLEUM | PACIFIC | 1,672 | 6.9 | 17,837 | 1.6 |
| SU_2A_6T | GT 26 | DIESEL | FARM | FARM | PACIFIC | 1,165 | 10.8 | 2,626 | 1.8 |
| SU_2A_6T | GT 26 | DIESEL | U.S & C | BUILDING | PACIFIC | 2,378 | 6.5 | 13,413 | 2.3 |
| SU_2A_6T | GT 26 | DIESEL | U.S & C | NON_FRGT | PACIFIC | 8,908 | 6.7 | 16,629 | 1.6 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | MIXED | PACIFIC | 2,729 | 9.8 | 20,712 | 1.6 |
| SU_2A_6T | GT 26 | DIESEL | LOCAL_FH | NON_FRGT | PACIFIC | 1,196 | 5.3 | 3,784 | 1.4 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | FOOD | PACIFIC | 1,645 | 7.9 | 42,554 | 1.4 |
| SU_2A_6T | GT 26 | DIESEL | IC_PRIV | BUILDING | PACIFIC | 2,751 | 7.1 | 22,460 | 1.9 |
| SU_3A | | | | ALL | PACIFIC | 100,635 | 5.1 | 19,756 | 2.6 |
| SU_3A | LT 26 | GAS | OTHER | ALL | PACIFIC | 17,701 | 6.3 | 12,449 | 1.2 |
| SU_3A | 26-33 | DIESEL | U.S & C | BUILDING | PACIFIC | 2,613 | 5.2 | 8,523 | 1.8 |
| SU_3A | 26-33 | DIESEL | U.S & C | NON_FRGT | PACIFIC | 7,650 | 5.1 | 19,133 | 1.4 |
| SU_3A | 26-33 | DIESEL | LOCAL_FH | NON_FRGT | PACIFIC | 1,488 | 5.8 | 40,015 | 1.4 |
| SU_3A | 33-55 | DIESEL | PRIVATE | BUILDING | PACIFIC | 2,126 | 4.7 | 16,122 | 2.2 |
| SU_3A | 33-55 | DIESEL | PRIVATE | PETROLEUM | PACIFIC | 1,336 | 6.4 | 27,577 | 1.7 |
| SU_3A | 33-55 | DIESEL | FARM | FARM | PACIFIC | 1,154 | 5.0 | 6,042 | 1.6 |
| SU_3A | 33-55 | DIESEL | FED_GOV | NON_FRGT | PACIFIC | 2,051 | 4.5 | 14,600 | 1.3 |
| SU_3A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | PACIFIC | 13,522 | 4.5 | 14,600 | 1.3 |
| SU_3A | 33-55 | DIESEL | U.S & C | BUILDING | PACIFIC | 9,646 | 5.0 | 14,067 | 2.3 |
| SU_3A | 33-55 | DIESEL | U.S & C | NON_FRGT | PACIFIC | 4,648 | 5.0 | 15,901 | 1.4 |
| SU_3A | 33-55 | DIESEL | LOCAL_FH | BUILDING | PACIFIC | 2,759 | 5.0 | 33,003 | 3.2 |
| SU_3A | 33-55 | DIESEL | LOCAL_FH | NON_FRGT | PACIFIC | 1,548 | 6.8 | 36,118 | 1.3 |
| SU_3A | 33-55 | DIESEL | OWNER_OP | BUILDING | PACIFIC | 2,304 | 5.1 | 20,813 | 2.9 |
| SU_3A | GT 55 | DIESEL | PRIVATE | BUILDING | PACIFIC | 1,432 | 4.1 | 21,266 | 4.2 |
| SU_3A | GT 55 | DIESEL | PRIVATE | PETROLEUM | PACIFIC | 1,751 | 6.1 | 40,551 | 4.2 |
| SU_3A | GT 55 | DIESEL | U.S & C | BUILDING | PACIFIC | 3,168 | 4.4 | 23,998 | 6.5 |

FIGURE D-6 (cont.)

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_3A | GT 55 | DIESEL | IC_PRIV | BUILDING | PACIFIC | 1,121 | 4.5 | 17,834 | 5.4 |
| COMB_34A | | | | ALL | PACIFIC | 52,384 | 5.4 | 23,871 | 2.5 |
| COMB_34A | LT 33 | DIESEL | LOCAL_FH | MIXED | PACIFIC | 1,177 | 8.9 | 20,121 | 1.2 |
| COMB_34A | 33-55 | DIESEL | PRIVATE | FOOD | PACIFIC | 1,351 | 5.8 | 39,860 | 2.2 |
| COMB_34A | 33-55 | DIESEL | S&L_GOV | NON_FRGT | PACIFIC | 5,660 | 5.0 | 13,419 | 1.4 |
| COMB_34A | 33-55 | DIESEL | LOCAL_FH | MIXED | PACIFIC | 2,716 | 5.8 | 21,639 | 1.6 |
| COMB_34A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | PACIFIC | 18,051 | 5.1 | 13,497 | 2.8 |
| COMB_56A | | | | ALL | PACIFIC | 91,396 | 4.7 | 47,187 | 7.8 |
| COMB_56A | LT 55 | DIESEL | LOCAL_FH | MIXED | PACIFIC | 1,213 | 5.3 | 15,312 | 5.5 |
| COMB_56A | GT 55 | DIESEL | PRIVATE | FOOD | PACIFIC | 1,484 | 4.9 | 34,898 | 7.1 |
| COMB_56A | GT 55 | DIESEL | PRIVATE | PETROLEUM | PACIFIC | 1,525 | 5.1 | 81,027 | 10.0 |
| COMB_56A | GT 55 | DIESEL | S&L_GOV | NON_FRGT | PACIFIC | 21,607 | 4.7 | 13,497 | 8.1 |
| COMB_56A | GT 55 | DIESEL | U,S & C | BUILDING | PACIFIC | 1,319 | 5.1 | 36,864 | 9.6 |
| COMB_56A | GT 55 | DIESEL | LOCAL_FH | FARM | PACIFIC | 1,348 | 4.5 | 52,311 | 6.5 |
| COMB_56A | GT 55 | DIESEL | LOCAL_FH | FOREST | PACIFIC | 1,506 | 4.3 | 40,540 | 9.3 |
| COMB_56A | GT 55 | DIESEL | LOCAL_FH | BUILDING | PACIFIC | 1,185 | 5.0 | 39,248 | 9.0 |
| COMB_56A | GT 55 | DIESEL | LOCAL_FH | MIXED | PACIFIC | 3,770 | 4.8 | 25,071 | 7.6 |
| COMB_56A | GT 55 | DIESEL | IC_GEN | MIXED | PACIFIC | 2,792 | 4.8 | 103,102 | 8.6 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | FOOD | PACIFIC | 1,106 | 4.5 | 90,194 | 6.5 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | BUILDING | PACIFIC | 1,962 | 4.8 | 69,705 | 9.1 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | PETROLEUM | PACIFIC | 1,203 | 4.9 | 72,474 | 8.2 |
| COMB_56A | GT 55 | DIESEL | IC_SPEC | MIXED | PACIFIC | 1,017 | 4.7 | 80,953 | 7.3 |
| COMB_56A | GT 55 | DIESEL | IC_EXEMP | FARM | PACIFIC | 2,433 | 4.5 | 77,712 | 7.9 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FARM | PACIFIC | 1,787 | 4.7 | 78,335 | 8.6 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | FOOD | PACIFIC | 4,437 | 4.8 | 55,455 | 6.6 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | BUILDING | PACIFIC | 2,225 | 4.7 | 56,337 | 8.4 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | CHEMICAL | PACIFIC | 1,084 | 5.0 | 57,030 | 7.8 |
| COMB_56A | GT 55 | DIESEL | IC_PRIV | PETROLEUM | PACIFIC | 1,208 | 4.9 | 79,420 | 8.6 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FARM | PACIFIC | 2,375 | 4.4 | 83,247 | 8.2 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | FOOD | PACIFIC | 1,006 | 4.4 | 92,131 | 6.4 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | BUILDING | PACIFIC | 1,087 | 4.7 | 45,304 | 9.1 |
| COMB_56A | GT 55 | DIESEL | OWNER_OP | MIXED | PACIFIC | 1,432 | 4.7 | 69,855 | 8.2 |
| DOUBLES | | | | ALL | PACIFIC | 19,483 | 4.7 | 51,055 | 9.0 |
| DOUBLES | GT 55 | DIESEL | PRIVATE | FOOD | PACIFIC | 1,031 | 5.1 | 43,113 | 6.4 |
| DOUBLES | GT 55 | DIESEL | FARM | FARM | PACIFIC | 1,074 | 5.1 | 17,164 | 9.9 |
| DOUBLES | GT 55 | DIESEL | LOCAL_FH | FARM | PACIFIC | 1,266 | 4.6 | 38,892 | 9.5 |
| DOUBLES | GT 55 | DIESEL | LOCAL_FH | BUILDING | PACIFIC | 1,264 | 4.7 | 44,333 | 8.3 |
| DOUBLES | GT 55 | DIESEL | IC_GEN | MIXED | PACIFIC | 1,059 | 4.2 | 116,365 | 8.7 |

FIGURE D-6 (cont.)

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SMALL_CAR | | | | ALL | AK_HI | 175,284 | 20.7 | 8,872 | 0.0 |
| SMALL_CAR | ALL | GAS | HIGHINC | PERSONAL | AK_HI | 45,394 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | GAS | MIDINC | PERSONAL | AK_HI | 58,019 | 20.4 | 9,114 | 0.0 |
| SMALL_CAR | ALL | GAS | LOWINC | PERSONAL | AK_HI | 40,642 | 20.0 | 7,159 | 0.0 |
| SMALL_CAR | ALL | GAS | PRIVATE | NON_FRGT | AK_HI | 26,052 | 20.8 | 9,532 | 0.0 |
| SMALL_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | AK_HI | 4,557 | 33.3 | 10,050 | 0.0 |
| BIG_CAR | | | | ALL | AK_HI | 548,772 | 15.5 | 9,282 | 0.0 |
| BIG_CAR | ALL | GAS | HIGHINC | PERSONAL | AK_HI | 150,632 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | MIDINC | PERSONAL | AK_HI | 179,463 | 15.4 | 9,085 | 0.0 |
| BIG_CAR | ALL | GAS | LOWINC | PERSONAL | AK_HI | 118,217 | 15.3 | 7,122 | 0.0 |
| BIG_CAR | ALL | GAS | TAXI | NON_FRGT | AK_HI | 1,211 | 15.4 | 40,622 | 0.0 |
| BIG_CAR | ALL | GAS | PRIVATE | NON_FRGT | AK_HI | 81,122 | 15.4 | 10,247 | 0.0 |
| BIG_CAR | ALL | GAS | S&L_GOV | NON_FRGT | AK_HI | 10,529 | 15.4 | 10,663 | 0.0 |
| BIG_CAR | ALL | DIESEL | PRIVATE | NON_FRGT | AK_HI | 5,792 | 24.8 | 10,803 | 0.0 |
| CYCLE | | | | ALL | AK_HI | 18,494 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | HIGHINC | PERSONAL | AK_HI | 7,473 | 50.0 | 2,013 | 0.0 |
| CYCLE | ALL | GAS | MIDINC | PERSONAL | AK_HI | 7,509 | 50.0 | 2,279 | 0.0 |
| CYCLE | ALL | GAS | LOWINC | PERSONAL | AK_HI | 3,156 | 50.0 | 2,908 | 0.0 |
| IC_BUS | | | | ALL | AK_HI | 453 | 5.9 | 61,142 | 0.0 |
| TRANS_BUS | | | | ALL | AK_HI | 1,174 | 3.8 | 35,910 | 0.0 |
| TRANS_BUS | ALL | DIESEL | FHBUS | NON_FRGT | AK_HI | 1,174 | 3.8 | 35,910 | 0.0 |
| OTHER_BUS | | | | ALL | AK_HI | 2,838 | 7.3 | 7,445 | 0.0 |
| OTHER_BUS | ALL | GAS | FHBUS | NON_FRGT | AK_HI | 1,143 | 7.4 | 7,396 | 0.0 |
| OTHER_BUS | ALL | GAS | PRIVATE | NON_FRGT | AK_HI | 1,005 | 7.4 | 7,396 | 0.0 |
| SU_2A_4T | | | | ALL | AK_HI | 204,872 | 14.8 | 9,934 | 0.2 |
| SU_2A_4T | 00-10 | GAS | HIGHINC | PERSONAL | AK_HI | 42,760 | 14.7 | 10,910 | 0.0 |
| SU_2A_4T | 00-10 | GAS | MIDINC | PERSONAL | AK_HI | 61,862 | 15.0 | 10,141 | 0.0 |
| SU_2A_4T | 00-10 | GAS | LOWINC | PERSONAL | AK_HI | 38,069 | 15.0 | 8,179 | 0.0 |
| SU_2A_4T | 00-10 | GAS | FED_GOV | NON_FRGT | AK_HI | 2,900 | 13.9 | 6,424 | 0.8 |
| SU_2A_4T | 00-10 | GAS | S&L_GOV | NON_FRGT | AK_HI | 6,299 | 13.9 | 6,424 | 0.8 |
| SU_2A_4T | 00-10 | GAS | OTHER | ALL | AK_HI | 44,359 | 13.8 | 9,523 | 0.8 |
| SU_2A_4T | 00-10 | DIESEL | HIGHINC | PERSONAL | AK_HI | 1,481 | 13.3 | 17,607 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | MIDINC | PERSONAL | AK_HI | 2,142 | 13.5 | 16,367 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | LOWINC | PERSONAL | AK_HI | 1,318 | 13.5 | 13,185 | 0.0 |
| SU_2A_4T | 00-10 | DIESEL | OTHER | ALL | AK_HI | 3,682 | 26.1 | 19,084 | 0.8 |

VEHICLE FLEET, CHARACTERISTICS AND OWNERSHIP
1982

| VEHICLE | CAPACITY | FUEL | USER | COMMODITY | REGION | FLEET | MPG | MPV | TPV |
|---|---|---|---|---|---|---|---|---|---|
| SU_2A_6T | | | | ALL | AK_HI | 27,350 | 6.5 | 9,179 | 0.5 |
| SU_2A_6T | LT 26 | GAS | OTHER | ALL | AK_HI | 20,369 | 6.5 | 8,219 | 0.3 |
| SU_3A | | | | ALL | AK_HI | 8,261 | 5.6 | 13,480 | 2.8 |
| SU_3A | LT 26 | GAS | OTHER | ALL | AK_HI | 2,015 | 7.8 | 12,367 | 1.5 |
| SU_3A | 33-55 | DIESEL | U,S & C | BUILDING | AK_HI | 1,045 | 4.4 | 9,895 | 3.8 |
| COMB_34A | | | | ALL | AK_HI | 2,299 | 5.4 | 12,968 | 3.1 |
| COMB_56A | | | | ALL | AK_HI | 3,962 | 4.4 | 26,516 | 6.9 |
| DOUBLES | | | | ALL | AK_HI | 358 | 4.7 | 23,561 | 12.8 |

FIGURE D-6 (cont.)

# GLOSSARY

AASHO & AASHTO: Originally American Association of State Highway Officials, now American Association of State Highway and Transportation Officials. A group representing State Departments of Transportation and Highways in matters related to transportation policy.

AASHO Road Test: A road test conducted by the American Association of State Highway Officials (AASHO) from 1958-1961 to study the performance of various pavement designs subjected to loads of known magnitude and frequency.

AASHO Road Test Equations: The results of the AASHO Road Test were used to develop equations to predict the performance of different pavement sections under various axle loadings. They provide for allocating pavement thicknesses to different axle loadings under mixed traffic conditions.

Access Charge: A fee charged for the right to use all or a selected portion of the highway system for some extended period of time, such as a year. An access fee is a user charge which provides the user with access to the system but does not vary with the amount of usage.

Activity: Any characteristic of highway usage that is potentially, either directly or indirectly, subject to a user charge instrument. Examples are vehicle registrations, vehicle miles of travel, gallons of fuel consumed, ESAL-miles of travel, PCE-miles of travel, etc. Whether estimating revenue yield or evaluating efficiency or equity, estimating the relevant activity levels is a critical analytic task.

Alligator Cracking: Advanced stage of load related pavement cracking, resulting in variegated surface cracks.

Allocation Technique (or method): Any of the several distinct methods available for determining responsibility factors for a particular expenditure item (as for example, the incremental method or the consumption method).

Allocator: A quantitative measure that can be used to partition a total budget among a set of vehicle characteristics. Examples of allocators include vehicle miles of travel, axle-miles of travel, ton miles of travel, equivalent single-axle loadings (ESAL), and passenger car equivalents (PCE).

Arterial: A road used primarily for through traffic.

Attributable or Direct Costs: Costs for which a direct causal linkage can be established with some measure of road activity or vehicle (class) characteristic or with the expectation that some specific vehicle class will use a highway facility. These costs are also referred to as occasioned costs.

Average Daily Traffic (ADT): The number of vehicles passing a specified point on a highway during an average 24-hour period.

Axle Load: The total load transmitted by all wheels whose centers may be included between two parallel transverse vertical planes, extending across the full width of the vehicle.

Axle-Miles of Travel: A measure equal to the vehicle miles of travel multiplied by the number of its load-bearing axles.

Axle-Weight-Distance: A measure equal to axle miles of travel multiplied by the appropriate axle load.

Base Course: The layer or layers of material of designed thickness placed on a subbase or a subgrade to support a bituminous surface course or portland cement concrete pavement.

Benefits: Anything of value is a benefit (negative value is a disbenefit or a cost).

Collector: A road that connects local roads with arterials.

Common Costs: Costs incurred for the purpose of serving two or more classes of users on the same facility are regarded as common to the associated user classes.

Constant Dollars: Dollars of purchasing power which have been adjusted for inflation or price changes.

Constant Returns to Scale: See Returns to Scale.

Consumer Surplus: The difference between the price actually paid by consumers and the maximum amount they would individually be willing to pay is called consumer surplus. It is the area below the demand curve and above the price line.

Cost: See Economic Costs.

Cost Allocation: The analytic process of determining cost responsibilities of system users.

Cost Assignment: The level or proportion of costs assigned to particular, or all, users.

Cost Responsibility: The proportion of expenditures for which each vehicle class is responsible.

CTS: U.S. Bureau of the Census, Commodity Transportation Survey.

Current Dollars: Nominal values that have not been adjusted for inflation or price changes.

Debt Service: Funds allocated for repayment of previously incurred debt, including both principal and interest.

Deck: The roadway or surface of a bridge.

Default Value: An assumed value, usually for a variable; an equation, based on generally available information such as averages. Used in the absence of specifically relevant information or when it is equal to the desired value.

Delphi Technique: A research technique for obtaining opinions from experts in a subject area. Experts are kept separated while answering one or more questionnaires. The results are tabulated and analyzed and the process is repeated.

Design Section: A section of pavement with specified attributes that is studied for cost allocation.

Distress: Specific physical manifestation of pavement deterioration.

Earnings Credit: A method, considered without theoretical basis, for dividing highway costs responsibilities between highway users and the general public.

Economic Costs: The measure of what must be given up in order to obtain a good or service. The consumption of resources, now or in the future, needed to acquire the good or service.

Economic Efficiency: See Efficiency.

Economic Sector: A major division of the economy, i.e. the manufacturing sector or the transportation sector.

Economies of Scale: Reduction in the average unit cost of a product, in the long run, resulting from an expanded level of output. This term refers to costs of per unit production whereas return to scale refers only to changes in the quantity of output.

Effectiveness: The degree to which a policy alternative achieves a specified goal. Efficiency and equity are general goals, which society may choose to override for some other purpose. For example the U.S. may wish to reduce fuel consumption below the level that would be efficient because of international political considerations, or redistribute income by holding prices below efficient levels.

Efficiency: The measure of the success with which the resources available to society are employed to generate satisfaction to the members of society, or the total net benefits created by the use of those resources, is the overall measure of efficiency.

Efficiency Gains/Losses: The change in total net benefits from one equilibrium to another is the efficiency or welfare gain (or loss) of shifting from one policy, or price-output combination, to another.

Elastic Modulus: A measure of the stiffness of pavement under stress.

Elasticity: See Price Elasticity.

Equity: Generally taken to mean the state of being just, impartial or fair. Three subsidiary concepts are often discussed; horizontal, vertical and distributional equity. Horizontal equity refers to the fair treatment of individuals in similar circumstances. Vertical equity refers to the fair treatment of individuals in different circumstances. Distributional equity refers to the justness of the distribution of wealth among individuals.

ESAL: Equivalent single axle load, measuring the relative impact of an axle on the condition of a pavement in standard units, with a value of 1.0 assigned to an axle of 18,000 pounds. The relationship develops the equivalency measure based on the AASHO road test equations.

Excise Tax: A tax levied on the production or sale of specific items such as liquor, gasoline, cigarettes or vehicles.

Exempt Vehicles: Vehicle classes that are exempted from payment of one or more of the principal motor vehicle taxes or fees. Examples include publicly-owned vehicles, public transit vehicles, and some types of farm equipment.

Expenditure: The amount of money spent on something, usually representing the dollar portion of the price to the purchaser, is an expenditure. Expenditures may or may not be the same as costs.

Expressway: A divided arterial for through traffic with limited access and with grade separations at major intersections.

Externality: An effect on one or more persons not captured in the normal market that results from the action of a different person, entity, or firm. Externalities can be positive or negative.

Faulting: Differential vertical displacement of rigid slabs at a joint or crack.

Fee: A fee is a price paid for a service. In relation to highways, a fee or a user fee is the same as a user charge.

FHWA: Federal Highway Administration of the U.S. Department of Transportation.

Fixed Cost: Any cost that is not variable with current activity levels or use is a fixed cost. Examples are investments in right-of-way and interest on borrowed funds.

Flexible Pavement: A pavement structure consisting of bituminous surfacing (ranging from light bituminous surface treatment to sheet asphalt and bituminous concrete), base, and/or subbase. Untreated gravel surfaces have, in the past, been grouped with flexible pavements.

Freeway: An expressway with full control of access.

Functional Classification: The classification of roads and highways according to their general level of importance and character of service. The definition may differ State to State; FHWA uses the classifications, separately for urban and rural systems, Interstate, Other Freeways and Expressways, Other Principal Arterials, Minor Arterials, Major Collectors, Minor Collectors. In addition, roads of different jurisdictions; local, county, etc., are classified.

General Revenues: Revenues raised from general tax instruments, such as property, income and sales taxes. These are considered nonuser revenues in a highway finance context.

Gross Registered Weight (GRW): The weight declared by a user of a vehicle for the purpose of registration. This is usually the maximum loaded weight of the vehicle but in some circumstances is unladen or another weight basis.

Gross Vehicle Weight (GVW): The actual maximum loaded weight allowed for a vehicle (based on registration or legal limits) or the weight of a given vehicle as recorded on scales. This is sometimes referred to as operating weight.

Highway User: The owner of a motor vehicle in use on highways, roads and streets. Often cited as "user," "motor vehicle user," or even "motor vehicle."

HUTCM: Highway User Tax/Cost Model, developed for FHWA for the analysis of revenue attribution and tax impacts of the Surface Transportation Assistance Act of 1982.

Incremental Cost: The additional portion of cost which is occasioned or caused by a particular type of use.

Incremental Method: An allocation approach that assigns costs of highway operation, maintenance and improvements based on a particular vehicle attribute or characteristic by arbitrarily dividing facilities into levels of assignable cost which are associated with particular vehicle classes.

Internalized Costs: The costs of an activity borne by an individual or entity.

Instrument: A mechanism for collecting either a tax or user charge. Examples of user charge instruments are fuel taxes, parking surcharges, weight-distance taxes, annual use fees, and parking permit fees.

I/O or Input-Output: A model of the economy that measures the dollar value of component materials from each industry sector, per dollar value of the output of one particular industry sector. This type of model allows estimates of the effects of changes in one, i.e. the producing, sector on all supplying sectors.

IRP: International Registration Plan, a registration reciprocity agreement among States and Canadian provinces developed in 1973 by the American Association of Motor Vehicle Administrators.

Jurisdictional Classification: A highway classification scheme based on the level of government (Federal, State, County, Local) financially responsible for the particular road system.

Kip: A one thousand pound unit of weight.

Lane-Miles: The number of lanes in a section of street or highway multiplied by the length of the section in miles.

Long Run: The period in which all factors of production can vary, including capital as well as short run factors.

Marginal Cost: The extra cost of producing an extra unit of output. In the short run, marginal costs are measured by the change in variable costs only.

Marginal Cost Prices: Prices based on the additional costs of producing one more unit of output or activity. Prices set at marginal costs reflect the cost of the last unit of production. Prices set at marginal costs are most efficient, from an economic point of view, because they confront purchasers with the costs of the good produced and allow society to gain the maximum amount of satisfaction from the resources available.

Medium Run: A period between the long and short run where certain capital items can vary.

MPLSFW: Maximum Payload Shift Factor.

MPOGVW: Maximum Practical Operating Gross Vehicle Weight.

MRA: Multistate Reciprocal Agreement.

NCHRP: National Cooperative Highway Research Program.

Nomograph: A graphic representation that consists of several lines marked off to scale and arranged in such a way that by using a straightedge to connect known values on two lines an unknown value can be read at the point of intersection with a third line.

Non-User: A member of the general public.

NPTS: Federal Highway Administration, Nationwide Personal Transportation Survey, survey conducted by U.S. Bureau of the Census.

Occasioned Costs: Costs incurred by, or determined to be caused by, one or more classes of vehicles over and above the costs of the basic facility.

Off-Peak: A time when traffic is not at its heaviest. It describes all times other than peak.

OGW or OGVW: Operating Gross Vehicle Weight.

Opportunity Cost: The value of all things which must be foregone in order to acquire a good or service, whether now or in the future. Also measured as the value of the resource in the best alternative use.

Opportunity Value: See Opportunity Cost.

Pavement (pavement structure): One or more layers of specially processed materials placed on the subgrade to support the traffic loads and distribute them to the subgrade.

PCE: Passenger car equivalent, a measure of road space effectively occupied by a vehicle of a given type under given terrain, vehicle mix, road type, and congestion conditions. The reference unit is the standard passenger car operating under the conditions on the road category in question.

Peak-Hour Traffic: The highest number of vehicles found to be passing over a section of a lane or a roadway during 60 consecutive minutes.

PMGVW: Practical Maximum Gross Vehicle Weight.

PMGVWF: Practical Maximum Gross Vehicle Weight, Future.

PMGVWP: Practical Maximum Gross Vehicle Weight, Present.

Pavement Serviceability Index (PSI): A standard measure of pavement roughness and rideability ranging from 5.0 (new) through 2.5 (very rough) to zero (failure).

Price Elasticity: The responsiveness of a quantity to the change in a particular price. Measured as the ratio of the relative change in quantity to the relative change in the price that induced the quantity shift.

Price: The charges levied on users for goods or services consumed.

Producers Surplus: The excess of total revenues to the producer of a good or service over the cost of production (including normal return to capital). This is measured as the area above the supply curve and below the price line.

Prorate: To pay registration fees to two or more States based on the percentage of miles operated in each.

Pumping: The ejection of foundation material, either wet or dry, through joints or cracks or along edges of rigid slabs, due to vertical movements of the slab under traffic.

Rate: The level per unit of the taxable item, in dollars, at which a user fee or charge is set or levied, i.e., the per-unit price of the user charge. Examples are the amount for vehicle registration and the amount per gallon for fuel tax.

Reciprocity: The granting of privileges or exemptions by one State to vehicles properly registered in another State granting similar privileges or exemptions in return.

Residual Costs: The portion of total cost that is not recovered through prices or other charges to users.

Returns to Scale: The rate at which output changes as the quantity of all inputs are varied. Constant returns to scale pertains when output levels remain proportional to the levels of all inputs. Decreasing returns to scale pertains if output goes up less than proportionally with inputs. Increasing returns to scale pertains when output increases more than proportionally with all input levels. Also see Economies of Scale.

Right-of-Way: The strip of land, property, or interest therein, over which a highway or roadway is built.

Rigid Pavement: A pavement structure consisting of portland cement concrete surfacing with or without subbase.

Roadbed: The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.

Second-Best: The case where the assumptions required to guarantee the allocative efficiency of marginal cost pricing are not fulfilled. Ideal efficiency (price equals marginal cost in all markets, and investment everywhere is optimal) is referred to as "first-best;" anything else is second-best. All practical problems involve second-best conditions, in that there are always constraints on achieving an optimum allocation of resources.

Severance Tax: Tax paid on products of extractive industries.

SGVW: Starting Gross Vehicle Weight (the point where TSW shifting of vehicle loaded weight begins).

Short Run: The time period where certain factors of production, such as quantities of labor, can be varied but where other factors are fixed, such as the capital stock.

Short-Run Costs: An operating period where only certain costs vary with current use or activity, while a portion of the costs for all or part of a given facility is held fixed.

Shoulder: The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

Soil Strength: A measure of the soil's supporting value for pavement.

Soil Type: This term relates to the type of the subgrade soil and its effects on pavement design and costs. Three broad categories, poor, fair, and good, are most often used. Factors considered for classifying a particular soil are its supporting capacity, sensitivity to moisture, susceptibility to pumping, and performance under frost conditions.

STCC: Standard Transportation Commodity Codes, used to describe commodities shipped by various transportation modes.

Subbase: The layer or layers of material of designed thickness placed on a subgrade to support the base course of a flexible pavement or the portland cement concrete surface of a rigid pavement.

Subgrade: The top surface of a roadbed upon which the pavement structure and shoulders are constructed.

Subsidy: Monetary assistance from governments or individuals to support particular consumption or activities. This assistance can be in the form of expenditures, tax exemptions, hidden costs, or unpriced external costs imposed on non-consumers of the activity.

Tare Weight: A vehicle's unladen or empty weight.

Tax: A levy imposed by government on the resources of citizens and enterprises for the purpose of raising revenues to support government and its purposes.

Tandem Axle Load: The total load transmitted by all wheels on two or more consecutive axles whose centers may be included between two parallel transverse vertical planes spaced more than 40 inches and not more than 96 inches apart, extending across the full width of the vehicle.

Terminal PSI: Design condition at which pavement is determined to have failed and requires major rehabilitation. (See Pavement Serviceability Index, above.)

Terminal Serviceability: Terminal PSI is a measure of terminal serviceability.

Terrain Type: The type of topography through which a highway section passes based on the following definitions:

> Flat terrain is that condition where highway sight distances, as governed by both horizontal and vertical restrictions, are generally long or could be made to be so without construction difficulty or major expenses.

Rolling terrain is that condition where the natural slopes consistently rise above and fall below the highway grade line and where occasional steep slopes offer some restrictions to normal highway horizontal and vertical alignment.

Mountainous terrain is that condition where the longitudinal and transverse changes in the evaluation of the ground with respect to the highway are abrupt and where the roadbed requires frequent benching or side hill excavation.

TIUS: U.S. Bureau of the Census, Truck Inventory and Use Survey.

Ton-Mile Tax: A tax based on estimated weight and distance traveled for individual freight or goods movements.

Truck: A general term denoting a motor vehicle designed for transportation of property. The term includes single unit trucks and truck combinations.

Truck Combinations: A truck tractor and a semitrailer, either with or without a full trailer, or a truck with one or more full trailers.

TSW: Truck Size and Weight.

TWS: (FHWA) Truck Weight Study.

UPRA: Uniform Vehicle Registration Proration and Reciprocity Agreement.

Usage Pattern: Usage, or a usage pattern, is a description of how users are distributed on the highway system, including traffic volumes, sizes and weights of vehicles, and the types of roads they are using.

User Charge: A fee, tax or charge that is imposed on facility users as a condition of usage. An excise tax on gasoline or tires is a user charge because only highway users pay it, while a general sales tax on the same items is not a user charge.

User Charge Structure: A package of instruments and rates that constitute a financing for the expected highway expenditures. Non-user charge instruments may be included in the complete package.

User Cost: The value of resources used by the travel on or use of the highway system, such as pavement wear, time, space requirements. These are analogous, but not necessarily equal, to portions of highway expenditures.

User Fee: See User Charge.

User Revenues: Highway revenues raised through the imposition of user charges or fees.

Variable Cost: Costs that vary with the level of output or use. Short-run variable costs are those that could be avoided if certain or all current travel were to be eliminated. In the long-run all costs are variable.

Vehicle Class: Vehicles grouped into homogeneous categories for the purpose of analyzing cost responsibilities, impacts or setting user charges. Important characteristics are weight, size, number of axles, visual type (single unit, tractor trailer combination, tractor semi-trailer combination), and type of fuel.

VESYS Model: A mechanistic model of flexible pavement performance.

VMT: Vehicle Miles Traveled or Vehicle Miles of Travel.

Weight-Distance: An estimated measure of the average vehicle load multiplied by the trip distance, or annual travel distance.

Weight-Distance Tax: A tax based on gross vehicle weight and miles traveled.

# BIBLIOGRAPHY

## INDEX



*/ Excerpted from Transportation System Descriptors Used in Forecasting Federal Highway Revenues, by SYDEC, for U.S. DOT, FHWA, June, 1981.

# BIBLIOGRAPHY

1. PAVEMENT DAMAGE

American Association of State Highway Officials, AASHO Interim Guide for Design of Pavement Structures, Washington, DC, 1972.

American Trucking Associations, "Why Highways Wear Out," Washington, DC, no date.

Comptroller General, Deteriorating Highways and Lagging Revenues: The Need to Reassess the Federal Highway Program, CED-81-42, March 5, 1981.

General Accounting Office, Excessive Truck Weight: An Expensive Burden We Can No Longer Support, Comptroller General of the United States, July 16, 1979.

H. W. Lochner, Inc., "Commentary on AASHO Road Test (1958 to 1960)," Boston, March 22, 1983.

Markow, Michael J., "Modification of the System EAROMAR," prepared for the FHWA, Cambridge, MA, CMT Incorporated, October 1979.

McNeil, Sue and Chris Hendrickson, "Three Statistical Models of Pavement Management Based on Turnpike Data with an Application to Roadway Cost Allocation," Department of Civil Engineering, Carnegie-Mellon University, Pittsburgh, PA, September 25, 1981.

Rauhut, J. B., R. L. Lytton and M. I. Darter, "Pavement Damage Functions for Cost Allocation: Executive Summary," FHWA/RD-84/117, January, 1983.

_____________________, "Pavement Damage Functions for Cost Allocation: Vol 1, Damage Functions and Load Equivalence Factors," FHWA/RD-82/126, July, 1982.

Saag, J. B. and J. E. Leisch, "Synthesis of Information on Roadway Geometric Causal Factors," Jack E. Leisch & Associates, U.S. DOT, FHWA, January, 1981.

Varadarajan, R., Kenneth Fan, M. G. Menon and Harold Engle, "Bridge Deck Deterioration and Deck Life - Phase II," Delon Hampton & Associates, Chartered, U.S. DOT, FHWA, March, 1983.

1a. PAVEMENT REPAIR

American Association of State Highway Officials, "The AASHO Road Test," HRB Special Report 73, Washington, DC: National Academy of Sciences, 1962.

Federal Highway Administration, "Performance-Investment Analysis Process," Technical Report, U.S. DOT, September 1978.

Kendner, Robert L., and Raymond J. Krizek, "Factors Influencing Flexible Pavement Performance," NCHRP Report 22, Washington, DC: National Academy of Sciences, 1966.

Markow, Michael, "Simulation of Pavement Damage Costs," Cambridge, MA: MIT.

Transportation Research Board, "Pavement Systems: Assessment of Load Effects, Design and Bases," Transportation Research Record 725, 1979.

_____________________, "Layered Pavement Systems," Transportation Research Record 810, 1981.

Transportation Research Board, "Consequences of Deferred Maintenance," NCHRP Synthesis of Highway Practice Report 58, Washington: National Academy of Sciences, May, 1979.

Welsh, Lawrence E., et al., "Dynamic Measurements of Commercial Highway Vehicles (weighing-in-motion)," Sacramento, CA: California Dept. of Transportation, June, 1978.

Yoder, E.J., and M.W. Witczak, Principles of Pavement Design, 2nd ed., New York: John Wiley, 1975.

1b. USER COSTS

Federal Highway Administration, "Capital Cost Allocations and User Charge Structure Options," U.S. DOT, FHWA, July, 1981.

____________________, Vehicle Operating Costs, Fuel Consumption, and Pavement Type and Condition Factors, J.P. Zancewski, et al., under contract to FHWA, Office of Highway Planning, June, 1982.

Hollyer, Mark R. and Catherine G. Schneider, "An Analysis of Highway User Charges," Vol I, U.S. DOT, TSC SS-42-U9-2, January, 1983.

Internal Revenue Service, "Federal Highway Use Tax on Trucks, Truck Tractors, and Buses," Publication 349, Department of the Treasury, March, 1978.

Juster, R.D. and J.H. Batchelder, Highway Investment Analysis Package, Vol. II, Technical Manual, Washington, DC: U.S. DOT, FHWA, June, 1979.

System Design Concepts Inc., for the Federal Highway Administration, Analysis of Highway-User Cost Responsibilities and User Charges for All Levels of Government Combined. November, 1982.

2. ADMINISTRATION

Federal Highway Administration, An Analysis of States' Administrative and Compliance Problems Associated with Selected Highway User Taxes, Working Paper No. 11, U.S. DOT, FHWA, November, 1980.

______________________, Methodology for Estimating the Impacts of Changes in Highway Performance, Washington: U.S. DOT, FHWA, 1977.

Forkenbrock, David J. Methods for Improving Highway Financing in Iowa, Institute for Urban and Regional Research, The University of Iowa, Iowa City, Iowa, February 1983.

Lee, Douglass B., "The Costs of Private Automobile Usage to the City of San Francisco," Working Paper No. 171, Berkeley: University of California, Institute of Urban and Regional Development, April, 1972.

Lee, Douglass B., "Estimation of the Aggregate Subsidy to Highway Users," Working Paper 34, Iowa City: Institute of Urban and Regional Research, University of Iowa, October, 1980.

Scheiner, James I., Managing Cash in the Pennsylvania Department of Transportation, Transportation Research Board, January 20, 1982.

Transportation Research Board, Transportation Cash Flow Financial Management at the State Level, Committee A1A08, Subcommittee 3, October 17, 1979.

3. VEHICLE INTERFERENCE

American Association of State Highway and Transportation Officials, A Manual on User Benefit Analysis of Highway and Bus-Transit Improvements, 1977.

Highway Research Board, Highway Capacity Manual, Special Report 87, Washington, DC: National Academy of Sciences, 1965.

Keeler, Theodore E., Kenneth A. Small and Associates, "Part III: Automobile Costs and Final Intermodal Cost Comparisons," The Full Costs of Urban Transport, Monograph No. 21, Berkeley: University of California, Institute of Urban and Regional Development, July, 1975.

Transportation Research Board, "Running Costs of Motor Vehicles as Affected by Road Design and Traffic," NCHRP Report 111, Washington, DC: National Academy of Sciences, 1968.

4. NEGATIVE EXTERNALITIES

Baumol, William J., and Wallace E. Oates, "The Theory of Environmental Policy, Englewood Cliffs, NJ: Prentice-Hall, 1975.

Freeman, A. Myrick III, "The Benefits of Air and Water Pollution Control: A Review and Synthesis of Recent Estimates," report prepared for the Council on Environmental Quality, Brunswick, ME: Bowdoin College, December, 1979.

Fuller, John W., et al., Measurements of Highway User Interference Costs and Air Pollution and Noise Pollution Damage Costs. The University of Iowa. May, 1983.

Segal, David, "The Economic Benefits of Depressing an Urban Expressway: The Case of Boston's John Fitzgerald Expressway," paper prepared for presentation at the 1981 TRB meetings, Cambridge, MA: Harvard University, Graduate School of Design, December, 1980.

4a. AIR POLLUTION

Babcock, L.R., Jr. and N.L. Nagda, "Cost Effectiveness of Emission Control," Journal of the Air Pollution Control Association, 1, 28, 1973, pp. 173-179.

Benedict, H. M., C.J. Miller and R.E. Olson, Economic Impact of Air Pollutants on Plants in the United States, Final Report, Stanford Research Institute, 1971.

Colwill, D.M., J.R. Thompson and A.J. Rutter, The Impact of Road Traffic on Plants, Berkshire, England: Transport and Road Research Laboratory, 1979.

Cooper, B.S. and D.P. Rice, "The Economic Cost of Illness Revisited," Social Security Bulletin, 39, 2, 1976, pp. 21-36.

Cropper, M.L., "Measuring the Benefits from Reduced Morbidity," American Economic Associated Papers and Proceedings, 71, 2, 1981, pp. 235-240.

Freeman, A. Myrick III., The Benefits of Environmental Improvement, Baltimore: the Johns Hopkins University Press for Resources for the Future, 1979.

Freeman, A. Myrick III, "Hedonic Prices, Property Values and Measuring Environmental Benefits: A Survey of the Issues," Scandinavian Journal of Economics, 82, 2, 1979, pp. 154-173.

Haugaard, John, "Measures of Air Pollution Costs Attributable to Motor Vehicle Travel," Technical Report 134, Iowa City: Institute of Urban and Regional Research, University of Iowa, December, 1981.

Heintz, H.T., Jr., A. Hershaft and G.C. Horak, National Damages of Air and Water Pollution, a report to the U.S. Environmental Protection Agency, 1976.

Hershaft, A., A.M. Freeman III, T.D. Crocker and J.P. Stevens (eds.), Critical Review of Estimating Benefits of Air and Water Pollution Control, Washington, DC: U.S. Environmental Protection Agency, 1978.

Holzworth, G.C., Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States, U.S. Environmental Protection Agency Publication No. AP-101, 1972.

Lave, L.B. and E.P. Seskin, Air Pollution and Human Health, Baltimore: Johns Hopkins University, 1977.

Mendelsohn, R. and G. Orcutt, "An Empirical Analysis of Air Pollution Dose-Response Curve," Journal of Environmental Economics and Management, 6, 1979, pp. 85-106.

McDonald, G.C. and R.C. Schwing, "Instabilities of Regression Estimates Relating Air Pollution to Modality," Technometrics, 15, 1973, pp. 463-481.

National Academy of Sciences, Coordinating Committee on Air Quality Studies, The Costs and Benefits of Automobile Emission Control, Vol. 4 of Air Quality and Automobile Emission Control, Washington: NAS, 1974.

Rice, D.P., Estimating the Cost of Illness, Washington, DC: U.S. Department of Health, Education and Welfare, Public Health Services, Publication No. 947-6, 1966.

Salmon, R.L., Systems Analysis of the Effects of Air Pollution on Materials, Midwest Research Institute, 1970.

Schwing, R.C., B.W. Southworth, C.R. vonBuseck, C.J. Jackson, "Benefit Cost Analysis of Automotive Emission Reductions," Journal of Environmental Economics and Management, 7, 1, 1980, pp. 44-64.

Small, Kenneth A., "Estimating the Air Pollution Costs of Transport Modes," Journal of Transport Economics and Policy, 11, 2, May, 1977, pp. 109-132.

__________, "Air Pollution and Property Values: Further Comment," The Review of Economics and Statistics, 57, 1, February, 1975, pp. 105-107.

U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, Third Edition (including supplements 1-7), Research Triangle Park, NC: EPA, August, 1977.

Waddell, T.E., The Economic Damage of Air Pollution, Washington, DC: EPA, 1974.

4b. WATER POLLUTION

Champagne, David M., "Impact of Highway Deicing Salts on Rural Stream Water Quality," Transportation Research Record 647, 1977, pp. 47-52.

Murray, Donald M. and Ulrich F.W. Ernst, An Economic Analysis of the Impact of Highway Deicing, Cincinnati, OH: U.S. Environmental Protection Agency, Municipal Environmental Research Laboratory, May, 1976.

4c. NOISE

Allen, Gary R., "Highway Noise, Noise Mitigation, and Residential Property Values," prepared for presentation at the 1981 meetings of the TRB, Charlottesville, VA: University of Virginia, Virginia Highway and Transportation Research Council, 1981.

Anderson, Robert J. and Donald E. Wise, "The Effects of Highway Noise and Accessibility on Residential Property Values," Final Report, Washington, DC: DOT, FHWA, March, 1977.

Anthrop, Donald F., Noise Pollution, Lexington, MA: Lexington Books, 1973.

Cermak, G.W., et al., Analysis of Traffic Noise Abatement Strategies, General Motors Research Laboratories, Michigan, GM Report No. 3136.

EPA, Office of Noise Abatement and Control, Impact Characterization of Noise, Including Implications of Identifying and Achieving Levels of Cumulative Noise Exposure, Task Group 3 Report, July, 1973.

______________________, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March, 1974.

______________________, Population Distribution of the United States as a Function of Outdoor Noise Level, Vol. 2, June, 1974.

Hall, F.L., S. Birnie and S.M. Taylor, "The Effectiveness of Shielding in Reducing the Adverse Impacts of Highway Traffic Noise," Canada: McMaster University, Department of Civil Engineering, c. 1977.

Harter, M.R., "Noise Prediction Models: Their Importance as a Keystone in Applying Noise Standards," Transportation Research Circular No. 175, pp. 14-15.

Hartl, Frank B., "Transportation Systems: Noise Generation and Abatement," Studies in Urban Transportation, Milwaukee, WI: The University of Wisconsin-Milwaukee, February, 1974.

Hokanson, Barry, et al., "Measures of Noise Damage Costs Attributable to Motor Vehicle Travel," Technical Report 135, Iowa City: Institute of Urban and Regional Research, University of Iowa, December, 1981.

McMillan, Melville L., Bradford G. Reid, and David Gillen, "An Extension of the Hedonic Approach for Estimating the Value of Quiet," Land Economics, 56, August 3, 1980, pp. 315-328.

National Cooperative Highway Research Program, Highway Noise — Generation and Control, Report No. 173, National Academy of Sciences, 1976.

____________________, Highway Noise — A Design Guide for Prediction and Control, Report No. 174, National Academy of Sciences, 1976.

National Research Council, Noise Abatement: Policy Alternatives for Transportation, Analytical Studies for the U.S. EPA, Vol. 8, 1977.

Nelson, Jon P., Economic Analysis of Transportation Noise Abatement, Cambridge, MA: Ballinger, 1978.

Nelson, Jon P., Highway Noise and Property Values: A Survey of Recent Evidence, Working Paper, The Pennsylvania State University, June, 1981.

Perfater, M.A., Community Perception of Noise Barriers, Charlottesville: Virginia Highway and Transportation Research Council, 1980.

Plessas, D.J., "Airport Noise: Some Analytical and Policy Perspectives," Land Economics, 49, 1, 1979, pp. 14-21.

Reagan, Jerry A., "Comparison of $L_{eq}$ and $L_{dn}$ as Descriptors of Highway Traffic Noise," Transportation Research Record 789, 1980.

Schultz, T.J., Noise Assessment Guidelines: Technical Background, U.S. Department of Housing and Urban Development, Bolt, Beranek and Newman, Inc., 1971.

Starkie, D.N.M. and Johnson, D.M., The Economic Value of Peace and Quiet, Westmand, England: Saxon House, 1975.

U.S. Department of Transportation and Federal Interagency Committee on Urban Noise, Guidelines for Considering Noise in Land Use Planning and Control, June, 1980.

## 4d. CONGESTION DELAY


Baerwald, John E. (ed.), Transportation and Traffic Engineering Handbook, Englewood Cliffs, NJ: Prentice-Hall, 1976.

Cesario, Frank J., "Congestion and the Valuation of Recreation Benefits," Land Economics, 56, 3, August, 1980, pp. 329-338.

Cunagin, Wiley D., and Carroll J. Messer, Passenger Car Equivalents on Rural Highways, prepared for FHWA, College Station, TX: Texas Transportation Institute, December, 1982.

Forsyth, P.J., "The Value of Time in an Economy with Taxation," Journal of Transport Economics and Policy, Vol. XIV, September, 1980.

Harrison, A.J. and D.A. Quarmby, "The Value of Time in Transport Planning: A Review," Department of the Environment, Mathematical Advisory Unit, January, 1970.

Hensher, D.A., "Valuation of Commuter Travel Time Savings: An Alternative Procedure," Chapter 4 in T. Heggie (ed.), Travel Time and and Travel Choice. Oxford: Oxford University Press, 1976.

PRC Voorhees, Passenger Car Equivalence on Urban Arterial Roads, prepared for FHWA, McLean, VA: PRC Voorhees, November 23, 1981.

Seguin, E.L., K. W. Crowley, and W. D. Zweig, Passenger Car Equivalents on Urban Freeways, prepared for FHWA, State College, PA: Institute for Research, August, 1982.

Shuldiner, Paul W., "Procedures Used in Estimating Highway Congestion Costs," Staff Study, Cambridge, MA: Transportation Systems Center, U.S. DOT, October, 1981.

Stoner, James W., and Susan Marshall, "Measures of Marginal Traffic Interference Costs," Technical Report 133, Iowa City: University of Iowa, Institute of Urban and Regional Research, August, 1981.

Transportation Research Board, "Highway Capacity and Level of Service," Transportation Research Record 699, 1979.

______________________, "Interim Materials on Highway Capacity," Circular No. 212, Washington, DC: National Academy of Sciences, January, 1980.

Viton, Philip A., "Optimal Tolls on the Bay Bridge," Journal of Transport Economics and Policy.

4e. ACCIDENTS

Byer, Philip H., "Implying the Value of Life from Public Safety Improvements," Research Report No 64, Toronto: University of Toronto-York University Joint Program in Transportation, March, 1980.

Dardis, R., "The Value of Life: New Evidence from the Marketplace," The American Economic Review, December, 1980, pp. 1077-1082.

Diewald, W.J., "Incorporating Highway Safety into Level of Service," Transportation Engineering Journal, May, 1974, pp. 417-229.

Hartunian, N.S., D.N. Smart and M.S. Thompson, The Incidence and Economic Costs of Major Health Impairments — A Comparative Analysis of Cancer, Motor Vehicle Injuries, Coronary Heart Disease and Stroke, Lexington, MA: D.C. Heath and Co., 1981.

Sebastion, Angeli A., and Dennis M. Flemons, "NHTSA's Fatal Accident Reporting System," Transportation Research News,97, November-December, 1981, pp. 5-9.

Solomon, D., "Accidents on Main Rural Highways Related to Speed, Driver and Vehicle," Washington: U.S. Department of Commerce, 1964.

National Highway Traffic Safety Administration, "Societal Costs of Motor Vehicle Accidents," Preliminary Report, Washington: U.S. DOT, NHTSA, April, 1972.

____________________, "Fatal Accident Reporting for 1979", Washington: U.S. DOT, NHTSA, 1979.

____________________, "Report on Traffic Accidents and Injuries for 1979", Washington: U.S. DOT, NHTSA, 1979.

Transportation Research Board, "Operational Effects of Geometrics and Improvement Evaluations," Transportation Research Records 819, 1981.

____________________, "Highway Geometric Design," Transportation Research Record 806, 1981.

____________________, "Cost and Safety Effectiveness of Highway Design Elements," NCHRP Report 197, Washington, DC: National Academy of Sciences, 1978.

__________________, "Methods for Evaluating Highway Safety Improvements," NCHRP Report 162, Washington, DC: National Academy of Sciences, 1974.

Vickrey, William, "Automobile Accidents, Tort Law, Externalities, and Insurance: An Economist's Critique," Journal of Law and Contemporary Problems, 1969, pp. 464-484.

Yu, J.C., "Establishing the Relationship Between Level of Service and Highway Safety," Traffic Engineering, October, 1972, pp. 50-52.

Ziderman, A., "The Valuation of Accident Cost Savings: A Comment," Journal of Transport Economics and Policy, May, 1981, pp. 185-187.

5. THEORY

American Association of State Highway and Transportation Officials, "Our Highways," Washington, DC, 1984.

Atkinson, Anthony B. and Joseph E. Stiglits, Lectures on Public Economics, McGraw-Hill Book Company, New York, 1980.

Baumol, William J., Economic Theory and Operations Analysis, 4th ed., Englewood Cliffs, New Jersey: Prentice-Hall, 1977.

Baumol, William, and David Bradford, "Optimal Departures from Marginal Cost Pricing," American Economic Review, 60, June, 1970, pp. 265-283.

Boyd, Hayden, "Development and Synthesis of Highway Pricing Theory," Boston: Charles River Associates, September 29, 1981.

Drinka, Thomas P. and James R. Prescott, "Optimal Roadway Tolls and Operating Costs in Urbanized Regions," Regional Science Perspectives, 11, No. 2, 1981, pp. 15-27.

Henderson, James M. and Richard E. Quandt, Microeconomic Theory: A Mathematical Approach. 2nd ed. New York: McGraw-Hill, 1971.

Kahn, Alfred E., The Economics of Regulation: Principles and Institutions, New York: Wiley, 1970.

Lee, Douglass, Methods for Allocating Highway Costs, U.S. DOT, Transportation Systems Center, April, 1981.

Levin, Richard C., "Railroad Rates, Profitability, and Welfare under Deregulation," Bell Journal of Economics, 12, 1, Spring 1981, pp. 1-26.

Littlechild, S.C. and G.F. Thompson, "Aircraft Landing Fees: A Game Theory Approach," Bell Journal of Economics, 8, 1, Spring 1977, pp. 186-204.

Meyer, John R., John F. Kain and Martin Wohl, The Urban Transportation Problem, Cambridge, MA: Harvard University Press, 1965.

Mohring, Herbert, Transportation Economics, Cambridge, MA: Ballinger, 1976.

Musgrave, Richard A. and Peggy B. Musgrave, Public Finance in Theory and Practice, 2nd ed., New York: McGraw-Hill, 1976.

Pearce, David W. ed., The Dictionary of Modern Economics, MIT Press, Cambridge, MA, 1983.

Putman, Stephen H., "Integrated Policy Analysis of Metropolitan Transportation and Location," U.S. DOT, DOT-P-30-80-32, August, 1980.

Ramsey, F.P.A., "A Contribution to the Theory of Taxation," Economic Journal, 37, 1927, pp. 47-61.

Slavet, Joseph, Katharine Bradbury, and Philip Moss, Financing State-Local Services, Lexington, MA: D.C. Heath, 1975.

Walters, A.A., The Economics of Road User Charges, World Bank Staff Occasional Papers Number Five, Baltimore: Johns Hopkins Press, 1968.

Winston, Clifford, "The Welfare Effects of ICC Rate Regulation Revisited," Bell Journal of Economics, 12, 1, Spring 1981, pp. 232-244.

## 6. DATA SOURCES

Automotive Fleet Fact Book, various volumes, Bobit Publications, Redondo Beach, CA, April, 1979.

Interstate Commerce Commission/Federal Railroad Administration Rail Waybill Sample. Issued annually.

Motor Vehicle Manufacturers' Association, Motor Vehicle Facts and Figures, Detroit, MI, various years.

U.S. Department of Commerce, Bureau of the Census, Census of Transportation, Truck Inventory and Use Survey, 1977.

__________________, Commodity Transporation Survey, 1977.

U.S. Departments of Commerce and Housing and Urban Development, Annual Housing Survey, Urban and Rural Housing Characteristics, 1977.

U.S. Department of Transportation, Federal Highway Administration, Highway Statistics, (recent years).

__________________, Nationwide Commodity Transportation Survey, 1977.

__________________, National Highway Inventory and Performance Study Manual 1976, July, 1975.

__________________, Road User and Property Taxes on Selected Motor Vehicles, 1982.

Ward's Automotive Yearbook, various editions, Detroit, MI.

7. STATE STUDIES

Iowa Department of Transportation, "Guidelines for Allocating Highway System Costs in Iowa," September, 1983.

Johnson, Marilyn and Kent Bramlett, "State Highway Cost-Allocation Studies," U.S. DOT, FHWA, November, 1983.

Jorgensen Associates, State of New Mexico Highway Cost Allocation Study, February, 1972.

Maine Department of Transportation, Maine Highway Cost Allocation Study, 1982.

________________________, "New Revenue Structures," Maine Highway Cost Allocation Working Paper No. 9, 1982.

Merriss, John and Loyd Henion, "Oregon's Weight-Distance Tax: Theory and Practice," Transportation Research Forum, August, 1983.

Oregon Department of Transportation, "Motor Vehicle Cost Responsibility Study 1980," Final Report and Technical Appendum, 1981.

Schelling, David and Saklas, James, University of Maryland; and Counsel Trans. prepared for Maryland Department of Transportation, Maryland Cost Allocation Study, February, 1982.

Transportation Development Associates, Washington State Highway Cost Allocation Study, January, 1977.

University of Mississippi, prepared for U.S. Department of Transportation, Federal Highway Administration, The Role of Third Structure Taxes in the Highway User Tax Family, 1968.

U.S. Department of Transportation, Federal Highway Administration, Highway Cost Allocation Study Working Paper Number 15, State Highway Cost Allocation Methods, Florence Banks, March, 1982.

Wisconsin Department of Transportation, "Highway Cost Allocation Study - Final Report," Madison, WI, December, 1982.

8. TRUCK SIZE AND WEIGHT

Brown, James L., Dock Burke, F. L. Roberts, and C. Michael Walton, "Effects of Heavy Trucks on Texas Highways," Texas State Department of Highways and Public Transportation, September, 1978.

Cohen, Saul and Carol Holcomb, "Assessment of the Effects of Increased Truck Size and Weight Limits on Shippers and States - Literature Search and Review," for the Office of the Assistant Secretary for Policy and International Affairs, Report #DOT-P-10-79-28, May, 1979.

Public Law 97-424, Jan. 6, 1983, Sec. 133, Section 127 of Title 23 of United States Code. Contains "bridge formula" for increases in truck size and weight.

Transportation Research Record, "Changes in Legal Vehicle Weights and Dimensions - Some Economic Effects on Highways," NCHRP Report 141, Highway Research Board, 1973.

U.S. Department of Transportation, Office of the Secretary of Transportation, An Investigation of Truck Size and Weight Limits, Washington, DC, 1981.

U.S. Department of Transportation, Federal Highway Administration, Highway Cost Allocation Study - Working Paper Number 8, An Analysis of the Reliability of the Current Heavy Vehicle Use Tax Rates, August, 1980.

____________________, 1975-1979 National Truck Characteristics Report Perry M. Kent and Mary T. Robey, June, 1981.

____________________, Review of the Presentation of the Massachusetts Construction Industry Council on Heavy Trucks, July, 1983.

____________________, Highway Performance Monitoring System, Truck Weight Case Study, June, 1982.

U.S. Department of Transportation, Office of the Secretary, "The Investigation of Truck Size and Weight Limits," August, 1981. Details of the methods used in the Federal studies are contained in the Technical Supplement, Volumes 2, 4 and 7 to the DOT TS&W report to Congress.

Walton, C. M., Chien-Pei Yu, Paul Ng, and S. Tobias, "An Assessment of Recent State Truck Size and Weight Studies," Research Report 241-4, Center for Transportation Research, The University of Texas at Austin, July, 1982.

Walton, C. Michael, Chien-Pei Yu, and Paul Ng, "Truck Weight Shifting Methodology for Predicting Highway Loads," Research Report 241-5, Center for Transportation Research, The University of Texas at Austin, September, 1982.

## 9. FORECASTING METHODS


Box, G. E. P., and G. M. Jenkins, Time Series Analysis, Holden-Day, 1976.

Chatfield, C., The Analysis of Time Series: Theory and Practice, Chapman and Hall, London, 1975.

Chatterjee, S. and B. Price, Regression Analysis by Example, John Wiley, 1977.

Gilchrist, W., Statistical Forecasting, John Wiley, 1976.

Granger, C. W. J., Forecasting in Business and Economics, Academic Press, 1980.

Gujarati, D., Basic Econometrics, McGraw-Hill, 1978.

Harvey, A. C., The Econometric Analysis of Time Series, John Wiley, New York, 1981.

Johnston, J., Econometric Methods, 2nd edition, McGraw-Hill, New York, 1972.

Judge, G. A., R. C. Hill, W. Griffiths, H. Lutkepohl, and T. C. Lee, Introduction to the Theory and Practice of Econometrics, John Wiley, 1982.

Kmenta, J., Elements of Econometrics, Macmillan, New York, 1971.

Maddala, G. S., Econometrics, McGraw-Hill, 1977.

Pindyck, R. S. and D. L. Rubinfeld, Econometric Models and Economic Forecasts, 2nd edition, McGraw-Hill, 1981.

Systems Design Concepts, Inc., Transportation Systems Descriptors Used in Forecasting Federal Highway Revenues, NTIS Report No. FHWA/PL/81/009, (Springfield, VA: National Technical Information Service), 1981.

Transportation Research Board, "Freight Modelling and Forecasting," Transportation Research Record 889, National Academy of Sciences, 1982.

_______________________, "Travel Demand Forecasting Procedures," Transportation Research Record 895, National Academy of Sciences, 1982.

_______________________, "Freight Data Requirements for Statewide Transportation Systems Planning, Research Report," NCHRP Report 177. National Research Council, 1977.

_______________________, "Freight Data Requirements for Statewide Transportation Systems Planning, User's Manual," NCHRP Report 178, National Research Council, 1977.

10. TAXATION AND REGISTRATION

American Association of Motor Vehicle Administrators, "International Registration Plan," Washington, DC, April 1, 1982.

Hamilton, Nadine, "Exempt, Credit and Refund Categories of Highway-User Taxes," U.S. DOT, FHWA, May, 1980.

System Design Concepts, Inc., and Harold A. Hovey, "AASHTO Study of Motor Carrier Taxation and Registration Issues," Report to AASHTO, December, 1983.

Secretary of the Treasury, "Second Progress Report of the Study of Highway Excise Tax Structure," Report to the Congress, October, 1981.

U.S. Department of Transportation, Federal Highway Administration, The Evolution of the Highway-User Charge Principle, April, 1983.

______________________, Highway Taxes and Fees: How They are Collected and Distributed, 1982.

______________________, Highway Cost Allocation Study, Working Paper Number 3, Alternative Revenue Sources, September, 1979.

______________________, Financial Planning for State Transportation Programs, June, 1981.

______________________, General Principles of State Highway Finance and Taxation, November, 1981.

______________________, Highway Investment Practices and Trends, November, 1981.

______________________, State Highway User Taxes: Historical Development and Current Trends, 1982.

U.S. Department of Transportation and Interstate Commerce Commission, Uniform State Regulations: Motor Carrier Act of 1980, Section 19. Report to Congress, 1982.

U.S. Department of the Treasury, Final Report of the Study of Highway Excise Tax Structure, December, 1982.

11. COST ALLOCATION THEORY

Bhatt, Kiran, et al. An Analysis of Road Expenditures and Payments by Vehicle Class (1956-1975), Washington, DC: The Urban Institute, March, 1977.

Lee, Douglass B., "Methods for Allocating Highway Costs," Washington, DC, U.S. DOT, FHWA, April, 1981.

Sinclair, Benito A. and Associates, Inc., Incremental Analysis of Structural Construction Costs, NTIS Report No. FHWA/PL/81/008, (Springfield, VA: National Technical Information Service), 1981.

U.S. Department of Transportation, Federal Highway Administration, Hendrickson, Chris, Martin Wohl, and Sue McNeil, (Carnegie-Mellon). Economic Issues Inherent in the Allocation of Roadway Costs, September, 1981.

____________________, Final Report on the Federal Highway Cost Allocation Study, 1982.

____________________, Statewide Financial Planning Seminar, November, 1981.

____________________, Federal Highway Cost Allocation: An Examination of Current Trends, December 8, 1975.

This section of the bibliography is excerpted from Transportation System Descriptors Used in Forecasting Federal Highway Revenues prepared by System Design Concepts, Inc., Washington, DC, for the U.S. Department of Transportation, Federal Highway Administration, June, 1981.

## LUBRICATING OIL

1. Sales of Lubricating and Industrial Oils and Greases. U.S. Department of Commerce, Bureau of the Census, MA-29C (year)-1. Washington, DC, 1970-1978.

This source provides the sale of lubricating oil by gallons for motor vehicles.

2. "Energy Data Reports," Petroleum Statement Monthly. Department of Energy, Energy Information Administration, DOE/EIOA-0109/12 (year). Washington, DC, 1969-1979.

This source provides production levels of lubricating oil and also illustrates the domestic demand levels.

3. National Petroluem Refiners' Association, Sales and Production Levels Data, Washington, DC, 1980.

This source provides lubricating oil sales and production levels to compare with the government estimates.

4. Truck, Motorhome and Transmode Service Publication List. General Motors Corporation. No. X-7940.

This source provides the recommended oil changes by miles for the entire spectrum of GMC trucks.

5. Transit Operating Reports for 1976, American Public Transit Association. 1977.

This source provides transit bus usage of lubricating oil for 1978.

8. Federal Energy Administration. Trucking Activity and Fuel Consumption 1973, 1980, 1985, and 1990. Prepared by Jack Faucett Associates, Inc., Chevy Chase, Maryland, July 1976.

This source provides a sampling of truck MPG estimates from several sources.

9. National School Transportation Association, Springfield, Virginia.

This source provides MPG estimates for school buses.

10. General Services Administration. Federal Motor Vehicle Fleet Report. Transportation and Public Utilities Service, Washington, DC, 1975-1978.

This source provides fleet vehicle fuel usage information.

11. TIUS - Truck Inventory and Use Survey, Bureau of the Census. Washington, DC, 1977.

This source provides the MPG estimates for the necessary truck classes.

12. Fuel Efficiency Estimates. Mellon Institute. 1980.

This source provides data on fuel economy estimates for 1980 to 2000 by domestic autos (large, middle, small), domestic trucks, import trucks, import autos, and total fleet.

VEHICLE POPULATION

1. Federal Highway Administration. Highway Statistics. U.S. Department of Transportation, Tables MV-1, 9, and 10. Washington, DC, 1975-1978.

   This source provides vehicle registration population data for truck (private and commercial, government), bus (private and commercial, government). Also, this source provides data on bus by fuel types and school usage.

2. Facts and Figures. Motor Vehicle Manufacturers' Association. Washington, DC, 1975-1979.

   This source provides vehicle population data by registration for autos, trucks, buses, and motorcycles by several classes. It also provides autos and trucks in operation. (R.L. Polk & Company).

3. Transit Fact Book. American Public Transit Association. Washington, DC, 1975-1978.

   This source provides data concerning transit bus registrations in operation, and by public and private usage.

4. America's Most Fuel Efficient Passenger Transportation Service. American Bus Association, Washington, DC, 1975-1979.

   This source provides intercity bus population data by classes (I, II, and III) of carrier.

5. Bureau of the Census. "1977 Census of Transportation." Truck Inventory and Use Survey. U.S. Department of Commerce. Washington, DC, 1977.

This source provides important truck population data by State and the necessary truck categories for 1977.

6. R.L. Polk & Company data from TSC.

This source may be useful to supplement the Polk data in Facts & Figures. MVMA.

## DISAGGREGATE VMT AND FUEL EFFICIENCY BY FUNCTIONAL ROADWAY SYSTEM

### FUEL EFFICIENCY

1. Claffey, Paul J. Running Costs of Motor Vehicles As Affected by Road Design and Traffic. National Cooperative Highway Research Program Report III. Washington, DC, 1971.

This source provides the fuel efficiency data by the type of road, degree of grades (+ or -), number of stops, size of vehicle, degree of curves, speed travelled, and traffic volume. This source lacks the necessary highway class breakdowns but provides some vehicle class breakdowns.

2. Claffey, Paul J. Running Costs of Motor Vehicles As Affected by Highway Design, Interim Report. National Cooperative Highway Research Report 13. Washington, DC, 1965.

This source provides the same information contained in source 1 (only an earlier version) but this source provides a greater breakdown by weight categories.

3. Federal Highway Administration, Energy Impact Analysis Resource Information, U.S. Department of Transportation. Washington, DC, June 1976.

This source provides data on relationships of fuel consumption by weight of the vehicle, warm and cold starts, vehicle design and size, transit bus MPG estimates, (transit) route speed and stop frequencies, degree of grades, uniform speed, speed by mph, type of road, traffic volume, and number of stops all for a variety of vehicles.

VMT sources are included in the VMT section.

## VEHICLE SALES

1. Transit Fact Book. American Public Transit Association. Washington, DC, 1975-1978.

This source provides data concerning the number of transit buses delivered to private and public transit systesm.

2. MVMA Facts and Figures. Motor Vehicle Manufacturers' Association. Washington, DC, 1975-1979.

This source provides sales data and Polk's new registrations data on buses by autos, trucks by weight classes and body types, and motorcycles.

3. Automotive News. Crain Automotive Group, Inc. Detroit, Michigan, 1975-1980.

This source provides sales data by week, month, and year of autos and trucks by model (new and used) and model year.

## VMT


1. U.S. Congress, House of Representatives, Committee on Public Works and Transportation, The Status of the Nation's Highways: Conditions and Performance (95-29). Prepared by the Secretary of Transportation, U.S. Government Printing Office, Washington, DC, 1977.

   This source provides VMT data by the necessary functional highway classes and by State.

2. Comeau, Clifford M. "National Highway Inventory and Performance Summary," 1976 National Highway Inventory and Performance Study. U.S. Department of Transportation, Federal Highway Administration, Office of Highway Planning. Washington, DC, December 1977.

   This source provides data on speeds by the necessary functional highway classes, DVMT by the same highway classes, and other traffic counts. The source will be used with source 3 to estimate VMT and fuel efficiency disaggregate by the functional highway system.

3. Procedural Development Branch and Special Studies Branch. "National Functional System Mileage and Travel Summary. 1976 National Inventory and Performance Study. U.S. Department of Transportation, Federal Highway Administration, Office of Highway Planning. Washington, DC, June 1977.

   This source provides the necessary DVMT data by the necessary highway system by State. Also, this source with source 2 will aid in disaggregating VMT and fuel efficiency by highway class.

4. Mosbaek and Cohen. Methodology for Estimating the Impacts of Changes on Highway Performance. U.S. Department of Transportation, Federal Highway Administration, Washington, DC, August 1977.

This source provides a methodology for estimating fuel efficiency for vehicles by functional highway classes.

5. 1977 Vehicle Miles Travelled Tabulations. Prepared by System Design Concepts, Inc. as part of the Truck Size and Weight Study from FHWA data, Washington, DC, 1980.

This source provides the VMT data for the necessary vehicle classes but lacks the necessary functional highway classes. A combination of all the VMT sources will yield the VMT base data for the necessary vehicle classes and functional highway classes.

6. Federal Highway Administration. Highway Statistics. U.S. Department of Transportation, Washington, DC, 1975-1978.

This source provides the general wealth of data on VMT by several vehicle and highway classes.

7. Transit Fact Book. American Public Transportation Association, Washington, DC, 1975-1980.

This source provides a general wealth of information on transit bus VMT.

8. America's Most Fuel Efficient Passenger Transportation Service. American Bus Association. Washington, DC, 1975-1979.

This source provides a general wealth of data concerning intercity bus VMT.

9. National School Transportation Association, Springfield, VA.

This source provides a general wealth of data concerning school bus VMT.

10. 1977 TIUS Tabulations. Prepared by Federal Highway Administration as part of the Cost Allocation Study from TIUS data, Washington, DC, 1980.

This source provides the primary data for truck VMT by the necessary weight classes (not yet received).

11. Potential Fuel Conservation Measures by Motor Carriers in the Intercity Freight Market. Charles River Associates, March 1977.

This study contains data on vehicle miles for types of trailers by range of haul as well as distribution of vehicle miles by type of carrier.

12. Transportation Energy Conservation Data Book. Oak Ridge National Laboratory, Oak Ridge, TN, 1979.

Source contains a graph of average annual miles versus age for heavy-heavy truck and light trucks -- data from Truck Inventory and Use Survey.

13. Transport Statistics in the United States, Part 7. Interstate Commerce Commission, Washington, DC, 1976-1978.

For Class I and II Carriers, this publication lists VMT in intercity service.

14. Trucking Activity and Fuel Consumption, 1973, 1980, 1985 and 1990. Jack Faucett Associates, Chevy Chase, MD, July 1976.

This source provides average VMT data for a 1973 data base and projections.

AMOUNT SPENT ON REPLACEMENT PARTS

1. Census of Manufactures. DOC, Washington, DC, Data for 1967, '72, (preliminary) '77.

Source lists data for quantity and value shipped for motor vehicle parts and accessories, disaggregated by parts used for original equipment and parts used for replacement. However, parts shipped are not disaggregated by auto or truck end user. Calculations of value/quantity yield producers' price at wholesale, not purchasers' price at retail.

2. Census of Selected Service Industries. DOC, Washington, DC, 1977, 1972.

This census provides data on the number of employees and the total payroll of automotive and diesel repair shops. While these data will permit the determination of some labor costs, only about half of all repairs occur in repair shops.

3. Federal Highway Administration, Highway Statistics, U.S. Department of Transportation, Washington, DC, 1976-1978.

FHWA taxes collected on truck parts are available for the base years 1976, '77 and '78. These taxes are 8% of the final manufacturer's sale price. Source includes estimates of the amount of those taxes that are paid by private and commercial highway users. (The ATA publishes annually the percent of the highway user taxes paid by trucks -- about 99%. This figure is based on the original HCAS.)

4. NADA Data for 1980. National Automotive Dealers Association, McLean, VA, 1980.

Source tabulates dollars spent on franchised new car and truck dealer parts and service. Parts and service labor are disaggregated, so the fraction of maintenance costs that are parts expenditures can be calculated.

5. National Spending Study. Hertz Corporation, New York, NY, 1980.

This report includes operating costs breakdowns for an "intermediate" car, and lists maintenance costs within those breakdowns.

6. Trinc's Blue Book of the Trucking Industry. Trinc Transportation Consultants, Washington, DC, 1978.

For Class I and II carriers data are tabulated for many individual firms. Data are also aggregated by class of carrier and for all U.S. trucking firms. The data are not, however, disaggregated by labor and parts expenditures.

7. Truck Cost Study. Hertz Corporation, New York, NY, May 1980.

This report contains detailed data on all truck costs, including costs for maintenance. Since lease/rental trucks are used much more intensively than other trucks of the same weight class, annual maintenance figures will probably be significantly higher than average. Maintenance costs are estimated for a 23,000 GVW van and an 80,000 GCW tractor-trailer.

FUEL EFFICIENCY/TRUCKS

1. Potential Fuel Conservation Measures by Motor Carriers in the Intercity Freight Market. Charles River Associates, March 1977.

For the calculation of fuel efficiency based on load carried, this source contains data on fuel use by ton-mile and space utilization by equipment type.

2. Rose, A.B. and K.J. Reed, Energy Intensity and Related Parameters of Selected Transportation Modes: Freight Movements. Oak Ridge National Laboratory, Oak Ridge, TN. June 1979.

This study attempts to determine the causes of the divergences among published energy intensity values, including fuel efficiency of trucks. The report contains tables of MPG/year 1973, 1974, 1975, 1976 for the post office and large Federal fleets, in GVW classes less than 12,500, 12,500 to 17,000, over 17,000. The study also cites Faucett and Charles River Associates in providing the best estimate available for average fuel efficiency of class 8 trucks in intercity service (4.5 MPG, p. 6-10).

3. Study of Potential for Motor Vehicle Fuel Economy Improvement Truck and Bus Panel Report, Transportation Systems Center, DOT, NTIS #PB-241777, 10 Jan. 1975.

This study provides gasoline and diesel fuel economy estimates for 1973 trucks and buses over 10,000 lbs. GVW, by weight class (pp. 9, 10, 11). These data are for the most popular model within a weight class and are derived from the ATA and DOT Road User and Property Taxes Report.

4. Truck Cost Study. Hertz Corporation, New York, NY. May 1980.

Fuel efficiency for 23,000 lb. GVW van and 80,000 lb. GVW tractor-trailer can be calculated from cost per mile and mileage data presented in this study, for all three data base years.

PERCENT EXCESS TRAILERS PER POWER UNIT

1. Anderson, David L., Forecast Motor Carrier Traffic Demand and Equipment Requirements. Data Resources, Incorporated, Lexington, MA.

This article lists 1975 and 1976 estimates by Commercial Car Journal, FHWA and DRI of trailers in operation. The estimates do not match well. However, DRI says its estimates are "very close" to those of R.L. Polk, without citing the latter's data.

2. Federal Highway Administration, Highway Statistics. Department of Transportation. Washington, DC, 1976-1978.

This source lists trailer, semi-trailer and tractor-truck registrations by State.

3. Motor Vehicle Facts and Figures. Motor Vehicle Manufacturer's Association. Washington, DC. 1975-1979.

MVMA summarizes FHWA data on tractors and trailers.

4. Trinc's Blue Book of the Trucking Industry. Trinc Transportation Consultants. Washington, DC, 1978.

For Class I and II Carriers, this source lists total power units and number of trailers owned by firm. These data are also aggregated for all carriers and for special groups of carriers.

## PRICES


1. Census of Manufactures. DOC, Washington, DC. 1967, 1972, 1977.

    This source contains quantity and value of products shipped data for trucks by GVW, produced by manufacturers in SIC industry 3711. These data do not include trucks built in SIC 3713, Truck and Bus Bodies.

2. Producer Price Indexes. DOC, Washington, DC. 1979.

    Wholesale price indexes for trucks, 1964-1979: for trucks 10,000 lbs. and under, and 10,000 lbs. and over, were provided by the DOC.

3. Road User and Property Taxes on Selected Vehicles. Department of Transportation, Washington, DC. 1960, 1964, 1968, 1970, 1973, (preliminary) 1979.

    For the most popular model within certain GVW classes, this report lists vehicle prices and GVW, annual miles travelled, MPG, etc. These vehicles are equipped with options by the ATA to provide an average vehicle, and prices are reduced by a typical discount.

4. Truck Blue Book. National Market Reports, Chicago, Illinois: Maclean-Hunter Publishing Corporation, July, 1980.

    This book source lists the suggested factory price of standardly-equipped trucks. Listings are by model number; they provide axles configuration, GVW, GCW, as well as the suggested factory price of new trucks. Data are available from 1960 to 1980. Discussions with local truck dealers indicate that the actual purchase price of a truck averages about 85 percent of the suggested factory price, but that this can vary dramatically depending on market conditions.

5. Truck Cost Study. Hertz Corporation, New York, NY. May 1980.

Data in this source provide the cost (including discount and options) over the past seven years of a 23,000 lb. GVW van and an 80,000 lb. GCW tractor-trailer, both equipped with Hertz options.

6. Truck Trailers. DOC, Washington, DC. 1980.

This report, which is published monthly and summarized annually, has tables of quantity and value of products shipped, by type of trailer, 1970-1979. Since these are products-shipped data, their manipulation provides producer wholesale rather than producer retail prices.

SCRAPPAGE

1. Anderson, David L., Forecasting Motor Carrier Traffic Demand and Equipment Requirements. Data Resources, Inc., Lexington, MA.

This report describes the truck demand model of DRI (for classes 6, 7, 8). Included is a table of Class 8 Mack truck scrappage by model year. The average life of a Class 8 truck appears to be between 10 and 11 years, with about 8% scrappage per year. This source also estimates trailer retirement rates at four percent per model per year.

2. Facts and Figures. Motor Vehicle Manufacturers' Association, Washington, DC, 1976-1979.

These annual volumes provide historical data on factory sales of trucks and buses by GVW, factory sales of diesel trucks by GVW, and retail sales of trucks by GVW. Examination of these data shows that factory sales by GVW for trucks and buses provide the best match with TIUS data. This source also contains ATA estimates of taxes on the same vehicles used in Road User and Property Taxes. The 10% original excise taxes on trucks are divided by the estimated life of the vehicle. This estimated life comes from the original HCAS.

3. 1977 TIUS Tabulations. Prepared by Federal Highway Administration as part of the Cost Allocation Study from TIUS data, Washington, DC, 1980.

Comparison of TIUS figures of registrations per model per year and MVMA figures for factory sales in a model year provides a set of data from which scrappage for two truck classes were determined.

TIRE SALES/PRICES

1. Highway Tire Noise Symposium, Proceedings, SAE, Warrendale, PA, 1977.

The paper "Tire Noise Regulations — Technical and Economic Implications," included in this volume, presents six tire use/cost scenarios, for both bias-ply and radial tires.

2. The National Income and Products Accounts of the United States, 1929-74, DOC, Washington, DC. 1977.

These tables include annual data for 1960-74 personal consumption expenditures of tires, tubes and accessories. These expenditures do not include commercial firms' purchases of tires which are included in interindustry transactions.



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