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16. Abstract

The shortage of construction funds and increased traffic congestion in the urban areas of Texas have caused the State Department of Highways and Public Transportation (DHT) to concentrate on upgrading and incrasing the capacity of existing highways and freeways. In an effort to select those highway improvements that maximize future public benefits, the DHT is using the Highway Economic Evaluation Model (HEEM), developed in 1975-76 by the McKinsey and Company, Inc. of Dallas.

The HEEM, which is a computerized model, calculates a benefit/cost ration and a measure of mobility (average speed) for each proposed highway improvement. However, almost since implementation, questions have been raised about the HEEM's assumptions and its limitations to evaluate certain types of highway improvements, particularly high occupancy vehicle (HOV) projects.

The report contains the results of a study to revise the HEEM program to evaluate HOV projects and make other improvements in the program. It can also serve as the combined user's guide and programmer's supplement for the revised HEEM, now called HEEM-II. The revised program (HEEM-II) can evaluate 29 more highway types (improvements), including HOV types, than the original HEEM. It also can allocate traffic to different routes in a corridor segment on a minimum user cost basis. Also, it uses updated unit costs and assumed values, a different time horizon for calculating the benefit/cost ratio, two corridor traffic projections to determine the shape of the traffic growth curve, and corrected specification table values. Last, the tabular and graphic output format is more informative.

This report explains HEEM-II's inputs, calculations, and outputs and includes its program, written in ANSI 77 FORTRAN IV.

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REVISED HIGHWAY ECONOMIC EVALUATION MODEL (HEEM-II)

by

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Research Report 225-28F
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Economics of Highway Design Alternatives

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TEXAS TRANSPORTATION INSTITUTE
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PREFACE

The authors wish to express their appreciation to those who have assisted or facilitated this study. Special acknowledgement is given to Mr. James R. Farrar, Jr. of the Texas State Department of Highways and Public Transportation and the official study contact representative for his valuable comments and suggestions. Also, Mr. Jim Barr and Mr. Harold Cooner of the SDHPT made helpful comments from time to time. Also, special thanks are due Mr. Eric Schulte for preparing the graphs and Miss Patti McClurg for typing the manuscript.

ABSTRACT

The shortage of construction funds and increased traffic congestion in the urban areas of Texas have caused the State Department of Highways and Public Transportation (DHT) to concentrate on upgrading and increasing the capacity of existing highways and freeways. In an effort to select those highway improvements that maximize future public benefits, the DHT is using the Highway Economic Evaluation Model (HEEM), developed in 1975-76 by the McKinsey and Company, Inc. of Dallas.

The HEEM, which is a computerized model, calculates a benefit/cost ratio and a measure of mobility (average speed) for each proposed highway improvement. However, almost since implementation, questions have been raised about the HEEM's assumptions and its limitations to evaluate certain types of highway improvements, particularly high occupancy vehicle (HOV) projects.

The report contains the results of a study to revise the HEEM program to evaluate HOV projects and make other improvements in the program. It can also serve as the combined user's guide and programmer's supplement for the revised HEEM, now called HEEM-II. The revised program (HEEM-II) can evaluate 29 more highway types (improvements), including HOV types, than the original HEEM. It also can allocate traffic to different routes in a corridor segment on a minimum user cost basis. Also, it uses updated unit costs and assumed values, a different time horizon for calculating the benefit/cost ratio, two corridor traffic projections to determine the shape of the traffic growth curve, and corrected specification table values. Last, the tabular and graphic output format is more informative.

This report explains HEEM-II's inputs, calculations, and outputs and includes its program, written in ANSI 77 FORTRAN IV.

SUMMARY OF FINDINGS

The Highway Economic and Evaluation Model (HEEM) developed by McKinsey and Company for the State Department of Highways and Public Transportation (DHT) and implemented in 1976 is used to evaluate proposed highway improvements. Since implementation, questions have been raised about the HEEM's assumptions and its inability to evaluate certain proposed improvement alternatives, particularly high occupancy vehicle (HOV) alternatives. Therefore, the DHT authorized the Texas Transportation Institute (TTI) to study these problems and report its findings [3, 4]. Finally, the DHT asked TTI to revise the HEEM to enable it to evaluate HOV alternatives, correct programming errors, update unit costs, and rewrite the User's Guide [1] and Programmer's Supplement [2]. This report is designed to serve as a combined user's guide and programmer's supplement for the revised HEEM, called HEEM-II.

Most of the original HEEM program remains intact. The major changes are listed as follows:

1. A new corridor traffic allocation procedure is used to enable the model to evaluate HOV alternatives.
2. A total of 29 new highway types representing different highway improvement alternatives, several being freeway or arterial route HOV alternatives, are added to the model.
3. A 20 year (instead of a 40 year) planning horizon for calculating the benefit/cost ratio is specified as a default value in HEEM-II.
4. A set of updated unit costs, that is, values of time, vehicle operating costs, accident costs, and maintenance costs, is used in the model.

5. Two corridor traffic projections are required as inputs which take the place of the one year traffic projection, the specification of a type of traffic growth pattern and the terminal growth rate.
6. Percentage of trucks/buses and occupancy rates for cars/vans and trucks/buses can now be specified for each route in each corridor segment instead of only for the corridor segment(s) as a whole.
7. In case of evaluating HOV bypasses, the percentage of vehicles using the bypass must be specified.
8. The buildover provision is expanded to allow not only the evaluation of building over the existing route but also the building over an alternate route or both.
9. The expansion of the proposed route can now be an HOV alternative.
10. Inconvenience costs can be specified for evaluation of HOV alternatives.
11. The specification table is revised to include the new highway types and reflect correction errors in the values for other highway types.
12. The revised model can not only optimize the construction year but also the expansion year or both to gain the maximum benefits from an improvement.
13. The default values are changed for most of the general or corridor wide assumptions to reflect more practical and current conditions.
14. A more informative output format is given by HEEM-II, by depicting graphically the yearly allocation of traffic to each route in the corridor segment for the "do-nothing" and "if-construct" alternative and the yearly corridor segment discounted benefits of a proposed improvement. The output totals for the corridor segment, problem, and system analyses are changed to include more pertinent information.

For example, the net present value and internal rate of return are added to the corridor segment totals. Also, the economic measure is now called the benefit/cost ratio, because the latter is better known and more specifically defined than the former.

HEEM-II requires about the same amount of input data as the original HEEM, and it is easier to run. It can be used to analyze a greater variety of proposed highway improvements. HEEM-II could be improved to do an even better job of analyzing highway improvement alternatives. The last section of this report lists some recommended improvements to the model.

IMPLEMENTATION STATEMENT

This report presents the revised Highway Economic Evaluation Model, called HEEM-II. With a minimum of input data, HEEM-II can be used to evaluate proposed highway improvements, including high occupancy vehicle lanes on freeways or busways. Its output includes an economic measure (benefit/cost ratio) and a mobility measure (average speed) of the proposed improvement.

This report, which can serve as a user's guide and programmer's supplement for HEEM-II, can be implemented immediately for use in evaluating proposed highway improvements.

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INTRODUCTION

The shortage of construction funds and increased traffic congestion in the urban areas of Texas have caused the State Department of Highways and Public Transportation (DHT) to concentrate on upgrading and increasing the capacity of existing highways and freeways. For example, innovative improvements such as contraflow or concurrentflow bus lanes, busways, and bus bypasses on metered ramps are being made in an effort to increase the vehicle and person carrying capacity of freeways.

In an effort to select those highway improvements that maximize future public benefits, the DHT has been using the Highway Economic Evaluation Model (HEEM) since 1976. Now an improved version of this model, HEEM-II, has been developed and is ready for implementation.

Development of the Original HEEM

In the mid 1970's, the DHT was faced with a huge backlog of proposed highway improvements and a shrinking source of construction funds. Of this backlog of proposed projects, many would have to be scaled down and others would have to be deleted because of the shortage of funds. Faced with this dilemma, the DHT decided to have a procedure developed that would estimate the highway user benefits expected to be derived from an ultimate or scaled down version of each of the proposed improvements compared to the "do-nothing" alternate. The McKinsey and Company, Inc. of Dallas was contracted to develop the HEEM, which is a computerized model that calculates an economic measure (benefit/cost ratio) and a measure of mobility (average speed) for each improvement alternate. The DHT published the HEEM User's Guide [1] and Programmer's Supplement [2] in 1976 and began implementing the model with the help of the authors (McKinsey and Co.).

Need for HEEM-II

Almost since implementation, questions have been raised about some aspects of the original HEEM, particularily the validity of some of its assumptions. Therefore, the DHT asked the Texas Transportation Institute (TTI) to conduct a critical review of the "key" assumptions of the HEEM to determine the appropriateness of each one. A report of findings was published by TTI in January of 1979 [3].

Later, the DHT asked TTI to examine the HEEM's limitations for evaluating high occupancy vehicle (HOV) projects and recommend changes in the program which would allow it to evaluate such projects. The findings of that study were reported by TTI in January of 1982 [4]. More recently, the DHT asked TTI to revise the original HEEM program so that it could be used to evaluate HOV projects and to rewrite the user's guide and programmer's supplement. Other changes, some of which were required to allow the HEEM to evaluate HOV projects, include a new corridor traffic allocation procedure, the flexibility of setting a different time horizon for calculating the benefit/cost ratio, a set of updated unit costs, a provision for two corridor traffic projections, a more informative output format, and a corrected specification table.

The revised program (HEEM-II), which incorporates all of the above changes, is described in this report. In fact, this report can serve as the new user's guide and programmer's supplement.

Data Requirements of HEEM-II

The input data requirements of HEEM-II are not extensive. The data can be summarized as either required or optional. The required input data are as follows:

1. Corridor ADT for current and two projected years
2. Years of projected ADT
3. Characteristics of existing, proposed, alternate, and expanded highway segments
   a. Number of lanes
   b. Technical and safety factors
   c. Length in miles
   d. Facility type (conventional, freeway, etc.)
4. Construction and expansion years (if staged)
5. Construction cost of improvement (including right-of-way costs)

The optional input data are the assumed values given for each highway segment or problem (several segments). For instance, the percentage of trucks can be given for each highway segment or for the highway problem (applied to several segments). If the user does not supply the percentage of trucks, the model assumes a default value of 11 percent instead. Other optional data that can be supplied by the user are as follows: speed limit (conventional highways), occupancy rates, percentage of vehicles using HOV bypasses, diversion route speed, length of planning horizon, value of time for cars and trucks, HOV inconvenience costs, construction cost escalation rate, inflation-rate, and discount rate.

More detail data on HEEM-II's input data requirements are given in the "Use of HEEM-II" section of this report.

Data Sources for Development of HEEM-II

The original HEEM is fully documented in DHT's "Guide to the Highway Economic Evaluation Model" [1] and "Programmer's Supplement" [2]. Appropriate data from these two volumes are incorporated into HEEM-II and presented in this report.

The previously cited TTI reports [3,4] are used as source documents. Two other TTI reports [5,6] are used to support a change in the corridor traffic volume input requirements to determine the shape of the traffic volume growth curve over time.

CHARACTERISTICS OF HEEM-II

The characteristics of HEEM-II are covered in this section of the report. A highway corridor and its segmentation for use in HEEM-II are defined. Also, the highway improvement alternatives, major assumptions, and user benefit/cost determinations made by HEEM-II are explained.

Corridor Segmentation

HEEM-II uses a traffic corridor analysis approach to evaluating proposed highway improvement alternatives. A traffic corridor is defined as an urban or rural area containing one or more parallel highway routes that motorists might use to reach a given destination. Motorists usually choose to travel on the route in the corridor that allows them to reach their destination in the least time or at the lowest cost. If that route becomes congested, they will choose an alternate route in the corridor to make the same trip. If the alternate route becomes congested, they will try the previous route again or another route. They may even resort to a circuitous route to reach their destination.

If a traffic corridor becomes too congested, the DHT may propose to improve one of the routes or even construct a new route through the corridor to reduce congestion on the other routes. In such a case, HEEM-II should be used to estimate the reduction in user costs (i.e., user benefits) resulting from the improvement compared with the "do-nothing" alternative. If the existing, proposed, and alternate routes do not have the same design, traffic characteristics, and type of area through the corridor, each route should be divided into different segments. A change in the number of lanes, median treatment (undivided to divided), type of access (conventional road to freeway or add metering on an existing freeway), traffic volume or composition, type of area (rural to urban), speed limit, or major intersecting routes can help to define highway segments. A change has been made in the HEEM-II program which will allow both rural and urban highway types in the same segment. This was not possible in the original HEEM. While it is possible to combine rural and urban highway types, some care should be exercised due to the different underlying assumptions on peaking patterns and capacity for urban and rural highway types. Figure 1 shows the segmentation of a sample corridor.

HEEM-II analyzes each segment separately and combines all the segments (to a maximum of 99) in the corridor into one problem. Then, all problems (to a maximum of 99) can be added together to obtain a network or system solution.

Highway Improvement Alternatives

HEEM-II can be used to evaluate a variety of highway improvement alternatives. Table 1 lists the types of improvements that HEEM-II is equipped to evaluate against a "do-nothing" alternative. Some of these improvements are highway capacity enhancers. However, others only affect capacity indirectly, i.e., staging construction, changing speed limit, changing lane widths, changing percent of trucks, etc. Still others do not affect capacity at all.

Basic Highway Types

Some of the highway improvements listed in Table 1 are handled in HEEM-II by comparing different highway types, i.e., proposed highway versus the existing and alternate routes. Table 2 shows 70 urban and rural highway types, with differing speed limits, number of lanes, etc. Each of these highway types are

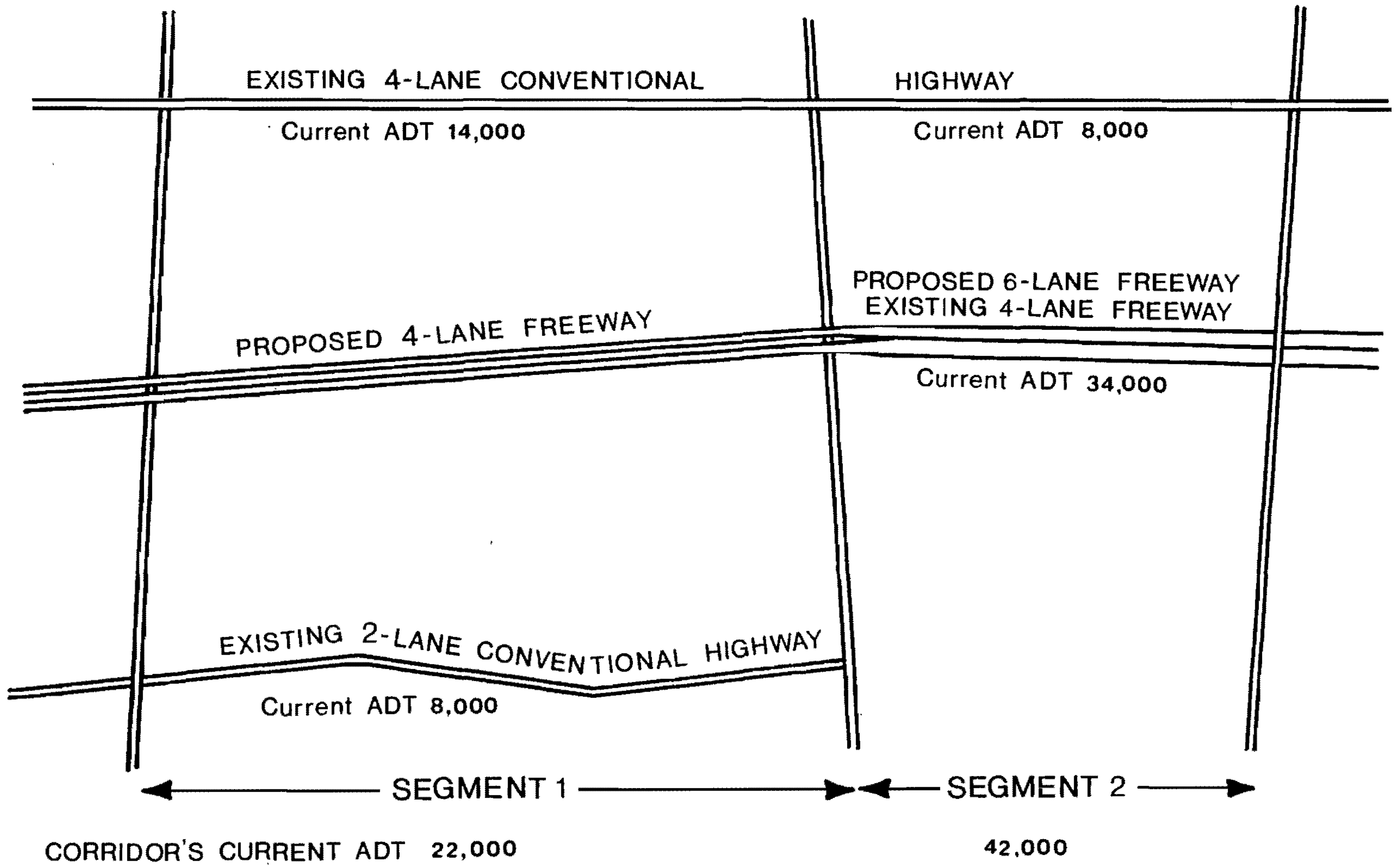


FIGURE 1. EXAMPLE OF CORRIDOR SEGMENTATION

Table 1. Types of Highway Improvements Evaluated with HEEM-II.

Type of Improvement	Effects on Capacity
Adding through lane(s)	Direct
Adding HOV lane on freeway or conventional highway	Direct
Adding busway on freeway or conventional highway	Direct
Adding ramp metering on freeway	Direct
Adding HOV bypass of metered ramps	Direct
Adding median on conventional highway	Indirect
Changing speed limit on conventional highway	Indirect
Changing lane width	Indirect
Changing shoulder width	Indirect
Changing horizontal alignment	Indirect
Changing vertical alignment	Indirect
Changing percent of trucks for corridor segment	Indirect
Differing percent of trucks for each corridor route	Indirect
Differing occupancy rates for each corridor route	Indirect
Building new highway instead of upgrading old	Direct
Upgrading conventional highway to expressway or freeway	Direct
Staging highway construction	None
Optimizing expansion year	None
Optimizing construction year	None
Optimizing construction and expansion year	None

Table 2. Code, Speed Limit and Description of Each Highway Type in HEEM-II

Highway Type Code	Speed Limit (MPH)[a]	Highway Type Description
-	b	Urban diverted[c]
U2C	25	Urban 2-lane conventional highway
U2C	35	Urban 2-lane conventional highway
U3C	25	Urban 3-lane conventional highway
U3C	35	Urban 3-lane conventional highway
U4C	25	Urban 4-lane conventional highway
U4C	35	Urban 4-lane conventional highway
U5C	25	Urban 5-lane conventional highway
U5C	35	Urban 5-lane conventional highway
U6C	25	Urban 6-lane conventional highway
U6C	35	Urban 6-lane conventional highway
U2E	-	Urban 2-lane expressway
U3E	-	Urban 3-lane expressway
U4E	-	Urban 4-lane expressway
U5E	-	Urban 5-lane expressway
U6E	-	Urban 6-lane expressway
U3F	-	Urban 3-lane freeway
U4F	-	Urban 4-lane freeway
U5F	-	Urban 5-lane freeway
U6F	-	Urban 6-lane freeway
U7F	-	Urban 7-lane freeway
U8F	-	Urban 8-lane freeway
U9F	-	Urban 9-lane freeway
U10F	-	Urban 10-lane freeway
U11F	-	Urban 11-lane freeway
U12F	-	Urban 12-lane freeway
U13F	-	Urban 13-lane freeway
U14F	-	Urban 14-lane freeway
U15F	-	Urban 15-lane freeway
U16F	-	Urban 16-lane freeway
U3M	-	Urban 3-lane metered freeway
U4M	-	Urban 4-lane metered freeway
U5M	-	Urban 5-lane metered freeway
U6M	-	Urban 6-lane metered freeway
U7M	-	Urban 7-lane metered freeway
U8M	-	Urban 8-lane metered freeway
U9M	-	Urban 9-lane metered freeway
U10M	-	Urban 10-lane metered freeway
U11M	-	Urban 11-lane metered freeway

(continued)

Table 2. Code, Speed Limit and Description of Each Highway Type in HEEM-II (Continued)

Highway Type Code	Speed Limit (MPH)[a]	Highway Type Description
U12M	-	Urban 12-lane metered freeway
U13M	-	Urban 13-lane metered freeway
U14M	-	Urban 14-lane metered freeway
U15M	-	Urban 15-lane metered freeway
U16M	-	Urban 16-lane metered freeway
U1AT	25	Urban 1-lane arterial contraflow
U1AT	35	Urban 1-lane arterial contraflow
U1AN	25	Urban 1-lane arterial concurrent flow
U1AN	35	Urban 1-lane arterial concurrent flow
U1T	-	Urban 1-lane freeway contraflow
U1N	-	Urban 1-lane freeway concurrent flow
U2N	-	Urban 2-lane freeway concurrent flow
U1S	-	Urban 1-lane freeway busway
U2S	-	Urban 2-lane freeway busway
-	b	Rural diverted[c]
R2C	40	Rural 2-lane conventional highway
R2C	55	Rural 2-lane conventional highway
R4C	40	Rural 4-lane conventional highway
R4C	55	Rural 4-lane conventional highway
R6C	40	Rural 6-lane conventional highway
R6C	55	Rural 6-lane conventional highway
R4D	-	Rural 4-lane divided highway
R6D	-	Rural 6-lane divided highway
R2E	-	Rural 2-lane expressway
R4E	-	Rural 4-lane expressway
R6E	-	Rural 6-lane expressway
R4F	-	Rural 4-lane freeway
R6F	-	Rural 6-lane freeway
R8F	-	Rural 8-lane freeway
R10F	-	Rural 10-lane freeway
R12F	-	Rural 12-lane freeway

- None specified

[a] The speed limit is used to determine whether the route is a high-speed or low-speed highway type for purposes such as determining capacity and accident rates. The user is not limited to using just these speed limits. Any speed limit can be input.

[b] Specified in program; default values are 15 miles per hour for rural diversion routes and 25 miles per hour for urban diversion routes. These can be changed by the program user.

[c] An unspecified circuitous route to handle any overflow traffic from specified corridor route.

assigned a highway type code in HEEM-II. In the case of speed limits, the user can compare the effects of speed limits other than those used for the highway types where speed limits are applicable. Two of the highway types are diversion routes, one for urban areas and one for rural areas. A diversion route is an unspecified circuitous route to handle overflow traffic from specified corridor routes.

Technical and Safety Adjustments

Several of the highway improvements listed in Table 1 are handled in HEEM-II by specifying different technical and/or safety factors than is assumed in the model. Those assumed in HEEM-II are for the typical condition, i.e., standard shoulder and lane widths, vertical and horizontal alignments, and percent of trucks.

Each technical or safety factor is an estimate of the percentage difference between the existing or proposed facility and a typical design or percent of trucks. Technical factors cannot exceed 100 percent, but safety factors can be greater than 100 percent if conditions suggest lower-than-typical accident rates. Table 3 shows the specified percentage reduction in the technical and safety factors for atypical conditions.

Major Assumptions

HEEM-II calculations are based on several major assumptions. Traffic growth in the corridor, speed/volume relationships, traffic peaking patterns, traffic allocation process, and program optimization techniques are the major assumptions of the model. These are discussed separately below.

Table 3. Percent Reduction in the Safety and Technical Factors for Atypical Conditions.

Facility	Freeway				Expressway				Conventional			
	Urban		Rural		Urban		Rural		Urban		Rural	
Criteria	Safety	Technical	Safety	Technical	Safety	Technical	Safety	Technical	Safety	Technical	Safety	Technical
Shoulders (Inside and Outside)												
6' - > Standard	5%	0%	0%	0%	5%	0%	5%	0%	--	--	5%	0%
4' - 6'	10	2	5	2	10	2	10	2	--	--	10	3
2' - 4'	15	5	10	5	15	5	15	5	--	--	15	10
0' - 2'	20	10	15	10	20	10	20	10	--	--	20	20
Lanes												
12' Width	0	0	0	0	0	0	0	0	0%	0%	0	0
11' Width	2	3	2	3	2	3	2	3	2	3	2	8
10' Width	5	10	5	10	5	10	5	10	5	10	5	15
9' Width	10	20	10	20	10	20	10	20	10	20	10	23
Vertical Alignment												
Flat - 0-3% Grade	0	0	0	0	0	0	0	0	0	0	0	0
Rolling - 3%-6% Grade	0	10	0	10	0	10	0	10	5	0	20	10
Moderate - > 6% Grade ≤ 1/2 L*	0	20	0	20	0	20	0	20	10	0	40	20
Steep - > 6% Grade > 1/2 L	0	30	0	30	0	30	0	30	15	0	60	30
Horizontal Alignment												
100% Straight	0	0	0	0	0	0	0	0	0	0	0	0
50%-100% Straight	5	0	5	0	5	0	5	0	5	0	5	0
0-50% Straight	10	0	10	0	10	0	10	0	10	0	10	0
Percent Trucks												
0-20%	--	--	--	--	--	--	--	--	0	0	0	0
20%-40%	--	--	--	--	--	--	--	--	20	20	20	20
>40%	--	--	--	--	--	--	--	--	30	30	30	30

* L = segment length

Traffic Growth in Corridor

HEEM-II takes into account traffic growth that may occur in a traffic corridor. The expected life of the improvement sets the time horizon for which projected traffic growth is applicable.

HEEM-II needs two corridor ADT traffic projections, one at or near the end of the time horizon and the other somewhere in between the beginning (current) and the end of the time horizon. With two ADT projections, the model can fit a curve that approximates the ADT growth over the whole time horizon, say 20 years. Figure 2 shows a set of curves fitted to several intermediate year ADT projections and one final year projection. The intermediate year projection is what determines the shape of the ADT curve used by HEEM-II. The ADT for each year of the time horizon is used as the basis for the corridor traffic allocation procedure discussed later in this section.

Ideally, the two projections should be based on historical ADT data for the traffic corridor being studied. DHT has a 10 year history of ADT at frequent locations along each highway in its RI2T log computerized file. One of the TTI studies [6] suggests equations developed from such historical data that can be used to make these projections. The estimating equations in the study need only one year of ADT data, preferably the current ADT. Separate equations can be used for corridors in different stages of land development, namely, undeveloped, developing, and developed. HEEM-II does not use these equations interally within the program, though the equations could be used to estimate the projected traffic volumes required for HEEM-II.

Speed/Volume Relationship

HEEM-II's user cost calculations are based on a family of speed/volume performance curves developed from empirical data with the aid of a computer

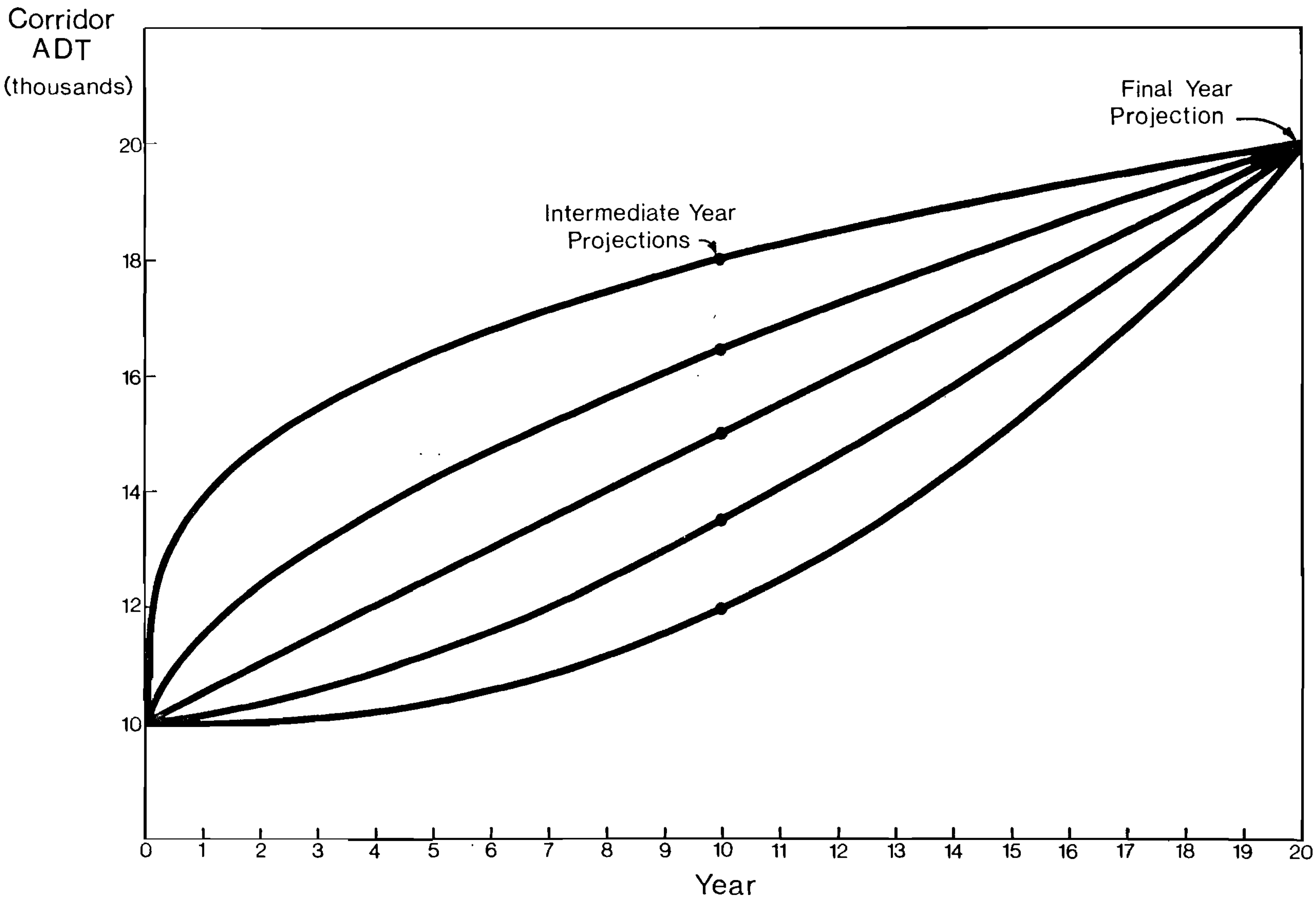


FIGURE 2. SAMPLE CURVE FITTED TO TWO CORRIDOR ADT PROJECTIONS FOR A 20 YEAR PLANNING HORIZON.

model, TRAFFIC, for use in the original HEEM [1]. Each curve shows the functional relationship between average daily speed and ADT. Each highway type listed in Table 2 is assigned an appropriate speed/volume curve. Figure 3 shows the speed/volume curves used for several urban and rural conventional highway types with different speed limits.

As can be seen from Figure 3, rural highway types have different shaped speed/volume curves than do urban highway types. Also, different speed limits have different shaped curves. Other speed/volume curves (not shown) are used for other highway types. Tabular data representing these speed/volume curves are described in Appendix A.

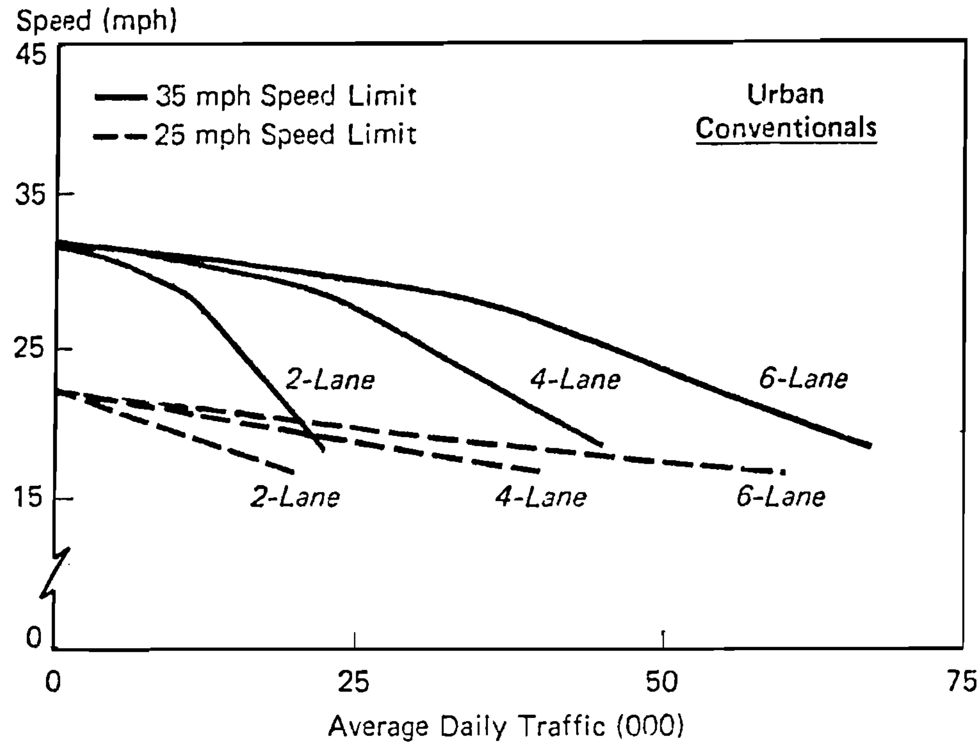
Traffic Peaking Patterns

The HEEM-II's speed/volume curves are constructed from differing traffic peaking patterns associated with urban and rural locations on freeways and conventional highways. Such peaking patterns are generated from empirical data for use in TRAFFIC [1] and indicate the percent of inbound and outbound average daily traffic that uses a facility during 15 minute increments of time over each hour of a 24 hour day.

Figure 4 shows the traffic peaking patterns for urban and rural conventional highway types used as a basis for the speed/volume relationships in HEEM-II. Another set of peaking curves (not shown) are used for urban and rural freeways, and expressway highway types.

Corridor Traffic Allocation Procedure

HEEM-II uses a new corridor traffic allocation procedure to calculate user costs. As explained earlier, the original HEEM model allocates corridor



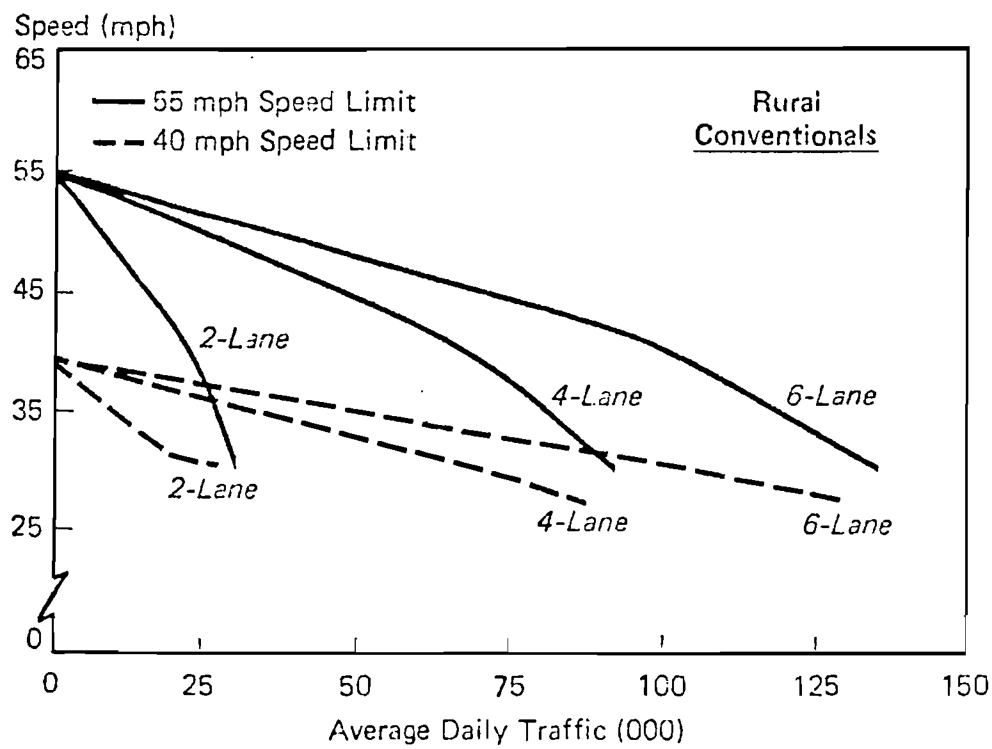


FIGURE 3. SPEED/VOLUME CURVES USED FOR URBAN AND RURAL CONVENTIONAL HIGHWAY TYPES [1].

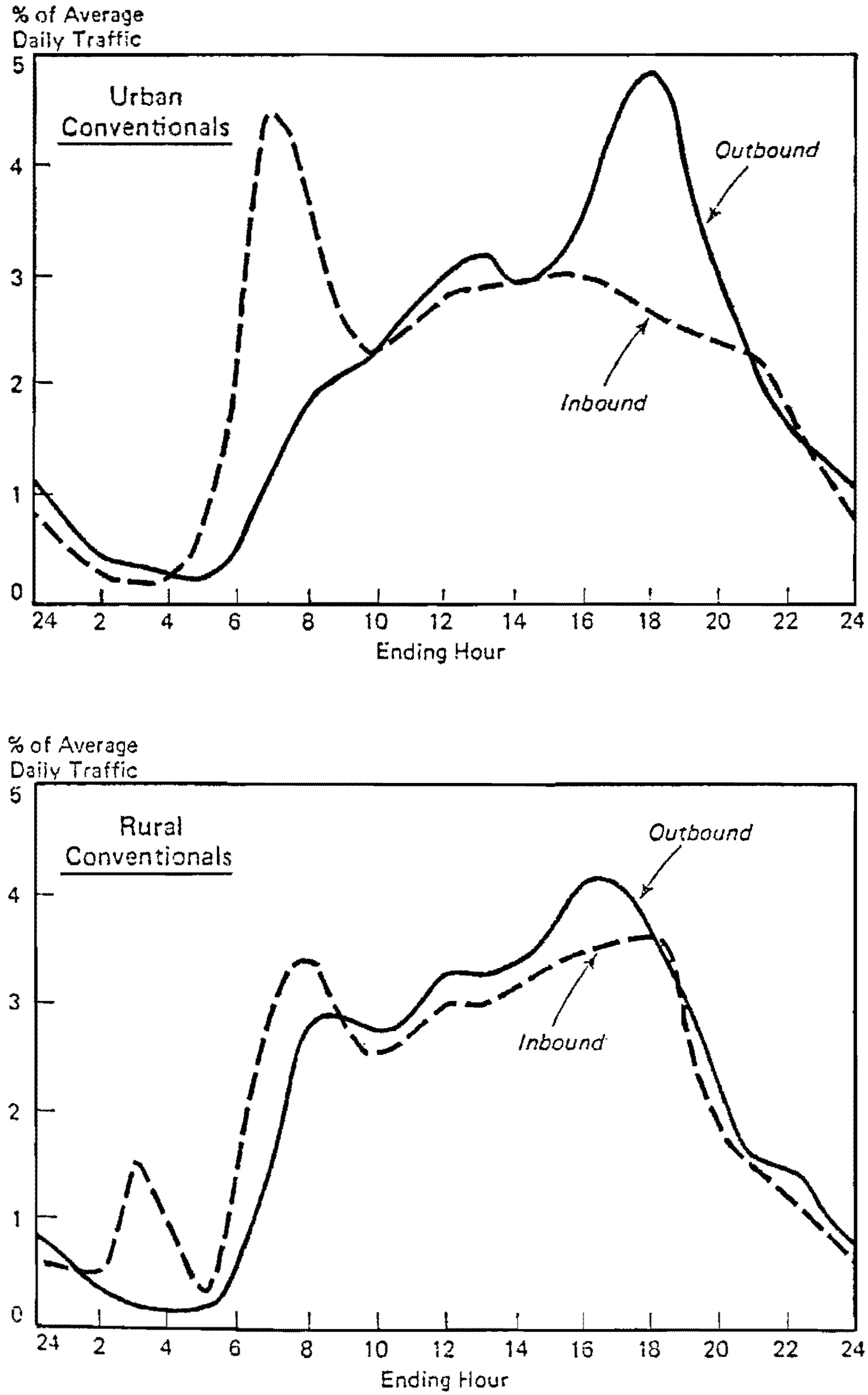


FIGURE 4. TRAFFIC PEAKING PATTERNS FOR URBAN AND RURAL CONVENTIONAL HIGHWAY TYPES [1].

traffic to specific routes (existing, alternate, or proposed) with a crude procedure that attempts to simulate highway users choosing the route that they perceive gets them to their destination in the least amount of time [1].

The HEEM-II uses a more realistic procedure which allocates traffic (vehicles or persons) in a way to minimize total user costs. In other words, highway users choose the route that allows them to reach their destination at the lowest total user cost. This result occurs when the average user costs for each person along each route in the corridor are equal. Such a procedure assumes that users are more concerned about minimizing user costs than travel time alone. However, the primary reason for adopting a new allocation procedure is to allow HEEM-II to evaluate proposed HOV highway improvement alternatives. The old procedure, would be even more unrealistic for HOV projects, since most HOV lanes are underutilized even when all other lanes are experiencing severe congestion.

As in the case of the old allocation procedure, the new procedure utilizes the same speed/volume curves representative of the routes defined in the corridor. Also, the same unit values of time, vehicle operating (running and cycling) costs, and accident costs are used, except they are updated to December 1982 and the running cost curve is fitted into one smooth continuous function. These equations and calculations are contained in Appendix A. Figure 5 shows the fitted vehicle operating costs curves for cars and trucks used by HEEM-II. They show the relationship between speed and cost per 1000 vehicle miles or cycles.

The number of speed change cycles per vehicle mile assumed in HEEM-II is the same as in the original HEEM and is shown in Figure 6. Actually, the number of cycles per mile is dependent on the amount of traffic. Therefore, a

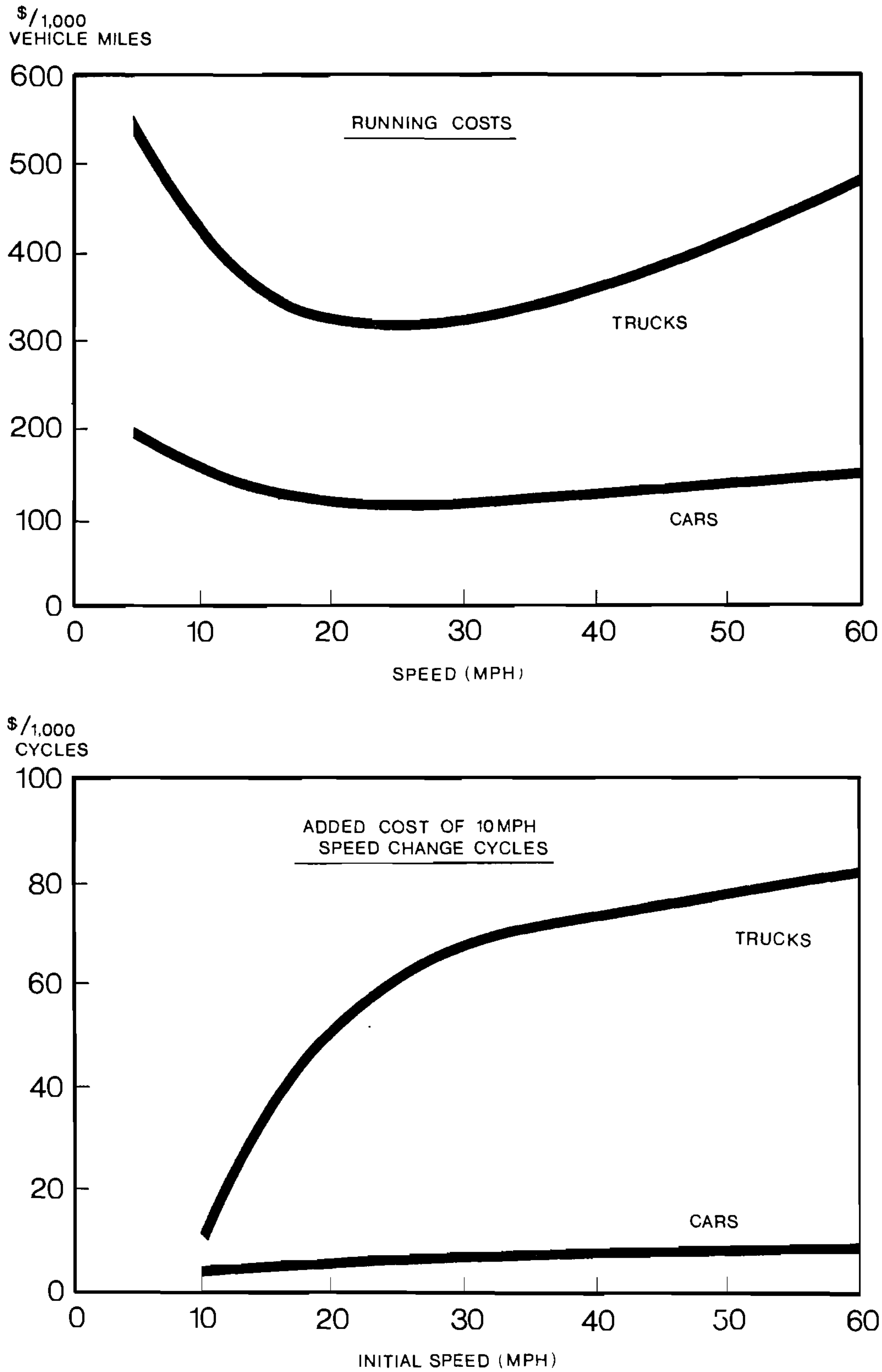
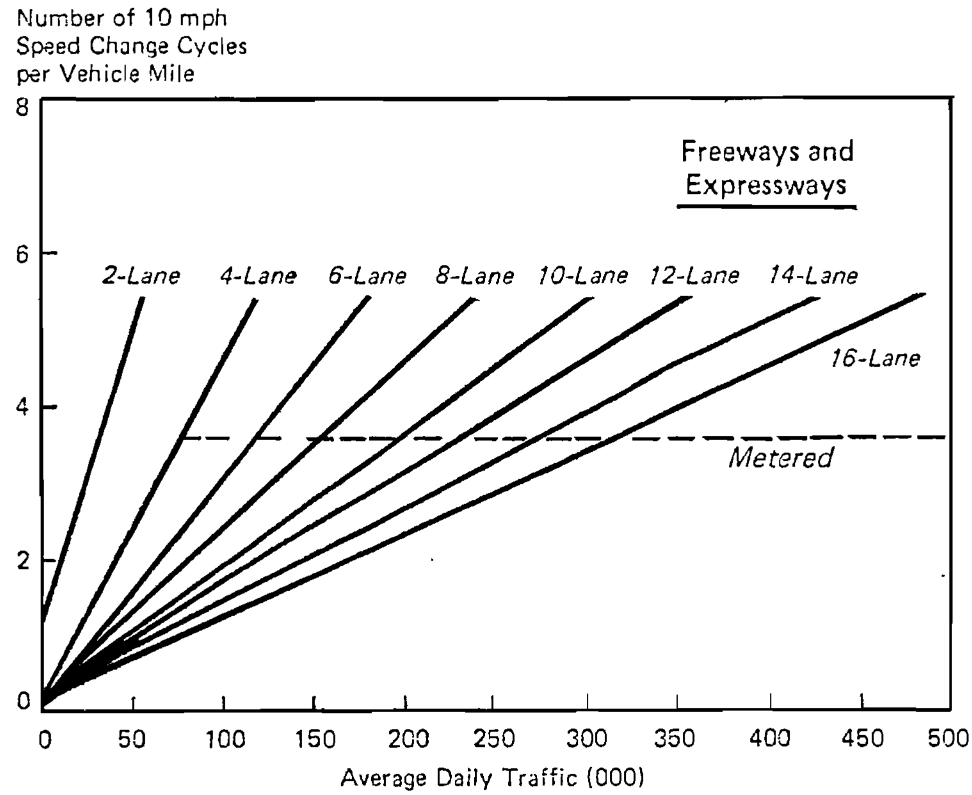


FIGURE 5. VEHICLE OPERATING COST/SPEED RELATIONSHIP BY VEHICLE TYPES USED BY HEEM-II [1].



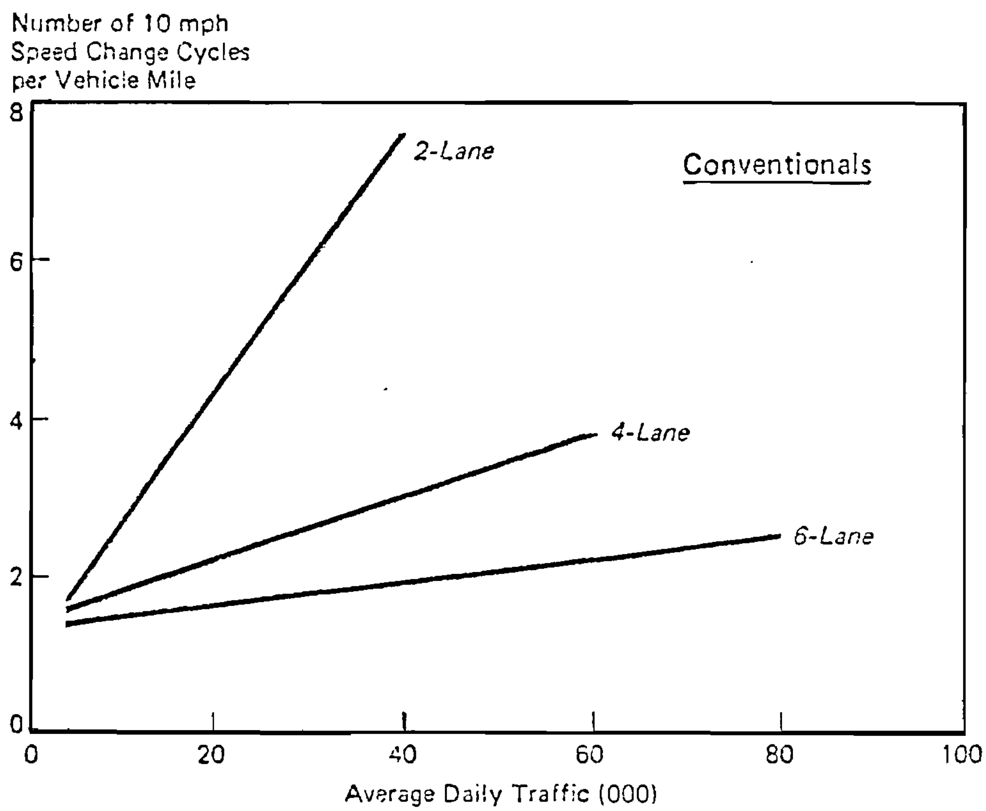


FIGURE 6. THE RELATIONSHIP BETWEEN THE NUMBER OF SPEED CHANGE CYCLES PER VEHICLE MILE AND ADT BY HIGHWAY TYPE [1].

family of curves shows the relationship between the number of cycles per vehicle and ADT. Each curve represents a particular highway type.

A total user cost function is calculated for each existing highway segment in the corridor. This cost function represents the sum of time (or delay) costs, vehicle operating costs, and accident costs at given levels of ADT. Figure 7 shows the components of the total user cost function for a 6-lane urban freeway based on 1975 yearly costs per mile. Figure 8 shows a family of total user cost functions representing several highway types that might be in a corridor segment. These functions are based on the number of vehicles instead of the number of persons. Because there are several HOV highway types analyzed in HEEM-II, the total user cost functions are based on the number of persons represented by a particular ADT.

The total user cost functions used in HEEM-II are updated to December 1982, and they are converted to average user cost functions for the purpose of allocating persons to the existing, proposed, and alternate routes in each corridor segment. Appendix A describes the complete corridor allocation procedure with the appropriate equations.

Program Optimization Techniques

HEEM-II has the ability to utilize several optimization techniques in evaluating proposed highway improvements. The three optimization techniques used in the program are as follows:

1. Optimizing the construction year,
2. Optimizing the expansion year, and
3. Optimizing the construction year and expansion year.

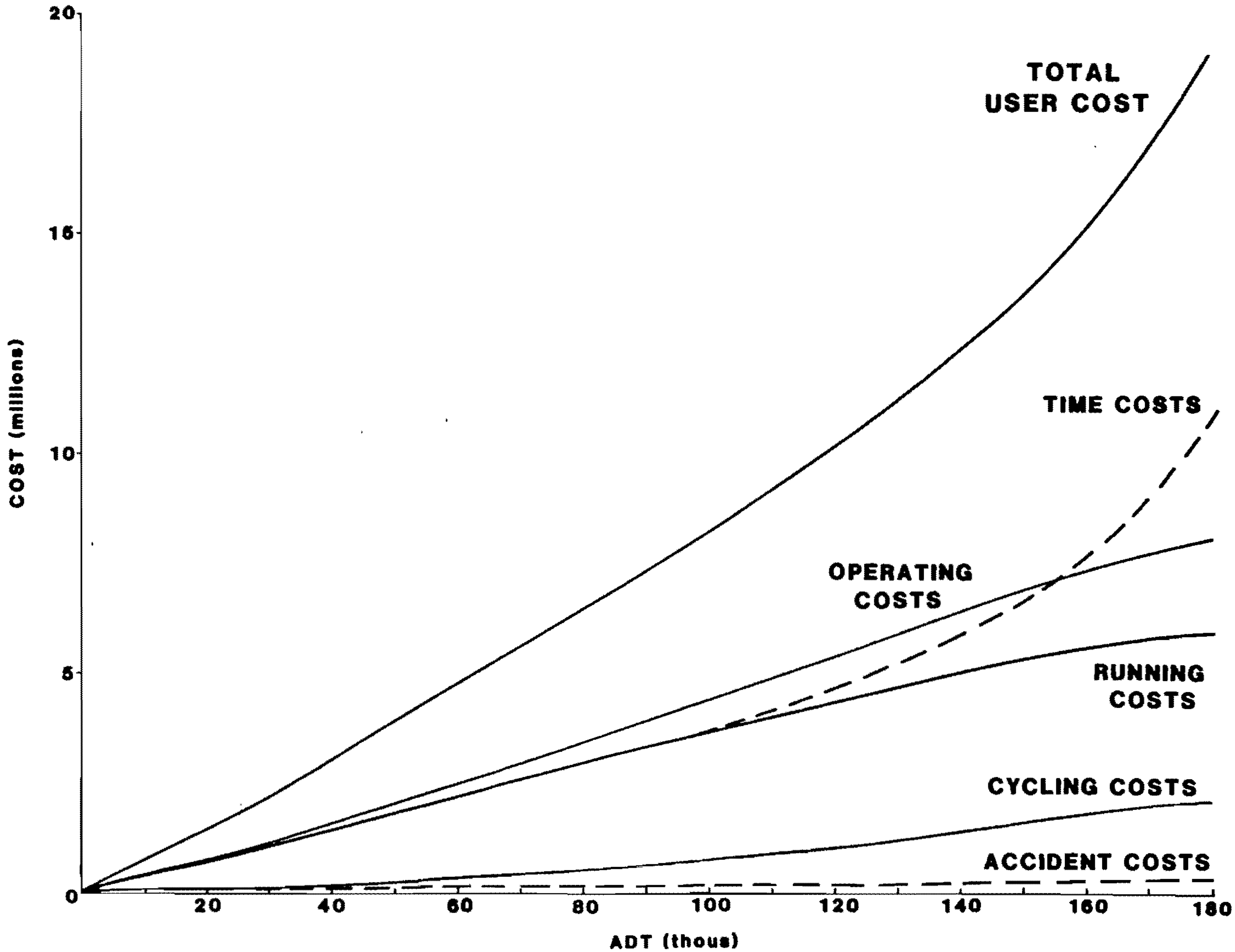


FIGURE 7. COMPONENTS OF TOTAL USER COST FUNCTION FOR A 6-LANE URBAN FREEWAY (1975 yearly cost per mile)

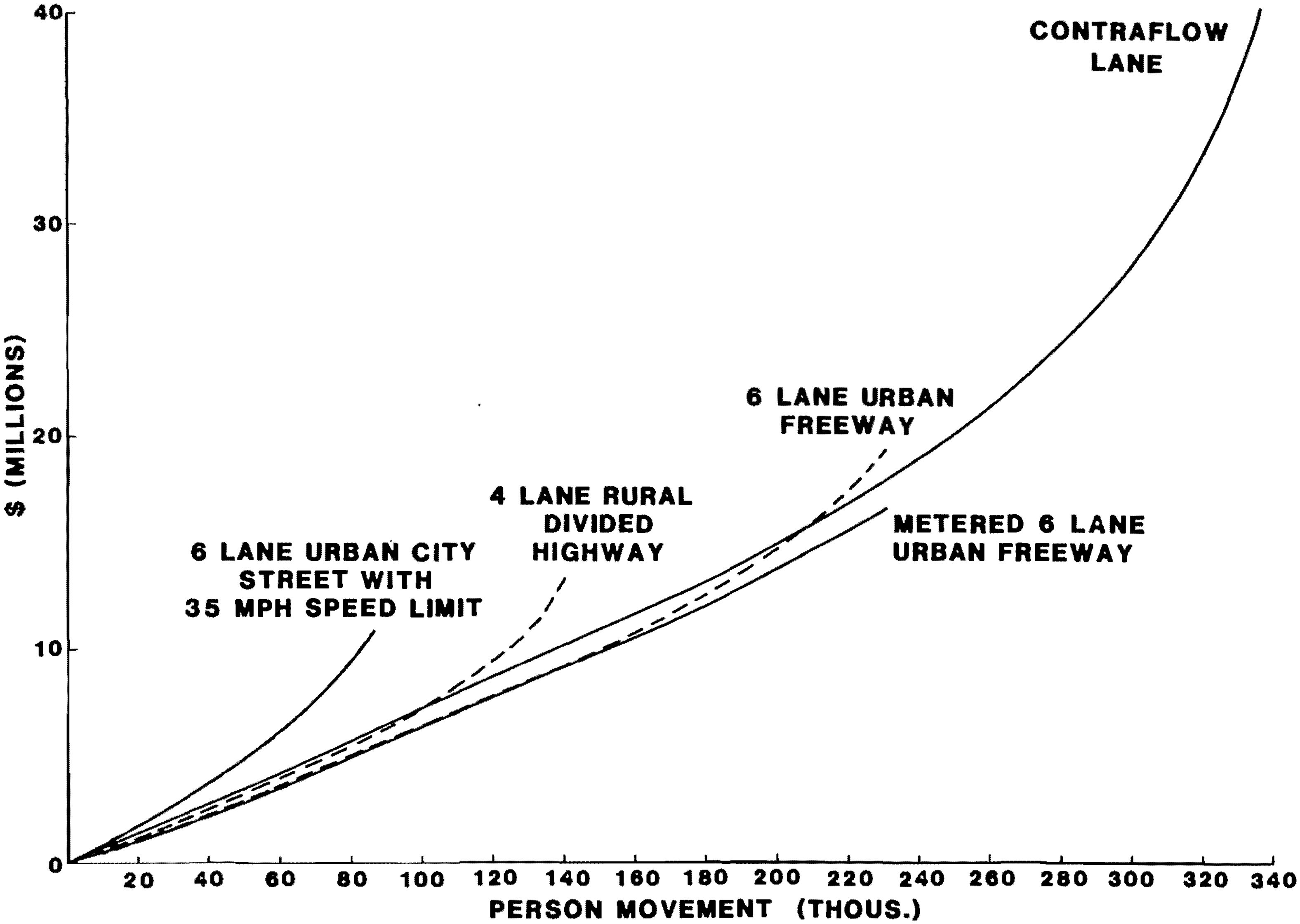


FIGURE 8. COMPARISON OF TOTAL PERSON USER COST FUNCTIONS
(1975 YEARLY COST PER MILE)

These techniques determine the year of construction and/or expansion that would bring about the greatest dollar amount of user benefits in relation to construction costs. In other words, HEEM-II cannot only determine whether a particular highway improvement is economically feasible but also can determine when in the planning horizon such an investment should be made in order to receive the greatest benefit from that investment. The user also has the flexibility to specify the construction and/or expansion year upon which the evaluation is made. In this case, the optimizing techniques would not be used.

One word of caution should be given to the user. The optimizing techniques do require more computer time and expense.

User Benefits and Cost Determination

As indicated earlier, HEEM-II is designed to determine the user benefits of proposed highway improvements and compare those benefits with the estimated improvement costs to determine the economic feasibility of the proposed improvement. The process by which this determination is made by the model involves three steps:

1. Inputs and assumptions,
2. Calculations, and
3. Outputs.

Figure 9 shows a schematic of the process used in the model to make the above determination. This process is summarized briefly below.

Inputs/Assumptions

The inputs of the model consist of a description of the existing and proposed highways in the corridor, the demand characteristics of these facilities,

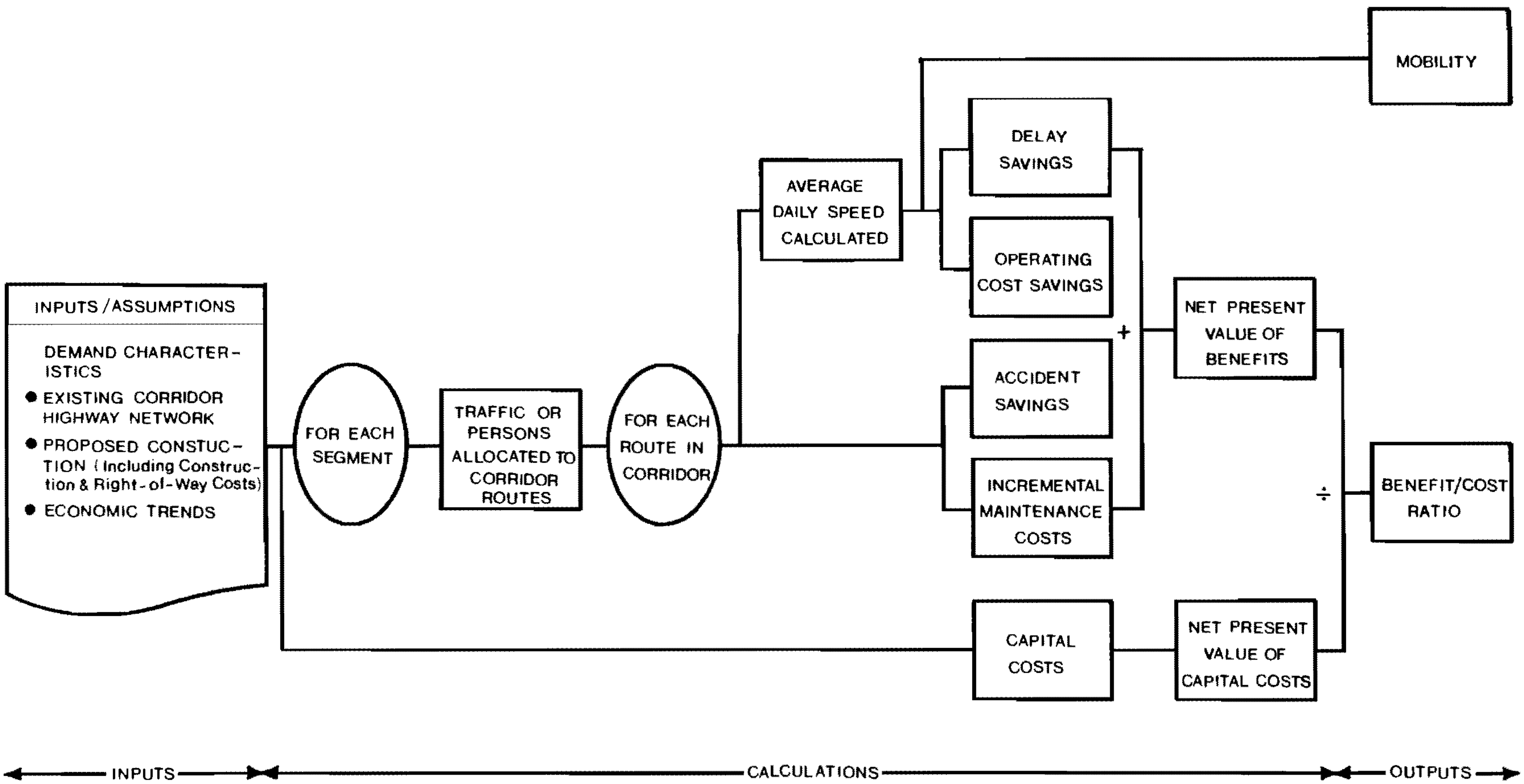


FIGURE 9. SCHEMATIC OF THE INPUTS, CALCULATIONS AND OUTPUTS OF HEEM-II [1].

the estimated construction and right-of-way costs of the proposed facility, and the assumptions, such as the projected traffic in the corridor, diversion speeds, percentage of trucks, inflation and discount rates, values of time, etc. All of the input requirements will be covered more thoroughly in the next major section of the report.

As mentioned in the first section of the report, HEEM-II's required inputs and assumptions are kept to a minimum. This is done by defining the basic highway types, speed/volume relationships, and default values for percentage of trucks, inflation and discount rates, values of time, etc. in the model. Also, unit vehicle operating costs, accident rates and costs and incremental maintenance costs are assumed in the model.

Calculations

The appropriate inputs/assumptions applicable to each highway route in a corridor under study are used to allocate the vehicles and persons to each corridor route and calculate the average daily speed and vehicle miles on a "do-nothing" and "if-construct" basis. The allocated vehicles/persons, average daily speeds, route segment lengths, unit values of time, unit vehicle operating costs, accident rates and costs, and unit maintenance costs are then used to calculate delay savings, operating cost savings, accident cost savings, and maintenance cost savings (generally negative) due to a particular highway improvement. These calculations are made by comparing the "do-nothing" and the "if-construct" alternatives. Then the delay savings, operating costs savings, accident cost savings, and maintenance cost savings are summed and discounted with an appropriate discount rate to obtain the net present value of the savings (benefits) due to the proposed improvement.

The construction and right-of-way costs are summed and discounted with the same discount rate used on benefits to obtain the net present value of the capital costs of the proposed improvement. If the construction year is the same as the current year the capital costs are not discounted.

Finally, the net present value of the benefits are divided by the net present value of the capital costs to obtain a benefit/cost ratio. Also, an internal rate of return is calculated which is the interest rate that equals the present value of benefits with the present value of costs, or gives a net present value of zero.

All the above calculations are made for each segment in a problem. If a problem has more than one segment, the model performs the calculations necessary to generate a problem summary. If more than one problem is included, the model performs the calculations necessary to generate a system summary. These calculations and their formulas are covered more thoroughly in Appendix A.

Outputs

The outputs of HEEM-II are presented in graphic and tabular form. A sample of the segment, problem, and system outputs for an example run are presented in the next section of the report.

The segment outputs include a printout of the input data, yearly corridor traffic allocations for "do-nothing" and "if-construct" alternatives, yearly savings (benefits) by type (with totals for each type), yearly mobility results (average daily speed and daily vehicle miles) for "do-nothing" and "if-construct" alternatives, and segment totals. Table 4 shows the output totals for each segment, problem, and system. As can be seen, all items except the internal rate of return are included in all totals.

Table 4. HEEM-II Output Totals for Each Corridor Segment, Problem, and System

Items in Totals	Segment Totals	Problem Totals	System Totals
Present Value of Benefits	X	X	X
Present Value of Construction Costs	X	X	X
Net Present Value	X	X	X
Benefit-Cost Ratio	X	X	X
Internal Rate of Return	X		
Delay Savings	X	X	X
Reduction in Operating Costs	X	X	X
Reduction in Accident Costs	X	X	X
Reduction in Maintenance Costs	X	X	X

USE OF HEEM-II

The use of HEEM-II requires the user to collect a minimum of data on each existing and proposed new or improved highway route in a corridor. There are also optional data items which can be used to alter the general assumptions of the problem or assumptions for specific routes within each segment. As described in a previous section, "Corridor Segmentation", a corridor consists of the existing route and, if desired, an alternative route. The proposed route can replace one or both of these routes or become an additional corridor route on new location. A proposed highway project should generally be coded as a problem in HEEM-II, with the project broken down into segments if there are different design or traffic characteristics along any of the routes within the defined corridor. If it is not necessary to divide the project into segments then the problem would consist of only one segment.

Once the data has been collected, it has to be converted into the model's card format. Then the HEEM-II job control cards (JCLs) are placed in front of the data cards and run through the computer to perform the necessary calculations. The computer will print out the results on each segment in tabular and graphic form. The user can run up to 99 segments in one problem and up to 99 problems in one system evaluation which adds up to a total of 9,801 segments that can be entered into the computer in one run.

This section of the report describes HEEM-II's input data, including the input data format, and output data for the user. These data are discussed separately below.

Input Data

The input data for HEEM-II are of two types, required and optional. Table 5 shows a complete list of both types of data, and Table 6 shows the input data

Table 5. Input Data for HEEM-II[a]

Required Data

1. Characteristics of existing, proposed/expanded, and alternate highway routes in each segment
   a. Length of segment
   b. Highway type code (see Table 2)
   c. Safety and technical performance factors
   d. Speed limit (conventional highways only)
2. Corridor ADT for current year and two projected years
3. Current year, and years for the two projected ADT's
4. Construction year and expansion year (if any)
5. Construction costs and expansion costs (if any)
6. Problem number
7. Segment number
8. Card number
9. Run type

Optional Data

1. General assumptions for problem
   a. Length of planning horizon (years)
   b. Percentage of trucks and buses
   c. Value of time for cars and trucks
   d. Inflation rate
   e. Construction cost escalation rate
   f. Discount rate
   g. Diversion route speed (urban and rural)
2. Route segment assumptions
   a. Percentage of trucks and buses
   b. Occupancy rates for cars/vans and trucks/buses
   c. Percentage of vehicles using HOV bypass
   d. HOV inconvenience cost per mile for vans/carpools and buses
   e. Adjustments to safety and technical performance factors (see Table 3)

[a] See Table 6 on where to enter data.

Table 6. Input Data Format for HEEM-II

Card and Card Column Numbers	Description of Input Data
Card 1 - General Assumptions for Problem (required for each problem)	
Card Columns	
*1-2	Problem number
*5	Card number (put a 1 in this column)
*6-9	Current year
11-14	Percentage trucks and buses (default = 11.0)
16-19	Car value of time ($/min.) (default = 0.17)
21-24	Truck value of time ($/min.) (default = 0.32)
26-29	Inflation rate (%) (default = 0.0)
31-34	Construction cost escalation rate (%) (default = 0.0)
36-39	Discount rate (%) (default = 8.0)
41-42	Rural diversion speed (mph) (default = 25.0)
44-45	Urban diversion speed (mph) (default = 15.0)
47-48	Planning horizon (default = 20 years)
50-72	Problem description
Card 2 - Segment Corridor Traffic and HOV Assumptions (required for each segment)	
Card Columns	
*1-2	Problem number
*3-4	Segment number
*5	Card number (put a 2 in this column)
*6-10	Current year ADT (000)
*12-16	Projection 1 ADT (000)
*18-21	Year of projection 1
*23-27	Projection 2 ADT (000)
*29-32	Year of projection 2
*34	Run type 1 - regular run 2 - optimize construction year 3 - optimize construction and expansion years 4 - optimize expansion year
36-38	HOV bus inconvenience cost ($/mile) (default = .446)[a]
40-42	HOV van/carpool inconvenience cost ($/mile) (default = .064)[a]
44-72	Segment description
Card 3 - Existing Highway (required for each segment)	
Card Columns	
*1-2	Problem number
*3-4	Segment number

* indicates required data

Continued

[a] Even though the default value uses 4 columns, any other value supplied by the user is limited to 3 columns.

Table 6. Input Data Format for HEEM-II (Continued)

Card and Card Column Numbers	Description of Input Data
*5	Card number (put a 3 in this column)
*6-9	Highway type (left justify)
*11-14	Length (miles)
*16-20	Safety factor (base = 100)
*22-26	Technical factor (base = 100)
*28-29	Speed limit (mph) (required for conventional highways and arterial HOV lanes)
44-47	Percentage trucks/buses (default = 11.0, same as problem default)
49-52	Car/van occupancy rate per vehicle (default = 1.3)
54-57	Truck/bus occupancy rate per vehicle (default = 1.0)
59	HOV bypass switch 0 or blank - no HOV bypass 1 - HOV bypass of metered ramps
61-64	Percentage vehicles which use HOV bypass
Card 4 - Proposed Highway (required for each segment)	
Card Columns	
*1-2	Problem number
*3-4	Segment number
*5	Card number (put a 4 in this column)
6-29	Same fields as Card 3
*31-34	Construction year
*36-40	Construction cost ($1,000,000)
42	Existing, alternate buildover switch 0 or blank - new location 1 - buildover existing route 2 - buildover alternate route 3 - buildover existing and alternate routes
44-64	Same fields as Card 3
Card 5 - Expansion of Proposed Highway or HOV as part of Proposed Highway (optional for each segment)	
Card Columns	
*1-2	Problem number
*3-4	Segment number
*5	Card number (put a 5 in this column)
6-29	Same fields as Card 3
*31-34	Expansion year (make the same as the construction year if this is a HOV and part of proposed highway)

* indicates required data

Continued

Table 6. Input Data Format for HEEM-II (Continued)

Card and Card Column Numbers	Description of Input Data
*36-40	Expansion cost ($1,000,000) (leave blank if this is a HOV and part of proposed highway)
42	Proposed buildover switch 0 or blank - buildover of proposed 1 - no buildover
44-64	Same fields as Card 3
Card 6 - Alternate Route (optional for each segment)	
Card Columns	
*1-2	Problem number
*3-4	Segment number
*5	Card number (put a 6 in this column)
6-29	Same fields as Card 3
44-64	Same fields as Card 3

* indicates required data

format giving the card and card column locations. There are no implied decimals in any of the data fields of Table 6. If a decimal is needed it must be placed in the appropriate position in the field. Care must be taken that the problem numbers and segment numbers are specified correctly. Each problem input consists of Card 1 and a set of Cards 2 through Card 4 for each segment within that problem. Cards 5 and 6 are optional for each segment and are not needed unless desired.

Figure 10 is the HEEM-II Input Data Code Sheet that can be copied and used to record the required and optional input data for each problem segment alternative. The required data is entered in the clear columns; the optional data is entered in the light shaded columns; and the black columns are to be left blank.

Required Data

HEEM-II requires as input data the characteristics of the existing, proposed/expanded, and alternate highway routes of each segment as shown in Table 5. The highway type code gives information on the location, facility type, and the number of lanes. These codes are listed in Table 2. One of these codes must be used to designate each corridor facility. Safety and technical performance factors must also be included as part of the input data. For ideal conditions the base conditions of 100 for each factor would be used. Table 3 contains adjustments to those factors when less than ideal or atypical conditions exist. In general, such adjustments reduce the ideal factors to something less than 100, even though the safety factor can go above 100 if unusually low accident rates are anticipated. Adjustments can be made for such factors as shoulder width, lane width, vertical alignment, horizontal alignment, and percent trucks.

CARD 1 GENERAL PARAMETERS FOR PROBLEM

PROBLEM NUMBER	(blank)	CARD NUMBER	CURRENT YEAR	(blank)	PROBLEM PARAMETERS*: PERCENT TRUCKS	(blank)	VALUE CAR TIME ($/min.)	(blank)	VALUE TRUCK TIME ($/min.)	(blank)	INFLATION RATE (%)	(blank)	CONSTR. COST ESCALATE RATE (%)	(blank)	DISCOUNT RATE (%)	(blank)	RURAL DIVERSION SPEED	(blank)	URBAN DIVERSION SPEED	(blank)	PLANNING HORIZON	(blank)	PROBLEM DESCRIPTION
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 27 28 29	30	31 32 33 34	35	36 37 38 39	40	41 42	43	44 45	46	47 48	49	50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72
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*parameters should not be varied indiscriminately

Note: No implied decimals

☐ required data

☐ optional data, program will provide default values if left blank

■ blank

CARD 2 SEGMENT CORRIDOR TRAFFIC & HOV ASSUMPTIONS

PROBLEM NUMBER	SEGMENT NUMBER	CARD NUMBER	CORRIDOR TRAFFIC: CURRENT ADT (000)	(blank)	PROJECTION 1 ADT (000)	(blank)	YEAR OF PROJ. 1	(blank)	PROJECTION 2 ADT (000)	(blank)	YEAR OF PROJ. 2	(blank)	RUN TYPE*	(blank)	HOV ASSUMPTIONS: BUS INCONVEN. COST ($/Mi.)	(blank)	Van/Carpool INCONVEN. COST ($/Mi.)	(blank)	SEGMENT DESCRIPTION
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 27	28	29 30 31 32	33	34	35	36 37 38	39	40 41 42	43	44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72
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*run type

1 = regular run
2 = optimize construction year
3 = optimize construction and expansion year
4 = optimize expansion year

Note: No implied decimals

☐ required data

☐ optional data, program will provide default values if left blank

■ blank

Figure 10. HEEM-II Input Data Code Sheet

CARD 3 EXISTING HIGHWAY

PROBLEM NUMBER	SEGMENT NUMBER	CARD NUMBER	HIGHWAY TYPE (left justify)		LENGTH (miles)		SAFETY FACTOR (Base = 100)		TECHNICAL FACTOR (Base = 100)		SPEED LIMIT (MPH)*		PERCENT TRUCKS /BUSES		CAR/VAN OCCUPANT RATE		TRUCK/ BUS OCCUPANT RATE		HOV bypass switch**		PERCENT VEHICLES USING HOV Bypass	
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	27	28 29	30 31 32 33 34 35 36 37 38 39 40 41 42 43	44 45 46 47	48	49 50 51 52	53	54 55 56 57	58	59	60	61 62 63 64	65 66 67 68 69 70 71 72
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*required for conventional highways

**HOV Bypass Switch

0 or blank = no HOV bypass
1 = HOV bypass of metered ramps

Note: No implied decimals

☐ required data

⊡ optional data, program will provide default values if left blank

■ blank

CARD 4 PROPOSED HIGHWAY

PROBLEM NUMBER	SEGMENT NUMBER	CARD NUMBER	HIGHWAY TYPE (left justify)		LENGTH (miles)		SAFETY FACTOR (Base = 100)		TECHNICAL FACTOR (Base = 100)		SPEED LIMIT (MPH)*		CONSTR. YEAR		CONSTR. COST ($1,000,000)		Buildover switch**		PERCENT TRUCKS /BUSES		CAR/VAN OCCUPANT RATE		TRUCK/ BUS OCCUPANT RATE		HOV bypass switch***		PERCENT VEHICLES USING HOV Bypass	
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	27	28 29	30	31 32 33 34	35	36 37 38 39 40	41	42	43	44 45 46 47	48	49 50 51 52	53	54 55 56 57	58	59	60	61 62 63 64	65 66 67 68 69 70 71 72
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*required for conventional highways

**Existing, Alternate Buildover Switch

0 or blank = new location
1 = buildover existing highway
2 = buildover alternate highway
3 = buildover existing and alternate highways

***HOV Bypass Switch

0 or blank = no HOV bypass
1 = HOV bypass of metered ramps

Note: No implied decimals

☐ required data

⊡ optional data, program will provide default values if left blank

■ blank

Figure 10. HEEM-II Input Data Code Sheet (Continued)

CARD 5 EXPANSION OF PROPOSED HIGHWAY OR HOV AND PART OF PROPOSED HIGHWAY

PROBLEM NUMBER	SEGMENT NUMBER	CARD NUMBER	HIGHWAY TYPE (left justify)		LENGTH (miles)		SAFETY FACTOR (Base = 100)		TECHNICAL FACTOR (Base = 100)		SPEED LIMIT (MPH)*		EXPANSION YEAR**		EXPANSION COST*** ($1,000,000)		Buildover switch****		PERCENT TRUCKS/ BUSES		CAR/VAN OCCUPANT RATE		TRUCK/ BUS OCCUPANT RATE		HOV bypass switch*****		PERCENT VEHICLES USING HOV Bypass	
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	27	28 29	30	31 32 33 34	35	36 37 38 39 40	41	42	43	44 45 46 47	48	49 50 51 52	53	54 55 56 57	58	59	60	61 62 63 64	65 66 67 68 69 70 71 72
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*required for conventional highways

**make same as construction year if this is an HOV and part of proposed highway

***leave blank if this is HOV and part of proposed highway

****Proposed Buildover Switch

0 or blank = buildover of proposed highway (expansion of proposed)
1 = no buildover (HOV as part of proposed)

*****HOV Bypass Switch

0 or blank = no HOV bypass
1 = HOV bypass of metered ramps

Note: No implied decimals

☐ required data

⊡ optional data, program will provide default values if left blank

■ blank

CARD 6 ALTERNATE ROUTE

PROBLEM NUMBER	SEGMENT NUMBER	CARD NUMBER	HIGHWAY TYPE (left justify)		LENGTH (miles)		SAFETY FACTOR (Base = 100)		TECHNICAL FACTOR (Base = 100)		SPEED LIMIT (MPH)*		PERCENT TRUCKS/ BUSES		CAR/VAN OCCUPANT RATE		TRUCK/ BUS OCCUPANT RATE		HOV bypass switch**		PERCENT VEHICLES USING HOV Bypass	
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	27	28 29	30 31 32 33 34 35 36 37 38 39 40 41 42 43	44 45 46 47	48	49 50 51 52	53	54 55 56 57	58	59	60	61 62 63 64	65 66 67 68 69 70 71 72
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*required for conventional highways

**HOV Bypass Switch

0 or blank = no HOV bypass
1 = HOV bypass of metered ramps

Note: No implied decimals

☐ required data

☐ optional data, program will provide default values if left blank

■ blank

Figure 10. HEEM-II Input Data Code Sheet (Continued)

The length of each segment route is also required. Some caution should be exercised when using widely different lengths for highways within the same segment. The reason for this is the sensitivity of the traffic allocation procedure to the highway lengths. Longer lengths result in higher user costs, so highways with longer lengths relative to other corridor highways will be allocated less traffic than would have occured had the lengths been the same.

Besides the current year corridor ADT, HEEM-II requires two projections of corridor ADT during the planning horizon, and the years of these projections must be given. The second projection should be some sort of intermediate projection. For example a projection for 1990 could be used, in addition to a projection for 2000. The purpose is to eliminate the need for an assumed traffic growth pattern, as is in the case of the original HEEM.

The construction costs (which include the right-of-way costs) for each segment of the proposed facility need to be input to HEEM-II. Costs should be estimated in current dollars with no allowance for inflation for projects to be built in the future. For expansion projects, other than HOV projects which are to be constructed with the proposed highway, expansion costs must also be input. For HOV projects built with the proposed facility, the expansion costs should be omitted (those costs should be included with those of the proposed highway). Unless the construction and/or the expansion years are to be optimized by HEEM-II, the year of construction and (if applicable) expansion must also be supplied as input.

Optional Data

Optional data that can be input to HEEM-II are of two types: general assumptions applying to a whole problem or project and segment assumptions applying to individual routes within the corridor. Though the user has the option of overriding the default values of the general problem assumptions and the segment assumptions, it is not advisable to vary the general problem assumptions indiscriminately. The default values for both the general problem assumptions and segment assumptions are shown in Table 6. Such values need to be updated periodically. The dollar values in the model are updated to December 1982. The U.S. Bureau of Labor Statistics Producer and Consumer Price Indexes can be used to update these values annually. The default percentage trucks represent the 1980 statewide average of combination trucks on rural highways in Texas.

One of the optional general problem assumptions that the user can make in HEEM-II is the length of the planning horizon. Any planning horizon can now be specified up to 40 years. If the field in Card 1 of Table 6 is left blank, then the default value of 20 years is used. The maximum declining traffic growth rate used in the old model has been replaced with the planning horizon. Therefore, an assumption on the growth rate is no longer needed.

The percentage of trucks and buses appears as an optional general problem assumption and also as a route segment assumption. In case of the general assumption, the same percentage of trucks and buses used applies to all routes of each segment of a problem. In the case of the route segment assumption, a different percentage of trucks and buses can be assumed for each highway route of each segment. If a different percentage of trucks is used for all route segments, the general problem assumption is ignored completely. These data are entered in the appropriate columns on Cards 1, 3, 4, 5, and 6, as shown in Table 6.

Another general problem assumption that the user has the option of specifying is the value of time for cars and trucks. The value of time given for cars is different from that given for trucks. Therefore, the user can change either or both. In the case of car value of time, a vehicle occupancy rate of 1.3 is assumed in calculating the car value of time specified in the model as a default value (see Card 1 of Table 6). The occupancy rate 1.0 is assumed for trucks in calculating the truck value of time specified in the model.

Other general problem assumptions that the user has the option of specifying in HEEM-II are: the inflation rate to be applied to the stream of dollar benefits, the construction cost escalation rate to be applied to construction costs made beyond the current year, the discount rate to be applied to a stream of benefits and costs to determine the present value of the benefits and costs, and last, the appropriate speed for a urban or rural diversion route. If the user does not specify a value for any of these assumptions, the default values shown in Table 6 will be used instead.

The reason the default values for both inflation and the construction cost escalation rate are zero is not because no inflation is anticipated in the future. Calculations are made in terms of "constant" or "real" dollars. This eliminates the need to project future inflation since everything is measured in today's dollars. The only reason to use the inflation rate and/or the cost escalation rate would be if one were anticipated to be higher than the other one. If they are anticipated to be about the same, then no adjustments need to be made and the default values can be used.

If there is a significant difference between the two, the adjustments to the input can be handled in one of two ways. Suppose construction costs were projected to go up about 8 percent annually during the planning horizon, but overall prices were projected to go up only 6 percent annually over the same period. One method to take that into account would be to input the inflation rate as 6.0 and the construction cost escalation rate as 8.0. That would also require an adjustment to the discount rate by adding the inflation rate to the discount rate. Using the default discount rate of 8 percent, then the discount rate would be input as 14.0. An alternative method would leave the discount rate unchanged and just input the difference between the inflation rate and the construction cost escalation rate. For this second alternative, just 2.0 would be input for the construction cost escalation rate, no adjustment would be needed for the inflation rate or the discount rate. If any non-zero inflation rate is used, the inflation rate should be added to the 8 percent discount rate and input to override the default value for the discount rate.

A route segment assumption that the user can specify in the model is the vehicle occupancy rate for cars/vans and for trucks/buses. Occupancy rates for either group of vehicles can be specified on the appropriate cards (Cards 3 through 6) of Table 6. If none are specified, the default occupancy rates are 1.3 for cars/vans and 1.0 for trucks/buses. Having different occupancy rates and percentage of trucks specified for each route in a segment is especially useful for HOV lanes where different vehicle mixes and occupancy rates may be present.

Still another segment assumption that can be made is for highways which have a HOV bypass of metered ramps. In such cases, the percentage of ADT using the bypass must be specified and the bypass switch must be coded 1 in Column 59 of the appropriate card(s), as shown in Table 6.

In cases where HOV lane(s) are considered for a segment, the HOV inconvenience cost per mile can be assumed separately for vans/carpools and buses. If the user does not supply a value for each vehicle type, the default values of $0.446 per mile for buses and $0.064 per mile for vans/carpools are used by the model, as shown on Card 2 of Table 6. HOV inconvenience costs are used to adjust the traffic allocated to HOV highway types. In general, the higher the costs are, the lower the volume of traffic that is allocated to the HOV lane(s). The default values provided in the model are based on actual data collected on the IH45 contraflow lane in Houston. For the derivation, see Appendix A.

Another required input is the speed limit on conventional highways and arterial HOV lanes. In the original HEEM, while any speed limit could be specified for these highway types, only two were used to calculate user costs. In HEEM-II the speed limit is used directly to calculate user costs for these highway types. Speed limits are not needed for other highway and HOV lane types. See Table 2 for a listing of highway types requiring speed limits.

As indicated earlier, safety and technical factors can be specified for each highway route segment with atypical alignments, shoulder widths or lane widths. These factors can be specified in the appropriate columns of Cards 3 through 6. See Table 3, page 12.

Flexibility is added to the program in the definition and use of the various routes specified for each segment. This was done mainly to accommodate HOV lanes, but can be used in other situations. It is now possible to specify that the proposed route will replace no other routes or will replace the existing route, the alternate route, or both. This option is given in Column 42 of Card 4, as shown in Table 6. The expansion of the proposed route also has the option of not replacing the proposed route. This option is given in Column 42 of Card 5. For example, a proposed contraflow lane on a 6-lane freeway could be handled by specifying the existing route as a 6-lane freeway, the proposed route as a 5-lane freeway, and the expansion as a 1-lane contraflow lane. The proposed route would not be builtover with the expansion. Another example would be an existing 6-lane freeway with one lane being used as an alternate concurrent flow going to be upgraded to an 8-lane freeway with a 1-lane busway. In this case the proposed route would replace both the existing and alternate routes, but the expansion route would not replace the proposed route.

Output Data

The output data given by HEEM-II are summarized in Table 7. The model gives five types of output data as follows:

1. All input data,
2. Allocation of yearly corridor traffic,
3. Discounted yearly benefits.
4. Yearly mobility of traffic, and
5. Totals.

Table 7 also shows the type of output given for each segment, problem and system analysis. Only the segment analysis receives all five types of output. The problem and system analyses do not receive the second type of output,

Table 7. Output Data of HEEM-II

Type of Data	Segment	Problem	System
1. All input data (see Table 5)	yes	yes	no
2. Allocation of corridor traffic yearly (graphic and tabular)			
a. For do-nothing alternative	yes	no	no
b. For if-construct alternative	yes	no	no
3. Discounted benefits yearly (graphic and tabular)			
a. Hours of delay saved	yes	yes[a]	no
b. Delay savings	yes	yes[a]	no
c. Reduction in operating costs	yes	yes[a]	no
d. Reduction in accident costs	yes	yes[a]	no
e. Reduction in maintenance costs	yes	yes[a]	no
f. Total benefits	yes	yes[a]	no
4. Mobility of traffic yearly in miles/hr. and daily vehicle miles			
a. Whole corridor			
(1) For do-nothing alternative	yes	yes	yes
(2) For if-construct alternative	yes	yes	yes
b. State facility			
(1) For do-nothing alternative	yes	yes	yes
(2) For if-construct alternative	yes	yes	yes
5. Totals			
a. Present value of benefits	yes	yes	yes
b. Present value of construction costs	yes	yes	yes
c. Net present value	yes	yes	yes
d. Benefit-cost ratio	yes	yes	yes
e. Internal rate or return	yes	no	no
f. Delay savings	yes[b]	yes[b]	yes
g. Reduction in operating costs	yes[b]	yes[b]	yes
h. Reduction in accident costs	yes[b]	yes[b]	yes
i. Reduction in maintenance costs	yes[b]	yes[b]	yes

[a] only tabular discounted yearly benefits are presented for problem summaries
[b] totals are presented at the bottom of the yearly discounted benefits listing

partly to reduce the overall amount of output. Also, the problem and system analyses serve to summarize the more detailed output of the segment analysis.

All Input Data

All input data are printed out first before the results for the segment, problem, and system analyses. It is important the input data is printed out so that the user will know exactly what the results of other outputs represent.

Since a problem includes one or more segments, the problem control data which includes the current year designation and general problem assumptions, as listed in Table 5, are printed out first. The user needs to be reminded again that the general problem assumptions are optional, because they have default values. The user should be cautioned again, too, about indiscriminant variation of these assumptions. If more than one problem is run at the same time, the input data applicable to each problem is printed out first before each problem's results.

The input data applicable to each highway segment, as shown in Table 5, are printed out first before each segment's results. The printout gives the problem and segment number, description of the segment improvement, the segment traffic data, type of segment run, and the characteristics or data on each route segment. Again, many of these route segment characteristics have default values that can be used.

Allocation of Corridor Traffic

Next, the allocation of annual corridor traffic is shown for each segment in graphic and tabular form for both the "do-nothing" and "if-construct" alternatives. The number of vehicles and persons allocated to each facility in the corridor are shown in the output. Therefore, the users can inspect and compare allocations made to each facility (including the diversion route) and can compare the allocations for the "do-nothing" and "if-construct" alternatives. The graphic and tabular outputs help the reader see how traffic is allocated through the whole time horizon.

Discounted Benefits

Following the traffic allocation output, discounted annual benefits are also shown in graphic and tabular form for each segment. They are shown only in tabular form for the problem. The delay savings and total benefits are shown on the graph. The table also shows the hours of delay saved, the reduction in operating costs, reduction in accident costs, and reduction in maintenance costs (which are generally negative) for each year in the time horizon. Also, time horizon totals are given for each of the above categories. Again, the user can see how much delay savings and other cost reductions change over the time horizon as the result of a particular segment improvement.

Mobility of Traffic

After the discounted benefits output, a tabular presentation is given of the mobility of annual traffic for each segment, problem, and system. The problem mobility table is presented after the last segment and the mobility table for the system is presented after the last problem.

Mobility, as measured in miles per hour and daily vehicle miles of travel, is shown for the "do-nothing" and "if-construct" alternates for the state facility (one being improved or added) and for the corridor as a whole which may contain non-state facilities. If only one segment of one problem is being studied, the mobility table for the problem and system will be the same. By studying these mobility tables, the user can see how the corridor or state facility mobility will change as a result of a particular improvement.

Totals

Finally, the segment, problem and system totals are shown under their respective mobility tables. Again, if only one segment is being analyzed, then the problem and system totals are the same for the same items of information. Where there are more than one segment being analyzed, the problem totals do not reveal which segment improvement might not be economically feasible. On the other hand, an individual segment's results may not be meaningful in the absense of the whole improvement (project made up of several segments) as represented by the problem. Also, it takes the system totals to reveal the economic justification of system-wide improvements involving several problems (projects).

The output for each segment provides three measures of effectiveness, net present value, benefit-cost ratio, and internal rate of return. All three compare the calculated user benefits to the estimated construction cost (including right-of-way cost) as an indication of the economic desirability of the project. The net present value is simply the difference between the discounted benefits and discounted capital cost, and if it is positive, the project is economically justified. The benefit-cost ratio measures the amount of benefits per dollar construction cost, and is the ratio of the discounted benefits to the discounted construction cost. If the ratio is greater than one, then the project is economically justified. The internal rate of return is the rate such that the discounted benefits are equal to the discounted construction costs. If the internal rate of return is greater than the assumed discount rate, the project is economically justified.

In general, all three measures of effectiveness will be consistent with each other to the extent that all three will give the same indication for the economic justification of the project. The only possible exception is the internal rate of return. When a project generates both positive and negative flows of benefits, it is possible to have more than one internal rate of return or none at all. HEEM-II only searches for one rate. When the calculated internal rate of return is inconsistent with the other measures of effectiveness, it is a result of the existence of one or more other solutions which have not been calculated in the program and should be ignored.

The advantage of having more than one measure of effectiveness relates to the problem of choosing among economically desirable projects for funding. With more than one measure to look at, the problem of choosing one project over another becomes a matter of informed judgement rather than relying on a mechanical ranking process. These additional measures of effectiveness should aid in the project selection process.

If more than one alternative is to be considered for some or all projects, or if a budget constraint does not allow funding of all economically desirable projects, then a manual, incremental analysis must be performed using the HEEM-II output. This technique is described in detail in a later section titled "Developing a System Plan."

Sample Problems

The output results of several sample problems, each having more than one segment are presented here to help the user become more familiar with them. First, the complete output of the analysis results for only one segment of the first probem is presented. Then, only a printout of the analysis results for the three problems, and the system totals is presented. The full output for all segments of each problem is shown in Appendix C.

The sample data consists of 11 segments divided into four problems. Each segment has an almost unique type of change (improvement) evaluated for economic feasibility. Table 8 shows a description of the segment changes covered by the four problems.

Segment 1 of Problem 1 Outputs

For the sake of simplicity, the general problem assumptions have the same values for all four sample problems. Table 9 shows the input printout page of these assumptions for Problem 1. All of the assumed values are default values. Next, Table 10 shows the input printout page of assumptions for Segment 1 of Problem 1. First, a description is given of the type of change proposed for that segment. The proposed highway is a U4F (urban 4-lane freeway) to be built on a new location (not a buildover). The traffic data for given years are listed next. Then the type of segment run is given. A regular run is one that does not involve an optimization of the construction year, expansion year, or both. The remaining input data listed in Table 10 are the characteristics assumed for each highway route, that is, existing, proposed, and alternate routes, in Segment 1.

Table 11 shows the printout of the "do-nothing" corridor traffic allocation (vehicles and persons) to the different routes of Segment 1 of Problem 1. Since the proposed route is not built, allocations are made early in the time horizon to existing and alternate facilities. Then, as traffic becomes congested (when lines become vertical), some traffic is diverted to a diversion route. Table 12 shows the printout of the "if-construct" corridor traffic

Table 8. Types of Highway Improvements Evaluated in Sample Problems

Problem and Segment	Type of Highways in Corridor[a]				
	Current Corridor		Corridor with Proposed Improvement		
	Existing Route	Alternate Route	Existing Route	Alternate Route	New Route
Problem 1					
Segment 1	U4C	U2C	U4C	U2C	U4F
Segment 2	U4F	U4C	U6F	U4C	
Problem 2					
Segment 1	U6F		U6F		U1S
Segment 2	U5F	U1T	U6F	U1S	
Problem 3					
Segment 1	R4E		R8F[b]		
Segment 2	U4C	U4F	U4C[c]	U4F	
Segment 3	U4C		U4C		U1AN
Segment 4	U2E		U6E[d]		
Problem 4					
Segment 1	R2C		R6C		
Segment 2	R2E	R4F	R6D	R4F	
Segment 3	U4F		U6F		

[a] Highway codes defined in Table 2.
[b] Staged from R6E, expansion year optimized.
[c] Improve business route of existing freeway bypass, no change in capacity, but widened lanes and improved alignment.
[d] Staged from U4E, construction year, and expansion your optimized.

Table 9. Printout of Input Data for Sample Problem 1

```
PROBLEM    1                                          SAMPLE PROBLEM 1

       PROBLEM CONTROL DATA -

       CURRENT YEAR - 1983

       ASSUMPTIONS -

         1. PERCENTAGE TRUCKS %                  11.00
         2. VALUE CAR TIME    $/MIN               0.17
         3. VALUE TRUCK TIME $/MIN                0.32
         4. INFLATION RATE %                      0.00
         5. CONST COST ESCALATION RATE %          0.00
         6. DISCOUNT RATE %                       8.00
         7. RURAL DIVERSION ROUTE SPEED          25.00
         8. URBAN DIVERSION ROUTE SPEED          15.00

       PLANNING HORIZON - 20 YEARS
```

Table 10. Printout of Input Data for Segment 1 of Sample Problem 1

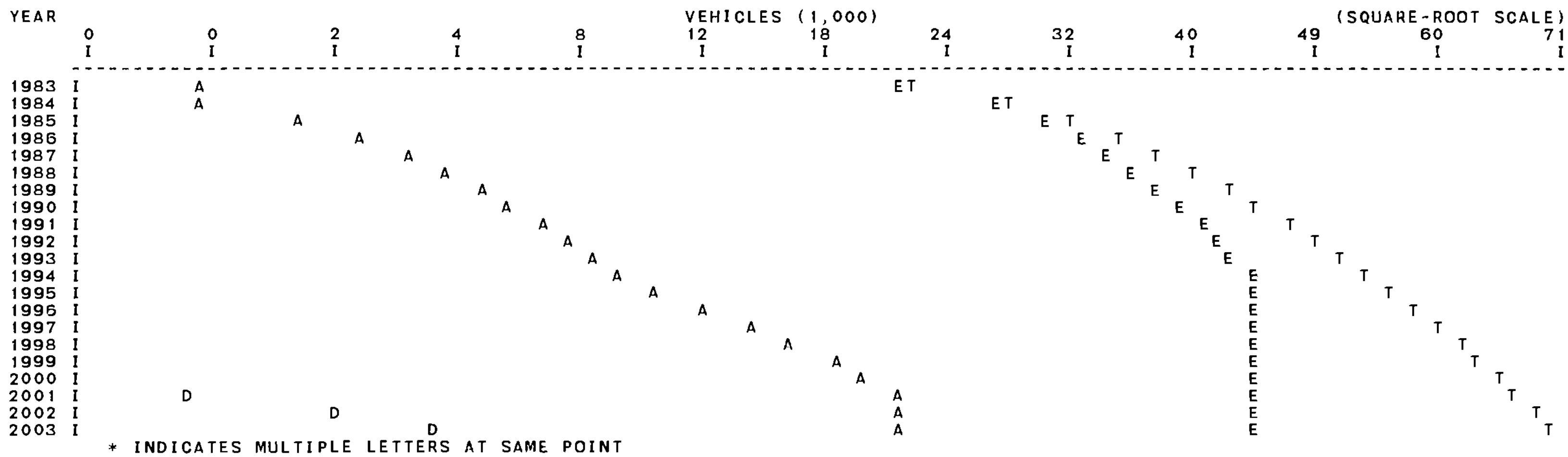
```
PROBLEM    1                                           SAMPLE PROBLEM 1

SEGMENT    1          DESCRIPTION - 4-LN FRWY  NEW LOCATION

       TRAFFIC DATA - CURRENT YEAR     1983   VOLUME (1,000)      22.00
                      PROJECTED YEAR1 1990   VOLUME (1,000)      45.00
                      PROJECTED YEAR2 2000   VOLUME (1,000)      65.00

       SEGMENT RUN TYPE - REGULAR RUN

       EXISTING  HIGHWAY DATA - HIGHWAY TYPE    U4C
                                LENGTH      2.30 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)      90.00     100.00
                                SPEED LIMIT  40. MPH
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00

       PROPOSED  HIGHWAY DATA - HIGHWAY TYPE    U4F
                                LENGTH      2.50 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)      95.00     100.00
                                CONSTRUCTION YEAR    1986
                                CONSTRUCTION COST (MILLIONS)  $ 50.00
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00

       ALTERNATE HIGHWAY DATA - HIGHWAY TYPE    U2C
                                LENGTH      2.90 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)      90.00      95.00
                                SPEED LIMIT  40. MPH
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00
```

Table 11. Printout of "Do-Nothing" Corridor Traffic Allocation for Segment 1 of Sample Problem 1

PROBLEM 1 SAMPLE PROBLEM 1

SEGMENT 1 DESCRIPTION - 4-LN FRWY NEW LOCATION

*** DO-NOTHING CORRIDOR TRAFFIC ALLOCATION ***



YEAR	EXISTING (E) VEHICLES	EXISTING (E) PERSONS	ALTERNATE (A) VEHICLES	ALTERNATE (A) PERSONS	PROPOSED (P) VEHICLES	PROPOSED (P) PERSONS	EXPANSION (X) VEHICLES	EXPANSION (X) PERSONS	DIVERTED (D) VEHICLES	DIVERTED (D) PERSONS	TOTAL (T) VEHICLES	TOTAL (T) PERSONS
1983	21603.	27370.	397.	504.	0.	0.	0.	0.	0.	0.	22000.	27874.
1984	27383.	34694.	448.	568.	0.	0.	0.	0.	0.	0.	27832.	35263.
1985	30015.	38029.	1492.	1891.	0.	0.	0.	0.	0.	0.	31507.	39920.
1986	32201.	40798.	2454.	3109.	0.	0.	0.	0.	0.	0.	34654.	43907.
1987	34150.	43267.	3351.	4246.	0.	0.	0.	0.	0.	0.	37500.	47513.
1988	35928.	45520.	4214.	5339.	0.	0.	0.	0.	0.	0.	40142.	50860.
1989	37541.	47565.	5089.	6448.	0.	0.	0.	0.	0.	0.	42631.	54013.
1990	39078.	49512.	5922.	7503.	0.	0.	0.	0.	0.	0.	45000.	57015.
1991	40520.	51338.	6751.	8554.	0.	0.	0.	0.	0.	0.	47271.	59892.
1992	41889.	53073.	7571.	9593.	0.	0.	0.	0.	0.	0.	49460.	62665.
1993	43179.	54707.	8399.	10641.	0.	0.	0.	0.	0.	0.	51578.	65349.
1994	44402.	56258.	9231.	11696.	0.	0.	0.	0.	0.	0.	53634.	67954.
1995	45000.	57015.	10636.	13475.	0.	0.	0.	0.	0.	0.	55636.	70490.
1996	45000.	57015.	12589.	15950.	0.	0.	0.	0.	0.	0.	57589.	72965.
1997	44987.	56998.	14511.	18386.	0.	0.	0.	0.	0.	0.	59498.	75384.
1998	44992.	57005.	16376.	20748.	0.	0.	0.	0.	0.	0.	61367.	77753.
1999	45000.	57015.	18200.	23060.	0.	0.	0.	0.	0.	0.	63200.	80075.
2000	44989.	57001.	20011.	25354.	0.	0.	0.	0.	0.	0.	65000.	82355.
2001	45000.	57015.	21375.	27082.	0.	0.	0.	0.	394.	499.	66769.	84596.
2002	45000.	57015.	21375.	27082.	0.	0.	0.	0.	2133.	2703.	68508.	86800.
2003	45000.	57015.	21375.	27082.	0.	0.	0.	0.	3846.	4874.	70221.	88971.

Table 12. Printout of "If-Construct" Corridor Traffic Allocation for Segment 1 of Sample Problem 1

```
PROBLEM    1                                  SAMPLE PROBLEM 1

SEGMENT    1         DESCRIPTION - 4-LN FRWY  NEW LOCATION

                                        *** IF-CONSTRUCT CORRIDOR TRAFFIC ALLOCATION ***

YEAR                                                   VEHICLES (1,000)                                     (SQUARE-ROOT SCALE)
      0         0         2         4         8        12        18        24        32        40        49        60        71
      I         I         I         I         I         I         I         I         I         I         I         I         I
     ------------------------------------------------------------------------------------------------------------------------------
1983 I         A                                                        ET
1984 I         A                                                                ET
1985 I                 A                                                            E T
1986 I       A     E                                                                    P T
1987 I        A    E                                                                        PT
1988 I        A    E                                                                           PT
1989 I        A    E                                                                              PT
1990 I        A    E                                                                                PT
1991 I        A          E                                                                           P  T
1992 I        A               E                                                                        P  T
1993 I        A                   E                                                                     P   T
1994 I        A                       E                                                                  P    T
1995 I        A                          E                                                                P     T
1996 I        A                            E                                                               P      T
1997 I        A                               E                                                             P       T
1998 I        A                                 E                                                            P        T
1999 I        A                                   E                                                           P        T
2000 I        A                                     E                                                          P          T
2001 I        A                                       E                                                        P           T
2002 I        A                                         E                                                       P            T
2003 I        A                                          E                                                       P            T
       * INDICATES MULTIPLE LETTERS AT SAME POINT
```

YEAR	EXISTING (E) VEHICLES	EXISTING (E) PERSONS	ALTERNATE (A) VEHICLES	ALTERNATE (A) PERSONS	PROPOSED (P) VEHICLES	PROPOSED (P) PERSONS	EXPANSION (X) VEHICLES	EXPANSION (X) PERSONS	DIVERTED (D) VEHICLES	DIVERTED (D) PERSONS	TOTAL (T) VEHICLES	TOTAL (T) PERSONS
1983	21603.	27370.	397.	504.	0.	0.	0.	0.	0.	0.	22000.	27874.
1984	27383.	34694.	448.	568.	0.	0.	0.	0.	0.	0.	27832.	35263.
1985	30015.	38029.	1492.	1891.	0.	0.	0.	0.	0.	0.	31507.	39920.
1986	827.	1048.	313.	396.	33515.	42463.	0.	0.	0.	0.	34654.	43907.
1987	851.	1079.	313.	397.	36336.	46038.	0.	0.	0.	0.	37500.	47513.
1988	863.	1093.	322.	408.	38958.	49359.	0.	0.	0.	0.	40142.	50860.
1989	888.	1125.	332.	421.	41411.	52468.	0.	0.	0.	0.	42631.	54013.
1990	908.	1150.	340.	431.	43752.	55434.	0.	0.	0.	0.	45000.	57015.
1991	1935.	2452.	344.	436.	44992.	57005.	0.	0.	0.	0.	47271.	59892.
1992	3021.	3827.	345.	437.	46094.	58401.	0.	0.	0.	0.	49460.	62665.
1993	4063.	5148.	348.	441.	47167.	59760.	0.	0.	0.	0.	51578.	65349.
1994	5078.	6433.	346.	439.	48210.	61082.	0.	0.	0.	0.	53634.	67954.
1995	6065.	7684.	347.	439.	49224.	62366.	0.	0.	0.	0.	55636.	70490.
1996	7010.	8882.	359.	455.	50220.	63628.	0.	0.	0.	0.	57589.	72965.
1997	7952.	10075.	362.	459.	51184.	64850.	0.	0.	0.	0.	59498.	75384.
1998	8866.	11233.	364.	461.	52137.	66058.	0.	0.	0.	0.	61367.	77753.
1999	9770.	12378.	363.	460.	53067.	67236.	0.	0.	0.	0.	63200.	80075.
2000	10648.	13491.	364.	461.	53988.	68403.	0.	0.	0.	0.	65000.	82355.
2001	11509.	14581.	374.	473.	54886.	69541.	0.	0.	0.	0.	66768.	84596.
2002	12366.	15668.	365.	462.	55777.	70670.	0.	0.	0.	0.	68508.	86800.
2003	13197.	16720.	374.	474.	56651.	71776.	0.	0.	0.	0.	70221.	88971.

allocation to each route of Segment 1. Traffic is allocated to the proposed route beginning with the year of construction (1986), and none of the routes become congested enough to cause traffic to be diverted during the 20 year planning horizon.

The next printout page (Table 13) contains the discounted yearly benefits for Segment 1 of Problem 1 in graphic and tabular form. The total benefits from the proposed improvement are considerable, reaching $106,815,400 for the planning period.

The final segment output page (Table 14) covers the yearly corridor and state facility mobility for Segment 1 of Problem 1 for the "do-nothing" and "if-construct" alternative. Also, at the bottom of this page, the totals are given for the Segment 1 analysis. Mobility measured in average daily speed (MPH) and daily vehicle miles is shown for both alternatives. The results indicate to the user that the corridor and state facility mobility decreases through the planning horizon for the "do-nothing" alternate, where as it increases for the "if construct" alternate. Maximum mobility (speed) is achieved in 1987 for the corridor and 1986 for the state facility.

The segment totals for Segment 1 reveal to the user whether the proposed new 4-lane freeway is economically justified from a net present value of total benefits to total construction cost relationship. The user sees that the benefit/cost ratio is 2.69, suggesting that the improvement is economically feasible. Further more, the net present value of the benefits of the improvement is $67,123,700 and the internal rate of return is a respectable 25.27%.

Although not presented in this section, the outputs for Segment 2 of sample Problem 1 follows that for Segment 1 before the Problem 1 output is given. By referring to Segment 2 of Problem 1 totals in Appendix C, the user

Table 13. Printout of Discounted Yearly Benefits for Segment 1 of Sample Problem 1

```
PROBLEM    1                             SAMPLE PROBLEM 1

SEGMENT    1          DESCRIPTION - 4-LN FRWY  NEW LOCATION

       CURRENT YEAR        1983
       CONSTRUCTION YEAR   1986
                                      *** SEGMENT DISCOUNTED YEARLY BENEFITS ***

YEAR                                DISCOUNTED DELAY SAVINGS(S) AND TOTAL BENEFITS(B) ($1,000)
      0        549      1099      1648      2197      2746      3296      3845      4394      4943      5493      6042      6591
      I         I         I         I         I         I         I         I         I         I         I         I         I
     -----------------------------------------------------------------------------------------------------------------------------
1983 I*
1984 I*
1985 I*
1986 I                                                                                     S     B
1987 I                                                                                            S      B
1988 I                                                                                                  S     B
1989 I                                                                                                       S     B
1990 I                                                                                                          S      B
1991 I                                                                                                             S      B
1992 I                                                                                                               S      B
1993 I                                                                                                                S      B
1994 I                                                                                                                S       B
1995 I                                                                                                              S       B
1996 I                                                                                                          S       B
1997 I                                                                                                      S        B
1998 I                                                                                                    S        B
1999 I                                                                                                   S        B
2000 I                                                                                                   S        B
2001 I                                                                                                 S        B
2002 I                                                                                        S      B
2003 I                                                                                S    B
```

YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	519.8	4657.0	-737.3	1150.8	-51.6	5018.9
1987	609.2	5054.0	-757.9	1167.3	-47.8	5415.6
1988	700.2	5378.9	-770.1	1168.7	-44.2	5733.4
1989	792.5	5636.4	-740.0	1159.3	-41.0	6014.7
1990	888.5	5851.3	-725.0	1141.5	-37.9	6229.8
1991	980.6	5979.5	-669.5	1095.1	-35.1	6370.1
1992	1075.9	6074.6	-613.8	1046.4	-32.5	6474.7
1993	1174.5	6140.1	-561.7	998.4	-30.1	6546.7
1994	1276.7	6180.3	-513.0	951.4	-27.9	6590.8
1995	1346.7	6036.0	-457.0	910.5	-25.8	6463.6
1996	1397.2	5798.4	-400.0	874.7	-23.9	6249.2
1997	1465.5	5631.4	-347.1	838.6	-22.1	6100.8
1998	1550.3	5516.2	-298.6	802.5	-20.5	5999.6
1999	1654.3	5450.0	-243.7	766.6	-19.0	5953.9
2000	1781.9	5435.6	-196.7	731.4	-17.6	5952.7
2001	1893.0	5346.8	-181.0	687.9	-16.3	5837.4
2002	1856.3	4854.9	-246.2	619.4	-15.1	5213.0
2003	1820.0	4407.2	-299.9	557.3	-13.9	4650.6
TOTAL	22782.9	99428.4	-8758.3	16667.6	-522.3	106815.4

Table 14. Printout of Corridor and State Facility Mobility and Segment Totals for Segment 1 of Sample Problem 1

PROBLEM 1 SAMPLE PROBLEM I

SEGMENT 1 DESCRIPTION - 4-LN FRWY NEW LOCATION

*** MOBILITY ***

	---------- CORRIDOR ----------				------- STATE FACILITY -------			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	33.3	50.8	33.3	50.8	33.2	49.7	33.2	49.7
1984	30.3	64.3	30.3	64.3	30.2	63.0	30.2	63.0
1985	29.0	73.4	29.0	73.4	28.7	69.0	28.7	69.0
1986	28.0	81.2	57.9	86.6	27.4	74.1	58.7	83.8
1987	27.1	88.3	57.9	93.7	26.2	78.5	58.6	90.8
1988	26.3	94.9	57.8	100.3	25.2	82.6	58.5	97.4
1989	25.6	101.1	57.7	106.5	24.2	86.3	58.4	103.5
1990	24.9	107.1	57.7	112.5	23.3	89.9	58.3	109.4
1991	24.3	112.8	57.2	117.9	22.5	93.2	58.2	112.5
1992	23.7	118.3	56.8	123.2	21.7	96.3	58.2	115.2
1993	23.2	123.7	56.4	128.3	20.9	99.3	58.1	117.9
1994	22.7	128.9	56.0	133.2	20.2	102.1	58.1	120.5
1995	22.6	134.3	55.6	138.0	19.9	103.5	58.0	123.1
1996	22.5	140.0	55.3	142.7	19.9	103.5	58.0	125.5
1997	22.2	145.6	55.0	147.3	19.9	103.5	58.0	128.0
1998	21.7	151.0	54.7	151.8	19.9	103.5	57.9	130.3
1999	21.2	156.3	54.5	156.2	19.9	103.5	57.9	132.7
2000	20.5	161.5	54.2	160.5	19.9	103.5	57.9	135.0
2001	20.0	165.5	54.0	164.8	19.9	103.5	57.8	137.2
2002	20.0	165.5	53.8	168.9	19.9	103.5	57.8	139.4
2003	20.0	165.5	53.6	173.1	19.9	103.5	57.7	141.6

SEGMENT TOTALS

PRESENT VALUE OF BENEFITS ($000) =	106815.4
PRESENT VALUE OF CONSTRUCTION COST ($000) =	39691.6
NET PRESENT VALUE ($000) =	67123.7
BENEFIT/COST RATIO =	2.69
INTERNAL RATE OF RETURN (%) =	25.27

can see that the proposed improvement (4-lane to 6-lane urban freeway) is also economically feasible, with a benefit/cost ratio of 1.04.

<u>Problem 1 Outputs</u>

The printed outputs for sample Problem 1 (Table 15) follow the outputs of Segements 1 and 2 of Problem 1. Both segments involved freeway improvements on perhaps the same freeway. Therefore, it is desirable to analyze these two segments in the same problem.

The Problem 1 output page shows yearly discounted benefits and mobility in tabular form. The problem tables present the same type of information as the segment tables. In the case of the discounted benefits, the Problem 1 benefits are obtained by a summation of the benefits of Segments 1 and 2. In the case of the mobility results, the Problem 1 speeds are weighted averages of Segments 1 and 2 speeds. The Problem 1 daily vehicle miles of travel are summations of Segments 1 and 2 daily vehicle miles.

The Problem 1 totals at the bottom of the output page include the same items as shown in the segment totals, except no internal rate of return is given. The benefit/cost ratio for Problem 1 is 2.46, indicating that the problem improvements, as a whole, are economically feasible. However, the problem benefit/cost ratio does not tell the user that both segment improvements are economically justifiable, because this is based on a summation of the segment benefits and costs.

Although not presented in this section, the segment and problem outputs of Problems 2, 3, and 4 follow the segment and problem outputs of Problem 1. By referring to Appendix C, the user can see detailed segment and problem printouts for sample Problems 2 through 4.

Table 15. Printout of Discounted Yearly Benefits, Corridor and State Facility Mobility and Problem Totals for Sample Problem 1

PROBLEM 1 SAMPLE PROBLEM 1

**** PROBLEM DISCOUNTED YEARLY BENEFITS ****

YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	497.3	4455.8	-283.5	1168.7	-62.0	5279.0
1987	586.1	4862.6	-305.5	1184.6	-57.4	5684.3
1988	682.0	5238.5	-347.3	1203.9	-53.2	6042.0
1989	780.1	5548.6	-351.0	1212.8	-49.2	6361.2
1990	881.7	5806.7	-367.1	1208.8	-45.6	6602.9
1991	979.1	5970.5	-340.0	1172.9	-42.2	6761.2
1992	1079.8	6096.7	-311.4	1132.6	-39.1	6878.9
1993	1183.4	6186.7	-283.7	1090.2	-36.2	6957.0
1994	1290.6	6247.6	-257.7	1047.2	-33.5	7003.6
1995	1365.5	6120.5	-222.8	1009.1	-31.0	6875.8
1996	1420.7	5896.0	-184.7	974.4	-28.7	6657.0
1997	1493.9	5740.5	-150.0	938.9	-26.6	6502.9
1998	1583.3	5633.6	-117.7	902.3	-24.6	6393.6
1999	1692.0	5574.4	-78.3	865.6	-22.8	6338.9
2000	1824.1	5564.5	-45.0	828.7	-21.1	6327.1
2001	1939.9	5479.2	-42.2	783.3	-19.5	6200.7
2002	1910.9	4997.6	-122.2	712.5	-18.1	5569.9
2003	1883.6	4561.2	-190.5	648.2	-16.8	5002.1
TOTAL	23074.1	99981.2	-4000.5	18084.8	-627.7	113437.7

*** MOBILITY ***

	CORRIDOR				STATE FACILITY			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	47.9	126.1	47.9	126.1	48.1	123.6	48.1	123.6
1984	45.9	150.2	45.9	150.2	46.1	147.4	46.1	147.4
1985	44.8	164.9	44.8	164.9	45.1	159.1	45.1	159.1
1986	43.9	177.4	56.5	182.8	44.4	168.7	57.0	178.7
1987	43.1	188.5	56.5	193.9	43.7	177.2	56.9	189.8
1988	42.3	198.8	56.5	204.2	43.0	183.6	56.9	200.0
1989	41.5	208.6	56.4	213.8	42.3	189.2	56.8	209.5
1990	40.8	217.8	56.4	222.9	41.7	194.4	56.8	218.5
1991	40.2	226.6	56.1	231.4	41.1	199.4	56.7	224.6
1992	39.6	235.1	55.9	239.6	40.5	204.1	56.7	230.3
1993	39.0	243.3	55.7	247.4	40.0	208.6	56.6	235.7
1994	38.5	251.3	55.5	255.0	39.5	212.8	56.6	240.9
1995	38.2	259.4	55.3	262.4	39.3	215.6	56.6	246.0
1996	37.9	267.6	55.1	269.5	39.4	217.0	56.5	251.0
1997	37.5	275.6	54.9	276.5	39.5	218.2	56.5	255.8
1998	37.0	283.4	54.8	283.4	39.6	219.5	56.4	260.5
1999	36.5	291.1	54.6	290.0	39.6	220.8	56.4	265.1
2000	35.9	298.6	54.4	296.6	39.7	222.0	56.4	269.6
2001	35.5	304.8	54.3	303.0	39.8	223.2	56.3	274.0
2002	35.5	307.0	54.2	309.3	39.8	224.3	56.3	278.4
2003	35.4	309.2	54.0	315.6	39.7	225.3	56.3	282.6

PROBLEM TOTALS

PRESENT VALUE OF BENEFITS ($000) =	113437.7
PRESENT VALUE OF CONSTRUCTION COST ($000) =	46042.3
NET PRESENT VALUE ($000) =	67395.4
BENEFIT/COST RATIO =	2.46

System Outputs

The printed outputs for the sample system, composed of the four sample problems, are shown in Table 16. The user sees that the system outputs show the system construction costs, mobility, and totals. The system values are arrived at in the same way as the problem values. However, the system totals contain four more items than the problem totals. The new items are the first four system totals, namely delay savings, reduction in operating costs, reduction in accident costs, and reduction in maintenance costs. Of course, all of these add up to the total system benefits (not shown) due to the proposed system improvements. The user can see from these totals, that three of the four contribute positively to the benefits of the system improvements.

The net present value of the system benefits amount to $352,311,200 and the system benefit/cost ratio is 2.77. Thus, both of these measures indicate that the system improvements, as a whole, are economically feasible.

Developing A System Plan

The HEEM-II output can be used to help develop a system plan for improving the highways in a particular DHT district or the state as a whole under a given budget constraint. The process involves: (1) defining all appropriate alternative highway design improvements for each project, (2) determining economic feasibility of each design alternative, (3) determining most economically feasible design alternative, and (4) ranking all project alternatives under a budget constraint. Each of these steps in the process is discussed separately below.

In the discussion below, a problem is synonymous with a whole highway project. Therefore, each route segment of a problem is not considered as a

Table 16. Printout of Mobility of System Corridor and State Facility and System Totals for Sample Problems 1-4

PROBLEM(S) PROCESSED THIS RUN -- 4

SAMPLE PROBLEM 1 SAMPLE PROBLEM 2 SAMPLE PROBLEM 3 SAMPLE PROBLEM 4

*** SYSTEM CONSTRUCTION COST (MILLIONS) = 253.45 ***

*** SYSTEM MOBILITY ***

	---------- CORRIDORS ---------				------ STATE FACILITIES ------			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	48.1	1808.4	48.1	1808.4	46.7	1585.7	46.7	1585.7
1984	46.4	1959.1	46.4	1959.1	44.8	1716.4	44.8	1716.4
1985	45.1	2070.4	45.1	2070.4	43.3	1808.8	43.3	1808.8
1986	44.0	2182.1	49.8	2073.9	42.4	1875.4	47.8	1338.3
1987	43.1	2297.9	49.1	2177.0	41.6	1943.9	47.5	1394.1
1988	42.2	2419.4	48.5	2284.0	40.8	2014.5	47.2	1453.3
1989	41.4	2547.7	48.0	2395.9	39.9	2088.6	46.9	1516.4
1990	40.6	2683.5	47.6	2513.3	39.0	2166.2	46.7	1584.3
1991	40.4	2801.2	47.1	2635.8	38.7	2222.5	46.5	1654.5
1992	40.3	2911.4	48.4	2764.4	38.6	2267.9	47.8	1593.9
1993	40.2	3027.7	48.1	2903.3	38.4	2315.8	47.5	1661.9
1994	40.2	3150.2	47.7	3049.2	38.3	2366.4	47.2	1733.6
1995	40.1	3279.4	47.4	3202.4	38.2	2418.1	46.9	1809.7
1996	40.1	3415.5	47.1	3362.9	38.1	2471.6	46.6	1889.3
1997	40.0	3558.6	46.8	3530.8	37.9	2526.9	46.3	1973.2
1998	39.7	3710.7	46.5	3706.9	37.4	2580.1	45.9	2060.2
1999	39.0	3869.4	46.2	3891.0	36.8	2636.7	45.7	2149.6
2000	37.7	4034.6	45.9	4082.9	36.0	2697.3	45.3	2243.4
2001	36.2	4206.0	45.4	4283.3	35.1	2760.1	44.6	2339.1
2002	34.5	4389.4	44.7	4492.0	34.5	2796.3	43.7	2436.8
2003	32.8	4561.1	44.0	4709.1	34.4	2805.5	42.6	2537.8

SYSTEM TOTALS

DELAY SAVING ($000) =	532949.3
REDUCTION IN OPERATING COSTS ($000) =	-16137.7
REDUCTION IN ACCIDENT COSTS ($000) =	34425.5
REDUCTION IN MAINTENANCE COSTS ($000) =	215.7
PRESENT VALUE OF BENEFITS ($000) =	551452.8
PRESENT VALUE OF CONSTRUCTION COST ($000) =	199141.6
NET PRESENT VALUE ($000) =	352311.2
BENEFIT/COST RATIO =	2.77

whole project. However, each segment could be designated as a separate project, and several projects combined into one problem. In most cases, the highway project being considered for funding represents a portion of an existing or proposed highway that has different traffic or design characteristics. In order to properly evaluate a project or problem, it is divided into segments so that the traffic and design characteristics are the same for each segment.

Defining Problem Alternatives/Alternate Design Improvements

All of the appropriate alternative highway design improvements for each problem being considered in developing a system plan must be properly defined by segment according to one of the HEEM-II highway types. For example, Table 17 shows the alternative designs for each segment (three) of a sample problem. The existing and three proposed highway types are shown. The problem route may not be the only route in the corridor. Therefore, the alternative routes must be defined into segments corresponding to those of the problem route, as shown in Figure 1.

Each successive proposed highway type for each segment of a problem should be a consistent and logical extension of the previous highway type (i.e., a higher type design). The example in Table 17 meets the above requirements, even though the existing Segment 2 highway type, U6F, is connected to Segments 1 and 3 which are highway type R4D. In this case, the problem route passes through rural, urban,rural areas consecutively. Finally, each alternative highway improvement for the problem as a whole should be defined, as shown in Table 17, to represent all the segment types it encompuses. Such a description can be used for identification of each problem alternative in the analysis and ranking process. Also, the problem can be identified as the existing,

Table 17. Alternative Highway Improvements for Each Segment of a Sample Problem

Sample Problem and Segment	Alternative Highway Types			
	Existing	Proposed 1	Proposed 2	Proposed 3
1	R4D	R4E	R4F	R4F
2	U6F	U6F	U6F	U6F
3	R4D	R4E	R4F	R6F
Problem (Project)	R4D/U6F	R4E/U6F	R4F/U6F	R4F/R6F/U6F

proposed 1, proposed 2, etc. alternative, as shown in the sample problem presented here. HEEM-II identifies each problem (and segment) by number. It also identifies the existing and one proposed alternative for each problem segment in the same manner as shown in Table 17.

Determining Economic Feasibility of Design Alternatives

The required and/or optional input data for each design alternative can be run on HEEM-II to generate the output data needed to properly analyze the economic feasibility of each alternative and to provide the input data necessary to determine which alternative should be chosen first under a budget constraint. All of the HEEM-II output is presented and explained in the previous section of this report. Table 18 shows the minimum output that is needed for this analysis.

The HEEM-II output needed to evaluate the alternatives of the sample problem as defined in Table 17, is presented in Table 18. When compared to the existing route or "no-build" alternative, all three of the proposed alternatives are economically feasible, since each shows benefit/cost ratios that are greater than one. Therefore, all three can be advanced to the next stage in the analytical process, i.e., to determine through an incremental analysis which mutually exclusive design alternative should be chosen first under a budget constraint. It is important to point out that the alternatives should be ordered such that the total construction and right-of-way cost are increasing for successive alternatives to the no-build alternative for the incremental analysis. Table 18 shows this progressive increase for successive alternaties with Proposed Alternative 1 being the lowest cost, Proposed Alternative 2 being the next-to-lowest cost, and Proposed Alternative 3 being the highest cost.

Table 18. Present Value of Total Benefits and Costs and Benefit/Cost Ratios for Existing Versus Proposed Highway Alternatives Sample Problem Using HEEM-II

Sample Problem Results	Existing Versus Proposed Alternatives		
	Proposed 1	Proposed 2	Proposed 3
Present Value of Total Benefits ($ Millions)	138.3	456.4	491.8
Present Value of Total Costs ($ Millions)	4.2	19.1	27.7
Benefit/Cost Ratio	32.9	23.8	17.8

It should be emphasized that all of the appropriate alternative highway improvements for each problem being considered in developing a system plan must be analyzed in the same manner as the sample problem explained above. Each HEEM-II run can process up to 99 different problems at the same time but only one proposed alternative, say the first one, for each problem can be included in one run if the system totals are being used. Different problems can be used to define different design alternatives of the same project in the same run, but the system totals will be meaningless and should be ignored in that case.

Determining Most Economically Feasible Design Alternative

Determining the most economically feasible design alternative for each project considered in the system plan requires the use of the incremental analysis technique. Table 19 shows the incremental benefits, costs, and benefit/cost ratios calculated manually for the proposed alternatives of the sample problem defined in Table 17. These values are derived from the data presented in Table 18.

Incremental benefits of Proposed Alternative 1 of the sample problem are the present value of total benefits estimated to result from the implementation of Proposed Alternative 1 over the existing alternative as shown in Table 18. Proposed Alternative 1 is considered the first increment in the improvement process of the existing facility. Proposed Alternative 2 is the second increment, and Proposed Alternative 3 is the third. Incremental costs for Proposed Alternative 1 are obtained in the same manner, as shown in Table 18. The incremental benefit/cost ratio for Proposed Alternative 1 is obtained by dividing the incremental benefits of Proposed Alternative 1 (over the existing alternative) by the incremental costs of Proposed Alternative 1, as shown in

Table 19. Incremental Benefits, Costs, and Benefit/Cost Ratios for Proposed Alternatives of Sample Problem, Obtained by Manual Calculations

Sample Problem Results	Existing Versus Proposed 1[a]	Proposed 1 Versus Proposed 2[a]	Proposed 2 Versus Proposed 3[a]
Incremental Benefits ($ Millions)	138.3	318.1	35.4
Incremental Costs ($ Millions)	4.2	14.9	8.6
Incremental Benefit/Cost Ratio	32.9	21.3	4.1

[a] Derived from Table 18.

Table 18. In other words, the incremental values for Proposed Alternative 1, appearing in Table 19, are taken directly from Table 18.

The incremental values for Proposed Alternatives 2 and 3 are calculated differently from that of Proposed Alternative 1. In the case of Table 18, the benefits and costs are derived by the HEEM-II from comparing each proposed alternative with the existing alternative. The values for Proposed Alternatives 2 and 3, as shown in Table 18, are not incremental values. The incremental values for these alternatives are obtained by comparing Proposed Alternative 1 with Proposed Alternative 2 and Proposed Alternative 2 with Proposed Alternative 3. In other words, the incremental benefits of Proposed Alternative 2 are obtained by subtracting the total benefits of Proposed Alternative 1 from the total benefits of Proposed Alternative 2, obtained from Table 18. The incremental costs are obtained in like manner. The incremental values represent the additional increment of benefits or costs resulting from the additional improvement, and these values are shown in Table 19. Then the additional increment of benefits is divided by the additional increment of costs incurred by adding Proposed Alternative 2 to obtain the incremental benefit/cost ratio for Proposed Alternative 2. The incremental benefit/cost ratio for Proposed Alternative 3 is obtained in a like manner.

The equations to obtain the incremental costs, incremental benefits, and incremental benefit/cost ratio, respectively, are given below:

A_{ij} = alternative j of project i

C_{ij} = initial construction cost of A_{ij}

$MC_{ij} = C_{ij} - C_{i,j-1}$, the marginal or incremental cost of A_{ij}

where $MC_{i,j-1} = 0$ for $j = 1$

B_{ij} = present value of net benefits of A_{ij} over its service life

$MB_{ik} = B_{ij} - B_{i,j-1}$. the marginal or incremental benefit of A_{ij}

where $MB_{i,j-1} = 0$ for $j = 1$

$R_{ij} = MB_{ij}/MC_{ij}$, the incremental benefit-cost ratio of A_{ij}

$i = 1, 2, \ldots, m$

$j = 1, 2, \ldots, n$

A review of the Table 19 results shows that Proposed Alternative 1 has the largest incremental benefit/cost ratio of the three proposed alternatives of the sample problem. Therefore, Proposed Alternative 1 is the best alternative of the three for implementation. Proposed Alternative 2 is the next best alternative, since its incremental benefit/cost ratio is higher than that of Proposed Alternative 3.

Again, the incremental benefit/cost ratios for each proposed alternative of each problem to be considered in the system plan must be manually calculated in cases where a problem has more than one proposed alternative. The incremental benefit/cost ratio for the first or only problem alternative can be obtained directly from the HEEM-II output.

Any design alternative which has an incremental benefit/cost ratio of less than 1.0 should not be included in the system plan, because the additional construction and/or right-of-way costs are greater than the additional benefits generated by that proposed alternative. A proposed alternative could have an initial (or total) benefit/cost ratio greater than 1.0 and have an incremental benefit/ cost ratio less than 1.0, because the latter is based on the additional benefits and costs generated by one proposed alternative versus another. On the other hand, the initial benefit/cost ratio for each proposed alternative is based on the total benefits and costs generated by comparing each proposed alternative with the existing or "no-build" alternative. Therefore, the final slate of project alternatives to be considered in the system plan for possible funding must have both the initial and incremental benefit/cost ratios equal to or greater than 1.0.

Ranking Project Alternatives Under Budget Constraint

The final step in the development and implementation of a system plan is to rank the proposed alternative(s) of each project remaining in the final slate of project alternatives by the size of its incremental benefit/cost ratio. Table 20 shows a sample slate of 25 alternatives representing 13 projects ranked by their incremental benefit/cost ratios.

Three of the projects have three alternatives and six have two alternatives. The remaining four have only one alternative. One of the projects with three alternatives is the sample project used in Tables 17, 18, and 19 and identified as Project 1 in Table 20. The first alternative of this project is ranked third and the second alternative is ranked fifth. The third alternative is ranked twenty-second.

If no budget constraint on construction and right-of-way costs is imposed on the above slate of projects, then the last alternative of each of the 13 projects could be constructed. For example, the third (last) alternative of Projects 1, 6, and 13 could be constructed. The first and second alternatives are replaced by the third alternative of each project, so they are redundant, i.e., they are mutually exclusive design alternatives. The projects with two alternatives could have their second alternatives constructed instead of their first, and those with one alternative could have their first alternatives constructed.

Table 20. Sample Slate of Proposed Project Design Alternatives Ranked by Incremental Benefit/Cost Ratios

Rank	Project Number	Proposed Alternative Number	Proposed Alternative Highway Type	Cost of Construction[a] ($ Millions) Actual	Cost of Construction[a] ($ Millions) Cumulative	Incremental Benefit/Cost Ratio
1	2	1	U6F	9.2	9.2	112.5
2	3	1	U4F	8.1	17.3	41.3
3	1	1	R4E/U6F	7.1	24.4	32.9
4	8	1	U4F/U8F	2.9	27.3	22.6
5	1	2	R4F/U6F	25.2	52.5	21.3
6	4	1	RF/R4D	14.6	67.1	20.5
7	5	1	U4E	2.3	69.4	20.4
8	6	1	R4C/R2C	26.0	95.4	17.9
9	7	1	U6M/U6M	18.0	113.4	14.5
10	7	2	U8M/U6M	8.4	121.8	12.9
11	3	2	U6F	1.4	123.2	12.7
12	6	2	R4E/R2C	16.0	139.2	11.4
13	9	1	U4F/U6F	67.8	207.0	10.9
14	10	1	R4D/R4E	2.5	209.5	10.8
15	10	2	R4D/R4F	2.2	211.7	10.2
16	11	1	U6F	108.8	320.5	9.2
17	6	3	R4F/R4F	8.7	329.2	8.8
18	12	1	R2C	5.4	334.6	8.0
19	13	1	U6F	32.0	366.6	6.3
20	13	2	U6F/U8F	58.7	425.2	6.1
21	4	2	R6F	18.0	443.2	5.7
22	1	3	R4F/R6F/U6F	14.6	457.8	4.1
23	13	3	U8F	24.2	482.0	3.9
24	12	2	R4D	2.4	484.4	3.4
25	2	2	U8F	8.2	492.6	2.5

[a] Includes right-of-way cost.

If a budget constraint of $210.0 million in construction and right-of-way costs is imposed on this slate of project alternatives, then by looking down the cumulative construction cost column in Table 20, the first 14 ranked alternatives can be included. With that budget, then one alternative of ten projects could be constructed. For instance, the second alternative of Projects 1, 3, 6, and 7 could be constructed in place of the first, and the first alternative of Projects 2, 4, 5, 8, 9, and 10 could be constructed. No alternatives of Projects 11, 12, and 13 could be constructed under this budget constraint.

It should be pointed out that with a budget constraint of $210.0 million the initial set of alternatives would cost $209.5 million, leaving a surplus of $0.5 million. Therefore, the optimum set of design alternatives may not be identified yet. There are various switching rules that could be applied in an attempt to identify a set of alternatives that would use up all of the $210.0 million. An easy one to apply would be to drop the last alternative chosen in the initial set and continue the selection process, adding as many design alternatives as the remaining budget will allow [9]. After this process is completed, the total net benefits of the initial set of projects are compared with the benefits of the second set of projects. The set having the greater amount of total net benefits is selected as the optimal set.

To summarize, ranking the different design alternatives of the 13 projects by the size of their incremental benefit/cost ratios assures the selection of alternatives that yields the highest total benefits for a given level of construction capital and/or right-of-way expenditures. In other words, the economically optimum slate of projects is selected by comparing the incremental benefit/cost ratios of all competing design alternaties represented by that slate of projects.

It is possible for one project to have its highest cost alternative built before even the first or lowest cost alternative of another project is built at a given budget level. This result means that the additional investment required to add any of the alternatives (increments) of the former project would yield a greater return in additional benefits than the additional investment on the first alternative of the latter project would yield. Therefore, it is very important to apply the incremental benefit/cost analysis in developing a system plan for implementation, especially when a budget constraint is imposed.

CONCLUSIONS AND RECOMMENDATIONS

The revision of the original HEEM into HEEM-II is extensive and merits the following conclusions and recommendations.

Conclusions

1. The user will find the HEEM-II can analyze considerably more highway types (improvements) than can the original HEEM.
2. HEEM-II is more flexible with regard to input data than is the original HEEM.
3. HEEM-II uses a new corridor traffic allocation procedure which more accurately represents the decisions of those traveling in the corridor than does the original HEEM.
4. The output of HEEM-II is more informative to the user than the original HEEM.
5. This one-volume user's and programmer's manual for HEEM-II should be much easier to use than the two-volume manual for the original HEEM.

Recommendations

1. Hold several workshops over the state to train DHT personnel to use HEEM-II.
2. Revise HEEM-II to enable it to evaluate appropriate highway improvements on an hourly basis.
3. Revise HEEM-II so that an incremental analysis can be run on mutually exclusive design alternatives as well as a slate of highway projects.
4. The technical and safety factors, speed/volume relationships, and traffic peaking characteristics used in HEEM-II need to be validated with recent Texas data.

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APPENDIX A

BENEFIT-COST CALCULATIONS

The calculation of benefits in HEEM-II, for the most part, follow the calculations in the old HEEM, with some important changes on calculations of future corridor traffic volumes and the method of allocation based upon the user costs per person. All major calculations in HEEM-II are described in this section.

Calculation of Projected Traffic Volumes

Three corridor traffic volumes must be provided for each segment as part of the input data. These are the current ADT, and two projected ADT's. ADT for each year during the planning horizon can be caculated using the following formula,

$$ADT_t = ADT_1 \; e^{S1} \; (t-1)^S \qquad (1)$$

where ADT_t = estimated ADT for year t

ADT_1 = current ADT, t = 1

$S = [\ln(ADT_{P1+1}-ADT_1) - \ln(ADT_{P2+1}-ADT_1)] \div (\ln P1-\ln P2)$

$S1 = \ln(ADT_{P1+1}-ADT_1) - (\ln P1)S$

ADT_{P1+1} = projected ADT for year P1 + 1

ADT_{P2+1} = projected ADT for year P2 + 1

P1 = difference between first projected year and current year

P2 = difference between second projected year and current year

with $ADT_{P1+1} > ADT_{P2+1} > ADT_1$

and P1 > P2.

The corridor ADT can then be converted into persons by multiplying by the weighted average of the car occupancy rate of 1.3 and the truck occupancy rate of 1.0.

$$PADT_t = ADT_t(1.3-0.3PT) \quad (2)$$

where $PADT_t$ = daily person corridor demand for year t

PT = percentage trucks ÷ 100.

Allocation of Corridor Traffic

After corridor traffic has been calculated for each year during the planning horizon, then the traffic must be allocated to each corridor route. To allow for the possibility of varying occupancy rates especially for HOV lanes, persons are allocated to the corridor routes and the number of vehicles are allowed to vary according to the occupancy rates. The actual allocation process uses a much more realistic method to assign persons to a particular highway than the capacity method used previously in the old HEEM. Persons are allocated to each corridor highway in such a fashion that the daily user costs per person are approximately equal. The equations for calculating those costs are based upon the parameters in the Highway Specification Table (Table 21), labeled from A to K. These values have been changed and updated to December 1982 prices. As can be seen in Table 21, several highway types are identified by different speed limits. In order to increase the flexibility of the model, the speed parameters for those particular highway types are adjusted for speed limits different than those given in Table 21. Those adjustments are as follows,

for highway numbers 7, 8, 9, 10, 19, and 20,

$$C = -3.68 + 1.067(SL)$$

where SL = speed limit (mph),

for $SL \geq 40$

$$D = 5.54 + 0.641(SL)$$

$$E = 19.84 + 0.201(SL),$$

for $SL < 40$

TABLE 21. HIGHWAY SPECIFICATION TABLE

HIGHWAY TYPE	HWY NO.	SPEED/VOLUME PARAMETERS A CAPACITY ADT	B BREAKPOINT ADT	C BEG. SPD. (MPH)	D BRKPT SPD (MPH)	E CAP. SPD. (MPH)	SPEED-CHANGE CYCLES F INTCPT	G SLOPE	ACCIDENTS COST H $ PER ACC.	RATE I INTCPT	J SLOPE	MAINTENANCE COST K AV. YRLY CST/MI ($)
URBAN DVRTD	1	0.	0.	0.00	0.00	0.00	1.1390	0.00016390	6280.	12.0	0.	0.
U2C 25 MPH	3	20000.	10000.	22.00	19.32	16.70	1.1390	0.00016390	6280.	12.0	0.	9100.
U2C 35 MPH	4	22500.	11250.	32.00	28.48	18.82	1.1390	0.00016390	6280.	12.0	0.	9100.
U3C 25 MPH	51	30000.	15000.	22.00	19.38	16.70	1.7320	0.00006634	6280.	11.6	0.	10300.
U3C 35 MPH	52	33750.	16875.	32.00	28.48	18.82	1.7320	0.00006634	6280.	11.6	0.	10300.
U4C 25 MPH	5	40000.	20000.	22.00	19.32	16.70	1.1390	0.00004080	6280.	11.2	0.	11600.
U4C 35 MPH	6	45000.	22500.	32.00	28.48	18.82	1.3690	0.00004080	6280.	11.2	0.	11600.
U5C 25 MPH	53	50000.	25000.	22.00	19.38	16.70	1.0392	0.00003803	6280.	10.8	0.	12800.
U5C 35 MPH	54	56250.	28125.	32.00	28.48	18.82	1.0392	0.00003803	6280.	10.8	0.	12800.
U6C 25 MPH	23	60000.	30000.	22.00	19.32	16.70	1.2940	0.00003190	6280.	10.4	0.	14000.
U6C 35 MPH	24	67500.	33750.	32.00	28.48	18.82	1.2940	0.00003190	6280.	10.4	0.	14000.
U2E	34	40000.	25000.	47.00	38.41	28.45	1.1000	0.00008600	8770.	6.0	0.	7300.
U3E	55	60000.	37500.	47.00	38.41	28.45	0.1097	0.00006100	8770.	5.8	0.	8100.
U4E	27	80000.	50000.	47.00	38.41	28.45	0.0854	0.00004540	8770.	5.6	0.	9000.
U5E	56	100000.	62500.	47.00	38.41	28.45	0.0658	0.00003660	8770.	5.4	0.	9800.
U6E	28	120000.	75000.	47.00	38.41	28.45	0.0581	0.00002830	8770.	5.2	0.	10600.
U3F	57	90000.	56250.	60.00	57.02	35.30	0.1097	0.00006100	8770.	2.9	0.	21800.
U4F	12	120000.	75000.	60.00	57.02	35.30	0.0854	0.00004540	8770.	2.8	0.	26000.
U5F	58	150000.	93750.	60.00	57.02	35.30	0.0658	0.00003660	8770.	2.7	0.	30100.
U6F	14	180000.	112500.	60.00	57.02	35.30	0.0581	0.00002830	8770.	2.6	0.	34200.
U7F	59	210000.	131250.	60.00	57.02	35.30	0.0470	0.00002614	8770.	2.5	0.	38300.
U8F	16	240000.	150000.	60.00	57.02	35.30	0.0834	0.00002270	8770.	2.4	0.	42500.
U9F	60	270000.	168750.	60.00	57.02	35.30	0.0366	0.00002033	8770.	2.3	0.	46600.
U10F	25	300000.	187500.	60.00	57.02	35.30	0.1214	0.00001685	8770.	2.2	0.	50700.
U11F	61	330000.	206250.	60.00	57.02	35.30	0.0299	0.00001664	8770.	2.1	0.	54800.
U12F	26	360000.	225000.	60.00	57.02	35.30	0.1430	0.00001459	8770.	2.0	0.	59000.
U13F	62	390000.	243750.	60.00	57.02	35.30	0.0253	0.00001408	8770.	1.9	0.	63100.

TABLE 21. HIGHWAY SPECIFICATION TABLE (CONT.)

HIGHWAY TYPE	HWY NO.	SPEED/VOLUME PARAMETERS A CAPACITY ADT	B BREAKPOINT ADT	C BEG. SPD. (MPH)	D BRKPT SPD (MPH)	E CAP. SPD. (MPH)	SPEED-CHANGE CYCLES F INTCPT	G SLOPE	ACCIDENTS COST H $ PER ACC.	RATE I INTCPT	J SLOPE	MAINTENANCE COST K AV. YRLY CST/MI ($)
U14F	36	420000.	262500.	60.00	57.02	35.30	0.1430	0.00001252	8770.	1.8	0.	67200.
U15F	63	450000.	281250.	60.00	57.02	35.30	0.0219	0.00001220	8770.	1.7	0.	71300.
U16F	37	480000.	300000.	60.00	57.02	35.30	0.1430	0.00001095	8770.	1.6	0.	75500.
U3M	64	90000.	60000.	60.00	56.82	45.82	0.1097	0.00006100	8770.	2.6	0.	21800.
U4M	31	120000.	80000.	60.00	56.82	45.82	0.0854	0.00004540	8770.	2.5	0.	26000.
U5M	65	150000.	100000.	60.00	56.82	45.82	0.0658	0.00003660	8770.	2.4	0.	30100.
U6M	32	180000.	120000.	60.00	56.82	45.82	0.0581	0.00002830	8770.	2.3	0.	34200.
U7M	66	210000.	140000.	60.00	56.82	45.82	0.0470	0.00002610	8770.	2.3	0.	38300.
U8M	29	240000.	160000.	60.00	56.82	45.82	0.0834	0.00002270	8770.	2.2	0.	42500.
U9M	67	270000.	180000.	60.00	56.82	45.82	0.0366	0.00002033	8770.	2.1	0.	46600.
U10M	30	300000.	200000.	60.00	56.82	45.82	0.1214	0.00001685	8770.	2.0	0.	50700.
U11M	68	330000.	220000.	60.00	56.82	45.82	0.0299	0.00001664	8770.	1.9	0.	54800.
U12M	33	360000.	240000.	60.00	56.82	45.82	0.1430	0.00001460	8770.	1.8	0.	59000.
U13M	69	390000.	260000.	60.00	56.82	45.82	0.0253	0.00001408	8770.	1.7	0.	63100.
U14M	38	420000.	280000.	60.00	56.82	45.82	0.1430	0.00001252	8770.	1.6	0.	67200.
U15M	70	450000.	300000.	60.00	56.82	45.82	0.0219	0.00001220	8770.	1.5	0.	71300.
U16M	39	480000.	320000.	60.00	56.82	45.82	0.1430	0.00001095	8770.	1.4	0.	75500.
U1AT 25 MPH	49	10000.	5000.	22.00	19.38	16.70	1.1390	0.00016390	6280.	12.4	0.	7900.
U1AT 35 MPH	47	11250.	5625.	32.00	28.48	18.82	1.1390	0.00016390	6280.	12.0	0.	7900.
U1AN 25 MPH	50	10000.	5000.	22.00	19.38	16.70	1.1390	0.00016390	6280.	12.4	0.	15800.
U1AN 35 MPH	48	11250.	5625.	32.00	28.48	18.82	1.1390	0.00016390	6280.	12.0	0.	15800.
U1T	42	30000.	18750.	60.00	57.02	35.30	0.3289	0.00018300	8770.	3.1	0.	81500.
U1N	43	30000.	18750.	60.00	57.02	35.30	0.3289	0.00018300	8770.	4.7	0.	27200.
U2N	44	60000.	37500.	60.00	57.02	35.30	0.1644	0.00009150	8770.	4.5	0.	35400.
U1S	45	30000.	18750.	60.00	57.02	35.30	0.3289	0.00018300	8770.	3.1	0.	13600.
U2S	46	60000.	37500.	60.00	57.02	35.30	0.1644	0.00009150	8770.	3.0	0.	17700.

TABLE 21. HIGHWAY SPECIFICATION TABLE (CONT.)

HIGHWAY TYPE	HWY NO.	SPEED/VOLUME PARAMETERS A CAPACITY ADT	B BREAKPOINT ADT	C BEG. SPD. (MPH)	D BRKPT SPD (MPH)	E CAP. SPD. (MPH)	SPEED-CHANGE CYCLES F INTCPT	G SLOPE	ACCIDENTS COST H $ PER ACC.	RATE I INTCPT	J SLOPE	MAINTENANCE COST K AV. YRLY CST/MI ($)
RURAL DVRTD	2	0.	0.	0.00	0.00	0.00	1.1390	0.00016390	25700.	6.0	0.	0.
R2C 40 MPH	7	27500.	21000.	39.00	31.18	27.89	1.1390	0.00016390	25700.	6.0	0.	5400.
R2C 55 MPH	8	31000.	22500.	55.00	40.80	30.90	1.1390	0.00016390	25700.	6.0	0.	5400.
R4C 40 MPH	9	87500.	67500.	39.00	30.97	27.89	1.3690	0.00004080	25700.	5.6	0.	7100.
R4C 55 MPH	10	92500.	67500.	55.00	40.83	30.86	1.3690	0.00004080	25700.	5.6	0.	7100.
R6C 40 MPH	19	130000.	100000.	39.00	31.07	27.97	1.2940	0.00003190	25700.	5.2	0.	10600.
R6C 55 MPH	20	135000.	100000.	55.00	40.94	32.70	1.2940	0.00003190	25700.	5.2	0.	10600.
R4D	40	110000.	65000.	60.00	50.82	28.40	0.0854	0.00004540	27810.	2.8	0.	9000.
R6D	41	165000.	97500.	60.00	50.82	28.40	0.0581	0.00002830	27810.	2.6	0.	10600.
R2E	35	55000.	32500.	60.00	51.35	29.99	1.1000	0.00008600	27970.	3.0	0.	7300.
R4E	21	110000.	65000.	60.00	51.35	29.99	0.0854	0.00004540	27970.	2.8	0.	9000.
R6E	22	165000.	97500.	60.00	51.35	29.99	0.0581	0.00002830	27970.	2.6	0.	10600.
R4F	11	110000.	65000.	60.00	57.11	30.98	0.0854	0.00004540	27970.	1.4	0.	14200.
R6F	13	165000.	97500.	60.00	57.11	30.98	0.0581	0.00002830	27970.	1.3	0.	17500.
R8F	15	220000.	130000.	60.00	57.11	30.98	0.0834	0.00002270	27970.	1.2	0.	20800.
R10F	17	275000.	162500.	60.00	57.11	30.98	0.1214	0.00001685	27970.	1.1	0.	24100.
R12F	18	330000.	195000.	60.00	57.12	30.98	0.1430	0.00001460	27970.	1.0	0.	27400.

$D = .8(C)$

$E = .9(D)$.

For highway numbers 3, 4, 5, 6, 23, 24, 47, 48, 49, 50, 51, 52, 53, and 54,

$C = SL - 3.0$

$D = -3.58 + 0.916(SL)$,

for $SL \geq 25$

$E = 11.4 + 0.212(SL)$,

for $SL < 25$

$E = .9(D)$.

If the ADT allocated to a highway (V) is less than or equal to the breakpoint ADT (B), then the average speed can be calculated,

$$SP = (tpf)[C + (D-C/B)(V)], \quad (3)$$

where tpf = technical performance factor ÷ 100

SP = average speed.

If $A \geq V > B$, then

$$SP = (tpf)[D + ((E-D)/(A-B))(V-B)]. \quad (4)$$

If $V > A$, then the allocated traffic is above capacity and to insure no more traffic is allocated,

$SP = 0.1(E)$.

Truck speed is assumed to be 90% of car speed.

Daily time cost per person (PVT) is then calculated as,

$$PVT = (60L/SP)[VT_c(PC/1.3) + VT_t(PT/.9)] \quad (5)$$

where L = highway length (miles)

VT_c = value of time, cars ($/min)

VT_t = value of time, trucks ($/min)

PC = highway segment percentage cars/vans ÷ 100

PT = highway segment percentage trucks/buses ÷ 100.

In an HOV bypass is present for a metered freeway ramp then an adjustment is made to the time cost if traffic volume is greater than the breakpoint volume, V > B. The speed is higher for those vehicles which use the bypass and do not have to wait at the ramp. Assuming a 5 min. ramp wait, an average trip length of 15 miles, no speed difference at breakpoint volume, B, and 80 percent of the 24 hour period is at capacity, at volume A, the speed of the bypass vehicles (SP_B) can be calculated as,

$$SP_B = (tpf)[D + (V-B)((144E-D(180-E))/((180-E)(A-B)))]. \qquad (6)$$

The time cost, adjusted for the HOV bypass is then

$$PVT_B = PVT[1 - r(1-(SP/SP_B))], \qquad (7)$$

where PVT_B = daily time cost per person, adjusted for an HOV bypass

r = proportion of vehicles using the HOV bypass.

Daily running costs per person are calculated using the following equations which are presented in TTI Research Report 225-24 [4] as approximations to the HEEM running cost calculations.

$$R_c = 1.91(L/1000)(152.0616 + 1.939548(SP) - .0085822(SP)^2 - 38.91707[\ln(SP)], \qquad (8)$$

$$R_t = 2.26(L/1000)(429.381938 + 5.598752(SP)(.9) - .003013(.9SP)^2 - 131.592[\ln(.9SP)], \qquad (9)$$

$$PR = R_c(PC/OCP_c) + R_t(PT/OCP_t), \qquad (10)$$

where R_c = daily running cost per car/van

R_t = daily running cost per truck/bus

PR = total daily running costs per person

OCP_c = car/van segment occupancy rate

OCP_p = truck/bus segment occupancy rate

1.91 = car running cost update factor from January 1975 to December 1982, using the Redbook [7] updating formula

2.26 = truck running cost update factor from January 1975 to December 1982, using the Redbook [7] updating formula.

Daily cycling costs per person are calculated with the following equations,

$$CY_c = 1.87[L(NC)/1000][3.9499 - (13.8413/SP)], \tag{11}$$

$$Cy_t = 2.04[L(NC)/1000][47.2458 - (428.198/SP)], \tag{12}$$

$$PCY = CY_c(PC/OCP_c) + CY_t(PT/OCP_t), \tag{13}$$

where CY_c = daily cycling cost per car/van

CY_t = daily cycling cost per truck/bus

NC = number of cycles per vehicle mile

= [F + G(V)]/tpf, with metered freeways $NC \leq 3.1$

PCY = total daily cycling cost per person

1.87 = car cycling cost update factor from January 1975 to December 1982 using the Redbook [7] updating formula

2.04 = truck cyclying cost update factor from January 1975 to December 1982 using the Redbook [7] updating formula.

Daily accident costs per person are calculated using the following equation, which includes a factor to incorporate varying occupancy rates presented in TTI Research Report 225-24 [4]. The mean cost per accident parameter H, was calculated using recent data collected by McFarland and Rollins on accident costs in Texas, and updated to December 1982 [8].

$$PAC = [(L)(H)/(10^6)(sf)][(.47/OCP)+.414][I+((J)(V)/1000)] \tag{14}$$

where PAC = daily accident cost per person

sf = safety factor ÷ 100

OCP = highway occupancy rate, weighted average of car and truck occupancy rates.

Total daily user costs per person (AC) are simply the sum of the component user costs.

$$AD = PVT + PR + PCY + PAC. \tag{15}$$

If an HOV highway type is being used, then the daily cost must be adjusted by the inconvenience cost for the HOV users. The inconvenience cost is a method to adjust for the perceived lower desirability of using an HOV lane in a bus, van, or carpool, compared to using a personal vehicle. The purpose is to improve the accuracy of the allocation to HOV highway types.

The default inconvenience costs were calculated using data from the contraflow lane on I-45 in Houston and the concurrent flow lane on US 101 in San Francisco. As of March 1981, the contraflow lane in Houston had an average utilization of 152 buses (23.6%) and 493 vanpools (76.4%) [10]. Using the cost equations in HEEM-II, the average daily user cost per person per mile on the main lanes was \$.294 and on the contraflow lane was \$.140. Information for the concurrent flow lane in San Francisco was taken from TTI Research Report 205-4 [11]. It shows 475 carpools (83.2%) and 96 buses (16.8%) using the HOV lane. HEEM-II cost calculations give the average daily user cost per person per mile on the main lanes as \$.279 and on the concurrent flow lane as \$.151.

If all relevant user costs are being calculated, then such a large discrepancy between the costs on the main lanes and the HOV lane should not exist. Motorists would switch to the lower cost HOV lane until the costs were approximately the same. Since that does not occur, some additional costs of using the HOV lane are not being calculated. These additional costs are called inconvenience costs and are defined as the difference of the calculated costs per person on the main lanes and the HOV lane. If the inconvenience costs for passengers in vanpools and carpools are assumed to be the same, then the information given above for the two HOV lanes can be used to calculate inconvenience costs for both bus passengers and van/carpool passengers. These values are easily calculated by solving the two equations,

$$.236\ IT + .764IC = .154$$

$$.168\ IT + .832\ IC = .128$$

which gives

$$IT = .446$$

$$IC = .064.$$

The average daily cost per person, adjusted for the HOV inconvenience costs can then be calculated,

$$AC_A = AC + (L)[PC(IC)+PT(IT)] \quad (16)$$

where AC_A = daily user cost per person, with the inconvenience cost added on

IC = van/carpool inconvenience cost per mile

IT = bus inconvenience cost per mile.

The iteration procedure to allocate persons to each corridor highway, initially allocates all persons to the highway with the highest capacity. Then a fraction of the total is taken from the highest cost highway and given to the lowest cost highway. That fraction of the total gradually diminishes and eventually stops when the number is less than 50. This process is repeated for each year during the planning horizon.

There is also an adjustment for those cases when the user costs along some highways are so much higher than other highways that even if all persons are allocated to the lower cost highways, the costs per person are still lower than the higher cost highways. The result is no persons are assigned to these higher cost highways. To account for the residual which use a particular highway independent of the relative costs, an adjustment is made to the daily cost per person if the allocated persons are less than 2 percent capacity. The adjusted cost is given by,

$AC_R = [(50)(TAC)(V)/A]$

where AC_R = average daily user cost per person, adjusted for residual demand

TAC = average daily user cost per person at 2 percent capacity.

There is also an adjustment for any highway which has persons allocated to it above its capacity. That excess is given to another highway which has not reached capacity. If all highways have reached capacity, then the excess is assigned to the diversion highway, which is an unspecified circuitous route, undefined within the corridor.

Calculation of Benefits and Costs

The calculation of costs and benefits utilize equations similar to those previously described for the allocation of corridor traffic. The major differences come from the effects of inflation and discounting on the calculations, and the addition of maintenance costs and construction costs in calculating the benefits and costs of the proposed project.

Average speed for each corridor route is calculated with the same equations(3) and (4) described in the previous section. For the diversion route, if the existing highway is a rural highway then assumption 7 is used. If the existing highway is an urban route then assumption 8 is used. The default value for assumption 7 is 25 mph and for assumption 8 is 15 mph. Each of these assumed values can be changed as part of the input data, but presumably the justification is that the diversion route is some unspecified circuitous route, and to compensate for the unspecified longer distance a low speed over the longest specified route in the segment is used. Average daily speed for trucks is also assumed to be 90 percent of the calculated average speed.

The calculation of total annual delay costs is similar to equation (5), but the form and components change slightly. It should be remembered that the value of car time assumes an occupancy rate of 1.3, while the value of truck time assumes an occupancy rate of 1.0. The delay cost equation is given below as,

$$DC = (L/SP)(60)(365)(V)(1+i)^{t-1}[VT_c(OCP_c)(PC/1.3)+VT_t(OCP_t)(PT/.9)]$$

where DC = annual delay cost in year t (current year t = 1)

i = inflation rate (assumption 4)

and all other variables are the same as previously defined.

Total annual running costs are calculated using the following equations,

$$RN_c = 1.91(L/1000)(F_c)(1+i)^{t-1}$$

$$RN_t = 2.26(L/1000)(F_t)(1+i)^{t-1}$$

$$RN = (365)(V)[(RN_c)(PC)+(RN_t)(PT)]$$

where RN_c = daily running costs per car in year t

RN_t = daily running costs per truck in year t

RN = total running costs in year t

$F_c = SP \div [-.034048 + .01577(SP)]$ if $SP < 25$

$= 1 \div [.01579 - .00005012(SP)]$ if $SP \geq 25$

$F_t = .9SP \div [-.0259 + .008094(.9SP)]$ if $.9SP < 25$

$= 1 \div [.009033 - .00007342(.9SP)]$ if $.9SP \geq 25$.

Total annual cycling costs are calculated using the same equations (11) and (12) from the previous section.

$$TCY = (365)(V)[CY_c(PC) + CY_t(PT)](1+i)^{t-1}$$

where TCY = total cycling costs in year t.

Total operating costs in year t (OC) is simply the sum of running costs and cycling costs.

$OC = RN + TCY.$

Accident costs are calculated as,

$$AC = [(365)(L)(H)(V)/((10^6)(sf))][.47+.414(OCP)]$$
$$[I+((J)(V)/1000)](1+i)^{t-1}$$

where AC = total accident cost for year t.

Maintenance costs are calculated as,

$$MN = (L)(K)(1+i)^{t-1}$$

where MN = total maintenance cost in year t.

The present value of each benefit component is then calculated by taking the difference between the do-nothing and if-construct calculations and discounting that difference.

$$DPV = \sum_{j=1}^{5} \sum_{t=1}^{P} (DC_{DN}-DC_{IC})[1/(1+r)]^{t-1} \qquad (17)$$

$$OPV = \sum_{j=1}^{5} \sum_{t=1}^{P} (OC_{DN}-OC_{IC})[1/(1+r)]^{t-1} \qquad (18)$$

$$APV = \sum_{j=1}^{5} \sum_{t=1}^{P} (AC_{DN}-AC_{IC})[1/(1+r)]^{t-1} \qquad (19)$$

$$MPV = \sum_{j=1}^{5} \sum_{t=1}^{P} (MN_{DN}-MN_{IC})[1/(1+r)]^{t-1} \qquad (20)$$

where DPV = present value of delay savings

OPV = present value of reduction in operating costs

APV = present value of reduction in accident costs

MPV = present value of reduction in maintenance costs (generally negative)

j = index for corridor highway

t = year

P = planning horizon plus one

DN = do-nothing alternative

IC = if-construct alternative

r = discount rate (assumption 6).

Total present value of benefits is simply the sum of the component benefits.

$$BPV = DPV + OPV + APV + MPV \qquad (21)$$

where BPV = present value of total benefits.

Construction costs are also discounted if construction does not take place in the current year or an expansion is proposed.

$$CPV = (CCST)[(1+e)/(1+r)]^{C-1} + (ECST)[(1+e)/(1+r)]^{E-1} \qquad (22)$$

where CPV = present value of construction costs

CCST = construction and right-of-way cost for initial project

ECST = construction and right-of-way cost for expansion if any

e = construction cost escalation rate (assumption 5)

C = construction year, with current year as 1

E = expansion year, with current year as 1.

Three economic measures of effectiveness are calculated, net present value, benefit-cost ratio, and internal rate of return. Net present value is the difference between total benefits and total construction costs,

$$NPV = BPV - CPV \qquad (23)$$

where NPV = net present value of project.

The benefit-cost ratio is the ratio of total benefits to total costs and measures the amount of benefits the project will generate per dollar construction cost.

$$BC = BPV/CPV \qquad (24)$$

where BC = benefit-cost ratio of project.

The internal rate of return is the discount rate (r) such that the net present value, equation (23), is equal to zero. There is no way to calculate the internal rate of return directly, it must be iterated. Different values of r are tried in equations (17) through (22) until equation (23) is very close to zero. A very efficient iteration technique known as Newton's method is used and generally finds a solution very quickly. But if the iterated value goes less than -100% or greater than 10000% and no solution has been found, the iteration will stop and print out "No Solution Found."

The calculation of mobility, which is the vehicle-mile weighted average speed on a highway or in a corridor, is given below.

$$WSP1 = \sum_{j=1}^{5} (L_j)(V_j)(SP_j)$$

$$WSP2 = \sum_{j=1}^{5} (L_j)(V_j)$$

$$MOB = WSP1/WSP2$$

where WSP1 = sum of corridor highways vehicle miles multipled by average speed

WSP2 = sum of corridor highways vehicle miles

MOB = corridor mobility

j = index of corridor highways

L_j = length of highway j (miles)

V_j = ADT on highway j

SP_j = average daily speed on highway j.

APPENDIX B

PROGRAM DOCUMENTATION

Program Description

HEEM-II is a computerized program written in FORTRAN IV and designed for batch input. The program has been tested on the IBM FORTRAN VS compiler with FIPS(F) option, which is the standard ANSI 77 FORTRAN version of the compiler. In the current version of the compiler, Region Fort uses 1316K, Region Lked uses 124K, and Region Go uses 236K. The source code is 1817 lines long.

HEEM-II consists of a main program, seven subroutines, and a block data section. The calling relationships between the main program and the subroutines are shown in Table 22. The block data contains the highway specification table parameters for each highway type (Table 21). The parameters are ordered by highway number in the block data, so the first line consists of highway number 1, urban diverted and continues on through the data. The main program controls input, editing, calling, and output. The EXPAND subroutine calculates the optimal construction and/or expansion years if needed. The CRDMND subroutine allocates corridor traffic to each highway within the corridor. The AVCOST subroutine calculates average daily cost per person for a particular highway, and is used in the traffic allocation process. The CALCO3 subroutine makes the cost and mobility calculations. The DIFFER subroutine calculates differences between the do-nothing and construct alternatives. The TOTAL subroutine accumulates segment and problem totals. The INIT subroutine zeros out all variables in the two common arrays.

This appendix contains a computer generated flow chart, a variable dictionary, and a program listing.

Table 22. HEEM-II Subroutine Calling Relationships

Program or Subroutine	Called By	Subroutines Called
MAIN	none	EXPAND, CRDMND, CALCO3, DIFFER, TOTAL, INIT
EXPAND	MAIN	CRDMND, CALCO3
CRDMND	MAIN, EXPAND	AVCOST
AVCOST	CRDMND	none
CALCO3	MAIN, EXPAND	none
DIFFER	MAIN	none
TOTAL	MAIN	none
INIT	MAIN	none

Program Flowchart

E=ENTRY, T=TERMINAL, C=CALL, R=READ, W=WRITE

```
C      TEXAS STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
C           REVISED HIGHWAY ECONOMIC EVALUATION MODEL (HEEM II)
C         REVISED AND UPDATED TO 12-31-82  BY JEFFERY L. MEMMOTT
C
      BLOCK DATA
      COMMON /LABA/ASSUMP(9),TABLE(11,70),IDUM(9784)
      COMMON/LABB/KDUM(2298)
      DIMENSION DUMY1(11,5),DUMY2(11,3),DUMY3(11,2),DUMY4(11,3),
     *DUMY5(11,3),DUMY6(11,5),DUMY7(11,4),DUMY8(11,3),DUMY9(11,5),
     *DUMY10(11,5),DUMY0(11,5),DUMY11(11,5),DUMY12(11,5),DUMY13(11,5),
     *DUMY14(11,5),DUMY15(11,5),DUMY16(11,2)
      EQUIVALENCE (TABLE(1,6),DUMY1(1,1)),(TABLE(1,11),DUMY2(1,1)),
     *(TABLE(1,14),DUMY3(1,1)),(TABLE(1,16),DUMY4(1,1)),
     *(TABLE(1,19),DUMY5(1,1)),(TABLE(1,22),DUMY6(1,1)),
     *(TABLE(1,27),DUMY7(1,1)),(TABLE(1,31),DUMY8(1,1)),
     *(TABLE(1,34),DUMY9(1,1)),(TABLE(1,39),DUMY10(1,1)),
     *(TABLE(1,1),DUMY0(1,1)),(TABLE(1,44),DUMY11(1,1))
      EQUIVALENCE
     *(TABLE(1,49),DUMY12(1,1)),(TABLE(1,54),DUMY13(1,1)),
     *(TABLE(1,59),DUMY14(1,1)),(TABLE(1,64),DUMY15(1,1)),
     *(TABLE(1,69),DUMY16(1,1))
      DATA
     X DUMY0/0.,0.,0.,0.,0.,1.139,1.639E-4,6280.,12.,0.,0.,
     X0.,0.,0.,0.,0.,1.139,1.639E-4,25700.,6.,0.,0.,
     X20000.,10000.,22.,19.32,16.70,1.139,1.639E-4,6280.,12.,0.,9100.,
     X22500.,11250.,32.,28.48,18.82,1.139,1.639E-4,6280.,12.,0.,9100.,
     X40000.,20000.,22.,19.32,16.70,1.139,4.08E-5,6280.,11.2,0.,11600./
      DATA DUMY1/
     X45000.,22500.,32.,28.48,18.82,1.369,4.08E-5,6280.,11.2,0.,11600.,
     X27500.,21000.,39.,31.18,27.89,1.139,1.639E-4,25700.,6.,0.,5400.,
     X31000.,22500.,55.,40.80,30.90,1.139,1.639E-4,25700.,6.,0.,5400.,
     X87500.,67500.,39.,30.97,27.89,1.369,4.08E-5,25700.,5.6,0.,7100.,
     X92500.,67500.,55.,40.83,30.86,1.369,4.08E-5,25700.,5.6,0.,7100./
      DATA DUMY2/
     X1.1E+5,65000.,60.,57.11,30.98,.0854,4.54E-5,27970.,1.4,0.,14200.,
     X1.2E+5,75000.,60.,57.02,35.3,.0854,4.54E-5,8770.,2.8,0.,26000.,
     X1.65E+5,97500.,60.,57.11,30.98,5.81E-2,2.83E-5,27970.,1.3,0.,
     X17500./
      DATA DUMY3/
     X1.8E+5,112500.,60.,57.02,35.3,5.81E-2,2.83E-5,8770.,2.6,0.,34200.,
     X2.2E+5,130000.,60.,57.11,30.98,8.34E-2,2.27E-5,27970.,1.2,0.,
     X20800./
      DATA DUMY4/
     X2.4E+5,150000.,60.,57.02,35.3,8.34E-2,2.27E-5,8770.,2.4,0.,42500.,
     X2.75E+5,162500.,60.,57.11,30.98,.1214,1.685E-5,27970.,1.1,0.,
     X24100.,
     X3.3E+5,195000.,60.,57.12,30.98,.143,1.46E-5,27970.,1.0,0.,27400./
      DATA DUMY5/
     X130000.,1.E+5,39.,31.07,27.97,1.294,3.1898E-5,25700.,5.2,0.,10600.
     X,
     X135000.,1.E+5,55.,40.94,32.70,1.294,3.1898E-5,25700.,5.2,0.,10600.
     X,
     X1.1E+5,65000.,60.,51.35,29.99,8.54E-2,4.54E-5,27970.,2.8,0.,9000./
      DATA DUMY6/
     X1.65E+5,97500.,60.,51.35,29.99,.0581,2.83E-5,27970.,2.6,0.,10600.,
```

1 2 3 4 5 6 7 8 9 0 . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1

```
X6.0E+4,3.E+4,22.,19.32,16.70,1.294,3.1898E-5,6280.,10.4,0.,14000.,
X67500.,33750.,32.,28.48,18.82,1.294,3.1898E-5,6280.,10.4,0.,14000.
*,
X3.E+5,187500.,60.,57.02,35.3,.1214,1.685E-5,8770.,2.2,0.,50700.,
X3.6E+5,225000.,60.,57.02,35.3,.1430,1.459E-5,8770.,2.,0.,59000./
 DATA DUMY7/
X80000.,50000.,47.,38.41,28.45,8.54E-2,4.54E-5,8770.,5.6,0.,9000.,
X120000.,75000.,47.,38.41,28.45,.0581,2.83E-5,8770.,5.2,0.,10600.,
X2.4E+5,160000.,60.,56.82,45.82,8.34E-2,2.27E-5,8770.,2.2,0.,
X42500.,
X3.E+5,200000.,60.,56.82,45.82,.1214,1.685E-5,8770.,2.,0.,50700./
 DATA DUMY8/
X1.2E+5,80000.,60.,56.82,45.82,8.54E-2,4.54E-5,8770.,2.5,0.,26000.,
X180000.,120000.,60.,56.82,45.82,5.81E-2,2.83E-5,8770.,2.3,0.,
X34200.,
X360000.,240000.,60.,56.82,45.82,.143,1.4598E-5,8770.,1.8,0.,
X59000./
 DATA DUMY9/
X40000.,25000.,47.,38.41,28.45,1.1,8.6E-5,8770.,6.,0.,7300.,
X55000.,32500.,60.,51.35,29.99,1.1,8.6E-5,27970.,3.,0.,7300.,
X420000.,262500.,60.,57.02,35.3,.143,1.252E-5,8770.,1.8,0.,67200.,
X480000.,300000.,60.,57.02,35.3,.143,1.095E-5,8770.,1.6,0.,75500.,
X420000.,280000.,60.,56.82,45.82,.143,1.252E-5,8770.,1.6,0.,67200./
 DATA DUMY10/
X480000.,320000.,60.,56.82,45.82,.143,1.095E-5,8770.,1.4,0.,75500.,
X110000.,65000.,60.,50.82,28.40,.0854,4.54E-5,27810.,2.8,0.,9000.,
X165000.,97500.,60.,50.82,28.40,.0581,2.83E-5,27810.,2.6,0.,10600.,
*30000.,18750.,60.,57.02,35.3,.3289,1.83E-4,8770.,3.1,0.,81500.,
*30000.,18750.,60.,57.02,35.3,.3289,1.83E-4,8770.,4.7,0.,27200./
 DATA DUMY11/
*60000.,37500.,60.,57.02,35.3,.1644,9.15E-5,8770.,4.5,0.,35400.,
*30000.,18750.,60.,57.02,35.3,.3289,1.83E-4,8770.,3.1,0.,13600.,
*60000.,37500.,60.,57.02,35.3,.1644,9.15E-5,8770.,3.,0.,17700.,
*11250.,5625.,32.,28.48,18.82,1.139,1.639E-4,6280.,12.,0.,7900.,
*11250.,5625.,32.,28.48,18.82,1.139,1.639E-4,6280.,12.,0.,15800./
 DATA DUMY12/
*10000.,5000.,22.,19.38,16.7,1.139,1.639E-4,6280.,12.4,0.,7900.,
*10000.,5000.,22.,19.38,16.7,1.139,1.639E-4,6280.,12.4,0.,15800.,
*30000.,15000.,22.,19.38,16.7,1.732,6.634E-5,6280.,11.6,0.,10300.,
*33750.,16875.,32.,28.48,18.82,1.732,6.634E-5,6280.,11.6,0.,10300.,
*50000.,25000.,22.,19.38,16.7,1.0392,3.803E-5,6280.,10.8,0.,12800./
 DATA DUMY13/
*56250.,28125.,32.,28.48,18.82,1.0392,3.803E-5,6280.,10.8,0.,12800.
*,
*60000.,37500.,47.,38.41,28.45,.1097,6.1E-5,8770.,5.8,0.,8100.,
*1.E+5,62500.,47.,38.41,28.45,.0658,3.66E-5,8770.,5.4,0.,9800.,
*9.E+4,56250.,60.,57.02,35.3,.1097,6.1E-5,8770.,2.9,0.,21800.,
*1.5E+5,93750.,60.,57.02,35.3,.0658,3.66E-5,8770.,2.7,0.,30100./
 DATA DUMY14/
*2.1E+5,131250.,60.,57.02,35.3,.047,2.614E-5,8770.,2.5,0.,38300.,
*2.7E+5,168750.,60.,57.02,35.3,.0366,2.033E-5,8770.,2.3,0.,46600.,
*3.3E+5,206250.,60.,57.02,35.3,.0299,1.664E-5,8770.,2.1,0.,54800.,
*3.9E+5,243750.,60.,57.02,35.3,.0253,1.408E-5,8770.,1.9,0.,63100.,
*4.5E+5,281250.,60.,57.02,35.3,.0219,1.22E-5,8770.,1.7,0.,71300./
 DATA DUMY15/
*9.E+4,6.E+4,60.,56.82,45.82,.1097,6.1E-5,8770.,2.6,0.,21800.,
*1.5E+5,1.E+5,60.,56.82,45.82,.0658,3.66E-5,8770.,2.4,0.,30100.,
*2.1E+5,1.4E+5,60.,56.82,45.82,.047,2.61E-5,8770.,2.3,0.,38300.,
*2.7E+5,1.8E+5,60.,56.82,45.82,.0366,2.033E-5,8770.,2.1,0.,46600.,
*3.3E+5,2.2E+5,60.,56.82,45.82,.0299,1.664E-5,8770.,1.9,0.,54800./
 DATA DUMY16/
*3.9E+5,2.6E+5,60.,56.82,45.82,.0253,1.408E-5,8770.,1.7,0.,63100.,
*4.5E+5,3.E+5,60.,56.82,45.82,.0219,1.22E-5,8770.,1.5,0.,71300./

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FORTCHT, VERSION A1     MAINTAINED BY DALE L. SCHAFER,    PHONE 845-1714
 E=ENTRY, T=TERMINAL, C=CALL, R=READ, W=WRITE

             COMMON /LABA/ASSUMP(9),TABLE(11,70),HDATA(5,5),VOLUME(41),
            1DMAND(7,41,2),XMAINT(7,41,2),SPEED(7,41,2),CYCLE(7,41,2),
            2XSPEED(7,41,2,2),XTIME(7,41,2,2),OCOST(7,41,2,2),DIFF(6,41),
            3PVAL(6,41),ADJCON(7),ALL(4),ACCNUM(7,41,2),ACCICO(7,41,2),
            4STORE(10),WSPCP1(7,41,2),WSPCP2(7,41,2),TPVAL(8),ICYR3,ICYR4,
            5XVTIME(7,41,2,2),XMN,SP,WSP1,WSP2,CY,XV(2),XT(2),XSP(2)
             COMMON/LABB/OCP(5),PVOL(41),IHW(5,41,2),PRS,INDX,AC(4),TPR(4),
            6XVT(2),XRN(2),XCY(2),OC(2),HSW(5),ACCNO,ACCOST,COST1,
            7COST2,X1,ITRIAL,Y,NO1,NO2,NO3,NO4,EXSW,ALTSW,ANS,IASW,TAC(4),
            8ISW,ICYR,ICYR2,IEYR2,IEYR,X,L1,L,EXSTOR(10),CCOST,ECOST,TBLE(5,4),

      EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
      E     9WP1(7,41,2),WP2(7,41,2),RATIO,RATIO2,II,CINC(2),ASMSEG(5,3),      E
      E     *BYPS(4),PBYPS(4),PRSW,IN(5),CAP(4),VOL(41,2),DEMAND(6,41,2)       E
      EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
                                           I
      ...........................................................................
      .      CHARACTER*80 CARD                                                  .
      .      CHARACTER*4 PROTIT                                                 .
      .      CHARACTER*4 BLANKS                                                 .
      .      CHARACTER*1 KAST                                                   .
      .      CHARACTER*1 KBLANK                                                 .
      .      CHARACTER*1 LINE                                                   .
      .      CHARACTER*1 KLTR                                                   .
      .      CHARACTER*4 HDAT                                                   .
      .      CHARACTER*4 HT                                                     .
      ...........................................................................
                                           I
             INTEGER Y,HIWAY,HMMSG,HWAY,YR
             INTEGER HLDTIT
             REAL TASSP(8)
             DIMENSION CP16Y1(41),CP26Y1(41),CP16Y2(41),CP26Y2(41),
            XWP11Y1(41),WP21Y1(41),WP12Y2(41),WP22Y2(41),INC(13),INP(11)
             DIMENSION HLDTIT(99,6),HMMSG(20),SVAL(8),IPYR(2),AVAR(2),KLTR(8)
                                           I
       C
       C     LITERAL VARIABLES
       C
                                           I
             DIMENSION HT(58),PROTIT(6),TI1(5),TI2(5),LINE(121),HDAT(4),
            1TI3(5),TI4(3),SEGTIT(8),TIT(7,21),GRWRTE(3,2),RUNTPE(10,4)
             DATA HT/'U4C','U2C','R2C','R4C','R4F','R6F','U4F','U6F','R8F',
            1'U8F','R10F','R12F','U10F','U12F','U6C','R6C','R4E','R6E','U8M',
            2'U10M','U4E','U6E','U4M','U6M','U12M','U2E','R2E','U14F','U16F',
            X'U14M','U16M','R4D','R6D','U1T','U1N','U2N','U1S','U2S','U1AT',
            *'U1AN','U3C','U5C','U3E','U5E','U3F','U5F','U7F','U9F','U11F',
            *'U13F','U15F','U3M','U5M','U7M','U9M','U11M','U13M','U15M'/
             DATA BLANKS/'    '/,
            3TI1/'CURR','ENT ','YEAR','    ','    '/,TI2/'CONS','TRUC',
            3    'TION',' YEA','R   '/,TI3/'EXPA','NSIO','N YE','AR  ',
            3    '    '/,TI4/'OR B','EYON','D   '/
             DATA TIT/'PERC','ENTA','GE T','RUCK','S % ',2*'    ','VALU',
            1'E CA','R TI','ME  ',' $/M','IN  ','    ','VALU','E TR','UCK ',
            2'TIME',' $/M','IN  ','    ','INFL','ATIO','N RA','TE %',3*'    ',
            3'CONS','T CO','ST E','SCAL','ATIO','N RA','TE %',
            4'DISC','OUNT',' RAT','E % ','    ','    ','    ',
1 2 3 4 5 6 7 8 9 0                                                     . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

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              5'RURA','L DI','VERS','ION ','ROUT','E SP','EED ',
              6'URBA','N DI','VERS','ION ','ROUT','E SP','EED ',
              7'MAX ','DECL',' GRW',' RAT','E IN',' PRO','J YR',
              8'EXIS','TING',5*'    ','PROP','OSED',5*'    ',
              9'EXPA','NDED',5*'    ','ALTE','RNAT','E   ',4*'    ',
              A'OPER','ATIN','G - ','CAR ','    ','    ','    ',
              B'OPER','ATIN','G - ','TRUC','K   ','    ','    ',
              C'DELA','Y - ','CAR ','    ','    ','    ','    ',
              D'DELA','Y - ','TRUC','K   ','    ','    ','    ',
              E'ACCI','DENT','    ','    ','    ','    ','    ',
              F'*TOT','AL B','ENEF','ITS ','    ','    ','    ',
              G'*TOT','AL C','ONST',' COS','T   ','    ','    ',
              H'MAIN','TENA','NCE ','    ','    ','    ','    '/
               DATA GRWRTE/'CONS','TANT','    ','DECL','ININ','G   '/,
              1RUNTPE/'REGU','LAR ','RUN ',7*'    ',
              *'OPTI','MIZE',' CON','STRU','CTIO','N YE','AR  ',3*'    ',
              2'OPTI','MIZE',' CON','STRU','CTIO','N & ','EXPA','NSIO','N YE',
              3'ARS ','OPTI','MIZE',' EXP','ANSI','ON Y','EAR ','ONLY','    ',
              4'    ','    '/
               DATA HLDTIT/594*'    '/,ISFLAG/0/,SVAL/8*0.0/,SYSCST/0.0/
               DATA KAST,KBLANK/'*',' '/
               DATA KLTR/'E','P','X','A','D','T','S','B'/
                                          I
         C
         C     RUN INITIALIZATION
         C
                                          I
         WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
         W     WRITE (6,410)                                                     W
         WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                          I
         ...........................................................................
         .   28 CONTINUE                                                         .
         .   30 CONTINUE                                                         .
         ...........................................................................
                                          I
         ...........................................................................
I---------------------  DO 5 I = 1,41                                            .
I        ...........................................................................
I                                         I
I        ...........................................................................
I        .     CP16Y1(I) = 0.0                                                   .
I        .     CP26Y1(I) = 0.0                                                   .
I        .     CP16Y2(I) = 0.0                                                   .
I        .     CP26Y2(I) = 0.0                                                   .
I        .     WP11Y1(I) = 0.0                                                   .
I        .     WP21Y1(I) = 0.0                                                   .
I        .     WP12Y2(I) = 0.0                                                   .
I        .     WP22Y2(I) = 0.0                                                   .
I        ...........................................................................
I                                         I
I        ...........................................................................
--------------------*  5 CONTINUE                                                .
         ...........................................................................
                                          I
                                          I
                                          I
                                          I
```

```
                                              I
......................................................................
.      IPROB = 0                                                     .
......................................................................
                                              I
 C
 C     PROCESS FIRST CARD - MUST BE PROBLEM HEADER
 C
                                              I
   400 FORMAT (A80)
                                              I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R      READ (5,400,END=610,ERR=615) CARD                                    *--------------------------------V
R                                                                           *----------------------------V   I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR                              I   I
                                              I                                                          I   I
   405 FORMAT (4X,I1)                                                                                    I   I
                                              I                                                          I   I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR                              I   I
R      READ (CARD,405) ICTYPE                                             R                              I   I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR                              I   I
                                              I                                                          I   I
......................................................................                                   I   I
.      IF (ICTYPE.EQ.1) GOTO 605                                            *------------------------V   I   I
......................................................................                               I   I   I
                                              I                                                      I   I   I
 C                                                                                                   I   I   I
 C     INVALID HEADER CARD                                                                           I   I   I
 C                                                                                                   I   I   I
                                              I                                                      I   I   I
   410 FORMAT ('1',55X,'***** H E E M II *****'/46X,'REVISED HIGHWAY ',                              I   I   I
      1'ECONOMIC EVALUATION MODEL'/58X,'VERSION(12-31-82)'/)                                         I   I   I
   415 FORMAT (/28H *** INVALID HEADER CARD ***/)                                                    I   I   I
                                              I                                                      I   I   I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                          I   I   I
W      WRITE (6,415)                                                      W                          I   I   I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                          I   I   I
                                              I                                                      I   I   I
   420 FORMAT (9X,3H***,A80,3H***)                                                                   I   I   I
                                              I                                                      I   I   I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                          I   I   I
W      WRITE (6,420) CARD                                                 W                          I   I   I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                          I   I   I
                                              I                                                      I   I   I
   425 FORMAT (/69H PROBLEM REJECTED. SCANNING FOR NEXT PROBLEM. FOLLOWIN                            I   I   I
      1G CARDS IGNORED/)                                                                             I   I   I
                                              I                                                      I   I   I
                                              OK-------------------------------------------------O   I   I   I
                                              I                                                  I   I   I   I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                      I   I   I   I
W  595 WRITE (6,425)                                                      W                      I   I   I   I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                      I   I   I   I
                                              I                                                  I   I   I   I
                                              I                                                  I   I   I   I
                                              I                                                  I   I   I   I
                                              I                                                  I   I   I   I
                                              I                                                  I   I   I   I
                                              I                                                  I   I   I   I
```

```
                                         I                                                       I    I    I    I
.........................................................................                        I    I    I    I
.      ISFLAG = 1                                                       .                        I    I    I    I
.      IFLAG = 1                                                        .                        I    I    I    I
.........................................................................                        I    I    I    I
                                         I                                                       I    I    I    I
 C                                                                                               I    I    I    I
 C     PROBLEM/SEGMENT SKIPPING CODE                                                             I    I    I    I
 C                                                                                               I    I    I    I
                                         I                                                       I    I    I    I
                                        OK-----------------------------------------------------O I    I    I    I
                                         I                                                     I I    I    I    I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR                     I I    I    I    I
R  600 READ (5,400,END=610,ERR=615) CARD                                   *-------------------I-I----I----I----V
R                                                                          *-------------------I-I----I----V    I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR                     I I    I    I    I
                                         I                                                     I I    I    I    I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR                     I I    I    I    I
R      READ (CARD,405) ICTYPE                                            R                     I I    I    I    I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR                     I I    I    I    I
                                         I                                                     I I    I    I    I
.........................................................................                      I I    I    I    I
.      IF (ICTYPE.LE.IFLAG.AND.ICTYPE.GT.0) GOTO 605                       *-------------------I-I----V    I    I
.........................................................................                      I I         I    I
                                         I                                                     I I         I    I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                     I I         I    I
W      WRITE (6,420) CARD                                                W                     I I         I    I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                     I I         I    I
                                         I                                                     I I         I    I
.........................................................................                      I I         I    I
.      GOTO 600                                                            *-------------------A I         I    I
.........................................................................                        I         I    I
                                                                                                 I         I    I
                                        OK-------------------------------------------------------I----O    I    I
                                         I                                                       I    I    I    I
.........................................................................                        I    I    I    I
.  605 CONTINUE                                                         .                        I    I    I    I
.........................................................................                        I    I    I    I
                                         I                                                       I    I    I    I
.........................................................................                        I    I    I    I
.      IF (ICTYPE.EQ.1) GOTO 620                                           *---------------V     I    I    I    I
.........................................................................                  I     I    I    I    I
                                         I                                                 I     I    I    I    I
   430 FORMAT ('1',8H PROBLEM,2X,A2,37X,5A4,A3/)                                           I     I    I    I    I
                                         I                                                 I     I    I    I    I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                 I     I    I    I    I
W      WRITE (6,430) IPNO,PROTIT                                         W                 I     I    I    I    I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                 I     I    I    I    I
                                         I                                                 I     I    I    I    I
.........................................................................                  I     I    I    I    I
.      GOTO 650                                                            *-----------V   I     I    I    I    I
.........................................................................              I   I     I    I    I    I
                                                                                       I   I     I    I    I    I
```

```
C
C     END OF FILE
C
                                   OK---------------------------------------------I---I---I---I---I---I---O
                                   I
.....................................................................
.   610 CONTINUE                                                    .
.....................................................................
                                   I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE(6,21) IPROB                                            W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                   I
    21 FORMAT('1',/,40X,'PROBLEM(S) PROCESSED THIS RUN --',I3,/)
                                   I
.....................................................................
I-------------------     DO 22 I = 1,IPROB,4                        .
I  ...................................................................
I                                  I
I  WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
I  W      WRITE(6,23) (HLDTIT(I,J),J=1,6),(HLDTIT(I+1,J),J=1,6),    W
I  W     X(HLDTIT(I+2,J),J=1,6),(HLDTIT(I+3,J),J=1,6)               W
I  WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
I                                  I
I      23 FORMAT(1X,4(5X,5A4,A3))
I                                  I
I  ...................................................................
--------------------*    22 CONTINUE                                .
.....................................................................
                                   I
.....................................................................
.      IF(ISFLAG.EQ.0) GO TO 31                                     *-------V
.....................................................................       I
                                   I                                        I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW       I
W      WRITE(6,32)                                                  W       I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW       I
                                   I                                        I
    32 FORMAT(/72H *** CAUTION---PROBLEM/SEGMENT OMITTED BECAUSE OF INVAL   I
      XID INPUT DATA ***/)                                                  I
                                   I                                        I
                                   OK---------------------------------------O
                                   I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W   31 WRITE(6,41) SYSCST                                           W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                   I
    41 FORMAT(1H0,8X,'*** SYSTEM CONSTRUCTION COST (MILLIONS) =',F10.2,'
      X***')
                                   I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE(6,15)                                                  W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                   I
                                   I
                                   I
                                   I
```

```
 15 FORMAT(//41X,23H*** SYSTEM MOBILITY ***/21X,30H---------- CORRIDOR
   XS ---------,10X,30H------ STATE FACILITIES ------/11X,2(10X,10HDO-
   XNOTHING,8X,12HIF CONSTRUCT)/9X,4HYEAR,5X,2(2(2X,3HMPH,5X,8HDVM(000
   X)),4X))

      DO 20 Y = 1,II,IEND

      IYRD = IYR+Y-1
      IF(CP26Y1(Y).EQ.0.0) CP26Y1(Y) = .0000001
      IF(CP26Y2(Y).EQ.0.0) CP26Y2(Y) = .0000001
      IF(WP21Y1(Y).EQ.0.0) WP21Y1(Y) = .0000001
      IF(WP22Y2(Y).EQ.0.0) WP22Y2(Y) = .0000001
      R6Y1 = CP16Y1(Y)/CP26Y1(Y)
      R6Y2 = CP16Y2(Y)/CP26Y2(Y)
      R1Y1 = WP11Y1(Y)/WP21Y1(Y)
      R2Y2= WP12Y2(Y)/WP22Y2(Y)
      DVM1 = CP26Y1(Y) / 1000.0
      DVM2 = CP26Y2(Y) / 1000.0
      DVM3 = WP21Y1(Y) / 1000.0
      DVM4 = WP22Y2(Y) / 1000.0

      WRITE(6,203) IYRD,R6Y1,DVM1,R6Y2,DVM2,R1Y1,DVM3,R2Y2,DVM4

 20 CONTINUE

      SEM=SVAL(6)/SVAL(7)
      SPV=SVAL(6)-SVAL(7)

 47 WRITE (6,43)

 43 FORMAT(//2X,'SYSTEM TOTALS'/)

      WRITE (6,79) (SVAL(I),I=2,5)

 79 FORMAT (8X,'DELAY SAVING ($000) =',23X,F12.1/8X,
   *'REDUCTION IN OPERATING COSTS ($000) =',7X,F12.1/8X,
   *'REDUCTION IN ACCIDENT COSTS ($000) =',8X,F12.1/8X,
   *'REDUCTION IN MAINTENANCE COSTS ($000) =',5X,F12.1)

      WRITE (6,598) SVAL(6),SVAL(7),SPV,SEM
```

```
                                             I
TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
T      STOP                                                                T
TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT


 C
 C     READ ERROR -- TERMINATE BATCH
 C

   440 FORMAT (/46H *** HARDWARE READ ERROR - BATCH CANCELLED ***/45H CON
      1SULT EDP COORDINATOR BEFORE RE-SUBMITTING)
                                            OK------------------------------------------------I---I---I---I---I---O   I
                                             I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W   615 WRITE (6,440)                                                      W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                             I
............................................................................
.      GOTO 610                                                             *------------I---I---I---I---I---I---A
............................................................................


 C
 C     PROBLEM INITIALIZATION
 C

                                            OK------------------------------------------------I---O
                                             I
............................................................................
.   620 IPROB = IPROB + 1                                                  .
.       IEND  = 1                                                          .
.       IFLAG = 0                                                          .
.       ISEG  = 0                                                          .
............................................................................
                                             I
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C      CALL INIT                                                           C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
                                             I
............................................................................
.      ASSUMP(1) = 11.00                                                   .
.      ASSUMP(2) =  0.17                                                   .
.      ASSUMP(3) =  0.32                                                   .
.      ASSUMP(4) =  0.00                                                   .
.      ASSUMP(5) =  0.00                                                   .
.      ASSUMP(6) =  8.00                                                   .
.      ASSUMP(7) = 25.00                                                   .
.      ASSUMP(8) = 15.00                                                   .
.      II=20                                                               .
............................................................................
                                             I
                                             I
                                             I
                                             I
                                             I
                                             I
```

```
I-------------------      DO 441 IC=1,5
I
I
I                   .      OCP(IC)=1.276
I
I
I
-------------------*   441 CONTINUE

   442 FORMAT (A2,3X,I4,6(1X,F4.0),2(1X,F2.0),1X,I2,1X,5A4,A3)

RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R      READ (CARD,442)          IPNO,IYR,TASSP,ISYR,PROTIT                  R
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR

WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,430) IPNO, PROTIT                                           W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW

RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R      READ(CARD,26)          (HLDTIT(IPROB,J),J=1,6)                       R
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR

    26 FORMAT(49X,5A4,A3)
   445 FORMAT (9X,22HPROBLEM CONTROL DATA -//9X,14HCURRENT YEAR -,I5/)

WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,445) IYR                                                    W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW

.      IF (IYR.GE.1970.AND.IYR.LE.2020) GOTO 625                    *-----------I---V

 C
 C     INVALID CURRENT YEAR
 C

   450 FORMAT (45H *** CURRENT YEAR OUTSIDE RANGE 1970-2020 ***)

WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,450)                                                        W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW

.      GOTO 595                                                     *-----------I---I---I---A
```

```
                     C
                     C     CHANGE ASSUMPTIONS IF NECESSARY AND DISPLAY
                     C

                       455 FORMAT (9X,13HASSUMPTIONS -/)

                                          OK----------------------------------------I---O
                                          I
                    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                    W  625 WRITE (6,455)                                                     W
                    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                          I
                       460 FORMAT (10X,I2,2H. ,7A4,2X,F7.2)
                                          I
                    ..........................................................................
I-------------------       DO 630 I = 1, 8                                                   .
I                   ..........................................................................
I                                         I
I                   ..........................................................................
I                   .      IF (TASSP(I).NE.0.0) ASSUMP(I) = TASSP(I)                         .
I                   ..........................................................................
I                                         I
I                   WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
I                   W      WRITE (6,460) I,(TIT(J,I),J=1,7),ASSUMP(I)                        W
I                   WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
I                                         I
I                   ..........................................................................
I                   .      IF (I.EQ.1.OR.I.EQ.4.OR.I.EQ.5.OR.I.EQ.6) ASSUMP(I)=ASSUMP(I)/100..
I                   ..........................................................................
I                                         I
I                   ..........................................................................
-------------------*   630 CONTINUE                                                          .
                    ..........................................................................
                                          I
                    ..........................................................................
                    .      IF (ISYR.NE.0) II=ISYR                                            .
                    ..........................................................................
                                          I
                    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                    W      WRITE (6,463) II                                                  W
                    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                          I
                       463 FORMAT (/9X,'PLANNING HORIZON - ',I2,' YEARS')
                                          I
                    ..........................................................................
                    .      IF (II.GT.0.AND.II.LE.40) GOTO 633                                *-----------I---V
                    ..........................................................................
                                          I
                     C
                     C     INVALID PLANNING HORIZON
                     C
                                          I
                    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                    W      WRITE (6,452)                                                     W
                    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                          I
```

```
   452 FORMAT (' *** PLANNING HORIZON NOT BETWEEN 1-40 YEARS ***')

.      GOTO 595                                                        *-----------I---I---I---A

                                                 OK-------------------------------------I---O

.  633 II=II+1
.      IF (II.GT.21) IEND=2

 C
 C     GET SEGMENT TRAFFIC DATA
 C

W      WRITE (6,430) IPNO,PROTIT                                       W

R      READ (5,400,END=645,ERR=615) CARD                               *-----------I-------I---V
R                                                                      *-----------I-------I---I---I---A

R      READ (CARD,405)          ICTYPE                                 R

.      IF (ICTYPE.EQ.2) GOTO 650                                       *-----------V

 C
 C     INVALID SEGMENT DATA CARD
 C

   465 FORMAT (/34H *** INVALID SEGMENT DATA CARD ***/)
                                                 OK-------------------------------------I---O

W  635 WRITE (6,465)                                                   W
W      WRITE (6,420) CARD                                              W

   470 FORMAT (/77H SEGMENT REJECTED. SCANNING FOR NEXT SEGMENT/PROBLEM.
      1FOLLOWING CARDS IGNORED/)
```

```
                                    OK----------------------------------------O   I   I   I   I   I   I   I
                                    I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W  640 WRITE (6,470)                                                      W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                    I
...........................................................................
.      ISFLAG = 1                                                         .
...........................................................................
                                    I
...........................................................................
.      IF (ICTYPE.EQ.1) GOTO 605                                          *-------I---I---I---I---I---A   I   I
...........................................................................
                                    I
...........................................................................
.      IFLAG=2                                                            .
...........................................................................
                                    I
...........................................................................
.      IF (ICTYPE.EQ.2) GOTO 650                                          *-------I---V   I   I   I   I   I   I
...........................................................................
                                    I
...........................................................................
.      GOTO 600                                                           *-------I---I---I---A   I   I   I   I
...........................................................................


 C
 C     END OF FILE
 C

   475 FORMAT (/42H *** PREMATURE END OF FILE ENCOUNTERED ***)
                                    OK----------------------------------------I---I---I-------O   I   I   I
                                    I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W  645 WRITE (6,475)                                                      W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                    I
...........................................................................
.      ISFLAG = 1                                                         .
...........................................................................
                                    I
...........................................................................
.      GOTO 610                                                           *-------I---I---I-------I---I---I---A
...........................................................................


 C
 C     PROCESS TRAFFIC DATA CARD

   480 FORMAT (2X,A2,1X,F5.0,2(1X,F5.0,1X,I4),1X,I1,2(1X,F3.0),1X,7A4,A1)
```

```
                                 OK
   650 ISEG = ISEG + 1
       ICTYPE=0
       ICKFLG = 0
       MIX=0

       DO 651 M1=1,5

       DO 651 M2=1,4

       TBLE(M1,M2)=0.

   651 CONTINUE

R      READ (CARD,480) ISEGNO,VOLUME(1),AVAR(1),IPYR(1),AVAR(2),IPYR(2),  R
R     *ISW,CINC,SEGTIT                                                     R

   485 FORMAT (1X,8H SEGMENT,2X,A2,9X,14HDESCRIPTION - ,7A4,A1/)

W      WRITE (6,485) ISEGNO,SEGTIT                                         W

   490 FORMAT (9X,27HTRAFFIC DATA - CURRENT YEAR,4X,I4,3X,14HVOLUME (1,00
      10),2X,F8.2/24X,15HPROJECTED YEAR1,I5,3X,14HVOLUME (1,000),2X,F8.2,
      */24X,'PROJECTED YEAR2 ',I4,3X,'VOLUME (1,000)',2X,F8.2)

W      WRITE (6,490) IYR,VOLUME(1),IPYR(1),AVAR(1),IPYR(2),AVAR(2)         W

.      IF (IPYR(1).GT.IYR.AND.IPYR(2).GT.IYR) GOTO 654

 C
 C     PROJECTED YEAR TOO SMALL
 C

   495 FORMAT (/46H *** PROJECTED YEAR LESS THAN CURRENT YEAR ***)

W      WRITE (6,495)                                                       W
```

```
      GOTO 640

C     CHECK IF PROJECTED VOLUMES INCREASING

  654 IF (IPYR(1).GT.IPYR(2).AND.AVAR(1).GT.AVAR(2)) GOTO 655
      IF (IPYR(2).GT.IPYR(1).AND.AVAR(2).GT.AVAR(1)) GOTO 655
      IF (AVAR(1).GT.VOLUME(1).AND.AVAR(2).GT.VOLUME(1)) GOTO 655
      WRITE (6,477)
  477 FORMAT (/' *** PROJECTED VOLUMES NOT INCREASING OVER TIME ***')
      GOTO 640
C
C     EXPAND TRAFFIC VOLUMES
C
  655 AVAR(1) = AVAR(1)*1000.
      AVAR(2)=AVAR(2)*1000.
      VOLUME(1) = VOLUME(1)*1000.
      I1 = IPYR(1) - IYR
      I2 = IPYR(2) - IYR
      IF (I1.LE.40.AND.I2.LE.40) GOTO 656
```

```
    498 FORMAT (/60H *** PROJECTED YEAR EXCEEDS 40 YEARS BEYOND CURRENT YE
       1AR ***)

W       WRITE(6,498)                                                       W

.       GOTO 640                                                           *--------A

                                   OK--------------------------------------I-------I---O

.   656 VOLUME(I1+1) = AVAR(1)                                             .
.       VOLUME(I2+1) = AVAR(2)                                             .
.       R1=I1                                                              .
.       R2=I2                                                              .
.       RT=R1/R2                                                           .

 C      CALCULATE PROJECTED VOLUMES

.       S=(ALOG(VOLUME(I1+1)-VOLUME(1))-ALOG(VOLUME(I2+1)-VOLUME(1)))      .
.      */ALOG(RT)                                                          .
.       S1=ALOG(VOLUME(I1+1)-VOLUME(1))-S*ALOG(R1)                         .

I--------------------   DO 688 I3=1,II                                    .
I
I
I
I       VOLUME(I3)=VOLUME(1)+EXP(S1)*(I3-1)**S                             .
I       PVOL(I3)=VOLUME(I3)*(1.3-.3*ASSUMP(1))                             .
I
I
--------------------*   688 CONTINUE                                       .

 C
 C      CHECK RUN TYPE - 1,2,3,OR 4
 C

.   690 IF (ISW.GE.1.AND.ISW.LE.4) GOTO 695                                *--------I-------I---V
```

```
                                           I
   512 FORMAT (/32H *** INVALID SEGMENT RUN TYPE - ,I1,4H ***)
                                           I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,512) ISW                                                     W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                           I
..............................................................................
.      GOTO 640                                                              *--------A
..............................................................................


   514 FORMAT (/9X,19HSEGMENT RUN TYPE - ,10A4)


                                           OK-------------------------------------------I--------I---O
                                           I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W  695 WRITE (6,514) (RUNTPE(J,ISW),J=1,10)                                  W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                           I
..............................................................................
.      EXSW   = 0.0                                                          .
.      ALTSW  = 0.0                                                          .
.      ITRIAL = 0                                                            .
.      ICYR   = 0                                                            .
.      IEYR   = 0                                                            .
.      NO3    = 1                                                            .
.      NO4    = 2                                                            .
..............................................................................
                                           I
 C
 C     HIGHWAY DATA INPUT LOOP - 'HIWAY' IS THE LOOP VARIABLE WHOSE
 C     VALUES ARE: 1=EXISTING, 2=PROPOSED, 3=EXPANDED, 4=ALTERNATE.
 C
 C     A NEW INPUT RECORD IS READ IN EACH PASS THROUGH THE LOOP.  THE
 C     DECISION TABLE BELOW SHOWS THE RELATIONS BETWEEN 'HIWAY' AND
 C     THE RECORD TYPE VARIABLE 'ICTYPE'.
 C
 C                        ICTYPE
 C                  1   2   3   4   5   6
 C                ************************      E=ERROR
 C              1 * E   E   O   E   E   E       O=OKAY
 C     HIWAY    2 * E   E   E   O   E   E       W=FALL OUT OF LOOP
 C              3 * W   W   E   E   O   S       S=ADD 1 TO HIWAY AND
 C              4 * W   W   E   E   E   O         PROCESS AS AN 'O'.
 C
                                           I
..............................................................................
I--------------------      DO 728 HWAY = 1, 4                                .
I          ..............................................................................
I                                          I
I          ..............................................................................
I          .      MYWAY = HWAY                                               .
I          .      HIWAY=HWAY                                                 .
I          ..............................................................................
I                                          I
I                                          I
```

```
1 2 3 4 5 6 7 8 9 0                                                                     . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1

RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R       READ (5,400,END=700,ERR=615) CARD                                    *--------I--------I---V
R                                                                            *--------I--------I---I---I---I---A
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
                                     I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R       READ (CARD,405)          ICTYPE                                    R
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
                                     I
..........................................................................
.       IF (ICTYPE.EQ.HIWAY+2) GOTO 706                                      *--------I---V
..........................................................................
                                     I
..........................................................................
.       IF (HIWAY.GE.3.AND.(ICTYPE.LE.2.AND.ICTYPE.GT.0)) GOTO 730           *---V
..........................................................................
                                     I
..........................................................................
.       IF (HIWAY.EQ.3.AND.ICTYPE.EQ.6) GOTO 705                             *-V I
..........................................................................
                                     I
..........................................................................
.       GOTO 635                                                             *-I-I---I---I---A
..........................................................................


 C
 C      END OF FILE
 C

                                     OK-----------------------------------------I-I---I---I---I---O
                                     I
..........................................................................
.  700 IF (HIWAY.LE.2) GOTO 645                                              *-I-I---I---I---I-------A
..........................................................................
                                     I
..........................................................................
.       IFLAG=IFLAG+3                                                      .
..........................................................................
                                     I
..........................................................................
.       GOTO 730                                                             *-I-V
..........................................................................


 C
 C      SPECIAL CASE 'S' FROM DECISION TABLE
 C

1 2 3 4 5 6 7 8 9 0                                                                     . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
1 2 3 4 5 6 7 8 9 0                                  PAGE 17                                  . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
                                                       OK-----------------------------------O
                                                       I
 .....................................................................
 .   705 HIWAY=HIWAY+1                                               .
 .       MYWAY = MYWAY + 1                                           .
 .....................................................................
                                                       I
 C
 C       NORMAL CASE 'O' FROM DECISION TABLE
 C
                                                       I
                                                       OK-----------------------------------I---I---O
                                                       I
 .....................................................................
 .   706 IX=HIWAY                                                    .
 .....................................................................
                                                       I
     810 FORMAT(T6,A1)
     516 FORMAT (T6,A4)
     518 FORMAT (T11,F4.0)
     520 FORMAT (T16,F5.0,1X,F5.0)
     524 FORMAT (T28,F2.0)
     526 FORMAT (T31,I4)
     528 FORMAT (T36,F5.0)
     530 FORMAT (T42,F1.0)
                                                       I
 RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
 R       READ (CARD,516)          HDAT(IX)                              R
 RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
                                                       I
 .....................................................................
 I------------------     DO 710 J = 1, 58                            .
 .....................................................................
                                                       I
 .....................................................................
 .       IF (HDAT(IX).EQ.HT(J)) GOTO 820                             *---I---I-------I-------V
 .....................................................................
                                                       I
 .....................................................................
 ------------------*   710 CONTINUE                                  .
 .....................................................................
                                                       I
     532 FORMAT (/28H *** INVALID HIGHWAY TYPE - ,A4,4H ***)
                                                       I
 WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
 W       WRITE (6,532) HDAT(IX)                                         W
 WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                                       I
 .....................................................................
 .       GOTO 640                                                    *---I---A
 .....................................................................

1 2 3 4 5 6 7 8 9 0                                                                           . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
                               OK
                               I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R  820 READ(CARD,810)          ICKTYP                                  R
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
                               I
.......................................................................
.      IF(ICKFLG.NE.0) GO TO 815                                        *
.......................................................................
                               I
.......................................................................
.      ICKHLD = ICKTYP                                                 .
.      ICKFLG = 1                                                      .
.......................................................................
                               I
.......................................................................
.      GO TO 712                                                        *
.......................................................................

                               OK
                               I
.......................................................................
.  815 IF(ICKTYP.EQ.ICKHLD) GO TO 712                                    *
.......................................................................
                               I
.......................................................................
.      MIX=1                                                           .
.......................................................................
                               I
 C
 C     HIGHWAY TYPE OKAY - GET REMAINDER OF DATA
 C
                               I
   534 FORMAT (/9X,2A4,A2,'HIGHWAY DATA - HIGHWAY TYPE',4X,A4)
                               I
                               OK
                               I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W  712 WRITE (6,534) (TIT(I2,9+MYWAY),I2=1,3),HDAT(IX)                 W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                               I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R  714 READ (CARD,518)          HDATA(IX,1)                            R
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
                               I
   536 FORMAT (34X,8HLENGTH  ,F7.2,6H MILES)
                               I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,536) HDATA(IX,1)                                       W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                               I
```

```
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R  716 READ (CARD,520)           HDATA(IX,2),HDATA(IX,3)                  R
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
                                  I
   538 FORMAT (34X,35HSAFETY/TECHNICAL FACTORS (BASE=100),2(2X,F8.2))
                                  I
...........................................................................
.       IF(HDATA(IX,3).LE.100.0) GO TO 901                                  *
...........................................................................
                                  I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W       WRITE(6,902)                                                      W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                  I
   902 FORMAT(/44H *** TECHNICAL FACTOR GREATER THAN 100.0 ***)
                                  I
...........................................................................
.       GO TO 640                                                           *
...........................................................................

                                  OK
                                  I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W  901 WRITE (6,538) HDATA(IX,2),HDATA(IX,3)                              W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                  I
...........................................................................
.       HDATA(IX,2)=HDATA(IX,2)/100.                                      .
.       HDATA(IX,3)=HDATA(IX,3)/100.                                      .
...........................................................................
                                  I
...........................................................................
.       IF ((J.GT.4.AND.J.LT.15).OR.(J.GT.16.AND.J.LT.39).OR.J.GT.42)       *
.      *GOTO 718                                                          .
...........................................................................
                                  I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R       READ (CARD,524)          HDATA(IX,4)                              R
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
                                  I
   540 FORMAT (34X,13HSPEED LIMIT  ,F3.0,4H MPH)
                                  I
...........................................................................
.       IF (HDATA(IX,4).GT.0.) GOTO 721                                     *
...........................................................................
                                  I
...........................................................................
.       IF (J.EQ.3.OR.J.EQ.4.OR.J.EQ.16) GOTO 713                           *
...........................................................................
                                  I
```

```
1 2 3 4 5 6 7 8 9 0                   PAGE 20                              . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
                                         I
           ..........................................................
           .      HDATA(IX,4)=30.                                   .
           ..........................................................
                                         I
           ..........................................................
           .      GOTO 721                                          *---I---I---I---I---V
           ..........................................................

                                         OK-----------------------------I---I---O
                                         I
           ..........................................................
           .  713 HDATA(IX,4)=55.                                   .
           ..........................................................
                                         I
                                         OK-----------------------------I---I-------I---O
                                         I
           WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
           W  721 WRITE (6,540) HDATA(IX,4)                        W
           WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                         I
                                         OK-----------------------------I---I-------I-------O
                                         I
           ..........................................................
           .  718 IF (HIWAY.NE.2) GOTO 722                          *---I---I-------I-------V
           ..........................................................
                                         I
           ..........................................................
           .      IF (ISW.EQ.2.OR.ISW.EQ.3) GOTO 720                *---I---I-------I---V
           ..........................................................
                                         I
           RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
           R      READ (CARD,526)          ICYR                    R
           RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
                                         I
              542 FORMAT (34X,5A4,I4)
                                         I
           WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
           W  900 WRITE (6,542) TI2,ICYR                           W
           WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                         I
           ..........................................................
           .      IF(ICYR.GE.IYR.AND.ICYR.LT.IYR+II) GO TO  720     *---I---I-------I---V
           ..........................................................
                                         I
              544 FORMAT (/21H *** INVALID YEAR ***)
                                         I
                                         OK-----------------------------I---I---O
                                         I
           WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
           W  719 WRITE (6,544)                                    W
           WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                         I
                                         I
                                         I
                                         I
1 2 3 4 5 6 7 8 9 0                                                    . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
.      GOTO 640

                                OK

RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R  720 READ (CARD,528)          COST1                                      R
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR

.      IF(COST1.GT.0.0) GO TO 33

WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE(6,34)                                                         W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW

    34 FORMAT(/69H *** CONSTRUCTION COST MUST BE A POSITIVE VALUE GREATER
      X THAN ZERO ***)

.      GO TO 640

   546 FORMAT (34X,31HCONSTRUCTION COST (MILLIONS)  $,F6.2)

                                OK

WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W   33 WRITE (6,546) COST1                                                 W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW

.      SYSCST = SYSCST + COST1                                             .

RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R      READ (CARD,530)          EXSW                                       R
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR

.      IF (EXSW.EQ.0.0) GOTO 727

.      IF (EXSW.LE.3.) GOTO 723
```

```
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,545)                                                       W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                   I
   545 FORMAT (/' *** EXISTING, ALTERNATE BUILDOVER SWITCH MUST BE',
      *' BETWEEN 0 AND 3 ***')
                                   I
.............................................................................
.      GOTO 640                                                            *-I-I---A
.............................................................................

                                   OK-----------------------------------O
                                   I
.............................................................................
.  723 IF (EXSW-2.) 731,732,733                                            *-V
.                                                                          *-I-I-V
.............................................................................
                                   I
.............................................................................
.  731 IF (EXSW.EQ.0.) GOTO 734                                            *-I-I-I-I-V
.............................................................................
                                   I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,560)                                                       W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                   I
   560 FORMAT (34X,'BUILDOVER OF EXISTING ROUTE')
                                   I
.............................................................................
.      GOTO 734                                                            *-I-I-I-I-V
.............................................................................

                                   OK-----------------------------------O
                                   I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W  732 WRITE (6,561)                                                       W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                   I
   561 FORMAT (34X,'BUILDOVER OF ALTERNATE ROUTE')
                                   I
.............................................................................
.      GOTO 734                                                            *---I-I-I-V
.............................................................................

                                   OK-------------------------------------I-O
                                   I
                                   I
                                   I
                                   I
                                   I
```

```
1 2 3 4 5 6 7 8 9 0                         PAGE 23                              . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1

WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W  733 WRITE (6,562)                                                      W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                     I
   562 FORMAT (34X,'BUILDOVER OF EXISTING AND ALTERNATE ROUTES')
                                     I
                                     OK---------------------------------------I---I-O
                                     I
..........................................................................
.  734 GOTO 727                                                           *---I---I---I---I---V
..........................................................................

                                     OK---------------------------------------I---I---I---I---I---O
                                     I
..........................................................................
.  722 IF (HIWAY.NE.3) GOTO 726                                           *---I---I---I---I---I---V
..........................................................................
                                     I
..........................................................................
.       IF (ISW.GT.1) GOTO 724                                            *-V
..........................................................................
                                     I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R       READ (CARD,526)          IEYR                                     R
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
                                     I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W       WRITE (6,542) TI3,IEYR                                            W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                     I
..........................................................................
.       IF(IEYR.LT.ICYR.OR.IEYR.GE.IYR+II) GO TO 719                      *-I-I---I---A
..........................................................................
                                     I
                                     OK------------------------------------O
                                     I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R  724 READ (CARD,528)          COST2                                     R
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
                                     I
   548 FORMAT (34X,28HEXPANSION COST (MILLIONS)  $,F6.2)
                                     I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W   36 WRITE (6,548) COST2                                                W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                     I
..........................................................................
.       SYSCST = SYSCST + COST2                                           .
..........................................................................
                                     I
                                     I
                                     I
1 2 3 4 5 6 7 8 9 0                                                        . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R      READ (CARD,530) PRSW                                              R
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
                                    I
..........................................................................
.      IF (PRSW.EQ.0.) GOTO 715                                          *---I---I---V
..........................................................................
                                    I
..........................................................................
.      IF (PRSW.EQ.1.) GOTO 725                                          *-V
..........................................................................
                                    I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,569)                                                     W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                    I
   569 FORMAT (' *** PROPOSED BUILDOVER SWITCH MUST BE 0 OR 1 ***')
                                    I
..........................................................................
.      GOTO 640                                                          *-I-I---A
..........................................................................



                                    OK-----------------------------------O
                                    I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W  725 WRITE (6,570)                                                     W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                    I
   570 FORMAT (34X,'PROPOSED HIGHWAY NOT BUILTOVER WITH EXPANSION')
                                    I
..........................................................................
.      IF (ICYR.EQ.IEYR) GOTO 729                                        *-V
..........................................................................
                                    I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,571)                                                     W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                    I
   571 FORMAT (' *** CONST. YEAR MUST EQUAL EXPAN. YEAR IF PROPOSED ',
      *'HIGHWAY NOT BUILTOVER ***')
                                    I
..........................................................................
.      GOTO 640                                                          *-I-I---A
..........................................................................



                                    OK-----------------------------------O
                                    I
..........................................................................
.  729 IF (ISW.NE.3.OR.ISW.NE.4) GOTO 715                                *---I---I---V
..........................................................................
                                    I
                                    I
                                    I
```

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WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,572)                                                     W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW

   572 FORMAT (' *** EXPANSION YEAR CANNOT BE OPTIMIZED WHEN PROPOSED ',
      *'HIGHWAY IS NOT BUILTOVER ***')

.      GOTO 640                                                           *---I---A

                                    OK----------------------------------------I---I---O

.  715 IF(COST2.GE.0.0) GO TO 726                                         *---I---I-------I---I---V

WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE(6,35)                                                       W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW

    35 FORMAT(/66H *** EXPANSION COST MUST BE A POSITIVE VALUE GREATER TH
      XAN ZERO ***)

.      GO TO 640                                                          *---I---A

                                    OK----------------------------------------I---I-------I---I---O

.  726 IF (HIWAY.EQ.4.) ALTSW=1.0                                        .

                                    OK----------------------------------------I---I-------I---O

RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R  727 READ (CARD,563) (ASMSEG(IX,J),J=1,3),BYPS(IX),PBYPS(IX)           R
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR

   563 FORMAT (T44,3(F4.0,1X),F1.0,1X,F4.0)

.      IF (ASMSEG(IX,1).EQ.0.) ASMSEG(IX,1)=ASSUMP(1)*100.               .

WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,564) ASMSEG(IX,1)                                        W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
```

```
564 FORMAT (34X,'PERCENT TRUCKS(BUSES)',T61,F5.2)

      ASMSEG(IX,1)=ASMSEG(IX,1)/100.
      IF (ASMSEG(IX,2).EQ.0.) ASMSEG(IX,2)=1.3

      WRITE(6,565) ASMSEG(IX,2)

565 FORMAT (34X,'CAR(VAN) OCCUPANCY RATE',T61,F5.2)

      IF (ASMSEG(IX,3).EQ.0.) ASMSEG(IX,3)=1.

      WRITE (6,566) ASMSEG(IX,3)

566 FORMAT (34X,'TRUCK(BUS) OCCUPANCY RATE',T61,F5.2)

      IF (BYPS(IX).EQ.0.) GOTO 735

      WRITE(6,567) PBYPS(IX)

567 FORMAT (34X,'HOV BYPASS OF ',F4.2,' PERCENT VEHICLES')

      PBYPS(IX)=PBYPS(IX)/100.

  OK

735 OCP(IX)=ASMSEG(IX,1)*ASMSEG(IX,3)+(1.-ASMSEG(IX,1))*ASMSEG(IX,2)

      IF (HIWAY.GT.3) GOTO 730

728 CONTINUE
```

```
                                         OK--------------------------------------O
  730 IF (ICYR.NE.0) ICYR = ICYR-IYR+1
      IF (IEYR.NE.0) IEYR = IEYR-IYR+1
      COST1=COST1*1.0E+6
      COST2=COST2*1.0E+6
C     SET DIVERTED ASSUMPTIONS
      ASMSEG(5,1)=ASSUMP(1)
      ASMSEG(5,2)=1.3
      ASMSEG(5,3)=1.
      OCP(5)=ASMSEG(5,1)*ASMSEG(5,3)+(1.-ASMSEG(5,1))*ASMSEG(5,2)
C     SET BUILD OVER EXISTING ROAD SWITCH
I---------------------
      DO 40 HIWAY=1,4
      TSPD=HDATA(HIWAY,4)
C     ASSIGN INDEX BY ROAD  TYPE AND  SPEED
      IF (HDAT(HIWAY).EQ.HT(2).AND.HDATA(HIWAY,4).LE.30.)
     1   HDATA(HIWAY,4)=25.
      IF (HDAT(HIWAY).EQ.HT(2).AND.HDATA(HIWAY,4).GT.30.)
     1   HDATA(HIWAY,4)=35.
      IF (HDAT(HIWAY).EQ.HT(1).AND.HDATA(HIWAY,4).LE.30.)
     1   HDATA(HIWAY,4)=25.
      IF (HDAT(HIWAY).EQ.HT(1).AND.HDATA(HIWAY,4).GT.30.)
     1   HDATA(HIWAY,4)=35.
      IF (HDAT(HIWAY).EQ.HT(3).AND.HDATA(HIWAY,4).LE.50.)
     1   HDATA(HIWAY,4)=40.
      IF (HDAT(HIWAY).EQ.HT(3).AND.HDATA(HIWAY,4).GT.50.)
     1   HDATA(HIWAY,4)=55.
      IF (HDAT(HIWAY).EQ.HT(4).AND.HDATA(HIWAY,4).LE.50.)
     1   HDATA(HIWAY,4)=40.
      IF (HDAT(HIWAY).EQ.HT(4).AND.HDATA(HIWAY,4).GT.50.)
     1   HDATA(HIWAY,4)=55.
      IF (HDAT(HIWAY).EQ.HT(16).AND.HDATA(HIWAY,4).LE.50.)
     1   HDATA(HIWAY,4)=40.
      IF (HDAT(HIWAY).EQ.HT(16).AND.HDATA(HIWAY,4).GT.50.)
     1   HDATA(HIWAY,4)=55.
      IF (HDAT(HIWAY).EQ.HT(15).AND.HDATA(HIWAY,4).LE.30.)
     1   HDATA(HIWAY,4)=25.
      IF (HDAT(HIWAY).EQ.HT(15).AND.HDATA(HIWAY,4).GT.30.)
     1   HDATA(HIWAY,4)=35.
      IF (HDAT(HIWAY).EQ.HT(39).AND.HDATA(HIWAY,4).LE.30.)
     *   HDATA(HIWAY,4)=25.
      IF (HDAT(HIWAY).EQ.HT(39).AND.HDATA(HIWAY,4).GT.30.)
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     *   HDATA(HIWAY,4)=35.
      IF (HDAT(HIWAY).EQ.HT(40).AND.HDATA(HIWAY,4).LE.30.)
     *   HDATA(HIWAY,4)=25.
      IF (HDAT(HIWAY).EQ.HT(40).AND.HDATA(HIWAY,4).GT.30.)
     *   HDATA(HIWAY,4)=35.
      IF (HDAT(HIWAY).EQ.HT(41).AND.HDATA(HIWAY,4).LE.30.)
     *   HDATA(HIWAY,4)=25.
      IF (HDAT(HIWAY).EQ.HT(41).AND.HDATA(HIWAY,4).GT.30.)
     *   HDATA(HIWAY,4)=35.
      IF (HDAT(HIWAY).EQ.HT(42).AND.HDATA(HIWAY,4).LE.30.)
     *   HDATA(HIWAY,4)=25.
      IF (HDAT(HIWAY).EQ.HT(42).AND.HDATA(HIWAY,4).GT.30.)
     *   HDATA(HIWAY,4)=35.

C     SET INDEX BY ROAD TYPE AND SPEED

   39 IF (HDAT(HIWAY).EQ.HT(2).AND.HDATA(HIWAY,4).EQ.25.) HSW(HIWAY)=3.
      IF (HDAT(HIWAY).EQ.HT(2).AND.HDATA(HIWAY,4).EQ.35.) HSW(HIWAY)=4.
      IF (HDAT(HIWAY).EQ.HT(1).AND.HDATA(HIWAY,4).EQ.25.) HSW(HIWAY)=5.
      IF (HDAT(HIWAY).EQ.HT(1).AND.HDATA(HIWAY,4).EQ.35.) HSW(HIWAY)=6.
      IF (HDAT(HIWAY).EQ.HT(3).AND.HDATA(HIWAY,4).EQ.40.) HSW(HIWAY)=7.
      IF (HDAT(HIWAY).EQ.HT(3).AND.HDATA(HIWAY,4).EQ.55.) HSW(HIWAY)=8.
      IF (HDAT(HIWAY).EQ.HT(4).AND.HDATA(HIWAY,4).EQ.40.) HSW(HIWAY)=9.
      IF (HDAT(HIWAY).EQ.HT(4).AND.HDATA(HIWAY,4).EQ.55.) HSW(HIWAY)=10.
      IF (HDAT(HIWAY).EQ.HT(5)) HSW(HIWAY)=11.
      IF (HDAT(HIWAY).EQ.HT(7)) HSW(HIWAY)=12.
      IF (HDAT(HIWAY).EQ.HT(6)) HSW(HIWAY)=13.
      IF (HDAT(HIWAY).EQ.HT(8)) HSW(HIWAY)=14.
      IF (HDAT(HIWAY).EQ.HT(9)) HSW(HIWAY)=15.
      IF (HDAT(HIWAY).EQ.HT(10)) HSW(HIWAY)=16.
      IF (HDAT(HIWAY).EQ.HT(11)) HSW(HIWAY)=17.
      IF (HDAT(HIWAY).EQ.HT(12)) HSW(HIWAY)=18.
      IF (HDAT(HIWAY).EQ.HT(16).AND.HDATA(HIWAY,4).EQ.40.)
     1   HSW(HIWAY)=19.
      IF (HDAT(HIWAY).EQ.HT(16).AND.HDATA(HIWAY,4).EQ.55.)
     1   HSW(HIWAY)=20.
      IF (HDAT(HIWAY).EQ.HT(17)) HSW(HIWAY)=21.
      IF (HDAT(HIWAY).EQ.HT(18)) HSW(HIWAY)=22.
      IF (HDAT(HIWAY).EQ.HT(15).AND.HDATA(HIWAY,4).EQ.25.)
     1   HSW(HIWAY)=23.
      IF (HDAT(HIWAY).EQ.HT(15).AND.HDATA(HIWAY,4).EQ.35.)
     1   HSW(HIWAY)=24.
      IF (HDAT(HIWAY).EQ.HT(13)) HSW(HIWAY)=25.
      IF (HDAT(HIWAY).EQ.HT(14)) HSW(HIWAY)=26.
      IF (HDAT(HIWAY).EQ.HT(21)) HSW(HIWAY)=27.
      IF (HDAT(HIWAY).EQ.HT(22)) HSW(HIWAY)=28.
      IF (HDAT(HIWAY).EQ.HT(19)) HSW(HIWAY)=29.
      IF (HDAT(HIWAY).EQ.HT(20)) HSW(HIWAY)=30.
      IF (HDAT(HIWAY).EQ.HT(23)) HSW(HIWAY)=31.
      IF (HDAT(HIWAY).EQ.HT(24)) HSW(HIWAY)=32.
      IF (HDAT(HIWAY).EQ.HT(25)) HSW(HIWAY)=33.
      IF (HDAT(HIWAY).EQ.HT(26)) HSW(HIWAY)=34.
      IF (HDAT(HIWAY).EQ.HT(27)) HSW(HIWAY)=35.
      IF (HDAT(HIWAY).EQ.HT(28)) HSW(HIWAY)=36.
      IF (HDAT(HIWAY).EQ.HT(29)) HSW(HIWAY)=37.
      IF (HDAT(HIWAY).EQ.HT(30)) HSW(HIWAY)=38.
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      IF (HDAT(HIWAY).EQ.HT(31)) HSW(HIWAY)=39.
      IF (HDAT(HIWAY).EQ.HT(32)) HSW(HIWAY)=40.
      IF (HDAT(HIWAY).EQ.HT(33)) HSW(HIWAY)=41.
      IF (HDAT(HIWAY).EQ.HT(34)) HSW(HIWAY)=42.
      IF (HDAT(HIWAY).EQ.HT(35)) HSW(HIWAY)=43.
      IF (HDAT(HIWAY).EQ.HT(36)) HSW(HIWAY)=44.
      IF (HDAT(HIWAY).EQ.HT(37)) HSW(HIWAY)=45.
      IF (HDAT(HIWAY).EQ.HT(38)) HSW(HIWAY)=46.
      IF (HDAT(HIWAY).EQ.HT(39).AND.HDATA(HIWAY,4).EQ.25.)HSW(HIWAY)=49.
      IF (HDAT(HIWAY).EQ.HT(39).AND.HDATA(HIWAY,4).EQ.35.)HSW(HIWAY)=47.
      IF (HDAT(HIWAY).EQ.HT(40).AND.HDATA(HIWAY,4).EQ.25.)HSW(HIWAY)=50.
      IF (HDAT(HIWAY).EQ.HT(40).AND.HDATA(HIWAY,4).EQ.35.)HSW(HIWAY)=48.
      IF (HDAT(HIWAY).EQ.HT(41).AND.HDATA(HIWAY,4).EQ.25.)HSW(HIWAY)=51.
      IF (HDAT(HIWAY).EQ.HT(41).AND.HDATA(HIWAY,4).EQ.35.)HSW(HIWAY)=52.
      IF (HDAT(HIWAY).EQ.HT(42).AND.HDATA(HIWAY,4).EQ.25.)HSW(HIWAY)=53.
      IF (HDAT(HIWAY).EQ.HT(42).AND.HDATA(HIWAY,4).EQ.35.)HSW(HIWAY)=54.
      IF (HDAT(HIWAY).EQ.HT(43)) HSW(HIWAY)=55.
      IF (HDAT(HIWAY).EQ.HT(44)) HSW(HIWAY)=56.
      IF (HDAT(HIWAY).EQ.HT(45)) HSW(HIWAY)=57.
      IF (HDAT(HIWAY).EQ.HT(46)) HSW(HIWAY)=58.
      IF (HDAT(HIWAY).EQ.HT(47)) HSW(HIWAY)=59.
      IF (HDAT(HIWAY).EQ.HT(48)) HSW(HIWAY)=60.
      IF (HDAT(HIWAY).EQ.HT(49)) HSW(HIWAY)=61.
      IF (HDAT(HIWAY).EQ.HT(50)) HSW(HIWAY)=62.
      IF (HDAT(HIWAY).EQ.HT(51)) HSW(HIWAY)=63.
      IF (HDAT(HIWAY).EQ.HT(52)) HSW(HIWAY)=64.
      IF (HDAT(HIWAY).EQ.HT(53)) HSW(HIWAY)=65.
      IF (HDAT(HIWAY).EQ.HT(54)) HSW(HIWAY)=66.
      IF (HDAT(HIWAY).EQ.HT(55)) HSW(HIWAY)=67.
      IF (HDAT(HIWAY).EQ.HT(56)) HSW(HIWAY)=68.
      IF (HDAT(HIWAY).EQ.HT(57)) HSW(HIWAY)=69.
      IF (HDAT(HIWAY).EQ.HT(58)) HSW(HIWAY)=70.

C     SET SPEED PARAMETERS FOR HIGHWAY TYPES

      INM=HSW(HIWAY)

      IF (INM.LT.1) GOTO 40

      IF (INM.GE.7.AND.INM.LE.10.OR.INM.EQ.19.OR.INM.EQ.20) GOTO 738

      IF (INM.GE.3.AND.INM.LE.6.OR.INM.GE.23.AND.INM.LE.24.OR.
     *INM.GE.47.AND.INM.LE.54) GOTO 739
```

```
      TBLE(3,HIWAY)=TABLE(3,INM)
      TBLE(4,HIWAY)=TABLE(4,INM)
      TBLE(5,HIWAY)=TABLE(5,INM)

      GOTO 737

OK

  738 TBLE(3,HIWAY)=-3.68+1.067*TSPD
      TBLE(4,HIWAY)=5.54+0.641*TSPD
      TBLE(5,HIWAY)=19.85+0.201*TSPD

      IF (TSPD.GE.40.) GOTO 737

      TBLE(4,HIWAY)=0.8*TBLE(3,HIWAY)
      TBLE(5,HIWAY)=0.9*TBLE(4,HIWAY)

      GOTO 737

OK

  739 TBLE(3,HIWAY)=TSPD-3.
      TBLE(4,HIWAY)=-3.58+0.916*TSPD
      TBLE(5,HIWAY)=11.4+0.212*TSPD
      IF (TSPD.LT.25.) TBLE(5,HIWAY)=0.9*TBLE(4,HIWAY)
C
C     SET SEGMENT HOV ASSUMPTIONS IF NECESSARY
C

OK

  737 IF ((HSW(HIWAY).GE.29..AND.HSW(HIWAY).LE.33.).OR.HSW(HIWAY).EQ.38.
     *.OR.HSW(HIWAY).EQ.39..OR.HSW(HIWAY).GE.64.) GOTO 736
```

```
      IF (BYPS(HIWAY).EQ.0.) GOTO 736

      WRITE (6,568)

  568 FORMAT (' *** HOV BYPASS MUST BE SPECIFIED WITH A METERED FREEWAY'
     *,' HIGHWAY TYPE')

      GOTO 640

  736 IF (HSW(HIWAY).LT.42..OR.HSW(HIWAY).GT.50.) GOTO 167

      IF (CINC(1).EQ.0.) CINC(1)=.446
      IF (CINC(2).EQ.0.) CINC(2)=.064

  167 IF (HIWAY.NE.2) GOTO 166

C     STORE PROPOSED PARAMETERS IN CASE OF RERUN

      STORE(1)=HDATA(2,1)
      STORE(2)=HDATA(2,2)
      STORE(3)=HDATA(2,3)
      STORE(4)=HDATA(2,4)
      STORE(5)=HSW(2)
      STORE(6)=ASMSEG(2,1)
      STORE(7)=ASMSEG(2,2)
      STORE(8)=ASMSEG(2,3)
      STORE(9)=BYPS(2)
      STORE(10)=PBYPS(2)

  166 IF (HIWAY.NE.3) GOTO 40
```

```
C      STORE EXPANSION PARAMETERS IN CASE OF RERUN

       EXSTOR(1)=HDATA(3,1)
       EXSTOR(2)=HDATA(3,2)
       EXSTOR(3)=HDATA(3,3)
       EXSTOR(4)=HDATA(3,4)
       EXSTOR(5)=HSW(3)
       EXSTOR(6)=ASMSEG(3,1)
       EXSTOR(7)=ASMSEG(3,2)
       EXSTOR(8)=ASMSEG(3,3)
       EXSTOR(9)=BYPS(3)
       EXSTOR(10)=PBYPS(3)

C       SET SWITCHES FOR DIVERSION:URBAN=1,RURAL=2

       IF (HSW(2).GE.3.AND.HSW(2).LE.6.OR.HSW(2).EQ.12.
      X OR.HSW(2).EQ.14.OR.HSW(2).EQ.16.OR.HSW(2).GE.23.AND.HSW(2).
      X LT.35.OR.HSW(2).GT.35.AND.HSW(2).LT.40.OR.HSW(2).GE.42) HSW(5)=1
       IF (HSW(2).GE.7.AND.HSW(2).LT.12.OR.HSW(2).EQ.13.
      X OR.HSW(2).EQ.15.OR.HSW(2).GE.17.AND.HSW(2).LT.23.OR.HSW(2).EQ.35.
      X OR.HSW(2).GE.40.AND.HSW(2).LT.42) HSW(5)=2

                                      OK

   40 CONTINUE

C      WRITE OUT INCONVENIENCE COST ASSUMPTIONS

       IF (CINC(1).EQ.0.) GOTO 115

WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,551)                                                     W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW

  551 FORMAT(/9X,'SEGMENT HOV ASSUMPTIONS -')

WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,552) CINC                                                W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW

  552 FORMAT(13X,'INCONVENIENCE COST ($/MILE) - BUS',10X,F5.3/T44,
     *'CARPOOL/VAN',2X,F5.3)

       IF (CINC(1).GE.0..AND.CINC(2).GE.0.) GOTO 168
```

```
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,553)                                                      W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW

   553 FORMAT(' *** INCONVENIENCE COST MUST BE POSITIVE ***')

.      GOTO 640                                                             *-------A

                                    OK---------------------------------------------I---O

.  168 CONTINUE

 C     CHECK IF ODD-LANE TYPE BEING USED WITH HOV

.      IDUM=0

I--------------------         DO 169 IX=1,4
I
I
I
I      IF (HSW(IX).GT.41..AND.HSW(IX).LT.51.) IDUM=1
I
I
I
--------------------*  169 CONTINUE

.      IF (IDUM.EQ.1) GOTO 115                                              *---------------I-------V

WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,573)                                                      W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW

   573 FORMAT (/' *** WARNING - ODD LANE HIGHWAY TYPE BEING USED WITHOUT'
      *,' HOV HIGHWAY TYPE ***')

 C     CHECK IF MIX OF URBAN AND RURAL HIGHWAY TYPES
                                    OK---------------------------------------------I-------O

.  115 IF (MIX.EQ.0) GOTO 116                                               *---------------I-------V
```

```
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W      WRITE (6,574)                                                      W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW

   574 FORMAT (/' *** WARNING - SEGMENT CONTAINS RURAL AND URBAN ',
      *'HIGHWAY TYPES ***')

 C      CONSTRUCTION OR NO - 1=DO-NOTHING,2=CONSTRUCT
 C      CHECK FOR OPTIMUM PATH
 C      CALC VALUES FOR EACH HIGHWAY TYPE
 C      IF OPTIMUM ONLY CALCULATE DEMAND FOR DO-NOTHING
                                      OK-------------------------------------O

.  116 IF (ISW.GT.1) NO4=1                                                   .

CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C      CALL CRDMND                                                         C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC

 C      REGULAR PATH

I--------------------        DO 70 L=1,2                                  .
I
I      C      CHECK FOR OPTIMUM ROUTINE
I
I      .      IF (L.GT.1.AND.ISW.GT.1) GOTO 61                            *--------V
I
I      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
I      C      CALL CALC03                                                 C
I      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
I
--------------------*    70 CONTINUE                                      .

.      GOTO 80                                                            *----V

 C      CHECK FOR TYPE OF OPTIMUM:2=CONSTRUCTION3=CONSTRUCTION+EXPAND,
 C      4 ONLY EXPAND
 C      WHEN ITRIAL=1,DIFFS WILL CALC FOR EACH HIGHWAY TYPE & ACCUM
```

130

```
      61 ITRIAL=1
C     OPTIMUM CONSTRUCTION AND/OR EXPANSION
C     SET MAXIMUM CONSTRUCTION TO PLANNING HORIZON
         ICYR4=II
         ICYR3=II
         IF (ICYR.NE.0) ICYR4=1
         IF (ICYR4.GT.22) ICYR4=22
         IF (ICYR3.GT.27) ICYR3=27
C        CALL EXPAND
C     SAVE BEST CONSTRUCTION YEAR
     119 ICYR=ICYR2
         IEYR=IEYR2
         IF (IEYR.EQ.ICYR.AND.EXSTOR(5).EQ.0.) IEYR=0
C     RECALCULATE BEST VALUES
C     CLEAR ARRAYS WHERE TRIAL & ERROR RESULTS HAD BEEN STORED
C     ITRIAL IS SET TO ZERO SO DIFFS WILL BE CALC ON EQUATED VALUES
      94 ITRIAL=0
         DO 96 Y=1,II
         DO 96 I2=1,8
         TPVAL(I2)=0.
         IF (I2.GT.6) GOTO 96
```

```
1 2 3 4 5 6 7 8 9 0                                PAGE 36                              . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
I I                                                   I                                                 I   I   I   I   I   I
I I                                                                                                     I   I   I   I   I   I
I I                 .......................................................................            I   I   I   I   I   I
I I                 .      DIFF(I2,Y)=0.                                                   .            I   I   I   I   I   I
I I                 .      PVAL(I2,Y)=0.                                                   .            I   I   I   I   I   I
I I                 .      DMAND(I2,Y,2)=0.                                                .            I   I   I   I   I   I
I I                 .      DEMAND(I2,Y,2)=0.                                               .            I   I   I   I   I   I
I I                 .......................................................................            I   I   I   I   I   I
I I                                                   I                                                 I   I   I   I   I   I
I I                                                   OK-----------------------------------------------I---I---O   I   I   I
I I                                                   I                                                 I   I       I   I   I
I I                 .......................................................................            I   I       I   I   I
-------------------*    96 CONTINUE                                                        .            I   I       I   I   I
                    .......................................................................            I   I       I   I   I
                                                      I                                                 I   I       I   I   I
                   CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC            I   I       I   I   I
                   C       CALL CRDMND                                                     C            I   I       I   I   I
                   C       CALL CALCO3                                                     C            I   I       I   I   I
                   CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC            I   I       I   I   I
                                                      I                                                 I   I       I   I   I
                    .......................................................................            I   I       I   I   I
                    .      IF (IEYR.NE.0) X1=(COST2*(1.+ASSUMP(5))**(IEYR-1)*(1./         .            I   I       I   I   I
                    .     1(1.+ASSUMP(6))**(IEYR-1)))                                      .            I   I       I   I   I
                    .      IF (IEYR.EQ.0.OR.PRS.EQ.1) X1=0.                                .            I   I       I   I   I
                    .      ECOST=X1*((1.+ASSUMP(6))**(IEYR-1))                             .            I   I       I   I   I
                    .      CCOST=COST1*(1.+ASSUMP(5))**(ICYR-1)                            .            I   I       I   I   I
                    .      ADJCON(1)=CCOST*(1./((1.+ASSUMP(6))                             .            I   I       I   I   I
                    .     1**(ICYR-1)))+X1                                                 .            I   I       I   I   I
                    .......................................................................            I   I       I   I   I
                                                      I                                                 I   I       I   I   I
                                                      OK-----------------------------------------------I---O       I   I   I
                                                      I                                                 I           I   I   I
                    .......................................................................            I           I   I   I
                    .   80 X1=6.                                                           .            I           I   I   I
                    .      NO1=1                                                           .            I           I   I   I
                    .      NO2=5                                                           .            I           I   I   I
                    .......................................................................            I           I   I   I
                                                      I                                                 I           I   I   I
                    C      CALCULATE DIFFERENCES BETWEEN DO-NOTHING AND CONSTRUCT                       I           I   I   I
                                                      I                                                 I           I   I   I
                   CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC            I           I   I   I
                   C       CALL TOTAL                                                      C            I           I   I   I
                   C       CALL DIFFER                                                     C            I           I   I   I
                   CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC            I           I   I   I
                                                      I                                                 I           I   I   I
                      203 FORMAT (9X,I4,2(4X,2(2X,F5.1,2X,F9.1)))                                       I           I   I   I
                      211 FORMAT   (/48X,16H*** MOBILITY ***/21X,30H---------- CORRIDOR ----           I           I   I   I
                         1------,10X,30H------- STATE FACILITY -------/11X,2(10X,10HDO-NOTHI           I           I   I   I
                         2NG,8X,12HIF CONSTRUCT)/9X,4HYEAR,5X,2(2(2X,3HMPH,5X,8HDVM(000)),4X           I           I   I   I
                         X))                                                                            I           I   I   I
                                                      I                                                 I           I   I   I
                    .......................................................................            I           I   I   I
I-------------------       DO 105 L=1,2                                                    .            I           I   I   I
I                   .......................................................................            I           I   I   I
I                                                     I                                                 I           I   I   I
I                                                     I                                                 I           I   I   I
I                                                     I                                                 I           I   I   I
I                                                     I                                                 I           I   I   I
I                                                     I                                                 I           I   I   I
1 2 3 4 5 6 7 8 9 0                                                                     . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
I I------------------        DO 105 Y=1,II
I I
I I                          VOL(Y,L)=DMAND(1,Y,L)+DMAND(2,Y,L)+DMAND(3,Y,L)+DMAND(4,Y,L)+
I I                         *DMAND(5,Y,L)
I I
--------------------*    105 CONTINUE

I-------------------         DO 107 M=1,2
I
I    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
I    W      WRITE (6,430) IPNO,PROTIT                                           W
I    W      WRITE (6,485) ISEGNO,SEGTIT                                         W
I    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
I
I    .      IF (M.GT.1) GOTO 108                                    *---------------I-------V
I
I    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
I    W      WRITE (6,204)                                                       W
I    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
I
I      204 FORMAT (/43X,'*** DO-NOTHING CORRIDOR TRAFFIC ALLOCATION ***')
I
I    .      GOTO 109                                                *---------------I---V   I
I                                                                                   I   I   I
I                                       OK------------------------------------------I---I---O
I                                       I
I    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
I    W  108 WRITE (6,212)                                                       W
I    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
I
I      212 FORMAT(/42X,'*** IF-CONSTRUCT CORRIDOR TRAFFIC ALLOCATION ***')
I                                       I
I                                       OK------------------------------------------I---O
I                                       I
I    .  109 TMAX=AMAX1(VOL(II,1),VOL(II,2))
I    .      MAX=TMAX/1000.+1.
I    .      RAX=MAX
I    .      ADD=SQRT(RAX)/12.
I
```

```
      DO 660 IB=1,13
      INC(IB)=(ADD*(IB-1))**2+.5
  660 CONTINUE
      WRITE (6,504) INC
  504 FORMAT (//3X,'YEAR',51X,'VEHICLES (1,000)',37X,
     *'(SQUARE-ROOT SCALE)'/13(6X,I4)/13(9X,'I')/8X,123('-'))
      DO 661 Y=1,II,IEND
      YR=IYR+Y-1
      DO 662 LZ=1,121
      LINE(LZ)=KBLANK
  662 CONTINUE
      DO 667 LX=1,6
      IF (LX.EQ.6) GOTO 663
      K=SQRT(DMAND(LX,Y,M)/1000.)*(1210./(120.5*ADD))+1.
      GOTO 664
```

```
1 2 3 4 5 6 7 8 9 0                                    PAGE 39                     . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1

                                          OK--------------------------------------------I---I---O
                                          I
   .....................................................................
   .  663 K=SQRT(VOL(Y,M)/1000.)*(1210./(120.5*ADD))+1.                .
   .....................................................................
                                          I
                                          OK--------------------------------------------I---O
                                          I
   .....................................................................
   .  664 IF (LINE(K).EQ.KBLANK) GOTO 665                              *----------------I-------V
   .....................................................................
                                          I
   .....................................................................
   .      LINE(K)=KAST                                                 .
   .....................................................................
                                          I
   .....................................................................
   .      GOTO 667                                                     *----------------I---V
   .....................................................................

                                          OK--------------------------------------------I---I---O
                                          I
   .....................................................................
   .  665 IF (K.LT.2) GOTO 667                                         *----------------I---V
   .....................................................................
                                          I
   .....................................................................
   .      LINE(K)=KLTR(LX)                                             .
   .....................................................................
                                          I
                                          OK--------------------------------------------I---O
                                          I
   .....................................................................
------------------*   667 CONTINUE                                     .
   .....................................................................
                                          I
   WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
   W  666 WRITE (6,502) YR,LINE                                        W
   WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                          I
      502 FORMAT (3X,I4,1X,'I',121A1)
                                          I
   .....................................................................
------------------*   661 CONTINUE                                     .
   .....................................................................
                                          I
   WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
   W      WRITE (6,208)                                                W
   WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                          I
                                          I
                                          I
                                          I
                                          I
1 2 3 4 5 6 7 8 9 0                                                        . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
I                                                  I                                                     I          I   I   I
I                     208 FORMAT (11X,'* INDICATES MULTIPLE LETTERS AT SAME POINT',                      I          I   I   I
I                        *//3X,'YEAR',6X,'EXISTING (E)',8X,'ALTERNATE (A)',                               I          I   I   I
I                        *7X,'PROPOSED (P)',8X,'EXPANSION (X)',7X,'DIVERTED (D)',                         I          I   I   I
I                        *10X,'TOTAL (T)')                                                                I          I   I   I
I                                                  I                                                     I          I   I   I
I                  WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW          I          I   I   I
I                  W       WRITE (6,209)                                                      W          I          I   I   I
I                  WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW          I          I   I   I
I                                                  I                                                     I          I   I   I
I                     209 FORMAT (11X,6('VEHICLES  PERSONS',3X))                                          I          I   I   I
I                                                  I                                                     I          I   I   I
I                  ..............................................................................        I          I   I   I
I I------------------         DO 103 Y=1,II,IEND                                              .          I          I   I   I
I I                ..............................................................................        I          I   I   I
I I                                                I                                                     I          I   I   I
I I                ..............................................................................        I          I   I   I
I I                .       IYRD=IYR+Y-1                                                       .          I          I   I   I
I I                ..............................................................................        I          I   I   I
I I                                                I                                                     I          I   I   I
I I                WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW          I          I   I   I
I I                W       WRITE (6,210) IYRD,DMAND(1,Y,M),DEMAND(1,Y,M),DMAND(4,Y,M),        W          I          I   I   I
I I                W      *DEMAND(4,Y,M),DMAND(2,Y,M),DEMAND(2,Y,M),DMAND(3,Y,M),             W          I          I   I   I
I I                W      *DEMAND(3,Y,M),DMAND(5,Y,M),DEMAND(5,Y,M),VOL(Y,M),PVOL(Y)          W          I          I   I   I
I I                WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW          I          I   I   I
I I                                                I                                                     I          I   I   I
I I                   210 FORMAT (3X,I4,1X,6(2X,F9.0,F9.0))                                               I          I   I   I
I I                                                I                                                     I          I   I   I
I I                ..............................................................................        I          I   I   I
I ------------------*   103 CONTINUE                                                          .          I          I   I   I
I                  ..............................................................................        I          I   I   I
I                                                  I                                                     I          I   I   I
I                  ..............................................................................        I          I   I   I
--------------------*   107 CONTINUE                                                          .          I          I   I   I
                   ..............................................................................        I          I   I   I
                                                   I                                                     I          I   I   I
                   WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW          I          I   I   I
                   W       WRITE (6,430) IPNO,PROTIT                                          W          I          I   I   I
                   W       WRITE (6,485) ISEGNO,SEGTIT                                        W          I          I   I   I
                   WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW          I          I   I   I
                                                   I                                                     I          I   I   I
                      224 FORMAT (9X,4A4,A1,I6,2A4,A2)                                                   I          I   I   I
                                                   I                                                     I          I   I   I
                   WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW          I          I   I   I
                   W       WRITE(6,224) TI1,IYR                                               W          I          I   I   I
                   WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW          I          I   I   I
                                                   I                                                     I          I   I   I
                   ..............................................................................        I          I   I   I
                   .       ICYRD=ICYR+IYR-1                                                   .          I          I   I   I
                   .       IEYRD=IEYR+IYR-1                                                   .          I          I   I   I
                   ..............................................................................        I          I   I   I
                                                   I                                                     I          I   I   I
                   ..............................................................................        I          I   I   I
                   .       IF (ISW.EQ.1) GOTO 139                                             *----------I-------V  I   I   I
                   ..............................................................................        I       I  I   I   I
                                                   I                                                     I       I  I   I   I
                                                   I                                                     I       I  I   I   I
                                                   I                                                     I       I  I   I   I
```

```
W      IF (ICYR.LT.22.OR.ISW.EQ.4) WRITE(6,224) TI2,ICYRD                W
W      IF (ICYR.EQ.22.AND.ISW.NE.4) WRITE(6,224) TI2,ICYRD,TI4           W

.      IF (IEYR.EQ.27) GO TO 133

.      GOTO 141

                                  OK

W  133 WRITE(6,224) TI3,IEYRD,TI4                                        W

.      GOTO 134

                                  OK

W  139 WRITE(6,224) TI2,ICYRD                                            W

                                  OK

W  141 IF (IEYR.NE.0) WRITE(6,224) TI3,IEYRD                             W

                                  OK

.  134 TMIN=0.                                                           .
.      TMAX=0.                                                           .

       DO 240 Y=1,II                                                     .

.      IF (PVAL(2,Y).LT.TMIN) TMIN=PVAL(2,Y)                             .
.      IF (PVAL(6,Y).LT.TMIN) TMIN=PVAL(6,Y)                             .
.      IF (PVAL(2,Y).GT.TMAX) TMAX=PVAL(2,Y)                             .
.      IF (PVAL(6,Y).GT.TMAX) TMAX=PVAL(6,Y)                             .
```

```
      240 CONTINUE

          MIN=TMIN
          IF (TMIN.LT.0) MIN=MIN-1
          MAX=TMAX
          IF (TMAX.GT.0) MAX=MAX+1
          ADD=(MAX-MIN)/12.

          IF (ADD.EQ.0.) GOTO 549

          DO 241 IB=1,13

          INC(IB)=MIN+ADD*(IB-1)+.5

      241 CONTINUE

      550 FORMAT (46X,'*** SEGMENT DISCOUNTED YEARLY BENEFITS ***'/)

      OK

      549 WRITE (6,550)

          IF (ADD.EQ.0.) GOTO 246

          WRITE (6,599) INC

      599 FORMAT (/3X,'YEAR',36X,'DISCOUNTED DELAY SAVINGS(S) AND TOTAL ',
         *'BENEFITS(B) ($1,000)'/13(3X,I7)/13(9X,'I')/8X,
         *123('-'))

          DO 242 Y=1,II,IEND
```

```
      YR=IYR+Y-1

      DO 243 LZ=1,121

      LINE(LZ)=KBLANK

  243 CONTINUE

      DO 244 LX=1,2

      LY=4*LX-2
      K=(PVAL(LY,Y)-MIN)*(1210./(120.5*ADD))+1.

      IF (LINE(K).EQ.KBLANK) GOTO 245

      LINE(K)=KAST

      GOTO 244

                                   OK

  245 LINE(K)=KLTR(LX+6)

                                   OK

  244 CONTINUE

WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W     WRITE (6,502) YR,LINE                                            W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
```

```
  242 CONTINUE
                                   OK
  246 IX=X1
      TPVAL(7)=ADJCON(IX)/1000.
      RATIO=TPVAL(6)/TPVAL(7)
      PV=TPVAL(6)-TPVAL(7)
      IRR=0
      ICT=0
      R=ASSUMP(6)
      CCOST=CCOST/1000.
      ECOST=ECOST/1000.
                                   OK
  143 P=0.
      P1=0.

      DO 140 Y=1,II

      DIS=DIFF(6,Y)/((1.+R)**Y)
      P=P+DIS*(1.+R)
      P1=P1-DIS*(Y-1)

  140 CONTINUE

      P=P-CCOST/((1.+R)**(ICYR-1))-ECOST/((1.+R)**(IEYR-1))
      P1=P1+CCOST*(ICYR-1)/((1.+R)**ICYR)+ECOST*(IEYR-1)/((1.+R)**IEYR)
      RA=ABS(P/P1)

      IF (RA.LT.0.0001) GOTO 144

      R=R-P/P1
```

```
      IF (R.LE.-1..OR.R.GT.100.) GOTO 142
      ICT=ICT+1
      IF (ICT.GT.50) GOTO 142
      GOTO 143
 142  IRR=1
 144  R=R*100.
      DO 42 I2 = 1,8
      SVAL(I2) = SVAL(I2) +TPVAL(I2)
  42  CONTINUE
 201  FORMAT (3X,'YEAR',9X,'HOURS OF DELAY',5X,'DELAY SAVINGS',6X,
     1'REDUCTION IN',7X,2('REDUCTION IN',7X),'TOTAL YEARLY'/
     218X,'SAVING PER',6X,'(S) IN DOLLARS',5X,'OPERATING COSTS',4X,
     *'ACCIDENT COSTS',4X,'MAINTENANCE COSTS',4X,'BENEFITS (B)'/17X,
     *'YEAR (1000)',10X,5('($1000)',12X))
      WRITE (6,201)
```

```
1 2 3 4 5 6 7 8 9 0                                                        . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
                                           I
I--------------------      DO 102 Y=1,II,IEND
I
I                                          I
I
I                          IYRD=IYR+Y-1
I
I                                          I
I     WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
I     W                    WRITE (6,200) IYRD,(PVAL(I,Y),I=1,6)                                    W
I     WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
I                                          I
I
--------------------*  102 CONTINUE

                                           I
                   200 FORMAT (3X,I4,6(7X,F12.1))
                                           I
      WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
      W                    WRITE (6,205) (TPVAL(I),I=1,6)                                          W
      WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                           I
                   205 FORMAT (2X,'TOTAL',6(7X,F12.1))
                                           I
      WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
      W                    WRITE (6,430) IPNO,PROTIT                                               W
      W                    WRITE (6,485) ISEGNO,SEGTIT                                             W
      W                    WRITE (6,211)                                                           W
      WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                           I

I--------------------      DO 111 Y=1,II,IEND
I
I                                          I
I
I                          IF(WP2(6,Y,1).EQ.0) WP2(6,Y,1) = .0000001
I                          IF(WP2(6,Y,2).EQ.0) WP2(6,Y,2) = .0000001
I                          IYRD=IYR+Y-1
I                          R5Y1=WSPCP1(6,Y,1)/WSPCP2(6,Y,1)
I                          R5Y2=WSPCP1(6,Y,2)/WSPCP2(6,Y,2)
I                          R1Y1 = WP1(6,Y,1)/WP2(6,Y,1)
I                          R2Y2 = WP1(6,Y,2)/WP2(6,Y,2)
I                          DVM1 = WSPCP2(6,Y,1) / 1000.0
I                          DVM2 = WSPCP2(6,Y,2) / 1000.0
I                          DVM3 = WP2(6,Y,1) / 1000.0
I                          DVM4 = WP2(6,Y,2) / 1000.0
I
I                                          I
I     WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
I     W                    WRITE(6,203) IYRD,R5Y1,DVM1,R5Y2,DVM2,R1Y1,DVM3,R2Y2,DVM4               W
I     WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
I                                          I
I                                          I
I                                          I
I                                          I
I                                          I
I                                          I
1 2 3 4 5 6 7 8 9 0                                                        . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
1 2 3 4 5 6 7 8 9 0                              PAGE 47                              . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
I                                                   I                                               I            I   I   I
I      .........................................................................                   I            I   I   I
-------------------*  111 CONTINUE                                              .                   I            I   I   I
       .........................................................................                   I            I   I   I
                                                    I                                               I            I   I   I
       WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                  I            I   I   I
       W      WRITE (6,591)                                                    W                   I            I   I   I
       WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                  I            I   I   I
                                                    I                                               I            I   I   I
          591 FORMAT (//2X,'SEGMENT TOTALS'/)                                                       I            I   I   I
                                                    I                                               I            I   I   I
       WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                  I            I   I   I
       W      WRITE (6,598) TPVAL(6),TPVAL(7),PV,RATIO                         W                   I            I   I   I
       WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                  I            I   I   I
                                                    I                                               I            I   I   I
          598 FORMAT (8X,'PRESENT VALUE OF BENEFITS ($000) =',10X,F12.1/8X,                         I            I   I   I
             *'PRESENT VALUE OF CONSTRUCTION COST ($000) =',1X,F12.1/8X,                            I            I   I   I
             *'NET PRESENT VALUE ($000) =',18X,F12.1/8X,'BENEFIT/COST RATIO ='                      I            I   I   I
             *,26X,F10.2)                                                                           I            I   I   I
                                                    I                                               I            I   I   I
       WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                  I            I   I   I
       W      WRITE (6,592)                                                    W                   I            I   I   I
       WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                  I            I   I   I
                                                    I                                               I            I   I   I
          592 FORMAT (8X,'INTERNAL RATE OF RETURN (%) =')                                           I            I   I   I
                                                    I                                               I            I   I   I
       .........................................................................                   I            I   I   I
       .      IF (IRR.EQ.0) GOTO 597                                           *--------------------I-------V    I   I   I
       .........................................................................                   I       I    I   I   I
                                                    I                                               I       I    I   I   I
       WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                  I       I    I   I   I
       W      WRITE (6,596)                                                    W                   I       I    I   I   I
       WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                  I       I    I   I   I
                                                    I                                               I       I    I   I   I
          596 FORMAT ('+',T48,'NO SOLUTION FOUND')                                                  I       I    I   I   I
                                                    I                                               I       I    I   I   I
       .........................................................................                   I       I    I   I   I
       .      GOTO 593                                                         *--------------------I---V   I    I   I   I
       .........................................................................                   I   I   I    I   I   I
                                                                                                    I   I   I    I   I   I
                                                    OK----------------------------------------------I---I---O    I   I   I
                                                    I                                               I   I        I   I   I
       WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                  I   I        I   I   I
       W  597 WRITE (6,594) R                                                  W                   I   I        I   I   I
       WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                  I   I        I   I   I
                                                    I                                               I   I        I   I   I
          594 FORMAT ('+',T55,F10.2)                                                                I   I        I   I   I
                                                    I                                               I   I        I   I   I
                                                    OK----------------------------------------------I---O        I   I   I
                                                    I                                               I            I   I   I
       .........................................................................                   I            I   I   I
       .  593 CONTINUE                                                         .                   I            I   I   I
       .........................................................................                   I            I   I   I
                                                    I                                               I            I   I   I
                                                    I                                               I            I   I   I
1 2 3 4 5 6 7 8 9 0                                 I                              . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
C     ADD TO GRAND TOTALS

  125 X1=7.
      NO1=6
      NO2=6

CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     CALL TOTAL                                                        C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC

C     CLEAR ARRAYS

      ECOST=0.
      CCOST=0.

      DO 130 J1=1,8

      TPVAL(J1)=0.

      DO 130 J2=1,II

      IF (J1.GT.6) GOTO 130

      PVAL(J1,J2)=0.

  130 CONTINUE

      ADJCON(6)=0.

      DO 132 Y=1,II
```

```
      DO 132 J2=1,2

      WP1(6,Y,J2) = 0.
      WP2(6,Y,J2) = 0.
      DMAND(6,Y,J2)=0.
      WSPCP1(6,Y,J2)=0.
      WSPCP2(6,Y,J2)=0.
      ACCNUM(6,Y,J2)=0.
      ACCICO(6,Y,J2)=0.
      XMAINT(6,Y,J2)=0.
      CYCLE(6,Y,J2)=0.
      DMAND(5,Y,J2)=0.
      DMAND(4,Y,J2)=0.
      DMAND(3,Y,J2)=0.
      DMAND(2,Y,J2)=0.
      DMAND(1,Y,J2)=0.
      DEMAND(1,Y,J2)=0.
      DEMAND(2,Y,J2)=0.
      DEMAND(3,Y,J2)=0.
      DEMAND(4,Y,J2)=0.
      DEMAND(5,Y,J2)=0.

      DO 132 J3=1,2

      XTIME(6,Y,J2,J3)=0.
      XVTIME(6,Y,J2,J3)=0.
      OCOST(6,Y,J2,J3)=0.

  132 CONTINUE

      ALL(1)=0.
      ALL(2)=0.
      ALL(3)=0.
      ALL(4)=0.
      COST1=0.
      COST2=0.
      EXSTOR(5)=0.

      DO 136 J2=1,5
```

```
1 2 3 4 5 6 7 8 9 0                                PAGE 50                                   . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
I                                                      I                                                  I             I   I   I
I                    .................................................................................   I             I   I   I
I                    .      IF (J2.GT.4) GOTO 131                                                    *---------------I-------V   I   I   I
I                    .................................................................................   I       I     I   I   I
I                                                      I                                                  I       I     I   I   I
I                    .................................................................................   I       I     I   I   I
I                    .      HDAT(J2)=BLANKS                                                          .   I       I     I   I   I
I                    .................................................................................   I       I     I   I   I
I                                                      I                                                  I       I     I   I   I
I                                                      OK-------------------------------------------------I-------O     I   I   I
I                                                      I                                                  I             I   I   I
I                    .................................................................................   I             I   I   I
I                    .  131 HSW(J2) =0.                                                              .   I             I   I   I
I                    .................................................................................   I             I   I   I
I                                                      I                                                  I             I   I   I
I                    .................................................................................   I             I   I   I
I I------------------       DO 136 J3=1,5                                                            .   I             I   I   I
I I                  .................................................................................   I             I   I   I
I I                                                    I                                                  I             I   I   I
I I                  .................................................................................   I             I   I   I
I I                  .      HDATA(J2,J3)=0.                                                          .   I             I   I   I
I I                  .................................................................................   I             I   I   I
I I                                                    I                                                  I             I   I   I
I I                  .................................................................................   I             I   I   I
--------------------*   136 CONTINUE                                                                 .   I             I   I   I
                     .................................................................................   I             I   I   I
                                                       I                                                  I             I   I   I
                     .................................................................................   I             I   I   I
                     .  100 CONTINUE                                                                 .   I             I   I   I
                     .................................................................................   I             I   I   I
                                                       I                                                  I             I   I   I
                      C                                                                                   I             I   I   I
                      C     END OF SEGMENT                                                                I             I   I   I
                      C                                                                                   I             I   I   I
                                                       I                                                  I             I   I   I
                                                       OK-------------------------------------------------I-------O     I   I   I
                                                       I                                                  I       I     I   I   I
                     .................................................................................   I       I     I   I   I
                     .  746 IF (IFLAG.GT.3) GOTO 610                                                 *---------------I-------I---I---I---A
                     .................................................................................   I       I     I   I   I
                                                       I                                                  I       I     I   I   I
                     .................................................................................   I       I     I   I   I
                     .      IF (IFLAG.EQ.3) GOTO 754                                                 *---------------I---V   I     I   I   I
                     .................................................................................   I   I   I     I   I   I
                                                       I                                                  I   I   I     I   I   I
                                                       OK-------------------------------------------O     I   I   I     I   I   I
                                                       I                                            I     I   I   I     I   I   I
                     .................................................................................   I   I   I     I   I   I
                     .  748 IF (ICTYPE.NE.1) GOTO 750                                                *-------V   I   I   I   I     I   I   I
                     .................................................................................   I   I   I   I   I     I   I   I
                                                       I                                          I   I   I   I   I     I   I   I
                     .................................................................................   I   I   I   I   I     I   I   I
                     .      IF (IFLAG.EQ.0) GOTO 754                                                 *-------I---I---I---V   I     I   I   I
                     .................................................................................   I   I   I   I   I     I   I   I
                                                       I                                          I   I   I   I   I     I   I   I
                                                       I                                          I   I   I   I   I     I   I   I
                                                       I                                          I   I   I   I   I     I   I   I
                                                       I                                          I   I   I   I   I     I   I   I
1 2 3 4 5 6 7 8 9 0                                                                          . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
.      GOTO 605                                                         *-------I---I---I---I---I---A   I   I
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

                                  OK------------------------------------O   I   I   I   I   I   I   I
                                   I
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
.  750 IF (ICTYPE.EQ.2) GOTO 605                                        *-----------I---I---I---I---A   I   I
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
                                   I
 C
 C     GET NEXT RECORD
 C
                                   I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R  751 READ (5,400,END=752,ERR=615) CARD                               *-------V
R                                                                       *-------I---I---I---I---I---I---A   I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
                                   I
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
R      READ (CARD,405)           ICTYPE                               R
RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
                                   I
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
.      IF (ICTYPE.EQ.1.OR.ICTYPE.EQ.2) GOTO 748                         *-------I---A   I   I   I   I       I
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
                                   I
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
.      GOTO 635                                                         *-------I-------A   I   I   I       I
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

 C
 C     END OF FILE

                                  OK------------------------------------O           I   I   I       I
                                   I
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
.  752 IFLAG=IFLAG+3                                                    .
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
                                   I
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
.      GOTO 746                                                         *-------------------I---A   I       I
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

 C
 C     DISPLAY TOTALS
 C
```

```
1 2 3 4 5 6 7 8 9 0                                   PAGE 52                                     . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
                                                         OK-----------------------------------------------------O       I        I
                                                         I                                                               I        I
                     CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC                          I        I
                     C  754 CALL DIFFER                                                        C                          I        I
                     CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC                          I        I
                                                         I                                                               I        I
                     ..........................................................................                          I        I
                     .      IX=X1                                                             .                          I        I
                     .      TPVAL(7)=ADJCON(IX)/1000.                                          .                          I        I
                     .      RATIO=TPVAL(6)/TPVAL(7)                                           .                          I        I
                     .      PV=TPVAL(6)-TPVAL(7)                                              .                          I        I
                     ..........................................................................                          I        I
                                                         I                                                               I        I
                     WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                          I        I
                     W      WRITE (6,430) IPNO,PROTIT                                         W                          I        I
                     WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                          I        I
                                                         I                                                               I        I
                        555 FORMAT (43X,'**** PROBLEM DISCOUNTED YEARLY BENEFITS ****')                                   I        I
                                                         I                                                               I        I
                     WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                          I        I
                     W  122 WRITE (6,555)                                                     W                          I        I
                     W      WRITE (6,201)                                                     W                          I        I
                     WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                          I        I
                                                         I                                                               I        I
                     ..........................................................................                          I        I
I--------------------       DO 106 Y=1,II,IEND                                                .                          I        I
I                    ..........................................................................                          I        I
I                                                        I                                                               I        I
I                    ..........................................................................                          I        I
I                    .      IYRD=IYR+Y-1                                                      .                          I        I
I                    ..........................................................................                          I        I
I                                                        I                                                               I        I
I                    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                          I        I
I                    W      WRITE (6,200) IYRD,(PVAL(I,Y),I=1,6)                              W                          I        I
I                    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                          I        I
I                                                        I                                                               I        I
I                    ..........................................................................                          I        I
--------------------*   106 CONTINUE                                                          .                          I        I
                     ..........................................................................                          I        I
                                                         I                                                               I        I
                     WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                          I        I
                     W      WRITE (6,205) (TPVAL(I),I=1,6)                                    W                          I        I
                     W      WRITE (6,211)                                                     W                          I        I
                     WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                          I        I
                                                         I                                                               I        I
                     ..........................................................................                          I        I
I--------------------       DO 117 Y=1,II,IEND                                                .                          I        I
I                    ..........................................................................                          I        I
I                                                        I                                                               I        I
I                    ..........................................................................                          I        I
I                    .      IYRD=IYR+Y-1                                                      .                          I        I
I                    .      R6Y1=WSPCP1(7,Y,1)/WSPCP2(7,Y,1)                                  .                          I        I
I                    .      R6Y2=WSPCP1(7,Y,2)/WSPCP2(7,Y,2)                                  .                          I        I
I                    .      R1Y1=WP1(7,Y,1)/WP2(7,Y,1)                                        .                          I        I
I                    .      R2Y2=WP1(7,Y,2)/WP2(7,Y,2)                                        .                          I        I
I                    .      DVM1 = WSPCP2(7,Y,1) / 1000.0                                     .                          I        I
I                    .      DVM2 = WSPCP2(7,Y,2) / 1000.0                                     .                          I        I
I                    .      DVM3 = WP2(7,Y,1) / 1000.0                                        .                          I        I
1 2 3 4 5 6 7 8 9 0                                                                           . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
1 2 3 4 5 6 7 8 9 0                                                              . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
I                   .      DVM4 = WP2(7,Y,2) / 1000.0                      .                      I     I
I                   ...........................................................                   I     I
I                                         I                                                       I     I
I                   WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                   I     I
I                   W      WRITE(6,203) IYRD,R6Y1,DVM1,R6Y2,DVM2,R1Y1,DVM3,R2Y2,DVM4      W       I     I
I                   WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                   I     I
I                                         I                                                       I     I
I                   ...........................................................                   I     I
--------------------*   117 CONTINUE                                       .                      I     I
                    ...........................................................                   I     I
                                          I                                                       I     I
                    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                   I     I
                    W      WRITE (6,299)                                   W                      I     I
                    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                   I     I
                                          I                                                       I     I
                       299 FORMAT (/2X,'PROBLEM TOTALS')                                          I     I
                                          I                                                       I     I
                    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                   I     I
                    W      WRITE (6,598) TPVAL(6),TPVAL(7),PV,RATIO        W                      I     I
                    WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW                   I     I
                                          I                                                       I     I
                    ...........................................................                   I     I
I--------------------   221 DO 10 I = 1,II                                 .                      I     I
I                   ...........................................................                   I     I
I                                         I                                                       I     I
I                   ...........................................................                   I     I
I                   .      CP16Y1(I) = CP16Y1(I) + WSPCP1(7,I,1)           .                      I     I
I                   .      CP26Y1(I) = CP26Y1(I) + WSPCP2(7,I,1)           .                      I     I
I                   .      CP16Y2(I) = CP16Y2(I) + WSPCP1(7,I,2)           .                      I     I
I                   .      CP26Y2(I) = CP26Y2(I) + WSPCP2(7,I,2)           .                      I     I
I                   .      WP11Y1(I) = WP11Y1(I) + WP1(7,I,1)              .                      I     I
I                   .      WP21Y1(I) = WP21Y1(I) + WP2(7,I,1)              .                      I     I
I                   .      WP12Y2(I) = WP12Y2(I) + WP1(7,I,2)              .                      I     I
I                   .      WP22Y2(I) = WP22Y2(I) + WP2(7,I,2)              .                      I     I
I                   ...........................................................                   I     I
I                                         I                                                       I     I
I                   ...........................................................                   I     I
--------------------*    10 CONTINUE                                       .                      I     I
                    ...........................................................                   I     I
                                          I                                                       I     I
                    ...........................................................                   I     I
                    .      IF (IFLAG.EQ.3) GOTO 610                        *----------------------I-----A
                    ...........................................................                   I
                                          I                                                       I
                    ...........................................................                   I
                    .      GOTO 605                                        *----------------------A
                    ...........................................................

                    ...........................................................
                    .      END                                             .
                    ...........................................................
```

```
FORTCHT, VERSION A1     MAINTAINED BY DALE L. SCHAFER,    PHONE 845-1714
 E=ENTRY, T=TERMINAL, C=CALL, R=READ, W=WRITE

                        EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
                        E      SUBROUTINE EXPAND                                                   E
                        EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
                                                             I
                               COMMON /LABA/ASSUMP(9),TABLE(11,70),HDATA(5,5),VOLUME(41),
                              1DMAND(7,41,2),XMAINT(7,41,2),SPEED(7,41,2),CYCLE(7,41,2),
                              2XSPEED(7,41,2,2),XTIME(7,41,2,2),OCOST(7,41,2,2),DIFF(6,41),
                              3PVAL(6,41),ADJCON(7),ALL(4),ACCNUM(7,41,2),ACCICO(7,41,2),
                              4STORE(10),WSPCP1(7,41,2),WSPCP2(7,41,2),TPVAL(8),ICYR3,ICYR4,
                              5XVTIME(7,41,2,2),XMN,SP,WSP1,WSP2,CY,XV(2),XT(2),XSP(2)
                               COMMON/LABB/OCP(5),PVOL(41),IHW(5,41,2),PRS,INDX,AC(4),TPR(4),
                              6XVT(2),XRN(2),XCY(2),OC(2),HSW(5),ACCNO,ACCOST,COST1,
                              7COST2,X1,ITRIAL,Y,NO1,NO2,NO3,NO4,EXSW,ALTSW,ANS,IASW,TAC(4),
                              8ISW,ICYR,ICYR2,IEYR2,IEYR,X,L1,L,EXSTOR(10),CCOST,ECOST,TBLE(5,4),
                                                             I
                        WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                        W     9WP1(7,41,2),WP2(7,41,2),RATIO,RATIO2,II,CINC(2),ASMSEG(5,3),        W
                        W     *BYPS(4),PBYPS(4),PRSW,IN(5),CAP(4),VOL(41,2),DEMAND(6,41,2)         W
                        WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                                             I
                               INTEGER Y
                                                             I
                         C     TRY  DIFFERENT EXPANSION YEARS
                                                             I
                        ............................................................................
I-----------------------       DO 100 ICYR1=1,ICYR4                                                .
I                       ............................................................................
I                                                            I
I                       ............................................................................
I                       .      IF (ISW.EQ.2) ICYR3=ICYR1                                           .
I                       ............................................................................
I                                                            I
I                       ............................................................................
I I---------------------       DO 100 IEYR3=ICYR1,ICYR3                                            .
I I                     ............................................................................
I I                                                          I
I I                      C     CLEAR OUT ARRAYS
I I                                                          I
I I                     ............................................................................
I I I-------------------       DO 7 Y=1,II                                                         .
I I I                   ............................................................................
I I I                                                        I
I I I                   ............................................................................
I I I I-----------------       DO 7 I2=1,9                                                         .
I I I I                 ............................................................................
I I I I                                                      I
I I I I                 ............................................................................
I I I I                 .      IF (I2.GT.6) GOTO 5                                                 *------------------------------------V
I I I I                 ............................................................................                                    I
I I I I                                                      I                                                                          I
I I I I                 ............................................................................                                    I
I I I I                 .      DIFF(I2,Y)=0.                                                       .                                    I
I I I I                 .      PVAL(I2,Y)=0.                                                       .                                    I
I I I I                 ............................................................................                                    I
I I I I                                                      I                                                                          I
I I I I                                                      I                                                                          I
1 2 3 4 5 6 7 8 9 0                                                                                  . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
1 2 3 4 5 6 7 8 9 0                          PAGE  2                                .9.8.7.6.5.4.3.2.1

                                              OK-------------------------------------------------------O

      5 IF (Y.GT.1.OR.I2.GT.8) GOTO 6                                      *---------------------------V

          TPVAL(I2)=0.

                                              OK-------------------------------------------------------O

      6 IF (I2.GT.6) GOTO 7                                                *---------------------------V

          DMAND(I2,Y,2)=0.
          DEMAND(I2,Y,2)=0.

                                              OK-------------------------------------------------------O

    ----------------*   7 CONTINUE

          Y=II

C         PERFORM CALCULATIONS
C         IF CONSTRUCTION ONLY, DON'T VARY EXPANSION YEAR
C         EXPANSION ONLY, DON'T VARY CONSTRUCTION YEAR

          IF (ISW.NE.2) GOTO 50                                            *---------------------------V

          ICYR=ICYR1

          IF (PRSW.EQ.1) GOTO 40                                           *-----------------------V

          IEYR=0

          GOTO 50                                                          *-----------------------I---V

1 2 3 4 5 6 7 8 9 0                                                                  .9.8.7.6.5.4.3.2.1
```

```
1 2 3 4 5 6 7 8 9 0                  PAGE  3                  . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1

                                     OK------------------------------------O
                                     I
..........................................................................
.   40 IEYR=ICYR                                                         .
..........................................................................
                                     I
                                     OK------------------------------------------O
                                     I
..........................................................................
.   50 IF (ISW.NE.3) GOTO 60                                             *-------V
..........................................................................
                                     I
..........................................................................
.      ICYR=ICYR1                                                        .
.      IEYR=IEYR3                                                        .
..........................................................................
                                     I
..........................................................................
.      GOTO 70                                                           *----V
..........................................................................

                                     OK-----------------------------------I---O
                                     I
..........................................................................
.   60 IF (ISW.NE.4) GOTO 70                                             *----V
..........................................................................
                                     I
..........................................................................
.      IEYR=IEYR3                                                        .
..........................................................................
                                     I
 C     SET FOR CONSTRUCT OPTION
 C     SET INDEX SO ONLY CONSTRUCT PHASE IS REPEATED
                                     I
                                     OK-----------------------------------O
                                     I
..........................................................................
.   70 NO3=2                                                             .
.      NO4=2                                                             .
..........................................................................
                                     I
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C      CALL CRDMND                                                       C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
                                     I
 C     SET L FOR CONSTRUCT PATH IN CALC
                                     I
..........................................................................
.      L=2                                                               .
..........................................................................
                                     I
                                     I
                                     I
                                     I
1 2 3 4 5 6 7 8 9 0                                           . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C      CALL CALC03                                                        C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
                                    I
       IF (IEYR3.GT.ICYR) X1=(COST2*(1.+ASSUMP(5))**(IEYR-1)*(1./
      1(1.+ASSUMP(6))**(IEYR-1)))
       IF (IEYR3.EQ.ICYR) X1=0.
       ECOST=X1*((1.+ASSUMP(6))**(IEYR-1))
       CCOST=COST1*(1.+ASSUMP(5))**(ICYR-1)
       ADJCON(1)=CCOST*(1./((1.+ASSUMP(6))
      1**(ICYR-1)))+X1
       TPVAL(7)=ADJCON(1)/1000.
       RATIO2=TPVAL(6)/TPVAL(7)
                                    I
 C     IF NOT BETTER, TRY AGAIN
                                    I
       IF (RATIO2.LT.RATIO) GOTO 100                *-----------V
                                    I                           I
 C     IF BETTER, STORE RESULT AND EXPANSION YEAR               I
                                    I                           I
       RATIO=RATIO2                                             I
       IEYR2=IEYR                                               I
       ICYR2=ICYR                                               I
                                    I                           I
                                    OK--------------------------O
                                    I
---------*   100 CONTINUE
                                    I
TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
T  101 RETURN                                                             T
TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT

       END
```

```
                       EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
                       E      SUBROUTINE CRDMND                                               E
                       EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
                                                           I
                              COMMON /LABA/ASSUMP(9),TABLE(11,70),HDATA(5,5),VOLUME(41),
                             1DMAND(7,41,2),XMAINT(7,41,2),SPEED(7,41,2),CYCLE(7,41,2),
                             2XSPEED(7,41,2,2),XTIME(7,41,2,2),OCOST(7,41,2,2),DIFF(6,41),
                             3PVAL(6,41),ADJCON(7),ALL(4),ACCNUM(7,41,2),ACCICO(7,41,2),
                             4STORE(10),WSPCP1(7,41,2),WSPCP2(7,41,2),TPVAL(8),ICYR3,ICYR4,
                             5XVTIME(7,41,2,2),XMN,SP,WSP1,WSP2,CY,XV(2),XT(2),XSP(2)
                              COMMON/LABB/OCP(5),PVOL(41),IHW(5,41,2),PRS,INDX,AC(4),TPR(4),
                             6XVT(2),XRN(2),XCY(2),OC(2),HSW(5),ACCNO,ACCOST,COST1,
                             7COST2,X1,ITRIAL,Y,NO1,NO2,NO3,NO4,EXSW,ALTSW,ANS,IASW,TAC(4),
                             8ISW,ICYR,ICYR2,IEYR2,IEYR,X,L1,L,EXSTOR(10),CCOST,ECOST,TBLE(5,4),
                                                           I
                       WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                       W     9WP1(7,41,2),WP2(7,41,2),RATIO,RATIO2,II,CINC(2),ASMSEG(5,3),    W
                       W     *BYPS(4),PBYPS(4),PRSW,IN(5),CAP(4),VOL(41,2),DEMAND(6,41,2)     W
                       WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                                           I
                              DIMENSION TALL(4)
                              INTEGER Y
                                                           I
                        C     ALLOCATES DEMAND
                        C     IN REGULAR RUN NO3=1 AND NO4=2;IN OPTIMUM RUN NO3=1 AND NO4=1
                        C     ONCE (TO CALCULATE DO-NOTHING) AND NO3=2 AND NO4 =2 MANY TIMES
                        C     (TO CALCULATE CONSTRUCT)
                        C     SORT CAPACITIES AND ALL(LX) FROM HIGHEST TO LOWEST
                                                           I
                       ........................................................................
I----------------------       DO 15 LX=1,4                                                    .
I                      ........................................................................
I                                                          I
I                      ........................................................................
I                      .      ALL(LX)=LX                                                      .
I                      .      IHSW=HSW(LX)                                                    .
I                      ........................................................................
I                                                          I
I                      ........................................................................
I                      .      IF (HSW(LX).EQ.0.) GOTO 16                                      *-----------------------------------V
I                      ........................................................................                                   I
I                                                          I                                                                      I
I                      ........................................................................                                   I
I                      .      CAP(LX)=TABLE(1,IHSW)*HDATA(LX,3)                               .                                   I
I                      .      TPR(LX)=CAP(LX)*OCP(LX)                                         .                                   I
I                      .      PRS=TPR(LX)/50.                                                 .                                   I
I                      .      INDX=LX                                                         .                                   I
I                      ........................................................................                                   I
I                                                          I                                                                      I
I                      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC                                   I
I                      C      CALL AVCOST                                                     C                                   I
I                      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC                                   I
I                                                          I                                                                      I
I                                                          I                                                                      I
I                                                          I                                                                      I
I                                                          I                                                                      I
1 2 3 4 5 6 7 8 9 0                                                                              . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
1 2 3 4 5 6 7 8 9 0                              PAGE  2                                     . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
I                                                   I                                                                          I
I                    .......................................................................                                   I
I                    .      TAC(LX)=AC(LX)                                                 .                                   I
I                    .      AC(LX)=0.                                                      .                                   I
I                    .......................................................................                                   I
I                                                   I                                                                          I
I                    .......................................................................                                   I
I                    .      GOTO 15                                                        *---------------------------V   I
I                    .......................................................................                            I   I
I                                                                                                                       I   I
I                                                                                                                       I   I
I                                                                                                                       I   I
I                                                  OK---------------------------------------------------------------------I---O
I                                                   I                                                                   I
I                    .......................................................................                            I
I                    .   16 CAP(LX)=0.                                                     .                            I
I                    .      AC(LX)=0.                                                      .                            I
I                    .      TAC(LX)=0.                                                     .                            I
I                    .......................................................................                            I
I                                                   I                                                                   I
I                                                  OK---------------------------------------------------------------------O
I                                                   I
I                    .......................................................................
---------------------*   15 CONTINUE                                                       .
                     .......................................................................
                                                    I
                     .......................................................................
I--------------------       DO 17 I=1,3                                                    .
I                    .......................................................................
I                                                   I
I                    .......................................................................
I                    .      L=4-I                                                          .
I                    .......................................................................
I                                                   I
I                    .......................................................................
I I------------------       DO 17 J=1,L                                                    .
I I                  .......................................................................
I I                                                 I
I I                  .......................................................................
I I                  .      IF (CAP(J).GT.CAP(J+1)) GOTO 17                                *------------------------------V
I I                  .......................................................................                               I
I I                                                 I                                                                      I
I I                  .......................................................................                               I
I I                  .      T=CAP(J)                                                       .                               I
I I                  .      T1=ALL(J)                                                      .                               I
I I                  .      CAP(J)=CAP(J+1)                                                .                               I
I I                  .      CAP(J+1)=T                                                     .                               I
I I                  .      ALL(J)=ALL(J+1)                                                .                               I
I I                  .      ALL(J+1)=T1                                                    .                               I
I I                  .......................................................................                               I
I I                                                 I                                                                      I
I I                                                OK------------------------------------------------------------------------O
I I                                                 I
I I                                                 I
I I                                                 I
I I                                                 I
I I                                                 I
I I                                                 I
1 2 3 4 5 6 7 8 9 0                                                                          . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
17 CONTINUE

DO 200 JT=1,4

TALL(JT)=ALL(JT)

200 CONTINUE

DO 41 L=NO3,NO4

DO 57 Y=1,II

DO 20 LL=1,4

IN(LL)=1
ALL(LL)=TALL(LL)
AC(LL)=0.

20 CONTINUE

X1=PVOL(Y)
IF (HSW(4).EQ.0.) IN(4)=0.
IF(HSW(3).EQ.0.) IN(3)=0

IF (L.EQ.1) GOTO 90

IF (Y.LT.ICYR) GOTO 90
```

```
1 2 3 4 5 6 7 8 9 0                                                    . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1

      IF (PRSW.NE.0.) GOTO 70                        *----------------------------V
      IF (Y.LT.IEYR) GOTO 60                         *-------------------------V  I
      IF (HSW(3).EQ.0.) GOTO 70                      *-------------------------I--V
      IN(2)=0                                                                  I  I
      GOTO 70                                        *-------------------------I--V
                              OK-----------------------------------------------O  I
   60 IN(3)=0                                                                     I
                              OK--------------------------------------------------O
   70 IF (EXSW.EQ.0.) GOTO 95                        *----------------------------V
      IF (EXSW-2.) 75,80,85                          *-------------------------V  I
                                                     *----------------------V  I  I
   75 IN(1)=0                                                               I  I  I
      GOTO 95                                        *----------------------I--I--V
                              OK--------------------------------------------I--O  I
   80 IN(4)=0                                                               I     I

1 2 3 4 5 6 7 8 9 0                                                    . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
      GOTO 95
OK
   85 IN(1)=0
      IN(4)=0
      GOTO 95
OK
   90 IN(2)=0
      IN(3)=0
OK
   95 DO 100 K=1,5
      IF (K.EQ.5) IN(K)=1
      IHW(K,Y,L)=IN(K)
      IF (K.EQ.5) GOTO 100
      IF (ALL(K).EQ.0.) GOTO 100
      IALL=ALL(K)
      IF (IN(IALL).EQ.0) ALL(K)=0.
OK
```

```
1 2 3 4 5 6 7 8 9 0                                 PAGE  6                                     . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
I I I                                                 I
I I I                   .........................................................................
I I ----------------*   100 CONTINUE                                                            .
I I                     .........................................................................
I I                                                   I
I I                     C     INITIALLY ALLOCATE ALL TRAFFIC TO ROUTE WITH HIGHEST CAPACITY
I I                                                   I
I I                     .........................................................................
I I I----------------         DO 300 LL3=1,4                                                    .
I I I                   .........................................................................
I I I                                                 I
I I I                   .........................................................................
I I I                   .     IALL=ALL(LL3)                                                     .
I I I                   .........................................................................
I I I                                                 I
I I I                   .........................................................................
I I I                   .     IF (ALL(LL3).EQ.0.) GOTO 300                                      *----------------------------------V
I I I                   .........................................................................                                  I
I I I                                                 I                                                                            I
I I I                   .........................................................................                                  I
I I I                   .     DEMAND(IALL,Y,L)=X1                                               .                                  I
I I I                   .     PRS=X1                                                            .                                  I
I I I                   .     INDX=ALL(LL3)                                                     .                                  I
I I I                   .........................................................................                                  I
I I I                                                 I                                                                            I
I I I                   CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC                                 I
I I I                   C     CALL AVCOST                                                      C                                 I
I I I                   CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC                                 I
I I I                                                 I                                                                            I
I I I                   .........................................................................                                  I
I I I                   .     CMAX=AC(INDX)                                                     .                                  I
I I I                   .     CMIN=AC(INDX)                                                     .                                  I
I I I                   .     IMAX=INDX                                                         .                                  I
I I I                   .     IMIN=INDX                                                         .                                  I
I I I                   .........................................................................                                  I
I I I                                                 I                                                                            I
I I I                   .........................................................................                                  I
I I I                   .     GOTO 310                                                          *------------------------------V   I
I I I                   .........................................................................                              I   I
I I I                                                                                                                          I   I
I I I                                                                                                                          I   I
I I I                                                                                                                          I   I
I I I                                                 OK-----------------------------------------------------------------------I---O
I I I                                                 I                                                                        I
I I I                   .........................................................................                              I
I I ----------------*   300 CONTINUE                                                            .                              I
I I                     .........................................................................                              I
I I                                                   I                                                                        I
I I                     C     TAKE TRAFFIC FROM HIGHEST COST ROUTE TO LOWEST COST ROUTE                                        I
I I                     C     UNTIL TRAFFFIC BEING ALLOCATED IS LESS THAN 50                                                   I
I I                                                   I                                                                        I
I I                                                   OK-----------------------------------------------------------------------O
I I                                                   I
I I                                                   I
I I                                                   I
I I                                                   I
I I                                                   I
I I                                                   I
1 2 3 4 5 6 7 8 9 0                                                                             . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
I I                                                    I
I I               ..........................................................................
I I               .  310 NHY=IHW(1,Y,L)+IHW(2,Y,L)+IHW(3,Y,L)+IHW(4,Y,L)                   .
I I               ..........................................................................
I I                                                    I
I I                                                    OK--------------------------------------O
I I                                                    I                                       I
I I               ..........................................................................   I
I I I-------------   315 DO 320 L3=1,4                                                     .   I
I I I             ..........................................................................   I
I I I                                                  I                                       I
I I I             ..........................................................................   I
I I I             .      IT=ALL(L3)                                                         .  I
I I I             ..........................................................................   I
I I I                                                  I                                       I
I I I             ..........................................................................   I
I I I             .      IF (IT.EQ.0) GOTO 320                                              *------------V  I
I I I             ..........................................................................   I      I
I I I                                                  I                                       I      I
I I I             ..........................................................................   I      I
I I I             .      IF (AC(IT).LE.CMAX) GOTO 330                                       *---------V  I  I
I I I             ..........................................................................   I  I  I
I I I                                                  I                                       I  I  I
I I I             ..........................................................................   I  I  I
I I I             .      CMAX=AC(IT)                                                        .  I  I  I
I I I             .      IMAX=IT                                                            .  I  I  I
I I I             ..........................................................................   I  I  I
I I I                                                  I                                       I  I  I
I I I                                                  OK------------------------------------O  I  I
I I I                                                  I                                          I  I
I I I             ..........................................................................      I  I
I I I             .  330 IF (AC(IT).GE.CMIN) GOTO 320                                       *------------V  I
I I I             ..........................................................................      I  I
I I I                                                  I                                          I  I
I I I             ..........................................................................      I  I
I I I             .      CMIN=AC(IT)                                                        .     I  I
I I I             .      IMIN=IT                                                            .     I  I
I I I             ..........................................................................      I  I
I I I                                                  I                                          I  I
I I I                                                  OK---------------------------------------O  I
I I I                                                  I                                             I
I I I             ..........................................................................         I
I I --------------*  320 CONTINUE                                                          .         I
I I               ..........................................................................         I
I I                                                    I                                             I
I I               ..........................................................................         I
I I               .      DEMAND(IMAX,Y,L)=DEMAND(IMAX,Y,L)-X1/NHY                          .         I
I I               .      PRS=DEMAND(IMAX,Y,L)                                               .         I
I I               .      INDX=IMAX                                                          .         I
I I               ..........................................................................         I
I I                                                    I                                             I
I I               CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC         I
I I               C      CALL AVCOST                                                      C         I
I I               CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC         I
I I                                                    I                                             I
I I                                                    I                                             I
I I                                                    I                                             I
I I                                                    I                                             I
```

```
1 2 3 4 5 6 7 8 9 0                                        PAGE  8                                              . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
I I                                                             I                                                                                 I
I I                      .........................................................................                                                I
I I                      .       CMAX=AC(IMAX)                                                   .                                                I
I I                      .       DEMAND(IMIN,Y,L)=DEMAND(IMIN,Y,L)+X1/NHY                        .                                                I
I I                      .       PRS=DEMAND(IMIN,Y,L)                                            .                                                I
I I                      .       INDX=IMIN                                                       .                                                I
I I                      .........................................................................                                                I
I I                                                             I                                                                                 I
I I                      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC                                                I
I I                      C       CALL AVCOST                                                     C                                                I
I I                      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC                                                I
I I                                                             I                                                                                 I
I I                      .........................................................................                                                I
I I                      .       CMIN=AC(IMIN)                                                   .                                                I
I I                      .........................................................................                                                I
I I                                                             I                                                                                 I
I I                      .........................................................................                                                I
I I                      .       IF (X1.LT.50.) GOTO 340                                          *--------------------------------V   I
I I                      .........................................................................                                 I   I
I I                                                             I                                                                  I   I
I I                      .........................................................................                                 I   I
I I                      .       X1=X1*(1.-1./NHY)                                               .                                 I   I
I I                      .........................................................................                                 I   I
I I                                                             I                                                                  I   I
I I                      .........................................................................                                 I   I
I I                      .       GOTO 315                                                         *--------------------------------I---A
I I                      .........................................................................                                 I
I I                                                                                                                                I
I I                                                                                                                                I
I I                       C      MAKE ADJUSTMENT FOR TRAFFIC ABOVE CAPACITY                                                        I
I I                                                                                                                                I
I I                                                                                                                                I
I I                                                            OK------------------------------------------------------------------O
I I                                                             I
I I                      .........................................................................
I I                      .   340 STAB=0.                                                         .
I I                      .........................................................................
I I                                                             I
I I                      .........................................................................
I I I--------------------        DO 350 L4=1,2                                                   .
I I I                    .........................................................................
I I I                                                           I
I I I                    .........................................................................
I I I I------------------        DO 350 L5=1,4                                                   .
I I I I                  .........................................................................
I I I I                                                         I
I I I I                  .........................................................................
I I I I                  .       L3=ALL(L5)                                                      .
I I I I                  .........................................................................
I I I I                                                         I
I I I I                  .........................................................................
I I I I                  .       IF (ALL(L5).EQ.0.) GOTO 350                                      *------------------------------------V
I I I I                  .........................................................................                                     I
I I I I                                                         I                                                                      I
I I I I                                                         I                                                                      I
I I I I                                                         I                                                                      I
I I I I                                                         I                                                                      I
I I I I                                                         I                                                                      I
1 2 3 4 5 6 7 8 9 0                                                                                         . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
      DEMAND(L3,Y,L)=DEMAND(L3,Y,L)+STAB
      STAB=0.

      IF (DEMAND(L3,Y,L).LE.TPR(L3)) GOTO 360

      STAB=DEMAND(L3,Y,L)-TPR(L3)
      DEMAND(L3,Y,L)=TPR(L3)
                                    OK
  360 IF (DEMAND(L3,Y,L).GT.0.) GOTO 350

      STAB=DEMAND(L3,Y,L)
      DEMAND(L3,Y,L)=0.
                                    OK
  350 CONTINUE

C     ALL THAT FALLS THROUGH IS DIVERTED

      DEMAND(5,Y,L)=STAB

      DO 57 L1=1,5

      DMAND(L1,Y,L)=DEMAND(L1,Y,L)/OCP(L1)

   57 CONTINUE

   41 CONTINUE
```

```
                                      I
.......................................................................
.       L=NO4                                                         .
.......................................................................
                                      I
TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
T       RETURN                                                        T
TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT

.......................................................................
.       END                                                           .
.......................................................................
```

```
EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
E      SUBROUTINE AVCOST                                                  E
EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
                                     I
       COMMON /LABA/ASSUMP(9),TABLE(11,70),HDATA(5,5),VOLUME(41),
      1DMAND(7,41,2),XMAINT(7,41,2),SPEED(7,41,2),CYCLE(7,41,2),
      2XSPEED(7,41,2,2),XTIME(7,41,2,2),OCOST(7,41,2,2),DIFF(6,41),
      3PVAL(6,41),ADJCON(7),ALL(4),ACCNUM(7,41,2),ACCICO(7,41,2),
      4STORE(10),WSPCP1(7,41,2),WSPCP2(7,41,2),TPVAL(8),ICYR3,ICYR4,
      5XVTIME(7,41,2,2),XMN,SP,WSP1,WSP2,CY,XV(2),XT(2),XSP(2)
       COMMON/LABB/OCP(5),PVOL(41),IHW(5,41,2),PRS,INDX,AC(4),TPR(4),
      6XVT(2),XRN(2),XCY(2),OC(2),HSW(5),ACCNO,ACCOST,COST1,
      7COST2,X1,ITRIAL,Y,NO1,NO2,NO3,NO4,EXSW,ALTSW,ANS,IASW,TAC(4),
      8ISW,ICYR,ICYR2,IEYR2,IEYR,X,L1,L,EXSTOR(10),CCOST,ECOST,TBLE(5,4),
                                     I
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
W     9WP1(7,41,2),WP2(7,41,2),RATIO,RATIO2,II,CINC(2),ASMSEG(5,3),       W
W     *BYPS(4),PBYPS(4),PRSW,IN(5),CAP(4),VOL(41,2),DEMAND(6,41,2)        W
WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                     I
       INTEGER X
                                     I
..........................................................................
.      L1=INDX                                                            .
.      X=HSW(L1)                                                          .
.      V=PRS/OCP(L1)                                                      .
..........................................................................
                                     I
C      CHECK IF TOTAL PERSONS IS LESS THAN 2% CAPACITY
                                     I
..........................................................................
.      BPR=TPR(L1)/50.                                                    .
..........................................................................
                                     I
..........................................................................
.      IF(PRS.GE.BPR) GOTO 5                                              *----------------------------------V
..........................................................................                                   I
                                     I                                                                       I
..........................................................................                                   I
.      AC(L1)=TAC(L1)/BPR*PRS                                             .                                  I
..........................................................................                                   I
                                     I                                                                       I
..........................................................................                                   I
.      GOTO 60                                                            *------------------------------V   I
..........................................................................                               I   I
                                                                                                         I   I
                                                                                                         I   I
C      CALCULATE AVERAGE SPEED                                                                           I   I
                                                                                                         I   I
                                                                                                         I   I
                                                                                                         I   I
1 2 3 4 5 6 7 8 9 0                                                       . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
1 2 3 4 5 6 7 8 9 0                          PAGE  2                             . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
                                                OK------------------------------------------------------------I---O
                                                I                                                             I
.........................................................................                                      I
.    5 IF (V.GT.TABLE(2,X)) GOTO 10                                     *-------------------------------------I---V
.........................................................................                                      I   I
                                                I                                                             I   I
.........................................................................                                      I   I
.      SP=HDATA(L1,3)*(TBLE(3,L1)+(TBLE(4,L1)-TBLE(3,L1))*V/TABLE(2,X))  .                                    I   I
.........................................................................                                      I   I
                                                I                                                             I   I
.........................................................................                                      I   I
.      GOTO 30                                                          *------------------------------V      I   I
.........................................................................                         I      I   I
                                                                                                   I      I   I
                                                                                                   I      I   I
                                                                                                   I      I   I
                                                OK-------------------------------------------------I------I---O
                                                I                                                  I      I
.........................................................................                         I      I
.   10 IF (V.GT.TABLE(1,X)*HDATA(L1,3)) GOTO 20                         *--------------------------I------I---V
.........................................................................                         I      I   I
                                                I                                                  I      I   I
.........................................................................                         I      I   I
.      SP=HDATA(L1,3)*(TBLE(4,L1)+(TBLE(5,L1)-TBLE(4,L1))/               .                        I      I   I
.     *(TABLE(1,X)-TABLE(2,X))*(V-TABLE(2,X)))                           .                        I      I   I
.........................................................................                         I      I   I
                                                I                                                  I      I   I
.........................................................................                         I      I   I
.      GOTO 30                                                          *--------------------------V      I   I
.........................................................................                         I      I   I
                                                                                                   I      I   I
                                                                                                   I      I   I
                                                                                                   I      I   I
                                                OK-------------------------------------------------I------I---O
                                                I                                                  I      I
.........................................................................                         I      I
.   20 SP=TBLE(5,L1)/10.                                                  .                        I      I
.........................................................................                         I      I
                                                I                                                  I      I
 C      NUMBER OF CYCLES PER VEHICLE MILE                                                          I      I
                                                I                                                  I      I
                                                OK-------------------------------------------------O      I
                                                I                                                         I
.........................................................................                                I
.   30 CY=(TABLE(6,X)+TABLE(7,X)*V)/HDATA(L1,3)                           .                               I
.      IF (CY.GT.8.7) CY=8.7                                              .                               I
.........................................................................                                I
                                                I                                                         I
.........................................................................                                I
.      IF (X.LT.29..OR.(X.GT.33..AND.X.LT.38.).OR.(X.GT.39..AND.X.LT.64.) *-------------------------------I---V
.     *) GOTO 40                                                          .                               I   I
.........................................................................                                I   I
                                                I                                                         I   I
                                                I                                                         I   I
                                                I                                                         I   I
                                                I                                                         I   I
                                                I                                                         I   I
                                                I                                                         I   I
1 2 3 4 5 6 7 8 9 0                                                           . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
      IF (CY.GT.3.1) CY=3.1
C     PERCENTAGE CARS (PC) PERCENTAGE TRUCKS (PT)
                                                OK
   40 PC=1.-ASMSEG(L1,1)
      PT=ASMSEG(L1,1)
C     DAILY TIME COST PER PERSON
      PVT=HDATA(L1,1)*60./SP*(ASSUMP(2)*PC/1.3+ASSUMP(3)*PT/.9)
C     CALCULATE TIME COST WITH HOV BYPASS
      IF (BYPS(L1).EQ.0.) GOTO 50
      IF (V.LE.TABLE(2,X)) GOTO 50
      BSP=HDATA(L1,3)*(TBLE(4,L1)+(V-TABLE(2,X))*((144.*TBLE(5,L1)-
     *TBLE(4,L1)*(180.-TBLE(5,L1)))/((180.-TBLE(5,L1))*(TABLE(1,X)-
     *TABLE(2,X)))))
      PVT=PVT*(1.-PBYPS(L)*(1.-SP/BSP))
C     RUNNING COSTS PER PERSON
                                                OK
   50 RC=1.91*HDATA(L1,1)/1000.*(152.0616+1.939548*SP-.0085822*(SP)**2-
     *38.91707*ALOG(SP))*PC/ASMSEG(L1,2)
      RT=2.26*HDATA(L1,1)/1000.*(429.381938+5.598752*SP*.9-.003013*
     *(SP*.9)**2-131.592*ALOG(SP*.9))*PT/ASMSEG(L1,3)
      PR=RC+RT
C     CYCLING COSTS PER PERSON
      CCY=1.87*HDATA(L1,1)*CY/1000.*(3.9499-13.8413/SP)*PC/ASMSEG(L1,2)
      TCY=2.04*HDATA(L1,1)*CY/1000.*(47.2458-428.198/(SP*.9)*PT/
     *ASMSEG(L1,3))
      PCY=CCY+TCY
```

```
1 2 3 4 5 6 7 8 9 0                              PAGE  4                                         . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
                                                    I                                                                               I
                   C     ACCIDENT COST PER PERSON                                                                                   I
                                                    I                                                                               I
                   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .   I
                   .     PAC=HDATA(L1,1)*TABLE(8,X)/(1.0E+6*HDATA(L1,2))*                                .                           I
                   .    *(.47/OCP(L1)+.414)*(TABLE(9,X)+TABLE(10,X)*V/1000.)                             .                           I
                   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .   I
                                                    I                                                                               I
                   C     TOTAL DAILY COST PER PERSON INCLUDING INCONVENIENCE COST IF ANY                                            I
                                                    I                                                                               I
                   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .   I
                   .     AC(L1)=PVT+PR+PCY+PAC                                                           .                           I
                   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .   I
                                                    I                                                                               I
                   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .   I
                   .     IF (HSW(L1).LT.42..OR.HSW(L1).GT.50.) GOTO 60                                   *-------------------------V
                   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .   I
                                                    I                                                                               I
                   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .   I
                   .     AC(L1)=AC(L1)+(PC*CINC(1)+PT*CINC(2))*HDATA(L1,1)                               .                           I
                   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .   I
                                                    I                                                                               I
                                                    OK------------------------------------------------------------------------------O
                                                    I
                   TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
                   T   60 RETURN                                                                         T
                   TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT

                   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
                   .     END                                                                             .
                   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
```

FORTCHT, VERSION A1   MAINTAINED BY DALE L. SCHAFER,   PHONE 845-1714
E=ENTRY, T=TERMINAL, C=CALL, R=READ, W=WRITE

```
                         EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
                         E      SUBROUTINE CALC03                                                 E
                         EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
                                                             I
                                COMMON /LABA/ASSUMP(9),TABLE(11,70),HDATA(5,5),VOLUME(41),
                               1DMAND(7,41,2),XMAINT(7,41,2),SPEED(7,41,2),CYCLE(7,41,2),
                               2XSPEED(7,41,2,2),XTIME(7,41,2,2),OCOST(7,41,2,2),DIFF(6,41),
                               3PVAL(6,41),ADJCON(7),ALL(4),ACCNUM(7,41,2),ACCICO(7,41,2),
                               4STORE(10),WSPCP1(7,41,2),WSPCP2(7,41,2),TPVAL(8),ICYR3,ICYR4,
                               5XVTIME(7,41,2,2),XMN,SP,WSP1,WSP2,CY,XV(2),XT(2),XSP(2)
                                COMMON/LABB/OCP(5),PVOL(41),IHW(5,41,2),PRS,INDX,AC(4),TPR(4),
                               6XVT(2),XRN(2),XCY(2),OC(2),HSW(5),ACCNO,ACCOST,COST1,
                               7COST2,X1,ITRIAL,Y,NO1,NO2,NO3,NO4,EXSW,ALTSW,ANS,IASW,TAC(4),
                               8ISW,ICYR,ICYR2,IEYR2,IEYR,X,L1,L,EXSTOR(10),CCOST,ECOST,TBLE(5,4),
                                                             I
                         WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                         W     9WP1(7,41,2),WP2(7,41,2),RATIO,RATIO2,II,CINC(2),ASMSEG(5,3),      W
                         W     *BYPS(4),PBYPS(4),PRSW,IN(5),CAP(4),VOL(41,2),DEMAND(6,41,2)       W
                         WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                                             I
                                DIMENSION VT(2)
                                INTEGER Y,X
                                                             I
                         ..........................................................................
I--------------------           DO 11 Y=1,II                                                     .
I                        ..........................................................................
I                                                            I
I                        ..........................................................................
I I------------------           DO 11 L1=1,5                                                     .
I I                      ..........................................................................
I I                                                          I
I I                      ..........................................................................
I I                      .   33 X=HSW(L1)                                                        .
I I                      ..........................................................................
I I                                                          I
I I                      ..........................................................................
I I                      .      IF (HSW(L1).EQ.0.) GOTO 20                                       *------------------------------------V
I I                      ..........................................................................                                      I
I I                                                          I                                                                           I
I I                      ..........................................................................                                      I
I I                      .      IF (IHW(L1,Y,L).EQ.0) GOTO 29                                    *-------------------------------V   I
I I                      ..........................................................................                                  I   I
I I                                                          I                                                                   I   I
I I                       C     SET DIVERSION LENGTH EQUAL TO EXISTING OR ALTERNATE, WHICHEVER                                    I   I
I I                       C     IS GREATER                                                                                        I   I
I I                                                          I                                                                   I   I
I I                      ..........................................................................                                  I   I
I I                      .   10 IF (L1.EQ.5) HDATA(L1,1)=AMAX1(HDATA(1,1),HDATA(4,1))            .                                  I   I
I I                      ..........................................................................                                  I   I
I I                                                          I                                                                   I   I
I I                       C     MAINTENANCE COSTS                                                                                 I   I
I I                                                          I                                                                   I   I
I I                      ..........................................................................                                  I   I
I I                      .   32 XMN=HDATA(L1,1)*TABLE(11,X)*(1.+ASSUMP(4))**(Y-1)                .                                  I   I
I I                      ..........................................................................                                  I   I
I I                                                          I                                                                   I   I
1 2 3 4 5 6 7 8 9 0                                                                          . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
      GOTO 30

   29 XMN=0.

   30 IF (DMAND(L1,Y,L).EQ.0.) GOTO 27

      IF (L1.NE.5) GOTO 22

      IF (HSW(5).EQ.1.) SP=ASSUMP(8)
      IF  (HSW(5).EQ.2.) SP=ASSUMP(7)

      GOTO 23

C     AVERAGE SPEED

   22 SLOP1=(TBLE(4,L1)-TBLE(3,L1))/TABLE(2,X)
      IF (DMAND(L1,Y,L).LE.TABLE(2,X)) SP=HDATA(L1,3)*(TBLE(3,L1)
     1+SLOP1*DMAND(L1,Y,L))
      SLOP2=(TBLE(5,L1)-TBLE(4,L1))/(TABLE(1,X)-TABLE(2,X))
      XNTCP=-SLOP2*TABLE(2,X)+TBLE(4,L1)
      IF (DMAND(L1,Y,L).GT.TABLE(2,X)) SP=HDATA(L1,3)
     1*(XNTCP+SLOP2*DMAND(L1,Y,L))

C     WEIGHTED AVG SPEED COMPONENTS

   23 WSP1=DMAND(L1,Y,L)*HDATA(L1,1)*SP
      WSP2=DMAND(L1,Y,L)*HDATA(L1,1)
```

```
C     NUMBER OF CYCLES PER VEHICLE MILE
C     SET DIVERSION TECH FACTOR TO 1

      IF (L1.EQ.5) HDATA(L1,3)=1.
      CY=(TABLE(6,X)+TABLE(7,X)*DMAND(L1,Y,L))/HDATA(L1,3)
      IF (CY.GT.8.7) CY=8.7

      IF (HSW(L1).LT.29..OR.(HSW(L1).GT.33..AND.HSW(L1).LT.38.).OR.
     1(HSW(L1).GT.39..AND.HSW(L1).LT.64.)) GOTO 45

   40 IF(CY.GT.3.1) CY = 3.1

   45 CONTINUE

C     CAR AND TRUCK COSTS: CAR=1,TRUCK=2

      DO 15 L2=1,2

C     DEMAND & SPEED

      IF (L2.EQ.2) GOTO 16

      XV(L2)=(1.-ASMSEG(L1,1))*DMAND(L1,Y,L)
      XSP(L2)=SP
      VT(1)=ASSUMP(2)*ASMSEG(L1,2)/1.3

      GOTO 17

   16 XV(L2)=ASMSEG(L1,1)*DMAND(L1,Y,L)
      XSP(L2)=.9*SP
```

```
      IF (X.GE.42..AND.X.LE.50.) GOTO 34

      GOTO 35

   OK

   34 VT(2)=ASSUMP(2)*ASMSEG(L1,3)/1.3

      GOTO 17

   OK

   35 VT(2)=ASSUMP(3)*ASMSEG(L1,3)

C     ELAPSED TIME

   OK

   17 IF (XSP(L2).EQ.0..OR.XV(L2).EQ.0.) GOTO 24

      XT(L2)=(HDATA(L1,1)/(XSP(L2))*365.*XV(L2))

C     VALUE OF TIME

      XVT(L2)=XT(L2)*VT(L2)*60.*(1.+ASSUMP(4))**(Y-1)

      GOTO 25
```

```
   24 XT(L2)=0.
      XVT(L2)=0.

      GOTO 21

C     CALCULATE VALUE OF TIME WITH HOV BYPASS

   25 IF (L1.GT.4) GOTO 21

      IF (BYPS(L1).EQ.0.) GOTO 21

      IF (DMAND(L1,Y,L).LE.TABLE(2,X)) GOTO 21

      BSP=HDATA(L1,3)*(TBLE(4,L1)+(DMAND(L1,Y,L)-TABLE(2,X))*
     *((144.*TBLE(5,L1)-TBLE(4,L1)*(180.-TBLE(5,L1)))/((180.-TBLE(5,L1))
     **(TABLE(1,X)-TABLE(2,X)))))
      IF (L2.EQ.2) BSP=BSP*.9
      XVT(L2)=XVT(L2)*(1.-PBYPS(L)*(1.-XSP(L2)/BSP))
      XT(L2)=XVT(L2)/VT(L2)/60./(1.+ASSUMP(4))**(Y-1)

C CAR & TRUCK RUN COSTS

   21 IF(L2.EQ.2) GO TO 18

C AVERAGE DAILY CAR RUN COSTS

      IF (XSP(L2).LE.25.AND.XSP(L2).NE.0)
     X XRN(L2)=(HDATA(L1,1)*XV(L2)/1000.)*
     X (XSP(L2)/(-3.4048E-2+1.577E-2*XSP(L2)))*
     X ((1.+ASSUMP(4))**(Y-1))*1.91
      IF (XSP(L2).GT.25) XRN(L2)=(HDATA(L1,1)*XV(L2)/1000.)*
     X (1./(1.579E-2-5.012E-5*XSP(L2)))*((1.+ASSUMP(4))**(Y-1))*1.91
```

```
C AVERAGE DAILY CYCLING COSTS - CARS

      XCY(L2)=(1.87)*((1.+ASSUMP(4))**(Y-1))*
     X           ((HDATA(L1,1)*XV(L2)*CY)/1000.)*
     X (3.9499-13.8413/XSP(L2))

      GO TO 19

C AVERAGE DAILY TRUCK RUN COSTS

                                        OK

   18 IF(XSP(L2).LE.25.AND.XSP(L2).NE.0)
     XXRN(L2)=(HDATA(L1,1)*XV(L2)/1000.)*
     X(XSP(L2)/(-2.59E-2+8.094E-3*XSP(L2)))*((1.+ASSUMP(4))**(Y-1))
     X *2.26
      IF (XSP(L2).GT.25) XRN(L2)=(HDATA(L1,1)*XV(L2)/1000.)*
     X (1./(9.033E-3-7.342E-5*XSP(L2)))*((1.+ASSUMP(4))**(Y-1))*2.26

C AVERAGE DAILY CYCLING COSTS - TRKS

      XCY(L2)=(2.04)*((1.+ASSUMP(4))**(Y-1))*
     X((HDATA(L1,1)*XV(L2)*CY)/1000.)*
     X (47.2458-428.198/XSP(L2))

C ANNUAL OPERATING COSTS

                                        OK

   19 OC(L2) = (XRN(L2)+XCY(L2))*(365.)

C     ADD INCONVENIENCE COST, IF ANY

      IF (HSW(L1).LT.42..OR.HSW(L1).GT.50.) GOTO 15

      OC(L2)=OC(L2)+CINC(L2)*XV(L2)*ASMSEG(L1,L2+1)*365.*
     *HDATA(L1,1)*(1.+ASSUMP(4))**(Y-1)
```

```
   15 CONTINUE

C      ACCIDENT NO.
C      SET DIVERSION SAFETY INDEX TO 1

      IF (L1.EQ.5) HDATA(L1,2)=1.
      ACCNO=((TABLE(9,X)+(TABLE(10,X)*DMAND(L1,Y,L)/1000.))/HDATA(L1,2)).
     1*(HDATA(L1,1)*DMAND(L1,Y,L)/1.0E+6)*(365.)
      ACCOST=(TABLE(8,X)*ACCNO*(1.+ASSUMP(4))**(Y-1))*
     *(.414*OCP(L1)+.47)

      GO TO 26

C      CLEAR PREVIOUS TOTALS  IF NO ROAD OF THIS TYPE -L1

   20 XMN=0.

   27 WSP1=0.
      WSP2=0.
      CY=0.
      XV(1)=0.
      XV(2)=0.
      XSP(1)=0.
      XSP(2)=0.
      XT(1)=0.
      XT(2)=0.
      XVT(1)=0.
      XVT(2)=0.
      XCY(1)=0.
      XCY(2)=0.
      OC(1)=0.
      OC(2)=0.
      ACCNO=0.
      ACCOST=0.
      SP=0.
      XRN(1)=0.
      XRN(2)=0.
```

```
C     SKIP EQUATE IF OPTIMUM TRIALS
                                        OK
   26 IF (ITRIAL.EQ.1) GOTO 5
C     EQUATE PATH
C     THIS SECTION WILL MOVE VALUES TO FINAL ARRAYS IN ALL CASES
C     DURING REGULAR RUN AND WILL
C     MOVE VALUES TO FINAL ARRAYS WHEN BEST NPV
C     REACHED IN OPTIMUM YEAR
      X=L1
      XMAINT(X,Y,L)=XMN
      SPEED(X,Y,L)=SP
      WSPCP1(X,Y,L)=WSP1
      WSPCP2(X,Y,L)=WSP2
      CYCLE(X,Y,L)=CY
      DO 99 L2=1,2
      XSPEED(X,Y,L,L2)=XSP(L2)
      XTIME(X,Y,L,L2)=XT(L2)
      XVTIME(X,Y,L,L2)=XVT(L2)
      OCOST(X,Y,L,L2)=OC(L2)
   99 CONTINUE
      ACCNUM(X,Y,L)=ACCNO
      ACCICO(X,Y,L)=ACCOST
      IF (L.NE.2) GOTO 11
      IF (X.GT.1.OR.Y.GT.1) GOTO 11
      ECOST=COST2*((1.+ASSUMP(5))**(IEYR-1))
      CCOST=COST1*(1.+ASSUMP(5))**(ICYR-1)
      ADJCON(X)=CCOST*(1./(1.+ASSUMP(6))**(ICYR-1))+
     1ECOST*(1./(1.+ASSUMP(6))**(IEYR-1))
```

```
      GOTO 11

C     DIFFERENCES ONLY CALCULATED HERE FOR OPTIMUM TRIALS
C     THIS SECTION IS SKIPPED DURING REGULAR RUN
C     THE CONTROL VARIABLE IS ITRIAL

                                OK
    5 X=L1
      DIFF(1,Y)=(DIFF(1,Y)+XTIME(X,Y,1,1)-XT(1)
     *+XTIME(X,Y,1,2)-XT(2))/1000.
      DIFF(2,Y)=(DIFF(2,Y)+XVTIME(X,Y,1,1)-XVT(1)
     *+XVTIME(X,Y,1,2)-XVT(2))/1000.
      DIFF(4,Y)=(DIFF(4,Y)+ACCICO(X,Y,1)-ACCOST)/1000.
      DIFF(5,Y)=(DIFF(5,Y)+XMAINT(X,Y,1)-XMN)/1000.
      DIFF(3,Y)=(DIFF(3,Y)+OCOST(X,Y,1,1)-OC(1)
     *+OCOST(X,Y,1,2)-OC(2))/1000.
      DIFF(6,Y)=DIFF(2,Y)+DIFF(3,Y)+DIFF(4,Y)+DIFF(5,Y)

C     CALCULATE NET PRESENT VALUE

      DO 41 J=1,6

      IF (J.EQ.1) GOTO 50

      PVAL(J,Y)=DIFF(J,Y)/((1.+ASSUMP(6))**(Y-1))

      GOTO 41

                                OK
   50 PVAL(J,Y)=DIFF(J,Y)
```

```
1 2 3 4 5 6 7 8 9 0                          PAGE 10                          . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
I I I                                          OK---------------------------------------------------------O  I
I I I                                          I                                                             I
I I I      ..........................................................................                        I
I I -----------*    41 CONTINUE                                            .                                 I
I I        ..........................................................................                        I
I I                                            I                                                             I
I I                                            OK------------------------------------------------------------O
I I                                            I
I I        ..........................................................................
-----------------*    11 CONTINUE                                          .
           ..........................................................................
                                               I
           ..........................................................................
           .    IF (ITRIAL.EQ.0) GOTO 999                                  *--------------------------------V
           ..........................................................................                        I
                                               I                                                             I
           ..........................................................................                        I
I-----------------    DO 91 J=1,6                                                                            I
I          ..........................................................................                        I
I                                              I                                                             I
I          ..........................................................................                        I
I          .    TPVAL(J)=0.                                                .                                 I
I          ..........................................................................                        I
I                                              I                                                             I
I          ..........................................................................                        I
I I---------------    DO 91 Y=1,II                                         .                                 I
I I        ..........................................................................                        I
I I                                            I                                                             I
I I        ..........................................................................                        I
I I        .    TPVAL(J)=TPVAL(J)+PVAL(J,Y)                                .                                 I
I I        ..........................................................................                        I
I I                                            I                                                             I
I I        ..........................................................................                        I
-----------------*    91 CONTINUE                                          .                                 I
           ..........................................................................                        I
                                               I                                                             I
                                               OK------------------------------------------------------------O
                                               I
           TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
           T  999 RETURN                                                   T
           TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT

           ..........................................................................
           .    END                                                        .
           ..........................................................................
```

```
FORTCHT, VERSION A1     MAINTAINED BY DALE L. SCHAFER,    PHONE 845-1714
 E=ENTRY, T=TERMINAL, C=CALL, R=READ, W=WRITE

                     EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
                     E      SUBROUTINE DIFFER                                                    E
                     EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
                                                          I
                            COMMON /LABA/ASSUMP(9),TABLE(11,70),HDATA(5,5),VOLUME(41),
                           1DMAND(7,41,2),XMAINT(7,41,2),SPEED(7,41,2),CYCLE(7,41,2),
                           2XSPEED(7,41,2,2),XTIME(7,41,2,2),OCOST(7,41,2,2),DIFF(6,41),
                           3PVAL(6,41),ADJCON(7),ALL(4),ACCNUM(7,41,2),ACCICO(7,41,2),
                           4STORE(10),WSPCP1(7,41,2),WSPCP2(7,41,2),TPVAL(8),ICYR3,ICYR4,
                           5XVTIME(7,41,2,2),XMN,SP,WSP1,WSP2,CY,XV(2),XT(2),XSP(2)
                            COMMON/LABB/OCP(5),PVOL(41),IHW(5,41,2),PRS,INDX,AC(4),TPR(4),
                           6XVT(2),XRN(2),XCY(2),OC(2),HSW(5),ACCNO,ACCOST,COST1,
                           7COST2,X1,ITRIAL,Y,NO1,NO2,NO3,NO4,EXSW,ALTSW,ANS,IASW,TAC(4),
                           8ISW,ICYR,ICYR2,IEYR2,IEYR,X,L1,L,EXSTOR(10),CCOST,ECOST,TBLE(5,4),
                                                          I
                     WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                     W     9WP1(7,41,2),WP2(7,41,2),RATIO,RATIO2,II,CINC(2),ASMSEG(5,3),        W
                     W     *BYPS(4),PBYPS(4),PRSW,IN(5),CAP(4),VOL(41,2),DEMAND(6,41,2)         W
                     WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                                          I
                            INTEGER Y,X
                                                          I
                     ..........................................................................
                     .  200 X=X1                                                               .
                     ..........................................................................
                                                          I
                     ..........................................................................
I--------------------       DO 15 Y=1,II                                                       .
I                    ..........................................................................
I                                                         I
I                    C      CALCS THE DIFFERENCE BETWEEN THE DO NOTHING CASE
I                    C      AND THE CONSTRUCTION CASE
I                                                         I
I                    ..........................................................................
I                    .      DIFF(1,Y)=(XTIME(X,Y,1,1)-XTIME(X,Y,2,1)                           .
I                    .     *+XTIME(X,Y,1,2)-XTIME(X,Y,2,2))/1000.                              .
I                    .      DIFF(2,Y)=(XVTIME(X,Y,1,1)-XVTIME(X,Y,2,1)                         .
I                    .     *+XVTIME(X,Y,1,2)-XVTIME(X,Y,2,2))/1000.                            .
I                    .      DIFF(4,Y)=(ACCICO(X,Y,1)-ACCICO(X,Y,2))/1000.                      .
I                    .      DIFF(5,Y)=(XMAINT(X,Y,1)-XMAINT(X,Y,2))/1000.                      .
I                    .      DIFF(3,Y)=(OCOST(X,Y,1,1)-OCOST(X,Y,2,1)                           .
I                    .     *+OCOST(X,Y,1,2)-OCOST(X,Y,2,2))/1000.                              .
I                    .      DIFF(6,Y)=DIFF(2,Y)+DIFF(3,Y)+DIFF(4,Y)+DIFF(5,Y)                  .
I                    ..........................................................................
I                                                         I
I                    C      CALCULATE NET PRESENT VALUE
I                                                         I
I                    ..........................................................................
I I------------------       DO 15 J=1,6                                                        .
I I                  ..........................................................................
I I                                                       I
I I                                                       I
I I                                                       I
I I                                                       I
I I                                                       I
I I                                                       I
1 2 3 4 5 6 7 8 9 0                                                          . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
I I                                    I
I I      .      IF (J.EQ.1) GOTO 50                         *-------------------------V
I I                                    I                                              I
I I      .      PVAL(J,Y)=DIFF(J,Y)/((1.+ASSUMP(6))**(Y-1))  .                        I
I I                                    I                                              I
I I      .      GOTO 15                                     *--------------------V    I
I I                                                                              I    I
I I                                    OK--------------------------------------- I ---O
I I                                    I                                         I
I I      .   50 PVAL(J,Y)=DIFF(J,Y)                          .                   I
I I                                    I                                         I
I I                                    OK----------------------------------------O
I I                                    I
-----------*   15 CONTINUE                                   .
                                       I
I-----------    DO 12 J=1,6                                  .
I                                      I
I        .      TPVAL(J)=0.                                  .
I                                      I
I I---------    DO 12 Y=1,II                                 .
I I                                    I
I I      .      TPVAL(J)=TPVAL(J)+PVAL(J,Y)                  .
I I                                    I
-----------*   12 CONTINUE                                   .
                                       I
         TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
         T      RETURN                                       T
         TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT

         .      END                                          .
```

```
FORTCHT, VERSION A1     MAINTAINED BY DALE L. SCHAFER,   PHONE 845-1714
 E=ENTRY, T=TERMINAL, C=CALL, R=READ, W=WRITE

                     EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
                     E       SUBROUTINE TOTAL                                                        E
                     EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
                                                         I
                            COMMON /LABA/ASSUMP(9),TABLE(11,70),HDATA(5,5),VOLUME(41),
                           1DMAND(7,41,2),XMAINT(7,41,2),SPEED(7,41,2),CYCLE(7,41,2),
                           2XSPEED(7,41,2,2),XTIME(7,41,2,2),OCOST(7,41,2,2),DIFF(6,41),
                           3PVAL(6,41),ADJCON(7),ALL(4),ACCNUM(7,41,2),ACCICO(7,41,2),
                           4STORE(10),WSPCP1(7,41,2),WSPCP2(7,41,2),TPVAL(8),ICYR3,ICYR4,
                           5XVTIME(7,41,2,2),XMN,SP,WSP1,WSP2,CY,XV(2),XT(2),XSP(2)
                            COMMON/LABB/OCP(5),PVOL(41),IHW(5,41,2),PRS,INDX,AC(4),TPR(4),
                           6XVT(2),XRN(2),XCY(2),OC(2),HSW(5),ACCNO,ACCOST,COST1,
                           7COST2,X1,ITRIAL,Y,NO1,NO2,NO3,NO4,EXSW,ALTSW,ANS,IASW,TAC(4),
                           8ISW,ICYR,ICYR2,IEYR2,IEYR,X,L1,L,EXSTOR(10),CCOST,ECOST,TBLE(5,4),
                                                         I
                     WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                     W      9WP1(7,41,2),WP2(7,41,2),RATIO,RATIO2,II,CINC(2),ASMSEG(5,3),          W
                     W      *BYPS(4),PBYPS(4),PRSW,IN(5),CAP(4),VOL(41,2),DEMAND(6,41,2)           W
                     WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
                                                         I
                            INTEGER Y,X
                                                         I
                     ..................................................................................
                     .      X=X1                                                                      .
                     ..................................................................................
                                                         I
                     ..................................................................................
I--------------------  200 DO 105 Y=1,II                                                              .
I                    ..................................................................................
I                                                        I
I                    ..................................................................................
I I------------------       DO 100 L1=NO1,NO2                                                         .
I I                  ..................................................................................
I I                                                      I
I I                  ..................................................................................
I I                  .      IF (Y.GT.1) GOTO 10                                                       *---------------------------------V
I I                  ..................................................................................                                  I
I I                                                      I                                                                                I
I I                  ..................................................................................                                  I
I I                  .      IF (NO1.GT.1.AND.NO1.LT.5) GOTO 10                                        *---------------------------------V
I I                  ..................................................................................                                  I
I I                                                      I                                                                                I
I I                  ..................................................................................                                  I
I I                  .      ADJCON(X)=ADJCON(X)+ADJCON(L1)                                            .                                  I
I I                  ..................................................................................                                  I
I I                                                      I                                                                                I
I I                                                      OK-------------------------------------------------------------------------------O
I I                                                      I
I I                  ..................................................................................
I I I----------------   10 DO 100 L2=1,2                                                              .
I I I                ..................................................................................
I I I                                                    I
I I I                                                    I
I I I                                                    I
I I I                                                    I
I I I                                                    I
1 2 3 4 5 6 7 8 9 0                                                          . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
```

```
      DMAND(X,Y,L2)=DMAND(X,Y,L2)+DMAND(L1,Y,L2)
      WSPCP1(X,Y,L2)=WSPCP1(X,Y,L2)+WSPCP1(L1,Y,L2)
      WSPCP2(X,Y,L2)=WSPCP2(X,Y,L2)+WSPCP2(L1,Y,L2)
      ACCNUM(X,Y,L2)=ACCNUM(X,Y,L2)+ACCNUM(L1,Y,L2)
      ACCICO(X,Y,L2)=ACCICO(X,Y,L2)+ACCICO(L1,Y,L2)
      XMAINT(X,Y,L2)=XMAINT(X,Y,L2)+XMAINT(L1,Y,L2)
      CYCLE(X,Y,L2)=CYCLE(X,Y,L2)+CYCLE(L1,Y,L2)

      IF(L1.GE.5) GO TO 75

      WP1(L1,Y,L2) = WSPCP1(L1,Y,L2)
      WP2(L1,Y,L2) = WSPCP2(L1,Y,L2)
                                   OK
   75 CONTINUE

      IF(L1.GT.2.AND.L1.LT.5) GO TO 99

      IF(L1.EQ.1.AND.L2.EQ.2.AND.Y.GE.ICYR) GO TO 99

      WP1(X,Y,L2)=WP1(X,Y,L2)+WP1(L1,Y,L2)
      WP2(X,Y,L2)=WP2(X,Y,L2)+WP2(L1,Y,L2)
                                   OK
   99 DO 100 L3=1,2

      XTIME(X,Y,L2,L3)=XTIME(X,Y,L2,L3)+XTIME(L1,Y,L2,L3)
      XVTIME(X,Y,L2,L3)=XVTIME(X,Y,L2,L3)+XVTIME(L1,Y,L2,L3)
      OCOST(X,Y,L2,L3)=OCOST(X,Y,L2,L3)+OCOST(L1,Y,L2,L3)

  100 CONTINUE
```

```
1 2 3 4 5 6 7 8 9 0                      PAGE  3                       . 9 . 8 . 7 . 6 . 5 . 4 . 3 . 2 . 1
I                                              I
I                    ...........................................................
--------------------*   105 CONTINUE                                          .
                     ...........................................................
                                               I
                     TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
                     T      RETURN                                            T
                     TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT

                     ...........................................................
                     .      END                                               .
                     ...........................................................
```

```
FORTCHT, VERSION A1     MAINTAINED BY DALE L. SCHAFER,    PHONE 845-1714
 E=ENTRY, T=TERMINAL, C=CALL, R=READ, W=WRITE

                     EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
                     E      SUBROUTINE INIT                                                      E
                     EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
                                                          I
                            COMMON /LABA/ASSUMP(9),TABLE(11,70),IDUM(9784)
                            COMMON /LABB/KDUM(2298)
                                                          I
                     ............................................................................
I--------------------       DO 100 I=1,9784                                                     .
I                    ............................................................................
I                                                         I
I                    ............................................................................
I                    .      IDUM(I)=0                                                           .
I                    ............................................................................
I                                                         I
I                    ............................................................................
--------------------*   100 CONTINUE                                                            .
                     ............................................................................
                                                          I
                     ............................................................................
I--------------------       DO 200 J=1,2298                                                     .
I                    ............................................................................
I                                                         I
I                    ............................................................................
I                    .      KDUM(J)=0                                                           .
I                    ............................................................................
I                                                         I
I                    ............................................................................
--------------------*   200 CONTINUE                                                            .
                     ............................................................................
                                                          I
                     TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
                     T      RETURN                                                              T
                     TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT


                     ............................................................................
                     .      END                                                                 .
                     ............................................................................
```

Variable Dictionary

Main Program

ACCICO(7,41,2)	accident costs, ACCICO(6,Y,J2) = segment annual accident costs for year Y and calculation type J2
ACCNUM(7,41,2)	number of accidents, ACCNUM(6,Y,J2) = segment annual number of accidents for year Y and calculation type J2
ADD	scaling variable for output graphs
ADJCON(7)	discounted construction and expansion cost
ALL(4)	variable to control the corridor traffic allocation, ALL(1) = route with highest capacity, ALL(2) = route with second highest capacity, ALL(3) = route with third highest capacity, ALL(4) = route with lowest capacity
ALTSW	alternate route switch, ALTSW = 1 if there is an alternate route, ALTSW = 0 otherwise
ASMSEG(5,3)	segment assumptions for each highway IX, ASMSEG(IX,1) = % trucks/buses, ASMSEG(IX,2) = car/van occupancy rate, ASMSEG(IX,3) = trucks/bus occupancy rate
ASSUMP(9)	initial assumptions, ASSUMP(1) = % trucks, ASSUMP(2) = value of car time ($/min), ASSUMP(3) = value of truck time ($/min), ASSUMP(4) = inflation rate (%), ASSUMP(5) = construction cost escalation rate (%), ASSUMP(6) = discount rate (%), ASSUMP(7) = speed on rural diversion routes (MPH), ASSUMP(8) = speed on urban diversion routes (MPH)
AVAR(2)	projected traffic volumes (000) from input data
BLANKS	array to blank out output line
BYPS(4)	HOV bypass switch for each highway, 0 or blank = no HOV bypass, 1 = HOV bypass

CARD	temporary storage for input data
CCOST	construction cost which has not been discounted, used to calculate internal rate of return
CINC(2)	HOV segment assumptions, CINC(1) = bus inconvenience costs ($/mile), CINC(2) = van/carpool inconvenience cost ($/mile)
COST1	segment construction cost
COST2	segment expansion cost
CP16Y1(41)	system sum of the daily vehicle miles multiplied by the average speed, for the existing corridors each year
CP16Y2(41)	system sum of the daily vehicle miles multiplied by the average speed, for the proposed corridors each year
CP26Y1(41)	system daily vehicle miles for the existing corridors each year
CP26Y2(41)	system daily vehicle miles for the proposed corridors each year
CYCLE(7,41,2)	number of cycles, CYCLE(6,Y,J2) = segment number of cycles per vehicle mile, for year Y, and calculation type J2
DEMAND(6,41,2)	person demand allocated to corridor routes for year Y and calculation type J2, DEMAND(1,Y,J2) = persons on existing route, DEMAND(2,Y,J2) = persons on proposed route, DEMAND(3,Y,J2) = persons on expansion route, DEMAND(4,Y,J2) = persons on alternate route, DEMAND(5,Y,J2) = persons on diversion route
DIFF(6,41)	difference between do-nothing and construct for year Y, DIFF(1,Y) = delay time (000 min), DIFF(2,Y) = delay cost ($000), DIFF(3,Y) = vehicle operating cost ($000), DIFF(4,Y) = accident cost ($000), DIFF(5,Y) = maintenance cost ($000), DIFF(6,Y) = DIFF(2,Y)+DIFF(3,Y)+DIFF(4,Y)+DIFF(5,Y)

DIS	variable used to calculate internal rate of return
DMAND(7,41,2)	vehicle demand allocated to corridor routes for year Y and calculation type J2, DMAND(1,Y,J2) = vehicles on existing route, DMAND(2,Y,J2) = vehicles on proposed route, DMAND(3,Y,J2) = vehicles on expansion route, DMAND(4,Y,J2) = vehicles on alternate route, DMAND(5,Y,J2) = vehicles on diversion route
DVM1	existing corridor daily vehicle miles (000), used to output data
DVM2	proposed corridor daily vehicle miles (000), used to output data
DVM3	existing state facility daily vehicle miles (000), used to output data
DVM4	proposed state facility daily vehicle miles (000), used to output data
ECOST	expansion cost which has not been discounted, used to calculate internal rate of return
EXSTOR(10)	array to store expansion parameters for optimization
EXSW	existing, alternate buildover switch, 0 or blank = no build-over, 1 = buildover existing route, 2 = buildover alternate route, 3 = buildover existing and alternate routes
GRWRTE(3,2)	array to print out headings for output data
HDAT(4)	highway type for each highway in corridor segment
HDATA(5,5)	array for data on each segment highway IX, HDATA(IX,1) = length (miles), HDATA(IX,2) = safety factor (base = 100), HDATA(IX,3) = technical performance factor (base = 100), HDATA(IX,4) = speed limit (mph)

HIWAY	switch used to indicate the highway type, 1 = existing, 2 = proposed, 3 = expansion, 4 = alternate
HLDTIT(99,6)	description for each problem, up to 99 problems, used in system summary
HMMSG(20)	array to print out headings for output data
HSW(5)	index to indicate proper data column from the BLOCK DATA for each highway in corridor segment
HT(58)	array containing valid highway types, used for editing and establishing TABLE index
HWAY	index to read in highway segment cards
I	index to set initial assumptions
I1	difference between the first projected year and the current year
I2	difference between the second projected year and the current year
I3	index to calculate each projected traffic volume
IB	index to set scale increments for output graphs
IC	index to set initial average occupancy rates for all routes in segment
ICKFLG	variable used to detect urban and rural facility types in same segment
ICKTYP	the latest facility type read in
ICT	the previous facility type read in, and used as a counter in the internal rate of return iteration
ICTYPE	card type on input data cards (1-6)
ICYR	construction year, converted to difference between construction year plus one and current year

ICYR2	best construction year in optimization run
ICYR3	maximum expansion year for optimization
ICYR4	maximum construction year for optimization
ICYRD	calendar construction year, used to print out construction year for output data
IDUM	switch, = 1 if add-lane highway type being used without a HOV lane, = 0 otherwise
IEND	skipping index, variable to indicate years to print for output, if IEND = 1 then each year will be printed, if IEND = 2 then every other year will be printed
IEYR	expansion year, converted to difference between expansion year plus one and current year
IEYR2	best expansion year in optimization run
IEYRD	calendar expansion year, used to print out expansion year for output data
IFLAG	variable used to indicate the last card type read in
II	planning horizon plus one (2-41)
INC(13)	scale incements for output graphs
INM	index for proper column from BLOCK DATA, used to adjust parameters for speed limit different then one assumed in the BLOCK DATA
IPNO	problem number
IPROB	the number of problems in a run
IPYR(2)	projected years for the two projected traffic volumes that are input
IRR	internal rate of return, vehicle is iterated, and printed out if a solution is found

ISEG	segment number
ISEGNO	segment number read in from input data
ISFLAG	variable used to indicate error which could affect system summary
ISW	switch to determine type of run, 1 = regular, 2 = optimize construction year, 3 = optimize construction and expansion years, 4 = optimize expansion year only
ISYR	planning horizon (1-40)
ITRIAL	optimization switch, 0 = regular run, 1 = optimization run
IX	switch used to indicate the highway type, 1 = existing, 2 = proposed, 3 = expansion, 4 = alternate, also used to indicate the integer version of X1
IYR	current year
IYRD	year for which data are being printed out for output
J	index to check the highway type read from input data
J1	variable used to clear out arrays before processing next segment
J2	variable used to clear out arrays before processing next segment, 1 = do-nothing, 2 = construct
J3	variable used to clear out arrays before processing next segment, 1 = car, 2 = truck
K	column position for symbol as each line is generated for output graphs
KAST	variable used to place multiple entry symbol in output graphs
KBLANK	variable used to test if more than one symbol occupies the same position in output graphs
KLTR(8)	symbols for allocation graphs

L	index indicating calculation type, 1 = do-nothing, 2 = construct
LINE(121)	array used to print out each line for each graph, it is all blank initially, with symbols added to the appropriate columns
LX	index to put symbols in line for output graphs
LY	index to put symbols in line for output graphs
LZ	index to blank out each line in output graphs
M	index used to print out traffic allocations, 1 = do-nothing traffic allocation, 2 = if construct traffic allocation
M1	index to zero out adjusted BLOCK DATA values
M2	index to zero out adjusted BLOCK DATA values
MAX	variable used in output graphs
MIN	variable used in output graphs
MIX	switch to indicate mix of facility types (rural and urban highway types in same segment)
MYWAY	variable used to print highway type description
NO1	variable used to indicate lower bound of elements to be summed in total subroutine, when X1 = 6, NO1 = 1, and when X1 = 7, NO1 = 6
NO2	variable used to indicate upper bound of elements to be summed in total subroutine, when X1 = 6, NO2 = 5, and when X1 = 7, NO2 = 6
NO3	variable to hold minimum range in calculations: in regular run NO3 = 1, in optimum run NO3 = 1 for do-nothing calculation, and NO3 = 2 for each construct iteration
NO4	variable to hold maximum range in calculations: in regular run NO4 = 2, in optimum run NO4 = 1 for do-nothing calculation, and NO4 = 2 for each construct iteration

OCOST(7,41,2,2)	operating cost, OCOST(6,Y,J2,J3) = segment annual operating cost for year Y, calculation type J2, and vehicle type J3
OCP(5)	occupancy rate for each highway in segment, it is the weighted average of the car and truck occupancy rates
P	temporary net present value which is iterated to zero in internal rate of return iteration
P1	first derivitive of P, used in internal rate of return iteration
PBYPS(4)	percent vehicles to use HOV bypass for each highway
PROFIT(6)	problem description
PRSW	proposed buildover switch, 0 or blank = buildover of proposed with expansion, 1 = no buildover
PV	net present value to be printed out
PVAL(6,41)	category benefits each year Y, PVAL(1,Y) = hours of delay savings (000), PVAL(2,Y) = net present value of delay savings ($000), PVAL(3,Y) = net present value of reduction in operating costs ($000), PVAL(4,Y) = net present value of reduction in accident costs ($000), PVAL(5,Y) = net present value of reduction in maintenance costs ($000), PVAL(6,Y) = net present value of total benefits ($000)
PVOL(41)	corridor projected number of persons for each year
R	temporary discount rate used in internal rate of return iteration
R1	difference between the first projected year and the current year
R1Y1	average existing state facility speed
R2	difference between the second projected year and the current year

R2Y2	average proposed state facility speed
R5Y1	segment average existing corridor speed
R5Y2	segment average proposed corridor speed
R6Y1	problem or system average existing corridor speed
R6Y2	problem or system average proposed corridor speed
RA	variable used to test internal rate of return iteration
RATIO	benefit-cost ratio to be printed out
RAX	variable used in traffic allocation graphs
RT	ratio of R1 and R2
RUNTPE(10,4)	array to print out headings for output data
S	slope term in calculating projected traffic volumes
S1	intercept term in calculating projected traffic volumes
SEGTIT(8)	segment description
SEM	system benefit-cost ratio
SPV	system net present value (000)
STORE(10)	array to store proposed parameters for optimization
SVAL(8)	system component net present values (000), SVAL(2) = delay savings, SVAL(3) = reduction in operating costs, SVAL(4) = reduction in accident costs, SVAL(5) = reduction in maintenance costs, SVAL(6) = total benefits, SVAL(7) = construction costs
SYSCST	system undiscounted construction cost, including expansions if any
TASSP(8)	temporary array to hold initial assumptions when they are read in
TBLE(5,4)	adjusted parameters for highway IX, values from the BLOCK DATA are adjusted for speed limits different than those assumed in the BLOCK DATA. TBLE(3,IX) = adjusted beginning speed (mph),

	TBLE(4,IX) = adjusted break point speed (mph), TBLE(5,IX) = adjusted capacity speed (mph)
TI1(5)	array to print out headings for output data
TI2(5)	array to print out headings for output data
TI3(5)	array to print out headings for output data
TI4(5)	array to print out headings for output data
TIT(7,21)	array used to print out headings for output data
TMAX	maximum value in setting scale for output graphs
TMIN	minimum value in setting scale for output graphs
TPVAL(8)	problem component net present values (000), TPVAL(2) = delay savings, TPVAL(3) = reduction in operating csots, TPVAL(4) = reduction in accident costs, TPVAL(5) = reduction in maintenance costs, TPVAL(6) = total benefits, TPVAL(7) = construction cost
TSPD	speed limit for current highway being processed
VOLUME(41)	corridor traffic volume each year (000), input for current year and two projected years, calculated for other years
WP1(7,41,2)	state facility sum of daily vehicle miles multiplied by the average speed for each year Y, WP1(6,Y,1) = existing segment, WP1(6,Y,2) = proposed segment, WP1(7,Y,1) = existing problem, WP1(7,Y,2) = proposed problem
WP11Y1(41)	system sum of the daily vehicle miles multiplied by the average speed, for the existing state facility each year
WP12Y2(41)	system sum of the daily vehicle miles multiplied by the average speed, for the proposed state facility each year
WP2(7,41,2)	state facility sum of daily vehicle miles for each year Y, WP2(6,Y,1) = existing segment, WP2(6,Y,2) = proposed segment,

	WP2(7,Y,1) = existing problem, WP2(7,Y,2) = proposed problem
WP21Y1(41)	system daily vehicle miles for the existing state facility each year
WP22Y2(41)	system daily vehicle miles for the proposed state facility each year
WSPCP1(7,41,2)	corridor sum of daily vehicle miles multiplied by the average speed each year Y, WSPCP(6,Y,1) = existing segment, WSPCP(6,Y,2) = proposed segment, WSPCP1(7,Y,1) = existing problem, WSPCP1(7,Y,2) = proposed problem
WSPCP2(7,41,2)	corridor sum of daily vehicle miles for each year Y, WSPC2(6,Y,1) = existing segment, WSPCP2(6,Y,2) = proposed segment, WSPCP2(7,Y,1) = existing problem, WSPCP2(7,Y,2) = proposed problem
X1	discounted expansion cost; also used to indicate type of total when totals are accumulated, when X1 = 6, segment totals are accumulated, when X1 = 7, problem/system totals are accumulated
Y	index for year (1-41)
YR	calendar year printed out for traffic allocation graphs

EXPAND Subroutine

ADJCON(7)	discounted construction and expansion cost
ASSUMP(9)	initial assumptions, ASSUMP(5) = construction cost escalation rate (%), ASSUMP(6) = discount rate (%)
CCOST	construction cost which has not been discounted
COST1	segment construction cost
COST2	segment expansion cost

DEMAND(6,41,2)	if construct person demand on corridor routes for year Y, DEMAND(1,Y,2) = persons on existing route, DEMAND(2,Y,2) = persons on proposed route, DEMAND(3,Y,2) = persons on expansion route, DEMAND(4,Y,2) = persons on alternate route, DEMAND(5,Y,2) = persons on diversion route
DIFF(6,41)	difference between do-nothing and construct for year Y, DIFF(1,Y) = delay time (000 min), DIFF(2,Y) = delay cost ($000), DIFF(3,Y) = vehicle operating cost ($000), DIFF(4,Y) = accident cost ($000), DIFF(5,Y) = maintenance cost ($000), DIFF(6,Y) = DIFF(2,Y)+DIFF(3,Y)+DIFF(4,Y)+ DIFF(5,Y)
DMAND(7,41,2)	if construct vehicle demand on corridor routes for year Y, DMAND(1,Y,2) = vehicles on existing route, DMAND(2,Y,2) = vehicles on proposed route, DMAND(3,Y,2) = vehicles on expansion route, DMAND(4,Y,2) = vehicles on alternate route, DMAND(5,Y,2) = vehicles on diversion route
ECOST	expansion cost which has not been discounted
I2	index to clear out arrays each time through the loops to find the optimal year(s)
ICYR	difference between the construction year plus one and the current year
ICYR1	index of construction year in optimization
ICYR2	best construction year found in optimization
ICYR3	maximum expansion year for optimization
ICYR4	maximum construction year for optimization
IEYR	difference between the expansion year plus one and the current year
IEYR2	best expansion year found in optimization

IEYR3	index for expansion year in optimization
II	planning horizon plus one (2-41)
ISW	switch to determine type of run, 1 = regular, 2 = optimize construction year, 3 = optimize construction and expansion years, 4 = optimize expansion year only
L	index indicating calculation type, L = 2 so only construct calculation will be repeated
NO3	variable to hold minimum range in calculations, NO3 = 2 so only construct calculation will be repeated
NO4	variable to hold maximum range in calculations, NO4 = 2 so only construct calculation will be repeated
PRSW	proposed buildover switch, 0 = buildover of proposed with expansion, 1 = no buildover
PVAL(6,41)	category of benefits for each year Y, PVAL(1,Y) = hours of delay savings (000), PVAL(2,Y) = net present value of delay savings ($000), PVAL(3,Y) = net present value of reduction in operating costs ($000), PVAL(4,Y) = net present value of reduction in accident costs ($000), PVAL(5,Y) = net present value of reduction in maintenance costs ($000), PVAL(6,Y) = net present value of total benefits ($000)
RATIO	highest benefit-cost ratio found in optimization
RATIO2	value of current benefit-cost ratio during optimization
TPVAL(8)	problem component net present values (000), TPVAL(6) = total benefits, TPVAL(7) = construction cost
X1	discounted expansion cost
Y	index for year (1-41)

CRDMND Subroutine

AC(4)	array to hold current daily cost per person for each highway
ALL(4)	variable to control person allocation, ALL(1) = route with highest capacity, ALL(2) = route with second highest capacity, ALL(3) = route with third highest capacity, ALL(4) = route with lowest capacity
CAP(4)	vehicle capacity of each route, adjusted by the technical performance factor
CMAX	highest cost per person among the routes during the traffic allocation iteration
CMIN	lowest cost per person among the routes during the traffic allocation iteration
DEMAND(6,41,2)	person demand allocated to corridor routes for year Y, and calculation type L, DEMAND(1,Y,L) = persons on existing route, DEMAND(2,Y,L) = persons on proposed route, DEMAND(3,Y,L) = persons on expansion route, DEMAND(4,Y,L) = persons on alternate route, DEMAND(5,Y,L) = persons on diversion route
DMAND(7,41,2)	vehicle demand allocated to corridor routes for year Y, and calculation type L, DMAND(1,Y,L) = vehicles on existing route, DMAND(2,Y,L) = vehicles on proposed route, DMAND(3,Y,L) = vehicles on expansion route, DMAND(4,Y,L) = persons on alternate route, DMAND(5,Y,L) = vehicles on diversion route
EXSW	existing, alternate buildover switch, 0 = no buildover, 1 = buildover existing route, 2 = buildover alternate route, 3 = buildover existing and alternate routes
HDATA(5,5)	array for data on each segment highway LX, HDATA(LX,3) = technical performance factor (base = 1)

HSW(5)	index to indicate proper data column from BLOCK DATA for each highway in corridor segment
I	index used to sort capacities from highest to lowest
IALL	integer form of ALL(K), used as array index
ICYR	difference between construction year plus one and current year
IEYR	difference between expansion year plus one and current year
IHSW	temporary variable to hold current value of HSW(LX)
IHW(5,41,2)	array to hold highways which should receive person allocation, highway K, year Y, and calculation type L
II	planning horizon plus 1 (2-41)
IMAX	index of the route with the highest cost per person in the person allocation iteration
IMIN	index of the route with the lowest cost per person in the person allocation iteration
IN(5)	switch to indicate whether or not any persons should be allocated to highway K, IN(K) = 1 if persons should be allocated to K, IN(K) = 0 otherwise
INDX	temporary index of corridor highway, used to calculate average cost per person in allocation process
IT	temporary variable for the current highway in resetting the highest and lowest cost routes after each iteration
J	index used to sort capacities from highest to lowest
JT	index used to store the order of allocation after the capacities have been sorted
K	index used to eliminate all highways from allocation process which should not receive persons

L	index to sort capacities from highest to lowest, also used to indicate calculation type, 1 = do-nothing, 2 = construct
L1	index used to convert person allocation into vehicle allocation
L3	index used to reset the highest and lowest cost routes after each iteration, also used to indicate the current highway in the adjustment loops for allocated persons above capacity
L4	index used to make adjustments to allocation for any route with allocated persons above capacity
L5	index used to make adjustments to allocation for any route with allocated persons above capacity
LL	index used to reset values each loop through allocation iteration
LL3	index to initially allocate all persons to route with highest capacity
LX	index used to sort capacities from highest to lowest
NHY	total number of highways persons being allocated to in the allocation iteration
NO3	variable to hold minimum range in calculations: in regular run NO3 = 1, in optimum run NO3 = 1 for do-nothing calculation, and NO3 = 2 for each construct iteration
NO4	variable to hold maximum range in calculations: in regular run NO4 = 2 in optimum run, NO4 = 1 for do-nothing calculation, and NO4 = 2 for each construct iteration
OCP(5)	occupancy rate for each highway in segment, it is the weighted average of the car and truck occupancy rates

PRS	number of persons temporarily assigned to a corridor highway, used to calculate the average cost per person in the allocation process
PRSW	proposed buildover switch, 0 = buildover of proposed highway, 1 = no buildover
PVOL(41)	corridor projected number of persons each year
STAB	excess number of persons which cannot be allocated to any corridor rute because they are at capacity, the excess becomes the persons assigned to the diversion route
T	temporary variable for current capacity, used in sorting of capacities from highest to lowest
T1	temporary variable for highway number, used in sorting capacities from highest to lowest
TABLE(11,70)	values of parameters in the BLOCK DATA for highway IHSW, TABLE(1,IHSW) = capacity (ADT)
TAC(4)	array to hold average cost per person for each corridor highway at 2% capacity
TALL(4)	array to hold order of initial allocation
TPR(4)	person capacity of each highway LX
X1	initially corridor person demand for current allocation, then becomes the number of persons switched from the highest cost route to the lowest cost route during each iteration
Y	index for year (1-41)

<u>AVCOST Subroutine</u>

AC(4)	array to hold current daily cost per person for each highway

ASMSEG(5,3)	segment assumptions for highway L1, ASMSEG(L1,1) = % trucks/buses, ASMSEG(L1,2) = car/van occupancy rate, ASMSEG(L1,3) = truck/bus occupancy rate
ASSUMP(9)	initial assumptions, ASSUP(2) = value of car time ($/min), ASSUMP(3) = value of truck time ($/min)
BPR	2% of the person capacity of highway L1
BSP	HOV bypass speed, used to calculate adjustment to time costs with an HOV bypass
CCY	car daily cycling costs per person
CINC(2)	HOV segment assumptions, CINC(1) = bus inconvenience costs ($/mile), CINC(2) = van/carpool inconvenience cost ($/mile)
CY	number of cycles per vehicle mile
HDATA(5,5)	array for delay on highway L1, HDATA(L1,1) = length (miles), HDATA(L1,2) = safety factor (base = 1), HDATA(L1,3) = technical performance factor (base = 1)
HSW(5)	index to indicate proper data column from BLOCK DATA for highway L1
INDX	index of current highway for which average cost per person is to be calculated
L1	index of current highway for whcih average cost per person is to be calculated
OCP(5)	occupancy rate for highway L1, it is the weighted average of the car and truck occupancy rates
PAC	daily accident cosat per person ($)
PC	percentage cars (converted to decimal form)
PCY	daily cycling costs per person ($)
PR	daily running costs per person ($)

PRS	number of persons allocated to highway L1
PT	percentage trucks (converted to decimal form)
PVT	daily time cost per person ($)
RC	car daily running costs per person ($)
RT	truck daily running cost per person ($)
SP	average speed (mph)
TABLE(11,70)	BLOCK DATA parameters for highway X, TABLE(1,X) = capacity (ADT), TABLE(2,X) = breakpoint (ADT), TABLE(6,X) = intercept term for cycles per vehicle mile, TABLE(7,X) = slope term for cycles per vehicle mile, TABLE(8,X) = mean cost per accident ($), TABLE(9,X) = intercept term for accident rate per million vehicle miles, TABLE(10,X) = slope term for accident rate per million vehicle miles
TAC(4)	average cost per person at 2% capacity for highway L1
TBLE(5,4)	adjusted parameters from BLOCK DATA for highway L1, TBLE(3,L1) = adjused beginning speed (mph), TBLE(4,L1) = adjusted break-point speed (mph), TBLE(5,L1) = adjusted capacity speed (mph)
TCY	truck daily cycling costs per person ($)
TPR(4)	person capacity of highway L1
V	number of vehicles (ADT) allocated to highway L1
X	index to indicate proper data column from BLOCK DATA for highway L1

<u>CALC03 Subroutine</u>

ACCICO(7,41,2)	array to hold annual accident costs for highway X, year Y, and calculation type L
ACCNO	annual number of accidents

ACCNUM(7,41,2)	array to hold number of accidents for highway X, year Y, and calculation type L
ACCOST	annual accident costs
ADJCON(7)	discounted construction and expansion cost
ASMSEG(5,3)	segment assumptions for each highway L1, ASMSEG(L1,1) = % trucks/buses, ASMSEG(L1,2) = car/van occupancy rate, ASMSEG(L1,3) = truck/bus occupancy rate
ASSUMP(9)	initial assumptions, ASSUMP(2) = value of car time ($/min), ASSUMP(3) = value of truck time ($/min), ASSUMP(4) = inflation rate, ASSUMP(5) = construction cost escalation rate, ASSUMP(6) = discount rate, ASSUMP(7) = speed on rural diversion routes (mph), ASSUMP(8) = speed on urban diversion routes (mph)
BSP	HOV bypass speed, used to calculate adjustment to time costs with an HOV bypass
BYPS	HOV bypass switch, 0 = no HOV bypass, 1 = HOV bypass
CCOST	construction cost which has not been discounted
CINC(2)	HOV segment assumptions, CINC(1) = bus inconvenience costs ($/mile), CINC(2) = van/carpool inconvenience cost ($/mile)
COST1	segment construction cost
COST2	segment expansion cost
CY	number of cycles per vehicle mile
CYCLE(7,41,2)	array to hold the number of cycles per vehicle mile for highway X, year Y, and calculation type L
DIFF(6,41)	difference between do-nothing and construct for year Y, DIFF(1,Y) = delay time (000 min), DIFF(2,Y) = delay cost ($000), DIFF(3,Y) = vehicle operating cost ($000), DIFF(4,Y) =

	accident cost ($000), DIFF(5,Y) = maintenance cost ($000), DIFF(6,Y) = DIFF(2,Y)+DIFF(3,Y)+DIFF(4,Y)+DIFF(5,Y)
DMAND(7,41,2)	vehicle demand allocated to highway L1, for year Y, and calculation type L
ECOST	expansion cost which has not been discounted
HDATA(5,5)	array for data on each highway L1, HDATA(L1,1) = length (miles), HDATA(L1,2) = safety factor (base = 1), HDATA(L1,3) = technical performance factor (base = 1)
HSW(5)	index to indicate proper data column from BLOCK DATA for each highway L1
ICYR	difference between the construction year plus one and the current year
IEYR	difference between the expansion year plus one and the current year
IHW(5,41,2)	array to indicate if costs should be calculated for highway L1, year Y, and calculation type L, IHW(L1,Y,L) = 1 if costs should be calculated, IHW(L1,Y,L) = 0 otherwise
ITRIAL	optimization switch, 0 = regular run, 1 = optimization run
J	index used to calculate present value
L	index indicating calculation type, L = 1 do-nothing, L = 2 construct
L1	index for highway type, 1 = existing, 2 = proposed, 3 = expansion, 4 = alternate, 5 = diversion
L2	index for vehicle type, 1 = car, 2 = truck
OC(2)	total annual operating costs for each vehicle type L2
OCOST(7,41,2,2)	array to hold total annual operating costs for highway X, year Y, calculation type L, and vehicle type L2

PVAL(6,41)	category of benefits for each year Y, PVAL(1,Y) = hours of delay savings (000), PVAL(2,Y) = net present value of delay savings ($000), PVAL(3,Y) = net present value of reduction in operating costs ($000), PVAL(4,Y) = net present value of reduction in accident costs ($000), PVAL(5,Y) = net present value of reduction in maintenance costs ($000), PVAL(6,Y) = net present value of total benefits ($000)
SLOP1	slope term for upper portion of speed-volume curve
SLOP2	slope term for lower portion of speed-volume curve
SP	average speed (mph)
SPEED(7,41,2)	array to hold average speed for highway X, year Y, and calculation type L
TABLE(11,70)	BLOCK DATA parameters for each highway X, TABLE(1,X) = capacity (ADT), TABLE(2,X) = breakpoint (ADT), TABLE(6,X) = intercept term for cycles per vehicle mile, TABLE(7,X) = slope term for cycles per vehicle mile, TABLE(8,X) = mean cost per accident ($), TABLE(9,X) = intercept term for accident rate per million vehicle miles, TABLE(10,X) = slope term for accident rate per million vehicle miles
TBLE(5 4)	adjusted parameters from BLOCK DATA for each highway L1, TBLE(3,L1) = adjused beginning speed (mph), TBLE(4,L1) = adjusted breakpoint speed (mph), TBLE(5,L1) = adjusted capacity speed (mph)
TPVAL(8)	total of present values over the planning horizon
VT(2)	value of time for each vehicle type L2, adjusted for segment occupancy rates
WSP1	highway daily vehicle miles multiplied by the average speed

WSP2	highway daily vehicle miles
WSPCP1(7,41,2)	array to hold daily vehicle miles multiplied by the average speed for highway X, year Y, and calculation type L
WSPCP2(7,41,2)	array to hold daily vehicle miles for highway X, year Y, and calculation type L
X	index to indicate proper data column from BLOCK DATA for highway L1, also used to equal L1 in moving values to final arrays
XCY(2)	daily cycling costs for vehicle type L2 ($)
XMAINT(7,41,2)	array to hold yearly maintenance costs for highway X, year Y, and calculation type L
XMN	yearly maintenance cost ($)
XNTCP	intercept term for lower portion of speed-volume curve
XRN	daily running costs for vehicle type L2 ($)
XSP(2)	average speed for vehicle type L2 (mph)
XSPEED(7,41,2,2)	array to hold average speed for highway X, year Y, calculation type L, and vehicle type L2
XT(2)	annual elapsed time in minutes for each vehicle type L2
XTIME(7,41,2,2)	array to hold annual elapsed time in minutes for highway X, year Y, calculation type L, and vehicle type L2
XV(2)	vehicle demand by vehicle type L2
XVT(2)	annual value of elapsed time for each vehicle type L2
XVTIME(7,41,2,2)	array to hold annual value of elapsed time for highway X, year Y, calculation type L, and vehicle type L2
Y	index for year (1-41)

<u>DIFFER Subroutine</u>

ACCICO(7,41,2)	annual accident costs for total X and year Y, ACCICO(X,Y,1) =

do-nothing, ACCICO(X,Y,2) = construct

ASSUMP(9)	initial assumptions, ASSUMPT(6) = discount rate
DIFF(6,41)	difference between do-nothing and construct for year Y, DIFF(1,Y) = delay time (000 min), DIFF(2,Y) = delay cost ($000), DIFF(3,Y) = vehicle operating cost ($000), DIFF(4,Y) = accident cost ($000), DIFF(5,Y) = maintenance cost ($000), DIFF(6,Y) = DIFF(2,Y)+DIFF(3,Y)+DIFF(4,Y)+DIFF(5,Y)
II	planning horizon plus one (2-41)
J	index used to calculate present values
OCOST(7,41,2,2)	total annual operating costs for total X and year Y; OCOST(X,Y,1,1) = do-nothing, cars; OCOST(X,Y,1,2) = do-nothing, trucks; OCOST(X,Y,2,1) = construct, cars; OCOST(X,Y,2,2) = construct, trucks
PVAL(6,41)	category of benefits for each year Y, PVAL(1,Y) = hours of delay savings (000), PVAL(2,Y) = net present value of delay savings ($000), PVAL(3,Y) = net present value of reduction in operating costs ($000), PVAL(4,Y) = net present value of reduction in accident costs ($000), PVAL(5,Y) = net present value of reduction in maintenance costs ($000), PVAL(6,Y) = net present value of total benefits ($000)
TPVAL(8)	total of present values over the planning horizon
X	type of total being accumulated, 6 = segment totals, 7 = problem/system totals
X1	type of total being accumulated, 6 = segment totals, 7 = problem/system totals
XMAINT(7,41,2)	yearly maintenance costs for total X and year Y, XMAINT(X,Y,1) = do-nothing, XMAINT(X,Y,2) = construct

XTIME(7,41,2,2)	annual elapsed time in minutes for total X, and year Y; XTIME(X,Y,1,1) = do-nothing, car; XTIME(X,Y,1,2) = do-nothing, truck; XTIME(X,Y,2,1) = construct, car; XTIME(X,Y,2,2) = construct, truck
XVTIME(7,41,2,2)	annual value of elapsed time for total X and year Y, XVTIME(X,Y,1,1) = do-nothing, car; XVTIME(X,Y,1,2) = do-nothing, truck; XVTIME(X,Y,2,1) = construct, car; XVTIME(X,Y,2,2) = construct, truck
Y	index indicating year (1-41)

TOTAL Subroutine

ACCICO(7,41,2)	accident costs for corridor route L1 or sum X, for year Y and calculation type L2
ACCNUM(7,41,2)	number of accidents for corridor route L1 or sum X, for year Y and calculation type L2
ADJCON(7)	discounted construction and expansion cost
CYCLE(7,41,2)	number of cycles per vehicle mile for corridor route L1 or sum X, for year Y and calculation type L2
DMAND(7,41,2)	vehicle demand allocated to corridor route L1 or sum X, for year Y and calculation type L2
ICYR	difference between construction year plus one and the current year
II	planning horizon plus one (2-41)
L1	index for highway type, 1 = existing, 2 = proposed, 3 = expansion, 4 = alternate, 5 = diversion
L2	index for calculation type, 1 = do-nothing, 2 = construct
L3	index for vehicle type 1 = cars, 2 = trucks

NO1	variable used to indicate lower bound of elements to be summed, when X1 = 6, NO1 = 1, and when X1 = 7, NO1 = 6
NO2	variable used to indcate upper bound of elements to be summed; when X1 = 6, NO1 = 5, and when X1 = 7, NO1 = 6
OCOST(7,41,2,2)	annual operating cost for corridor route L1 or sum X, for year Y and calculation type L2
WP1(7,41,2)	state facility sum of daily vehicle miles multiplied by the average speed for the existing state facility L1 or sum X, for year Y and calculation type L2
WP2(7,41,2)	state facility sum of daily vehicle miles for the existing state facility L1 on sum X, for year Y and calculation type L2
WSPCP1(7,41,2)	corridor sum of daily vehicle miles multiplied by the average speed for route L1 or sum X, for year Y and calculation type L2
WSPCP2(7,41,2)	corridor sum of daily vehicle miles for route L1 or sum X1, for year Y and calculation type L2
X	type of totàl being accumulated, 6 = segment totals, 7 = problem/system totals
X1	type of total being accumulated, 6 = segment totals, 7 = problem/system totals
XMAINT(7,41,2)	yearly maintenance costs for highway L1 or sum X, for year Y and calculation type L2
XTIME(7,41,2,2)	annual elapsed time in minutes for highway L1 or sum X, for year Y, calculation type L2, and vehicle type L3
XVTIME(7,41,2,2)	annual value of elapsed time for highway L1 or sum X, for year Y, calculation type L2, and vehicle type L3
Y	index indicating year

INIT Subroutine

I	index used to zero out LABA common array
IDUM(9784)	dummy array to zero out LABA common array
J	index used to zero out LABB common array
KDUM(2298)	dummy array to zero out LABB common array

Program Listing

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C      TEXAS STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
C           REVISED HIGHWAY ECONOMIC EVALUATION MODEL (HEEM II)
C         REVISED AND UPDATED TO 12-31-82  BY JEFFERY L. MEMMOTT
C
      BLOCK DATA
      COMMON /LABA/ASSUMP(9),TABLE(11,70),IDUM(9784)
      COMMON/LABB/KDUM(2298)
      DIMENSION DUMY1(11,5),DUMY2(11,3),DUMY3(11,2),DUMY4(11,3),
     *DUMY5(11,3),DUMY6(11,5),DUMY7(11,4),DUMY8(11,3),DUMY9(11,5),
     *DUMY10(11,5),DUMY0(11,5),DUMY11(11,5),DUMY12(11,5),DUMY13(11,5),
     *DUMY14(11,5),DUMY15(11,5),DUMY16(11,2)
      EQUIVALENCE (TABLE(1,6),DUMY1(1,1)),(TABLE(1,11),DUMY2(1,1)),
     *(TABLE(1,14),DUMY3(1,1)),(TABLE(1,16),DUMY4(1,1)),
     *(TABLE(1,19),DUMY5(1,1)),(TABLE(1,22),DUMY6(1,1)),
     *(TABLE(1,27),DUMY7(1,1)),(TABLE(1,31),DUMY8(1,1)),
     *(TABLE(1,34),DUMY9(1,1)),(TABLE(1,39),DUMY10(1,1)),
     *(TABLE(1,1),DUMY0(1,1)),(TABLE(1,44),DUMY11(1,1))
      EQUIVALENCE
     *(TABLE(1,49),DUMY12(1,1)),(TABLE(1,54),DUMY13(1,1)),
     *(TABLE(1,59),DUMY14(1,1)),(TABLE(1,64),DUMY15(1,1)),
     *(TABLE(1,69),DUMY16(1,1))
      DATA
     X DUMY0/0.,0.,0.,0.,0.,1.139,1.639E-4,6280.,12.,0.,0.,
     X0.,0.,0.,0.,0.,1.139,1.639E-4,25700.,6.,0.,0.,
     X20000.,10000.,22.,19.32,16.70,1.139,1.639E-4,6280.,12.,0.,9100.,
     X22500.,11250.,32.,28.48,18.82,1.139,1.639E-4,6280.,12.,0.,9100.,
     X40000.,20000.,22.,19.32,16.70,1.139,4.08E-5,6280.,11.2,0.,11600./
      DATA DUMY1/
     X45000.,22500.,32.,28.48,18.82,1.369,4.08E-5,6280.,11.2,0.,11600.,
     X27500.,21000.,39.,31.18,27.89,1.139,1.639E-4,25700.,6.,0.,5400.,
     X31000.,22500.,55.,40.80,30.90,1.139,1.639E-4,25700.,6.,0.,5400.,
     X87500.,67500.,39.,30.97,27.89,1.369,4.08E-5,25700.,5.6,0.,7100.,
     X92500.,67500.,55.,40.83,30.86,1.369,4.08E-5,25700.,5.6,0.,7100./
      DATA DUMY2/
     X1.1E+5,65000.,60.,57.11,30.98,.0854,4.54E-5,27970.,1.4,0.,14200.,
     X1.2E+5,75000.,60.,57.02,35.3,.0854,4.54E-5,8770.,2.8,0.,26000.,
     X1.65E+5,97500.,60.,57.11,30.98,5.81E-2,2.83E-5,27970.,1.3,0.,
     X17500./
      DATA DUMY3/
     X1.8E+5,112500.,60.,57.02,35.3,5.81E-2,2.83E-5,8770.,2.6,0.,34200.,
     X2.2E+5,130000.,60.,57.11,30.98,8.34E-2,2.27E-5,27970.,1.2,0.,
     X20800./
      DATA DUMY4/
     X2.4E+5,150000.,60.,57.02,35.3,8.34E-2,2.27E-5,8770.,2.4,0.,42500.,
     X2.75E+5,162500.,60.,57.11,30.98,.1214,1.685E-5,27970.,1.1,0.,
     X24100.,
     X3.3E+5,195000.,60.,57.12,30.98,.143,1.46E-5,27970.,1.0,0.,27400./
      DATA DUMY5/
     X130000.,1.E+5,39.,31.07,27.97,1.294,3.1898E-5,25700.,5.2,0.,10600.
```

```
X,
X135000.,1.E+5,55.,40.94,32.70,1.294,3.1898E-5,25700.,5.2,0.,10600.
X,
X1.1E+5,65000.,60.,51.35,29.99,8.54E-2,4.54E-5,27970.,2.8,0.,9000./
 DATA DUMY6/
X1.65E+5,97500.,60.,51.35,29.99,.0581,2.83E-5,27970.,2.6,0.,10600.,
X6.0E+4,3.E+4,22.,19.32,16.70,1.294,3.1898E-5,6280.,10.4,0.,14000.,
X67500.,33750.,32.,28.48,18.82,1.294,3.1898E-5,6280.,10.4,0.,14000.
*,
X3.E+5,187500.,60.,57.02,35.3,.1214,1.685E-5,8770.,2.2,0.,50700.,
X3.6E+5,225000.,60.,57.02,35.3,.1430,1.459E-5,8770.,2.,0.,59000./
 DATA DUMY7/
X80000.,50000.,47.,38.41,28.45,8.54E-2,4.54E-5,8770.,5.6,0.,9000.,
X120000.,75000.,47.,38.41,28.45,.0581,2.83E-5,8770.,5.2,0.,10600.,
X2.4E+5,160000.,60.,56.82,45.82,8.34E-2,2.27E-5,8770.,2.2,0.,
X42500.,
X3.E+5,200000.,60.,56.82,45.82,.1214,1.685E-5,8770.,2.,0.,50700./
 DATA DUMY8/
X1.2E+5,80000.,60.,56.82,45.82,8.54E-2,4.54E-5,8770.,2.5,0.,26000.,
X180000.,120000.,60.,56.82,45.82,5.81E-2,2.83E-5,8770.,2.3,0.,
X34200.,
X360000.,240000.,60.,56.82,45.82,.143,1.4598E-5,8770.,1.8,0.,
X59000./
 DATA DUMY9/
X40000.,25000.,47.,38.41,28.45,1.1,8.6E-5,8770.,6.,0.,7300.,
X55000.,32500.,60.,51.35,29.99,1.1,8.6E-5,27970.,3.,0.,7300.,
X420000.,262500.,60.,57.02,35.3,.143,1.252E-5,8770.,1.8,0.,67200.,
X480000.,300000.,60.,57.02,35.3,.143,1.095E-5,8770.,1.6,0.,75500.,
X420000.,280000.,60.,56.82,45.82,.143,1.252E-5,8770.,1.6,0.,67200./
 DATA DUMY10/
X480000.,320000.,60.,56.82,45.82,.143,1.095E-5,8770.,1.4,0.,75500.,
X110000.,65000.,60.,50.82,28.40,.0854,4.54E-5,27810.,2.8,0.,9000.,
X165000.,97500.,60.,50.82,28.40,.0581,2.83E-5,27810.,2.6,0.,10600.,
*30000.,18750.,60.,57.02,35.3,.3289,1.83E-4,8770.,3.1,0.,81500.,
*30000.,18750.,60.,57.02,35.3,.3289,1.83E-4,8770.,4.7,0.,27200./
 DATA DUMY11/
*60000.,37500.,60.,57.02,35.3,.1644,9.15E-5,8770.,4.5,0.,35400.,
*30000.,18750.,60.,57.02,35.3,.3289,1.83E-4,8770.,3.1,0.,13600.,
*60000.,37500.,60.,57.02,35.3,.1644,9.15E-5,8770.,3.,0.,17700.,
*11250.,5625.,32.,28.48,18.82,1.139,1.639E-4,6280.,12.,0.,7900.,
*11250.,5625.,32.,28.48,18.82,1.139,1.639E-4,6280.,12.,0.,15800./
 DATA DUMY12/
*10000.,5000.,22.,19.38,16.7,1.139,1.639E-4,6280.,12.4,0.,7900.,
*10000.,5000.,22.,19.38,16.7,1.139,1.639E-4,6280.,12.4,0.,15800.,
*30000.,15000.,22.,19.38,16.7,1.732,6.634E-5,6280.,11.6,0.,10300.,
*33750.,16875.,32.,28.48,18.82,1.732,6.634E-5,6280.,11.6,0.,10300.,
*50000.,25000.,22.,19.38,16.7,1.0392,3.803E-5,6280.,10.8,0.,12800./
 DATA DUMY13/
*56250.,28125.,32.,28.48,18.82,1.0392,3.803E-5,6280.,10.8,0.,12800.
```

```
*,
*60000.,37500.,47.,38.41,28.45,.1097,6.1E-5,8770.,5.8,0.,8100.,
*1.E+5,62500.,47.,38.41,28.45,.0658,3.66E-5,8770.,5.4,0.,9800.,
*9.E+4,56250.,60.,57.02,35.3,.1097,6.1E-5,8770.,2.9,0.,21800.,
*1.5E+5,93750.,60.,57.02,35.3,.0658,3.66E-5,8770.,2.7,0.,30100./
 DATA DUMY14/
*2.1E+5,131250.,60.,57.02,35.3,.047,2.614E-5,8770.,2.5,0.,38300.,
*2.7E+5,168750.,60.,57.02,35.3,.0366,2.033E-5,8770.,2.3,0.,46600.,
*3.3E+5,206250.,60.,57.02,35.3,.0299,1.664E-5,8770.,2.1,0.,54800.,
*3.9E+5,243750.,60.,57.02,35.3,.0253,1.408E-5,8770.,1.9,0.,63100.,
*4.5E+5,281250.,60.,57.02,35.3,.0219,1.22E-5,8770.,1.7,0.,71300./
 DATA DUMY15/
*9.E+4,6.E+4,60.,56.82,45.82,.1097,6.1E-5,8770.,2.6,0.,21800.,
*1.5E+5,1.E+5,60.,56.82,45.82,.0658,3.66E-5,8770.,2.4,0.,30100.,
*2.1E+5,1.4E+5,60.,56.82,45.82,.047,2.61E-5,8770.,2.3,0.,38300.,
*2.7E+5,1.8E+5,60.,56.82,45.82,.0366,2.033E-5,8770.,2.1,0.,46600.,
*3.3E+5,2.2E+5,60.,56.82,45.82,.0299,1.664E-5,8770.,1.9,0.,54800./
 DATA DUMY16/
*3.9E+5,2.6E+5,60.,56.82,45.82,.0253,1.408E-5,8770.,1.7,0.,63100.,
*4.5E+5,3.E+5,60.,56.82,45.82,.0219,1.22E-5,8770.,1.5,0.,71300./
 END
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```
      COMMON /LABA/ASSUMP(9),TABLE(11,70),HDATA(5,5),VOLUME(41),
     1DMAND(7,41,2),XMAINT(7,41,2),SPEED(7,41,2),CYCLE(7,41,2),
     2XSPEED(7,41,2,2),XTIME(7,41,2,2),OCOST(7,41,2,2),DIFF(6,41),
     3PVAL(6,41),ADJCON(7),ALL(4),ACCNUM(7,41,2),ACCICO(7,41,2),
     4STORE(10),WSPCP1(7,41,2),WSPCP2(7,41,2),TPVAL(8),ICYR3,ICYR4,
     5XVTIME(7,41,2,2),XMN,SP,WSP1,WSP2,CY,XV(2),XT(2),XSP(2)
      COMMON/LABB/OCP(5),PVOL(41),IHW(5,41,2),PRS,INDX,AC(4),TPR(4),
     6XVT(2),XRN(2),XCY(2),OC(2),HSW(5),ACCNO,ACCOST,COST1,
     7COST2,X1,ITRIAL,Y,NO1,NO2,NO3,NO4,EXSW,ALTSW,ANS,IASW,TAC(4),
     8ISW,ICYR,ICYR2,IEYR2,IEYR,X,L1,L,EXSTOR(10),CCOST,ECOST,TBLE(5,4),
     9WP1(7,41,2),WP2(7,41,2),RATIO,RATIO2,II,CINC(2),ASMSEG(5,3),
     *BYPS(4),PBYPS(4),PRSW,IN(5),CAP(4),VOL(41,2),DEMAND(6,41,2)
      CHARACTER*80 CARD
      CHARACTER*4 PROTIT
      CHARACTER*4 BLANKS
      CHARACTER*1 KAST
      CHARACTER*1 KBLANK
      CHARACTER*1 LINE
      CHARACTER*1 KLTR
      CHARACTER*4 HDAT
      CHARACTER*4 HT
      INTEGER Y,HIWAY,HMMSG,HWAY,YR
      INTEGER HLDTIT
      REAL TASSP(8)
      DIMENSION CP16Y1(41),CP26Y1(41),CP16Y2(41),CP26Y2(41),
     XWP11Y1(41),WP21Y1(41),WP12Y2(41),WP22Y2(41),INC(13),INP(11)
      DIMENSION HLDTIT(99,6),HMMSG(20),SVAL(8),IPYR(2),AVAR(2),KLTR(8)
C
C     LITERAL VARIABLES
C
      DIMENSION HT(58),PROTIT(6),TI1(5),TI2(5),LINE(121),HDAT(4),
     1TI3(5),TI4(3),SEGTIT(8),TIT(7,21),GRWRTE(3,2),RUNTPE(10,4)
      DATA HT/'U4C','U2C','R2C','R4C','R4F','R6F','U4F','U6F','R8F',
     1'U8F','R10F','R12F','U10F','U12F','U6C','R6C','R4E','R6E','U8M',
     2'U10M','U4E','U6E','U4M','U6M','U12M','U2E','R2E','U14F','U16F',
     X'U14M','U16M','R4D','R6D','U1T','U1N','U2N','U1S','U2S','U1AT',
     *'U1AN','U3C','U5C','U3E','U5E','U3F','U5F','U7F','U9F','U11F',
     *'U13F','U15F','U3M','U5M','U7M','U9M','U11M','U13M','U15M'/
      DATA BLANKS/'    '/,
     3TI1/'CURR','ENT ','YEAR','    ','    '/,TI2/'CONS','TRUC',
     3    'TION',' YEA','R   '/,TI3/'EXPA','NSIO','N YE','AR  ',
     3    '    '/,TI4/'OR B','EYON','D   '/
      DATA TIT/'PERC','ENTA','GE T','RUCK','S % ',2*'    ','VALU',
     1'E CA','R TI','ME  ',' $/M','IN  ','    ','VALU','E TR','UCK ',
     2'TIME',' $/M','IN  ','    ','INFL','ATIO','N RA','TE %',3*'    ',
     3'CONS','T CO','ST E','SCAL','ATIO','N RA','TE %',
     4'DISC','OUNT',' RAT','E % ','    ','    ','    ',
     5'RURA','L DI','VERS','ION ','ROUT','E SP','EED ',
     6'URBA','N DI','VERS','ION ','ROUT','E SP','EED ',
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     7'MAX ','DECL',' GRW',' RAT','E IN',' PRO','J YR',
     8'EXIS','TING',5*'    ','PROP','OSED',5*'    ',
     9'EXPA','NDED',5*'    ','ALTE','RNAT','E   ',4*'    ',
     A'OPER','ATIN','G - ','CAR ','    ','    ','    ',
     B'OPER','ATIN','G - ','TRUC','K   ','    ','    ',
     C'DELA','Y - ','CAR ','    ','    ','    ','    ',
     D'DELA','Y - ','TRUC','K   ','    ','    ','    ',
     E'ACCI','DENT','    ','    ','    ','    ','    ',
     F'*TOT','AL B','ENEF','ITS ','    ','    ','    ',
     G'*TOT','AL C','ONST',' COS','T   ','    ','    ',
     H'MAIN','TENA','NCE ','    ','    ','    ','    '/
      DATA GRWRTE/'CONS','TANT','    ','DECL','ININ','G   '/,
     1RUNTPE/'REGU','LAR ','RUN ',7*'    ',
     *'OPTI','MIZE',' CON','STRU','CTIO','N YE','AR  ',3*'    ',
     2'OPTI','MIZE',' CON','STRU','CTIO','N & ','EXPA','NSIO','N YE',
     3'ARS ','OPTI','MIZE',' EXP','ANSI','ON Y','EAR ','ONLY','    ',
     4'    ','    '/
      DATA HLDTIT/594*'    '/,ISFLAG/0/,SVAL/8*0.0/,SYSCST/0.0/
      DATA KAST,KBLANK/'*',' '/
      DATA KLTR/'E','P','X','A','D','T','S','B'/
C
C     RUN INITIALIZATION
C
      WRITE (6,410)
   28 CONTINUE
   30 CONTINUE
      DO 5 I = 1,41
      CP16Y1(I) = 0.0
      CP26Y1(I) = 0.0
      CP16Y2(I) = 0.0
      CP26Y2(I) = 0.0
      WP11Y1(I) = 0.0
      WP21Y1(I) = 0.0
      WP12Y2(I) = 0.0
      WP22Y2(I) = 0.0
    5 CONTINUE
      IPROB = 0
C
C     PROCESS FIRST CARD - MUST BE PROBLEM HEADER
C
  400 FORMAT (A80)
      READ (5,400,END=610,ERR=615) CARD
  405 FORMAT (4X,I1)
      READ (CARD,405) ICTYPE
      IF (ICTYPE.EQ.1) GOTO 605
C
C     INVALID HEADER CARD
C
  410 FORMAT ('1',55X,'***** H E E M II *****'/46X,'REVISED HIGHWAY ',
```

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     1'ECONOMIC EVALUATION MODEL'/58X,'VERSION(12-31-82)'/)
  415 FORMAT (/28H *** INVALID HEADER CARD ***/)
      WRITE (6,415)
  420 FORMAT (9X,3H***,A80,3H***)
      WRITE (6,420) CARD
  425 FORMAT (/69H PROBLEM REJECTED. SCANNING FOR NEXT PROBLEM. FOLLOWIN
     1G CARDS IGNORED/)
  595 WRITE (6,425)
      ISFLAG = 1
      IFLAG = 1
C
C     PROBLEM/SEGMENT SKIPPING CODE
C
  600 READ (5,400,END=610,ERR=615) CARD
      READ (CARD,405) ICTYPE
      IF (ICTYPE.LE.IFLAG.AND.ICTYPE.GT.0) GOTO 605
      WRITE (6,420) CARD
      GOTO 600
  605 CONTINUE
      IF (ICTYPE.EQ.1) GOTO 620
  430 FORMAT ('1',8H PROBLEM,2X,A2,37X,5A4,A3/)
      WRITE (6,430) IPNO,PROTIT
      GOTO 650
C
C     END OF FILE
C
  610 CONTINUE
      WRITE(6,21) IPROB
   21 FORMAT('1',/,40X,'PROBLEM(S) PROCESSED THIS RUN --',I3,/)
      DO 22 I = 1,IPROB,4
      WRITE(6,23) (HLDTIT(I,J),J=1,6),(HLDTIT(I+1,J),J=1,6),
     X(HLDTIT(I+2,J),J=1,6),(HLDTIT(I+3,J),J=1,6)
   23 FORMAT(1X,4(5X,5A4,A3))
   22 CONTINUE
      IF(ISFLAG.EQ.0) GO TO 31
      WRITE(6,32)
   32 FORMAT(/72H *** CAUTION---PROBLEM/SEGMENT OMITTED BECAUSE OF INVAL
     XID INPUT DATA ***/)
   31 WRITE(6,41) SYSCST
   41 FORMAT(1H0,8X,'*** SYSTEM CONSTRUCTION COST (MILLIONS) =',F10.2,'
     X***')
      WRITE(6,15)
   15 FORMAT(//41X,23H*** SYSTEM MOBILITY ***/21X,30H---------- CORRIDOR
     XS ---------,10X,30H------ STATE FACILITIES ------/11X,2(10X,10HDO-
     XNOTHING,8X,12HIF CONSTRUCT)/9X,4HYEAR,5X,2(2(2X,3HMPH,5X,8HDVM(000
     X)),4X))
      DO 20 Y = 1,II,IEND
      IYRD = IYR+Y-1
      IF(CP26Y1(Y).EQ.0.0) CP26Y1(Y) = .0000001
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```
      IF(CP26Y2(Y).EQ.0.0) CP26Y2(Y) = .0000001
      IF(WP21Y1(Y).EQ.0.0) WP21Y1(Y) = .0000001
      IF(WP22Y2(Y).EQ.0.0) WP22Y2(Y) = .0000001
      R6Y1 = CP16Y1(Y)/CP26Y1(Y)
      R6Y2 = CP16Y2(Y)/CP26Y2(Y)
      R1Y1 = WP11Y1(Y)/WP21Y1(Y)
      R2Y2= WP12Y2(Y)/WP22Y2(Y)
      DVM1 = CP26Y1(Y) / 1000.0
      DVM2 = CP26Y2(Y) / 1000.0
      DVM3 = WP21Y1(Y) / 1000.0
      DVM4 = WP22Y2(Y) / 1000.0
      WRITE(6,203) IYRD,R6Y1,DVM1,R6Y2,DVM2,R1Y1,DVM3,R2Y2,DVM4
   20 CONTINUE
      SEM=SVAL(6)/SVAL(7)
      SPV=SVAL(6)-SVAL(7)
   47 WRITE (6,43)
   43 FORMAT(//2X,'SYSTEM TOTALS'/)
      WRITE (6,79) (SVAL(I),I=2,5)
   79 FORMAT (8X,'DELAY SAVING ($000) =',23X,F12.1/8X,
     *'REDUCTION IN OPERATING COSTS ($000) =',7X,F12.1/8X,
     *'REDUCTION IN ACCIDENT COSTS ($000) =',8X,F12.1/8X,
     *'REDUCTION IN MAINTENANCE COSTS ($000) =',5X,F12.1)
      WRITE (6,598) SVAL(6),SVAL(7),SPV,SEM
      STOP
C
C     READ ERROR -- TERMINATE BATCH
C
  440 FORMAT (/46H *** HARDWARE READ ERROR - BATCH CANCELLED ***/45H CON
     1SULT EDP COORDINATOR BEFORE RE-SUBMITTING)
  615 WRITE (6,440)
      GOTO 610
C
C     PROBLEM INITIALIZATION
C
  620 IPROB = IPROB + 1
      IEND  = 1
      IFLAG = 0
      ISEG  = 0
      CALL INIT
      ASSUMP(1) = 11.00
      ASSUMP(2) =  0.17
      ASSUMP(3) =  0.32
      ASSUMP(4) =  0.00
      ASSUMP(5) =  0.00
      ASSUMP(6) =  8.00
      ASSUMP(7) = 25.00
      ASSUMP(8) = 15.00
      II=20
      DO 441 IC=1,5
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      OCP(IC)=1.276
  441 CONTINUE
  442 FORMAT (A2,3X,I4,6(1X,F4.0),2(1X,F2.0),1X,I2,1X,5A4,A3)
      READ (CARD,442)          IPNO,IYR,TASSP,ISYR,PROTIT
      WRITE (6,430) IPNO, PROTIT
      READ(CARD,26)          (HLDTIT(IPROB,J),J=1,6)
   26 FORMAT(49X,5A4,A3)
  445 FORMAT (9X,22HPROBLEM CONTROL DATA -//9X,14HCURRENT YEAR -,I5/)
      WRITE (6,445) IYR
      IF (IYR.GE.1970.AND.IYR.LE.2020) GOTO 625
C
C     INVALID CURRENT YEAR
C
  450 FORMAT (45H *** CURRENT YEAR OUTSIDE RANGE 1970-2020 ***)
      WRITE (6,450)
      GOTO 595
C
C     CHANGE ASSUMPTIONS IF NECESSARY AND DISPLAY
C
  455 FORMAT (9X,13HASSUMPTIONS -/)
  625 WRITE (6,455)
  460 FORMAT (10X,I2,2H. ,7A4,2X,F7.2)
      DO 630 I = 1, 8
      IF (TASSP(I).NE.0.0) ASSUMP(I) = TASSP(I)
      WRITE (6,460) I,(TIT(J,I),J=1,7),ASSUMP(I)
      IF (I.EQ.1.OR.I.EQ.4.OR.I.EQ.5.OR.I.EQ.6) ASSUMP(I)=ASSUMP(I)/100.
  630 CONTINUE
      IF (ISYR.NE.0) II=ISYR
      WRITE (6,463) II
  463 FORMAT (/9X,'PLANNING HORIZON - ',I2,' YEARS')
      IF (II.GT.0.AND.II.LE.40) GOTO 633
C
C     INVALID PLANNING HORIZON
C
      WRITE (6,452)
  452 FORMAT (' *** PLANNING HORIZON NOT BETWEEN 1-40 YEARS ***')
      GOTO 595
  633 II=II+1
      IF (II.GT.21) IEND=2
C
C     GET SEGMENT TRAFFIC DATA
C
      WRITE (6,430) IPNO,PROTIT
      READ (5,400,END=645,ERR=615) CARD
      READ (CARD,405)          ICTYPE
      IF (ICTYPE.EQ.2) GOTO 650
C
C     INVALID SEGMENT DATA CARD
C
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  465 FORMAT (/34H *** INVALID SEGMENT DATA CARD ***/)
  635 WRITE (6,465)
      WRITE (6,420) CARD
  470 FORMAT (/77H SEGMENT REJECTED. SCANNING FOR NEXT SEGMENT/PROBLEM.
     1FOLLOWING CARDS IGNORED/)
  640 WRITE (6,470)
      ISFLAG = 1
      IF (ICTYPE.EQ.1) GOTO 605
      IFLAG=2
      IF (ICTYPE.EQ.2) GOTO 650
      GOTO 600
C
C     END OF FILE
C
  475 FORMAT (/42H *** PREMATURE END OF FILE ENCOUNTERED ***)
  645 WRITE (6,475)
      ISFLAG = 1
      GOTO 610
C
C     PROCESS TRAFFIC DATA CARD
  480 FORMAT (2X,A2,1X,F5.0,2(1X,F5.0,1X,I4),1X,I1,2(1X,F3.0),1X,7A4,A1)
  650 ISEG = ISEG + 1
      ICTYPE=0
      ICKFLG = 0
      MIX=0
      DO 651 M1=1,5
      DO 651 M2=1,4
      TBLE(M1,M2)=0.
  651 CONTINUE
      READ (CARD,480) ISEGNO,VOLUME(1),AVAR(1),IPYR(1),AVAR(2),IPYR(2),
     *ISW,CINC,SEGTIT
  485 FORMAT (1X,8H SEGMENT,2X,A2,9X,14HDESCRIPTION - ,7A4,A1/)
      WRITE (6,485) ISEGNO,SEGTIT
  490 FORMAT (9X,27HTRAFFIC DATA - CURRENT YEAR,4X,I4,3X,14HVOLUME (1,00
     10),2X,F8.2/24X,15HPROJECTED YEAR1,I5,3X,14HVOLUME (1,000),2X,F8.2,
     */24X,'PROJECTED YEAR2 ',I4,3X,'VOLUME (1,000)',2X,F8.2)
      WRITE (6,490) IYR,VOLUME(1),IPYR(1),AVAR(1),IPYR(2),AVAR(2)
      IF (IPYR(1).GT.IYR.AND.IPYR(2).GT.IYR) GOTO 654
C
C     PROJECTED YEAR TOO SMALL
C
  495 FORMAT (/46H *** PROJECTED YEAR LESS THAN CURRENT YEAR ***)
      WRITE (6,495)
      GOTO 640
C     CHECK IF PROJECTED VOLUMES INCREASING
  654 IF (IPYR(1).GT.IPYR(2).AND.AVAR(1).GT.AVAR(2)) GOTO 655
      IF (IPYR(2).GT.IPYR(1).AND.AVAR(2).GT.AVAR(1)) GOTO 655
      IF (AVAR(1).GT.VOLUME(1).AND.AVAR(2).GT.VOLUME(1)) GOTO 655
      WRITE (6,477)
```

```
  477 FORMAT (/' *** PROJECTED VOLUMES NOT INCREASING OVER TIME ***')
      GOTO 640
C
C     EXPAND TRAFFIC VOLUMES
C
  655 AVAR(1) = AVAR(1)*1000.
      AVAR(2)=AVAR(2)*1000.
      VOLUME(1) = VOLUME(1)*1000.
      I1 = IPYR(1) - IYR
      I2 = IPYR(2) - IYR
      IF (I1.LE.40.AND.I2.LE.40) GOTO 656
  498 FORMAT (/60H *** PROJECTED YEAR EXCEEDS 40 YEARS BEYOND CURRENT YE
     1AR ***)
      WRITE(6,498)
      GOTO 640
  656 VOLUME(I1+1) = AVAR(1)
      VOLUME(I2+1) = AVAR(2)
      R1=I1
      R2=I2
      RT=R1/R2
C     CALCULATE PROJECTED VOLUMES
      S=(ALOG(VOLUME(I1+1)-VOLUME(1))-ALOG(VOLUME(I2+1)-VOLUME(1)))
     */ALOG(RT)
      S1=ALOG(VOLUME(I1+1)-VOLUME(1))-S*ALOG(R1)
      DO 688 I3=1,II
      VOLUME(I3)=VOLUME(1)+EXP(S1)*(I3-1)**S
      PVOL(I3)=VOLUME(I3)*(1.3-.3*ASSUMP(1))
  688 CONTINUE
C
C     CHECK RUN TYPE - 1,2,3,OR 4
C
  690 IF (ISW.GE.1.AND.ISW.LE.4) GOTO 695
  512 FORMAT (/32H *** INVALID SEGMENT RUN TYPE - ,I1,4H ***)
      WRITE (6,512) ISW
      GOTO 640
  514 FORMAT (/9X,19HSEGMENT RUN TYPE - ,10A4)
  695 WRITE (6,514) (RUNTPE(J,ISW),J=1,10)
      EXSW   = 0.0
      ALTSW  = 0.0
      ITRIAL = 0
      ICYR   = 0
      IEYR   = 0
      NO3    = 1
      NO4    = 2
C
C     HIGHWAY DATA INPUT LOOP - 'HIWAY' IS THE LOOP VARIABLE WHOSE
C     VALUES ARE: 1=EXISTING, 2=PROPOSED, 3=EXPANDED, 4=ALTERNATE.
C
C     A NEW INPUT RECORD IS READ IN EACH PASS THROUGH THE LOOP.  THE
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C     DECISION TABLE BELOW SHOWS THE RELATIONS BETWEEN 'HIWAY' AND
C     THE RECORD TYPE VARIABLE 'ICTYPE'.
C
C                        ICTYPE
C                  1   2   3   4   5   6
C                *************************     E=ERROR
C              1 * E   E   O   E   E   E       O=OKAY
C     HIWAY    2 * E   E   E   O   E   E       W=FALL OUT OF LOOP
C              3 * W   W   E   E   O   S       S=ADD 1 TO HIWAY AND
C              4 * W   W   E   E   E   O         PROCESS AS AN 'O'.
C
      DO 728 HWAY = 1, 4
      MYWAY = HWAY
      HIWAY=HWAY
      READ (5,400,END=700,ERR=615) CARD
      READ (CARD,405)           ICTYPE
      IF (ICTYPE.EQ.HIWAY+2) GOTO 706
      IF (HIWAY.GE.3.AND.(ICTYPE.LE.2.AND.ICTYPE.GT.0)) GOTO 730
      IF (HIWAY.EQ.3.AND.ICTYPE.EQ.6) GOTO 705
      GOTO 635
C
C     END OF FILE
C
  700 IF (HIWAY.LE.2) GOTO 645
      IFLAG=IFLAG+3
      GOTO 730
C
C     SPECIAL CASE 'S' FROM DECISION TABLE
C
  705 HIWAY=HIWAY+1
      MYWAY = MYWAY + 1
C
C     NORMAL CASE 'O' FROM DECISION TABLE
C
  706 IX=HIWAY
  810 FORMAT(T6,A1)
  516 FORMAT (T6,A4)
  518 FORMAT (T11,F4.0)
  520 FORMAT (T16,F5.0,1X,F5.0)
  524 FORMAT (T28,F2.0)
  526 FORMAT (T31,I4)
  528 FORMAT (T36,F5.0)
  530 FORMAT (T42,F1.0)
      READ (CARD,516)           HDAT(IX)
      DO 710 J = 1, 58
      IF (HDAT(IX).EQ.HT(J)) GOTO 820
  710 CONTINUE
  532 FORMAT (/28H *** INVALID HIGHWAY TYPE - ,A4,4H ***)
      WRITE (6,532) HDAT(IX)
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      GOTO 640
  820 READ(CARD,810)           ICKTYP
      IF(ICKFLG.NE.0) GO TO 815
      ICKHLD = ICKTYP
      ICKFLG = 1
      GO TO 712
  815 IF(ICKTYP.EQ.ICKHLD) GO TO 712
      MIX=1
C
C     HIGHWAY TYPE OKAY - GET REMAINDER OF DATA
C
  534 FORMAT (/9X,2A4,A2,'HIGHWAY DATA - HIGHWAY TYPE',4X,A4)
  712 WRITE (6,534) (TIT(I2,9+MYWAY),I2=1,3),HDAT(IX)
  714 READ (CARD,518)           HDATA(IX,1)
  536 FORMAT (34X,8HLENGTH  ,F7.2,6H MILES)
      WRITE (6,536) HDATA(IX,1)
  716 READ (CARD,520)           HDATA(IX,2),HDATA(IX,3)
  538 FORMAT (34X,35HSAFETY/TECHNICAL FACTORS (BASE=100),2(2X,F8.2))
      IF(HDATA(IX,3).LE.100.0) GO TO 901
      WRITE(6,902)
  902 FORMAT(/44H *** TECHNICAL FACTOR GREATER THAN 100.0 ***)
      GO TO 640
  901 WRITE (6,538) HDATA(IX,2),HDATA(IX,3)
      HDATA(IX,2)=HDATA(IX,2)/100.
      HDATA(IX,3)=HDATA(IX,3)/100.
      IF ((J.GT.4.AND.J.LT.15).OR.(J.GT.16.AND.J.LT.39).OR.J.GT.42)
     *GOTO 718
      READ (CARD,524)           HDATA(IX,4)
  540 FORMAT (34X,13HSPEED LIMIT  ,F3.0,4H MPH)
      IF (HDATA(IX,4).GT.0.) GOTO 721
      IF (J.EQ.3.OR.J.EQ.4.OR.J.EQ.16) GOTO 713
      HDATA(IX,4)=30.
      GOTO 721
  713 HDATA(IX,4)=55.
  721 WRITE (6,540) HDATA(IX,4)
  718 IF (HIWAY.NE.2) GOTO 722
      IF (ISW.EQ.2.OR.ISW.EQ.3) GOTO 720
      READ (CARD,526)           ICYR
  542 FORMAT (34X,5A4,I4)
  900 WRITE (6,542) TI2,ICYR
      IF(ICYR.GE.IYR.AND.ICYR.LT.IYR+II) GO TO  720
  544 FORMAT (/21H *** INVALID YEAR ***)
  719 WRITE (6,544)
      GOTO 640
  720 READ (CARD,528)           COST1
      IF(COST1.GT.0.0) GO TO 33
      WRITE(6,34)
   34 FORMAT(/69H *** CONSTRUCTION COST MUST BE A POSITIVE VALUE GREATER
     X THAN ZERO ***)
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      GO TO 640
  546 FORMAT (34X,31HCONSTRUCTION COST (MILLIONS)  $,F6.2)
   33 WRITE (6,546) COST1
      SYSCST = SYSCST + COST1
      READ (CARD,530)          EXSW
      IF (EXSW.EQ.0.0) GOTO 727
      IF (EXSW.LE.3.) GOTO 723
      WRITE (6,545)
  545 FORMAT (/' *** EXISTING, ALTERNATE BUILDOVER SWITCH MUST BE',
     *' BETWEEN 0 AND 3 ***')
      GOTO 640
  723 IF (EXSW-2.) 731,732,733
  731 IF (EXSW.EQ.0.) GOTO 734
      WRITE (6,560)
  560 FORMAT (34X,'BUILDOVER OF EXISTING ROUTE')
      GOTO 734
  732 WRITE (6,561)
  561 FORMAT (34X,'BUILDOVER OF ALTERNATE ROUTE')
      GOTO 734
  733 WRITE (6,562)
  562 FORMAT (34X,'BUILDOVER OF EXISTING AND ALTERNATE ROUTES')
  734 GOTO 727
  722 IF (HIWAY.NE.3) GOTO 726
      IF (ISW.GT.1) GOTO 724
      READ (CARD,526)          IEYR
      WRITE (6,542) TI3,IEYR
      IF(IEYR.LT.ICYR.OR.IEYR.GE.IYR+II) GO TO 719
  724 READ (CARD,528)          COST2
  548 FORMAT (34X,28HEXPANSION COST (MILLIONS)  $,F6.2)
   36 WRITE (6,548) COST2
      SYSCST = SYSCST + COST2
      READ (CARD,530) PRSW
      IF (PRSW.EQ.0.) GOTO 715
      IF (PRSW.EQ.1.) GOTO 725
      WRITE (6,569)
  569 FORMAT (' *** PROPOSED BUILDOVER SWITCH MUST BE 0 OR 1 ***')
      GOTO 640
  725 WRITE (6,570)
  570 FORMAT (34X,'PROPOSED HIGHWAY NOT BUILTOVER WITH EXPANSION')
      IF (ICYR.EQ.IEYR) GOTO 729
      WRITE (6,571)
  571 FORMAT (' *** CONST. YEAR MUST EQUAL EXPAN. YEAR IF PROPOSED ',
     *'HIGHWAY NOT BUILTOVER ***')
      GOTO 640
  729 IF (ISW.NE.3.OR.ISW.NE.4) GOTO 715
      WRITE (6,572)
  572 FORMAT (' *** EXPANSION YEAR CANNOT BE OPTIMIZED WHEN PROPOSED ',
     *'HIGHWAY IS NOT BUILTOVER ***')
      GOTO 640
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  715 IF(COST2.GE.0.0) GO TO 726
      WRITE(6,35)
   35 FORMAT(/66H *** EXPANSION COST MUST BE A POSITIVE VALUE GREATER TH
     XAN ZERO ***)
      GO TO 640
  726 IF (HIWAY.EQ.4.) ALTSW=1.0
  727 READ (CARD,563) (ASMSEG(IX,J),J=1,3),BYPS(IX),PBYPS(IX)
  563 FORMAT (T44,3(F4.0,1X),F1.0,1X,F4.0)
      IF (ASMSEG(IX,1).EQ.0.) ASMSEG(IX,1)=ASSUMP(1)*100.
      WRITE (6,564) ASMSEG(IX,1)
  564 FORMAT (34X,'PERCENT TRUCKS(BUSES)',T61,F5.2)
      ASMSEG(IX,1)=ASMSEG(IX,1)/100.
      IF (ASMSEG(IX,2).EQ.0.) ASMSEG(IX,2)=1.3
      WRITE(6,565) ASMSEG(IX,2)
  565 FORMAT (34X,'CAR(VAN) OCCUPANCY RATE',T61,F5.2)
      IF (ASMSEG(IX,3).EQ.0.) ASMSEG(IX,3)=1.
      WRITE (6,566) ASMSEG(IX,3)
  566 FORMAT (34X,'TRUCK(BUS) OCCUPANCY RATE',T61,F5.2)
      IF (BYPS(IX).EQ.0.) GOTO 735
      WRITE(6,567) PBYPS(IX)
  567 FORMAT (34X,'HOV BYPASS OF ',F4.2,' PERCENT VEHICLES')
      PBYPS(IX)=PBYPS(IX)/100.
  735 OCP(IX)=ASMSEG(IX,1)*ASMSEG(IX,3)+(1.-ASMSEG(IX,1))*ASMSEG(IX,2)
      IF (HIWAY.GT.3) GOTO 730
  728 CONTINUE
  730 IF (ICYR.NE.0) ICYR = ICYR-IYR+1
      IF (IEYR.NE.0) IEYR = IEYR-IYR+1
      COST1=COST1*1.0E+6
      COST2=COST2*1.0E+6
C     SET DIVERTED ASSUMPTIONS
      ASMSEG(5,1)=ASSUMP(1)
      ASMSEG(5,2)=1.3
      ASMSEG(5,3)=1.
      OCP(5)=ASMSEG(5,1)*ASMSEG(5,3)+(1.-ASMSEG(5,1))*ASMSEG(5,2)
C     SET BUILD OVER EXISTING ROAD SWITCH
      DO 40 HIWAY=1,4
      TSPD=HDATA(HIWAY,4)
C     ASSIGN INDEX BY ROAD  TYPE AND  SPEED
      IF (HDAT(HIWAY).EQ.HT(2).AND.HDATA(HIWAY,4).LE.30.)
     1   HDATA(HIWAY,4)=25.
      IF (HDAT(HIWAY).EQ.HT(2).AND.HDATA(HIWAY,4).GT.30.)
     1   HDATA(HIWAY,4)=35.
      IF (HDAT(HIWAY).EQ.HT(1).AND.HDATA(HIWAY,4).LE.30.)
     1   HDATA(HIWAY,4)=25.
      IF (HDAT(HIWAY).EQ.HT(1).AND.HDATA(HIWAY,4).GT.30.)
     1   HDATA(HIWAY,4)=35.
      IF (HDAT(HIWAY).EQ.HT(3).AND.HDATA(HIWAY,4).LE.50.)
     1   HDATA(HIWAY,4)=40.
      IF (HDAT(HIWAY).EQ.HT(3).AND.HDATA(HIWAY,4).GT.50.)
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     1    HDATA(HIWAY,4)=55.
      IF (HDAT(HIWAY).EQ.HT(4).AND.HDATA(HIWAY,4).LE.50.)
     1    HDATA(HIWAY,4)=40.
      IF (HDAT(HIWAY).EQ.HT(4).AND.HDATA(HIWAY,4).GT.50.)
     1    HDATA(HIWAY,4)=55.
      IF (HDAT(HIWAY).EQ.HT(16).AND.HDATA(HIWAY,4).LE.50.)
     1    HDATA(HIWAY,4)=40.
      IF (HDAT(HIWAY).EQ.HT(16).AND.HDATA(HIWAY,4).GT.50.)
     1    HDATA(HIWAY,4)=55.
      IF (HDAT(HIWAY).EQ.HT(15).AND.HDATA(HIWAY,4).LE.30.)
     1    HDATA(HIWAY,4)=25.
      IF (HDAT(HIWAY).EQ.HT(15).AND.HDATA(HIWAY,4).GT.30.)
     1    HDATA(HIWAY,4)=35.
      IF (HDAT(HIWAY).EQ.HT(39).AND.HDATA(HIWAY,4).LE.30.)
     *    HDATA(HIWAY,4)=25.
      IF (HDAT(HIWAY).EQ.HT(39).AND.HDATA(HIWAY,4).GT.30.)
     *    HDATA(HIWAY,4)=35.
      IF (HDAT(HIWAY).EQ.HT(40).AND.HDATA(HIWAY,4).LE.30.)
     *    HDATA(HIWAY,4)=25.
      IF (HDAT(HIWAY).EQ.HT(40).AND.HDATA(HIWAY,4).GT.30.)
     *    HDATA(HIWAY,4)=35.
      IF (HDAT(HIWAY).EQ.HT(41).AND.HDATA(HIWAY,4).LE.30.)
     *    HDATA(HIWAY,4)=25.
      IF (HDAT(HIWAY).EQ.HT(41).AND.HDATA(HIWAY,4).GT.30.)
     *    HDATA(HIWAY,4)=35.
      IF (HDAT(HIWAY).EQ.HT(42).AND.HDATA(HIWAY,4).LE.30.)
     *    HDATA(HIWAY,4)=25.
      IF (HDAT(HIWAY).EQ.HT(42).AND.HDATA(HIWAY,4).GT.30.)
     *    HDATA(HIWAY,4)=35.
C     SET INDEX BY ROAD TYPE AND SPEED
   39 IF (HDAT(HIWAY).EQ.HT(2).AND.HDATA(HIWAY,4).EQ.25.) HSW(HIWAY)=3.
      IF (HDAT(HIWAY).EQ.HT(2).AND.HDATA(HIWAY,4).EQ.35.) HSW(HIWAY)=4.
      IF (HDAT(HIWAY).EQ.HT(1).AND.HDATA(HIWAY,4).EQ.25.) HSW(HIWAY)=5.
      IF (HDAT(HIWAY).EQ.HT(1).AND.HDATA(HIWAY,4).EQ.35.) HSW(HIWAY)=6.
      IF (HDAT(HIWAY).EQ.HT(3).AND.HDATA(HIWAY,4).EQ.40.) HSW(HIWAY)=7.
      IF (HDAT(HIWAY).EQ.HT(3).AND.HDATA(HIWAY,4).EQ.55.) HSW(HIWAY)=8.
      IF (HDAT(HIWAY).EQ.HT(4).AND.HDATA(HIWAY,4).EQ.40.) HSW(HIWAY)=9.
      IF (HDAT(HIWAY).EQ.HT(4).AND.HDATA(HIWAY,4).EQ.55.) HSW(HIWAY)=10.
      IF (HDAT(HIWAY).EQ.HT(5)) HSW(HIWAY)=11.
      IF (HDAT(HIWAY).EQ.HT(7)) HSW(HIWAY)=12.
      IF (HDAT(HIWAY).EQ.HT(6)) HSW(HIWAY)=13.
      IF (HDAT(HIWAY).EQ.HT(8)) HSW(HIWAY)=14.
      IF (HDAT(HIWAY).EQ.HT(9)) HSW(HIWAY)=15.
      IF (HDAT(HIWAY).EQ.HT(10)) HSW(HIWAY)=16.
      IF (HDAT(HIWAY).EQ.HT(11)) HSW(HIWAY)=17.
      IF (HDAT(HIWAY).EQ.HT(12)) HSW(HIWAY)=18.
      IF (HDAT(HIWAY).EQ.HT(16).AND.HDATA(HIWAY,4).EQ.40.)
     1    HSW(HIWAY)=19.
      IF (HDAT(HIWAY).EQ.HT(16).AND.HDATA(HIWAY,4).EQ.55.)
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1    HSW(HIWAY)=20.
 IF (HDAT(HIWAY).EQ.HT(17)) HSW(HIWAY)=21.
 IF (HDAT(HIWAY).EQ.HT(18)) HSW(HIWAY)=22.
 IF (HDAT(HIWAY).EQ.HT(15).AND.HDATA(HIWAY,4).EQ.25.)
1    HSW(HIWAY)=23.
 IF (HDAT(HIWAY).EQ.HT(15).AND.HDATA(HIWAY,4).EQ.35.)
1    HSW(HIWAY)=24.
 IF (HDAT(HIWAY).EQ.HT(13)) HSW(HIWAY)=25.
 IF (HDAT(HIWAY).EQ.HT(14)) HSW(HIWAY)=26.
 IF (HDAT(HIWAY).EQ.HT(21)) HSW(HIWAY)=27.
 IF (HDAT(HIWAY).EQ.HT(22)) HSW(HIWAY)=28.
 IF (HDAT(HIWAY).EQ.HT(19)) HSW(HIWAY)=29.
 IF (HDAT(HIWAY).EQ.HT(20)) HSW(HIWAY)=30.
 IF (HDAT(HIWAY).EQ.HT(23)) HSW(HIWAY)=31.
 IF (HDAT(HIWAY).EQ.HT(24)) HSW(HIWAY)=32.
 IF (HDAT(HIWAY).EQ.HT(25)) HSW(HIWAY)=33.
 IF (HDAT(HIWAY).EQ.HT(26)) HSW(HIWAY)=34.
 IF (HDAT(HIWAY).EQ.HT(27)) HSW(HIWAY)=35.
 IF (HDAT(HIWAY).EQ.HT(28)) HSW(HIWAY)=36.
 IF (HDAT(HIWAY).EQ.HT(29)) HSW(HIWAY)=37.
 IF (HDAT(HIWAY).EQ.HT(30)) HSW(HIWAY)=38.
 IF (HDAT(HIWAY).EQ.HT(31)) HSW(HIWAY)=39.
 IF (HDAT(HIWAY).EQ.HT(32)) HSW(HIWAY)=40.
 IF (HDAT(HIWAY).EQ.HT(33)) HSW(HIWAY)=41.
 IF (HDAT(HIWAY).EQ.HT(34)) HSW(HIWAY)=42.
 IF (HDAT(HIWAY).EQ.HT(35)) HSW(HIWAY)=43.
 IF (HDAT(HIWAY).EQ.HT(36)) HSW(HIWAY)=44.
 IF (HDAT(HIWAY).EQ.HT(37)) HSW(HIWAY)=45.
 IF (HDAT(HIWAY).EQ.HT(38)) HSW(HIWAY)=46.
 IF (HDAT(HIWAY).EQ.HT(39).AND.HDATA(HIWAY,4).EQ.25.)HSW(HIWAY)=49.
 IF (HDAT(HIWAY).EQ.HT(39).AND.HDATA(HIWAY,4).EQ.35.)HSW(HIWAY)=47.
 IF (HDAT(HIWAY).EQ.HT(40).AND.HDATA(HIWAY,4).EQ.25.)HSW(HIWAY)=50.
 IF (HDAT(HIWAY).EQ.HT(40).AND.HDATA(HIWAY,4).EQ.35.)HSW(HIWAY)=48.
 IF (HDAT(HIWAY).EQ.HT(41).AND.HDATA(HIWAY,4).EQ.25.)HSW(HIWAY)=51.
 IF (HDAT(HIWAY).EQ.HT(41).AND.HDATA(HIWAY,4).EQ.35.)HSW(HIWAY)=52.
 IF (HDAT(HIWAY).EQ.HT(42).AND.HDATA(HIWAY,4).EQ.25.)HSW(HIWAY)=53.
 IF (HDAT(HIWAY).EQ.HT(42).AND.HDATA(HIWAY,4).EQ.35.)HSW(HIWAY)=54.
 IF (HDAT(HIWAY).EQ.HT(43)) HSW(HIWAY)=55.
 IF (HDAT(HIWAY).EQ.HT(44)) HSW(HIWAY)=56.
 IF (HDAT(HIWAY).EQ.HT(45)) HSW(HIWAY)=57.
 IF (HDAT(HIWAY).EQ.HT(46)) HSW(HIWAY)=58.
 IF (HDAT(HIWAY).EQ.HT(47)) HSW(HIWAY)=59.
 IF (HDAT(HIWAY).EQ.HT(48)) HSW(HIWAY)=60.
 IF (HDAT(HIWAY).EQ.HT(49)) HSW(HIWAY)=61.
 IF (HDAT(HIWAY).EQ.HT(50)) HSW(HIWAY)=62.
 IF (HDAT(HIWAY).EQ.HT(51)) HSW(HIWAY)=63.
 IF (HDAT(HIWAY).EQ.HT(52)) HSW(HIWAY)=64.
 IF (HDAT(HIWAY).EQ.HT(53)) HSW(HIWAY)=65.
 IF (HDAT(HIWAY).EQ.HT(54)) HSW(HIWAY)=66.
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      IF (HDAT(HIWAY).EQ.HT(55)) HSW(HIWAY)=67.
      IF (HDAT(HIWAY).EQ.HT(56)) HSW(HIWAY)=68.
      IF (HDAT(HIWAY).EQ.HT(57)) HSW(HIWAY)=69.
      IF (HDAT(HIWAY).EQ.HT(58)) HSW(HIWAY)=70.
C     SET SPEED PARAMETERS FOR HIGHWAY TYPES
      INM=HSW(HIWAY)
      IF (INM.LT.1) GOTO 40
      IF (INM.GE.7.AND.INM.LE.10.OR.INM.EQ.19.OR.INM.EQ.20) GOTO 738
      IF (INM.GE.3.AND.INM.LE.6.OR.INM.GE.23.AND.INM.LE.24.OR.
     *INM.GE.47.AND.INM.LE.54) GOTO 739
      TBLE(3,HIWAY)=TABLE(3,INM)
      TBLE(4,HIWAY)=TABLE(4,INM)
      TBLE(5,HIWAY)=TABLE(5,INM)
      GOTO 737
  738 TBLE(3,HIWAY)=-3.68+1.067*TSPD
      TBLE(4,HIWAY)=5.54+0.641*TSPD
      TBLE(5,HIWAY)=19.85+0.201*TSPD
      IF (TSPD.GE.40.) GOTO 737
      TBLE(4,HIWAY)=0.8*TBLE(3,HIWAY)
      TBLE(5,HIWAY)=0.9*TBLE(4,HIWAY)
      GOTO 737
  739 TBLE(3,HIWAY)=TSPD-3.
      TBLE(4,HIWAY)=-3.58+0.916*TSPD
      TBLE(5,HIWAY)=11.4+0.212*TSPD
      IF (TSPD.LT.25.) TBLE(5,HIWAY)=0.9*TBLE(4,HIWAY)
C
C     SET SEGMENT HOV ASSUMPTIONS IF NECESSARY
C
  737 IF ((HSW(HIWAY).GE.29..AND.HSW(HIWAY).LE.33.).OR.HSW(HIWAY).EQ.38.
     *.OR.HSW(HIWAY).EQ.39..OR.HSW(HIWAY).GE.64.) GOTO 736
      IF (BYPS(HIWAY).EQ.0.) GOTO 736
      WRITE (6,568)
  568 FORMAT (' *** HOV BYPASS MUST BE SPECIFIED WITH A METERED FREEWAY'
     *,' HIGHWAY TYPE')
      GOTO 640
  736 IF (HSW(HIWAY).LT.42..OR.HSW(HIWAY).GT.50.) GOTO 167
      IF (CINC(1).EQ.0.) CINC(1)=.446
      IF (CINC(2).EQ.0.) CINC(2)=.064
  167 IF (HIWAY.NE.2) GOTO 166
C     STORE PROPOSED PARAMETERS IN CASE OF RERUN
      STORE(1)=HDATA(2,1)
      STORE(2)=HDATA(2,2)
      STORE(3)=HDATA(2,3)
      STORE(4)=HDATA(2,4)
      STORE(5)=HSW(2)
      STORE(6)=ASMSEG(2,1)
      STORE(7)=ASMSEG(2,2)
      STORE(8)=ASMSEG(2,3)
      STORE(9)=BYPS(2)
```

```
      STORE(10)=PBYPS(2)
  166 IF (HIWAY.NE.3) GOTO 40
C     STORE EXPANSION PARAMETERS IN CASE OF RERUN
      EXSTOR(1)=HDATA(3,1)
      EXSTOR(2)=HDATA(3,2)
      EXSTOR(3)=HDATA(3,3)
      EXSTOR(4)=HDATA(3,4)
      EXSTOR(5)=HSW(3)
      EXSTOR(6)=ASMSEG(3,1)
      EXSTOR(7)=ASMSEG(3,2)
      EXSTOR(8)=ASMSEG(3,3)
      EXSTOR(9)=BYPS(3)
      EXSTOR(10)=PBYPS(3)
C      SET SWITCHES FOR DIVERSION:URBAN=1,RURAL=2
      IF (HSW(2).GE.3.AND.HSW(2).LE.6.OR.HSW(2).EQ.12.
     X OR.HSW(2).EQ.14.OR.HSW(2).EQ.16.OR.HSW(2).GE.23.AND.HSW(2).
     X LT.35.OR.HSW(2).GT.35.AND.HSW(2).LT.40.OR.HSW(2).GE.42) HSW(5)=1
      IF (HSW(2).GE.7.AND.HSW(2).LT.12.OR.HSW(2).EQ.13.
     X OR.HSW(2).EQ.15.OR.HSW(2).GE.17.AND.HSW(2).LT.23.OR.HSW(2).EQ.35.
     X OR.HSW(2).GE.40.AND.HSW(2).LT.42) HSW(5)=2
   40 CONTINUE
C     WRITE OUT INCONVENIENCE COST ASSUMPTIONS
      IF (CINC(1).EQ.0.) GOTO 115
      WRITE (6,551)
  551 FORMAT(/9X,'SEGMENT HOV ASSUMPTIONS -')
      WRITE (6,552) CINC
  552 FORMAT(13X,'INCONVENIENCE COST ($/MILE) - BUS',10X,F5.3/T44,
     *'CARPOOL/VAN',2X,F5.3)
      IF (CINC(1).GE.0..AND.CINC(2).GE.0.) GOTO 168
      WRITE (6,553)
  553 FORMAT(' *** INCONVENIENCE COST MUST BE POSITIVE ***')
      GOTO 640
  168 CONTINUE
C     CHECK IF ODD-LANE TYPE BEING USED WITH HOV
      IDUM=0
      DO 169 IX=1,4
      IF (HSW(IX).GT.41..AND.HSW(IX).LT.51.) IDUM=1
  169 CONTINUE
      IF (IDUM.EQ.1) GOTO 115
      WRITE (6,573)
  573 FORMAT (/' *** WARNING - ODD LANE HIGHWAY TYPE BEING USED WITHOUT'
     *,' HOV HIGHWAY TYPE ***')
C     CHECK IF MIX OF URBAN AND RURAL HIGHWAY TYPES
  115 IF (MIX.EQ.0) GOTO 116
      WRITE (6,574)
  574 FORMAT (/' *** WARNING - SEGMENT CONTAINS RURAL AND URBAN ',
     *'HIGHWAY TYPES ***')
C     CONSTRUCTION OR NO - 1=DO-NOTHING,2=CONSTRUCT
C     CHECK FOR OPTIMUM PATH
```

```
C     CALC VALUES FOR EACH HIGHWAY TYPE
C     IF OPTIMUM ONLY CALCULATE DEMAND FOR DO-NOTHING
  116 IF (ISW.GT.1) NO4=1
      CALL CRDMND
C     REGULAR PATH
      DO 70 L=1,2
C     CHECK FOR OPTIMUM ROUTINE
      IF (L.GT.1.AND.ISW.GT.1) GOTO 61
      CALL CALC03
   70 CONTINUE
      GOTO 80
C     CHECK FOR TYPE OF OPTIMUM:2=CONSTRUCTION3=CONSTRUCTION+EXPAND,
C     4 ONLY EXPAND
C     WHEN ITRIAL=1,DIFFS WILL CALC FOR EACH HIGHWAY TYPE & ACCUM
   61 ITRIAL=1
C     OPTIMUM CONSTRUCTION AND/OR EXPANSION
C     SET MAXIMUM CONSTRUCTION TO PLANNING HORIZON
      ICYR4=II
      ICYR3=II
      IF (ICYR.NE.0) ICYR4=1
      IF (ICYR4.GT.22) ICYR4=22
      IF (ICYR3.GT.27) ICYR3=27
      CALL EXPAND
C     SAVE BEST CONSTRUCTION YEAR
  119 ICYR=ICYR2
      IEYR=IEYR2
      IF (IEYR.EQ.ICYR.AND.EXSTOR(5).EQ.0.) IEYR=0
C     RECALCULATE BEST VALUES
C     CLEAR ARRAYS WHERE TRIAL & ERROR RESULTS HAD BEEN STORED
C     ITRIAL IS SET TO ZERO SO DIFFS WILL BE CALC ON EQUATED VALUES
   94 ITRIAL=0
      DO 96 Y=1,II
      DO 96 I2=1,8
      TPVAL(I2)=0.
      IF (I2.GT.6) GOTO 96
      DIFF(I2,Y)=0.
      PVAL(I2,Y)=0.
      DMAND(I2,Y,2)=0.
      DEMAND(I2,Y,2)=0.
   96 CONTINUE
      CALL CRDMND
      CALL CALC03
      IF (IEYR.NE.0) X1=(COST2*(1.+ASSUMP(5))**(IEYR-1)*(1./
     1(1.+ASSUMP(6))**(IEYR-1)))
      IF (IEYR.EQ.0.OR.PRS.EQ.1) X1=0.
      ECOST=X1*((1.+ASSUMP(6))**(IEYR-1))
      CCOST=COST1*(1.+ASSUMP(5))**(ICYR-1)
      ADJCON(1)=CCOST*(1./((1.+ASSUMP(6))
     1**(ICYR-1)))+X1
```

```
   80 X1=6.
      NO1=1
      NO2=5
C     CALCULATE DIFFERENCES BETWEEN DO-NOTHING AND CONSTRUCT
      CALL TOTAL
      CALL DIFFER
  203 FORMAT (9X,I4,2(4X,2(2X,F5.1,2X,F9.1)))
  211 FORMAT   (/48X,16H*** MOBILITY ***/21X,30H---------- CORRIDOR ----
     1------,10X,30H------- STATE FACILITY -------/11X,2(10X,10HDO-NOTHI
     2NG,8X,12HIF CONSTRUCT)/9X,4HYEAR,5X,2(2(2X,3HMPH,5X,8HDVM(000)),4X
     X))
      DO 105 L=1,2
      DO 105 Y=1,II
      VOL(Y,L)=DMAND(1,Y,L)+DMAND(2,Y,L)+DMAND(3,Y,L)+DMAND(4,Y,L)+
     *DMAND(5,Y,L)
  105 CONTINUE
      DO 107 M=1,2
      WRITE (6,430) IPNO,PROTIT
      WRITE (6,485) ISEGNO,SEGTIT
      IF (M.GT.1) GOTO 108
      WRITE (6,204)
  204 FORMAT (/43X,'*** DO-NOTHING CORRIDOR TRAFFIC ALLOCATION ***')
      GOTO 109
  108 WRITE (6,212)
  212 FORMAT(/42X,'*** IF-CONSTRUCT CORRIDOR TRAFFIC ALLOCATION ***')
  109 TMAX=AMAX1(VOL(II,1),VOL(II,2))
      MAX=TMAX/1000.+1.
      RAX=MAX
      ADD=SQRT(RAX)/12.
      DO 660 IB=1,13
      INC(IB)=(ADD*(IB-1))**2+.5
  660 CONTINUE
      WRITE (6,504) INC
  504 FORMAT (//3X,'YEAR',51X,'VEHICLES (1,000)',37X,
     *'(SQUARE-ROOT SCALE)'/13(6X,I4)/13(9X,'I')/8X,123('-'))
      DO 661 Y=1,II,IEND
      YR=IYR+Y-1
      DO 662 LZ=1,121
      LINE(LZ)=KBLANK
  662 CONTINUE
      DO 667 LX=1,6
      IF (LX.EQ.6) GOTO 663
      K=SQRT(DMAND(LX,Y,M)/1000.)*(1210./(120.5*ADD))+1.
      GOTO 664
  663 K=SQRT(VOL(Y,M)/1000.)*(1210./(120.5*ADD))+1.
  664 IF (LINE(K).EQ.KBLANK) GOTO 665
      LINE(K)=KAST
      GOTO 667
  665 IF (K.LT.2) GOTO 667
```

```
      LINE(K)=KLTR(LX)
  667 CONTINUE
  666 WRITE (6,502) YR,LINE
  502 FORMAT (3X,I4,1X,'I',121A1)
  661 CONTINUE
      WRITE (6,208)
  208 FORMAT (11X,'* INDICATES MULTIPLE LETTERS AT SAME POINT',
     *//3X,'YEAR',6X,'EXISTING (E)',8X,'ALTERNATE (A)',
     *7X,'PROPOSED (P)',8X,'EXPANSION (X)',7X,'DIVERTED (D)',
     *10X,'TOTAL (T)')
      WRITE (6,209)
  209 FORMAT (11X,6('VEHICLES  PERSONS',3X))
      DO 103 Y=1,II,IEND
      IYRD=IYR+Y-1
      WRITE (6,210) IYRD,DMAND(1,Y,M),DEMAND(1,Y,M),DMAND(4,Y,M),
     *DEMAND(4,Y,M),DMAND(2,Y,M),DEMAND(2,Y,M),DMAND(3,Y,M),
     *DEMAND(3,Y,M),DMAND(5,Y,M),DEMAND(5,Y,M),VOL(Y,M),PVOL(Y)
  210 FORMAT (3X,I4,1X,6(2X,F9.0,F9.0))
  103 CONTINUE
  107 CONTINUE
      WRITE (6,430) IPNO,PROTIT
      WRITE (6,485) ISEGNO,SEGTIT
  224 FORMAT (9X,4A4,A1,I6,2A4,A2)
      WRITE(6,224) TI1,IYR
      ICYRD=ICYR+IYR-1
      IEYRD=IEYR+IYR-1
      IF (ISW.EQ.1) GOTO 139
      IF (ICYR.LT.22.OR.ISW.EQ.4) WRITE(6,224) TI2,ICYRD
      IF (ICYR.EQ.22.AND.ISW.NE.4) WRITE(6,224) TI2,ICYRD,TI4
      IF (IEYR.EQ.27) GO TO 133
      GOTO 141
  133 WRITE(6,224) TI3,IEYRD,TI4
      GOTO 134
  139 WRITE(6,224) TI2,ICYRD
  141 IF (IEYR.NE.0) WRITE(6,224) TI3,IEYRD
  134 TMIN=0.
      TMAX=0.
      DO 240 Y=1,II
      IF (PVAL(2,Y).LT.TMIN) TMIN=PVAL(2,Y)
      IF (PVAL(6,Y).LT.TMIN) TMIN=PVAL(6,Y)
      IF (PVAL(2,Y).GT.TMAX) TMAX=PVAL(2,Y)
      IF (PVAL(6,Y).GT.TMAX) TMAX=PVAL(6,Y)
  240 CONTINUE
      MIN=TMIN
      IF (TMIN.LT.0) MIN=MIN-1
      MAX=TMAX
      IF (TMAX.GT.0) MAX=MAX+1
      ADD=(MAX-MIN)/12.
      IF (ADD.EQ.0.) GOTO 549
```

```
      DO 241 IB=1,13
      INC(IB)=MIN+ADD*(IB-1)+.5
  241 CONTINUE
  550 FORMAT (46X,'*** SEGMENT DISCOUNTED YEARLY BENEFITS ***'/)
  549 WRITE (6,550)
      IF (ADD.EQ.0.) GOTO 246
      WRITE (6,599) INC
  599 FORMAT (/3X,'YEAR',36X,'DISCOUNTED DELAY SAVINGS(S) AND TOTAL ',
     *'BENEFITS(B) ($1,000)'/13(3X,I7)/13(9X,'I')/8X,
     *123('-'))
      DO 242 Y=1,II,IEND
      YR=IYR+Y-1
      DO 243 LZ=1,121
      LINE(LZ)=KBLANK
  243 CONTINUE
      DO 244 LX=1,2
      LY=4*LX-2
      K=(PVAL(LY,Y)-MIN)*(1210./(120.5*ADD))+1.
      IF (LINE(K).EQ.KBLANK) GOTO 245
      LINE(K)=KAST
      GOTO 244
  245 LINE(K)=KLTR(LX+6)
  244 CONTINUE
      WRITE (6,502) YR,LINE
  242 CONTINUE
  246 IX=X1
      TPVAL(7)=ADJCON(IX)/1000.
      RATIO=TPVAL(6)/TPVAL(7)
      PV=TPVAL(6)-TPVAL(7)
      IRR=0
      ICT=0
      R=ASSUMP(6)
      CCOST=CCOST/1000.
      ECOST=ECOST/1000.
  143 P=0.
      P1=0.
      DO 140 Y=1,II
      DIS=DIFF(6,Y)/((1.+R)**Y)
      P=P+DIS*(1.+R)
      P1=P1-DIS*(Y-1)
  140 CONTINUE
      P=P-CCOST/((1.+R)**(ICYR-1))-ECOST/((1.+R)**(IEYR-1))
      P1=P1+CCOST*(ICYR-1)/((1.+R)**ICYR)+ECOST*(IEYR-1)/((1.+R)**IEYR)
      RA=ABS(P/P1)
      IF (RA.LT.0.0001) GOTO 144
      R=R-P/P1
      IF (R.LE.-1..OR.R.GT.100.) GOTO 142
      ICT=ICT+1
      IF (ICT.GT.50) GOTO 142
```

```
      GOTO 143
  142 IRR=1
  144 R=R*100.
      DO 42 I2 = 1,8
      SVAL(I2) = SVAL(I2) +TPVAL(I2)
   42 CONTINUE
  201 FORMAT (3X,'YEAR',9X,'HOURS OF DELAY',5X,'DELAY SAVINGS',6X,
     1'REDUCTION IN',7X,2('REDUCTION IN',7X),'TOTAL YEARLY'/
     218X,'SAVING PER',6X,'(S) IN DOLLARS',5X,'OPERATING COSTS',4X,
     *'ACCIDENT COSTS',4X,'MAINTENANCE COSTS',4X,'BENEFITS (B)'/17X,
     *'YEAR (1000)',10X,5('($1000)',12X))
      WRITE (6,201)
      DO 102 Y=1,II,IEND
      IYRD=IYR+Y-1
      WRITE (6,200) IYRD,(PVAL(I,Y),I=1,6)
  102 CONTINUE
  200 FORMAT (3X,I4,6(7X,F12.1))
      WRITE (6,205) (TPVAL(I),I=1,6)
  205 FORMAT (2X,'TOTAL',6(7X,F12.1))
      WRITE (6,430) IPNO,PROTIT
      WRITE (6,485) ISEGNO,SEGTIT
      WRITE (6,211)
      DO 111 Y=1,II,IEND
      IF(WP2(6,Y,1).EQ.0) WP2(6,Y,1) = .0000001
      IF(WP2(6,Y,2).EQ.0) WP2(6,Y,2) = .0000001
      IYRD=IYR+Y-1
      R5Y1=WSPCP1(6,Y,1)/WSPCP2(6,Y,1)
      R5Y2=WSPCP1(6,Y,2)/WSPCP2(6,Y,2)
      R1Y1 = WP1(6,Y,1)/WP2(6,Y,1)
      R2Y2 = WP1(6,Y,2)/WP2(6,Y,2)
      DVM1 = WSPCP2(6,Y,1) / 1000.0
      DVM2 = WSPCP2(6,Y,2) / 1000.0
      DVM3 = WP2(6,Y,1) / 1000.0
      DVM4 = WP2(6,Y,2) / 1000.0
      WRITE(6,203) IYRD,R5Y1,DVM1,R5Y2,DVM2,R1Y1,DVM3,R2Y2,DVM4
  111 CONTINUE
      WRITE (6,591)
  591 FORMAT (//2X,'SEGMENT TOTALS'/)
      WRITE (6,598) TPVAL(6),TPVAL(7),PV,RATIO
  598 FORMAT (8X,'PRESENT VALUE OF BENEFITS ($000) =',10X,F12.1/8X,
     *'PRESENT VALUE OF CONSTRUCTION COST ($000) =',1X,F12.1/8X,
     *'NET PRESENT VALUE ($000) =',18X,F12.1/8X,'BENEFIT/COST RATIO ='
     *,26X,F10.2)
      WRITE (6,592)
  592 FORMAT (8X,'INTERNAL RATE OF RETURN (%) =')
      IF (IRR.EQ.0) GOTO 597
      WRITE (6,596)
  596 FORMAT ('+',T48,'NO SOLUTION FOUND')
      GOTO 593
```

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  597 WRITE (6,594) R
  594 FORMAT ('+',T55,F10.2)
  593 CONTINUE
C     ADD TO GRAND TOTALS
  125 X1=7.
      NO1=6
      NO2=6
      CALL TOTAL
C     CLEAR ARRAYS
      ECOST=0.
      CCOST=0.
      DO 130 J1=1,8
      TPVAL(J1)=0.
      DO 130 J2=1,II
      IF (J1.GT.6) GOTO 130
      PVAL(J1,J2)=0.
  130 CONTINUE
      ADJCON(6)=0.
      DO 132 Y=1,II
      DO 132 J2=1,2
      WP1(6,Y,J2) = 0.
      WP2(6,Y,J2) = 0.
      DMAND(6,Y,J2)=0.
      WSPCP1(6,Y,J2)=0.
      WSPCP2(6,Y,J2)=0.
      ACCNUM(6,Y,J2)=0.
      ACCICO(6,Y,J2)=0.
      XMAINT(6,Y,J2)=0.
      CYCLE(6,Y,J2)=0.
      DMAND(5,Y,J2)=0.
      DMAND(4,Y,J2)=0.
      DMAND(3,Y,J2)=0.
      DMAND(2,Y,J2)=0.
      DMAND(1,Y,J2)=0.
      DEMAND(1,Y,J2)=0.
      DEMAND(2,Y,J2)=0.
      DEMAND(3,Y,J2)=0.
      DEMAND(4,Y,J2)=0.
      DEMAND(5,Y,J2)=0.
      DO 132 J3=1,2
      XTIME(6,Y,J2,J3)=0.
      XVTIME(6,Y,J2,J3)=0.
      OCOST(6,Y,J2,J3)=0.
  132 CONTINUE
      ALL(1)=0.
      ALL(2)=0.
      ALL(3)=0.
      ALL(4)=0.
      COST1=0.
```

```
      COST2=0.
      EXSTOR(5)=0.
      DO 136 J2=1,5
      IF (J2.GT.4) GOTO 131
      HDAT(J2)=BLANKS
  131 HSW(J2) =0.
      DO 136 J3=1,5
      HDATA(J2,J3)=0.
  136 CONTINUE
  100 CONTINUE
C
C     END OF SEGMENT
C
  746 IF (IFLAG.GT.3) GOTO 610
      IF (IFLAG.EQ.3) GOTO 754
  748 IF (ICTYPE.NE.1) GOTO 750
      IF (IFLAG.EQ.0) GOTO 754
      GOTO 605
  750 IF (ICTYPE.EQ.2) GOTO 605
C
C     GET NEXT RECORD
C
  751 READ (5,400,END=752,ERR=615) CARD
      READ (CARD,405)              ICTYPE
      IF (ICTYPE.EQ.1.OR.ICTYPE.EQ.2) GOTO 748
      GOTO 635
C
C     END OF FILE
  752 IFLAG=IFLAG+3
      GOTO 746
C
C     DISPLAY TOTALS
C
  754 CALL DIFFER
      IX=X1
      TPVAL(7)=ADJCON(IX)/1000.
      RATIO=TPVAL(6)/TPVAL(7)
      PV=TPVAL(6)-TPVAL(7)
      WRITE (6,430) IPNO,PROTIT
  555 FORMAT (43X,'**** PROBLEM DISCOUNTED YEARLY BENEFITS ****')
  122 WRITE (6,555)
      WRITE (6,201)
      DO 106 Y=1,II,IEND
      IYRD=IYR+Y-1
      WRITE (6,200) IYRD,(PVAL(I,Y),I=1,6)
  106 CONTINUE
      WRITE (6,205) (TPVAL(I),I=1,6)
      WRITE (6,211)
      DO 117 Y=1,II,IEND
```

```
      IYRD=IYR+Y-1
      R6Y1=WSPCP1(7,Y,1)/WSPCP2(7,Y,1)
      R6Y2=WSPCP1(7,Y,2)/WSPCP2(7,Y,2)
      R1Y1=WP1(7,Y,1)/WP2(7,Y,1)
      R2Y2=WP1(7,Y,2)/WP2(7,Y,2)
      DVM1 = WSPCP2(7,Y,1) / 1000.0
      DVM2 = WSPCP2(7,Y,2) / 1000.0
      DVM3 = WP2(7,Y,1) / 1000.0
      DVM4 = WP2(7,Y,2) / 1000.0
      WRITE(6,203) IYRD,R6Y1,DVM1,R6Y2,DVM2,R1Y1,DVM3,R2Y2,DVM4
  117 CONTINUE
      WRITE (6,299)
  299 FORMAT (/2X,'PROBLEM TOTALS')
      WRITE (6,598) TPVAL(6),TPVAL(7),PV,RATIO
  221 DO 10 I = 1,II
      CP16Y1(I) = CP16Y1(I) + WSPCP1(7,I,1)
      CP26Y1(I) = CP26Y1(I) + WSPCP2(7,I,1)
      CP16Y2(I) = CP16Y2(I) + WSPCP1(7,I,2)
      CP26Y2(I) = CP26Y2(I) + WSPCP2(7,I,2)
      WP11Y1(I) = WP11Y1(I) + WP1(7,I,1)
      WP21Y1(I) = WP21Y1(I) + WP2(7,I,1)
      WP12Y2(I) = WP12Y2(I) + WP1(7,I,2)
      WP22Y2(I) = WP22Y2(I) + WP2(7,I,2)
   10 CONTINUE
      IF (IFLAG.EQ.3) GOTO 610
      GOTO 605
      END
```

```
      SUBROUTINE EXPAND
      COMMON /LABA/ASSUMP(9),TABLE(11,70),HDATA(5,5),VOLUME(41),
     1DMAND(7,41,2),XMAINT(7,41,2),SPEED(7,41,2),CYCLE(7,41,2),
     2XSPEED(7,41,2,2),XTIME(7,41,2,2),OCOST(7,41,2,2),DIFF(6,41),
     3PVAL(6,41),ADJCON(7),ALL(4),ACCNUM(7,41,2),ACCICO(7,41,2),
     4STORE(10),WSPCP1(7,41,2),WSPCP2(7,41,2),TPVAL(8),ICYR3,ICYR4,
     5XVTIME(7,41,2,2),XMN,SP,WSP1,WSP2,CY,XV(2),XT(2),XSP(2)
      COMMON/LABB/OCP(5),PVOL(41),IHW(5,41,2),PRS,INDX,AC(4),TPR(4),
     6XVT(2),XRN(2),XCY(2),OC(2),HSW(5),ACCNO,ACCOST,COST1,
     7COST2,X1,ITRIAL,Y,NO1,NO2,NO3,NO4,EXSW,ALTSW,ANS,IASW,TAC(4),
     8ISW,ICYR,ICYR2,IEYR2,IEYR,X,L1,L,EXSTOR(10),CCOST,ECOST,TBLE(5,4),
     9WP1(7,41,2),WP2(7,41,2),RATIO,RATIO2,II,CINC(2),ASMSEG(5,3),
     *BYPS(4),PBYPS(4),PRSW,IN(5),CAP(4),VOL(41,2),DEMAND(6,41,2)
      INTEGER Y
C     TRY  DIFFERENT EXPANSION YEARS
      DO 100 ICYR1=1,ICYR4
      IF (ISW.EQ.2) ICYR3=ICYR1
      DO 100 IEYR3=ICYR1,ICYR3
C     CLEAR OUT ARRAYS
      DO 7 Y=1,II
      DO 7 I2=1,9
      IF (I2.GT.6) GOTO 5
      DIFF(I2,Y)=0.
      PVAL(I2,Y)=0.
    5 IF (Y.GT.1.OR.I2.GT.8) GOTO 6
      TPVAL(I2)=0.
    6 IF (I2.GT.6) GOTO 7
      DMAND(I2,Y,2)=0.
      DEMAND(I2,Y,2)=0.
    7 CONTINUE
      Y=II
C     PERFORM CALCULATIONS
C     IF CONSTRUCTION ONLY, DON'T VARY EXPANSION YEAR
C     EXPANSION ONLY, DON'T VARY CONSTRUCTION YEAR
      IF (ISW.NE.2) GOTO 50
      ICYR=ICYR1
      IF (PRSW.EQ.1) GOTO 40
      IEYR=0
      GOTO 50
   40 IEYR=ICYR
   50 IF (ISW.NE.3) GOTO 60
      ICYR=ICYR1
      IEYR=IEYR3
      GOTO 70
   60 IF (ISW.NE.4) GOTO 70
      IEYR=IEYR3
C     SET FOR CONSTRUCT OPTION
C     SET INDEX SO ONLY CONSTRUCT PHASE IS REPEATED
   70 NO3=2
```

```
      NO4=2
      CALL CRDMND
C     SET L FOR CONSTRUCT PATH IN CALC
      L=2
      CALL CALC03
      IF (IEYR3.GT.ICYR) X1=(COST2*(1.+ASSUMP(5))**(IEYR-1)*(1./
     1(1.+ASSUMP(6))**(IEYR-1)))
      IF (IEYR3.EQ.ICYR) X1=0.
      ECOST=X1*((1.+ASSUMP(6))**(IEYR-1))
      CCOST=COST1*(1.+ASSUMP(5))**(ICYR-1)
      ADJCON(1)=CCOST*(1./((1.+ASSUMP(6))
     1**(ICYR-1)))+X1
      TPVAL(7)=ADJCON(1)/1000.
      RATIO2=TPVAL(6)/TPVAL(7)
C     IF NOT BETTER, TRY AGAIN
      IF (RATIO2.LT.RATIO) GOTO 100
C     IF BETTER, STORE RESULT AND EXPANSION YEAR
      RATIO=RATIO2
      IEYR2=IEYR
      ICYR2=ICYR
  100 CONTINUE
  101 RETURN
      END
```

```
      SUBROUTINE CRDMND
      COMMON /LABA/ASSUMP(9),TABLE(11,70),HDATA(5,5),VOLUME(41),
     1DMAND(7,41,2),XMAINT(7,41,2),SPEED(7,41,2),CYCLE(7,41,2),
     2XSPEED(7,41,2,2),XTIME(7,41,2,2),OCOST(7,41,2,2),DIFF(6,41),
     3PVAL(6,41),ADJCON(7),ALL(4),ACCNUM(7,41,2),ACCICO(7,41,2),
     4STORE(10),WSPCP1(7,41,2),WSPCP2(7,41,2),TPVAL(8),ICYR3,ICYR4,
     5XVTIME(7,41,2,2),XMN,SP,WSP1,WSP2,CY,XV(2),XT(2),XSP(2)
      COMMON/LABB/OCP(5),PVOL(41),IHW(5,41,2),PRS,INDX,AC(4),TPR(4),
     6XVT(2),XRN(2),XCY(2),OC(2),HSW(5),ACCNO,ACCOST,COST1,
     7COST2,X1,ITRIAL,Y,NO1,NO2,NO3,NO4,EXSW,ALTSW,ANS,IASW,TAC(4),
     8ISW,ICYR,ICYR2,IEYR2,IEYR,X,L1,L,EXSTOR(10),CCOST,ECOST,TBLE(5,4),
     9WP1(7,41,2),WP2(7,41,2),RATIO,RATIO2,II,CINC(2),ASMSEG(5,3),
     *BYPS(4),PBYPS(4),PRSW,IN(5),CAP(4),VOL(41,2),DEMAND(6,41,2)
      DIMENSION TALL(4)
      INTEGER Y
C     ALLOCATES DEMAND
C     IN REGULAR RUN NO3=1 AND NO4=2;IN OPTIMUM RUN NO3=1 AND NO4=1
C     ONCE (TO CALCULATE DO-NOTHING) AND NO3=2 AND NO4 =2 MANY TIMES
C     (TO CALCULATE CONSTRUCT)
C     SORT CAPACITIES AND ALL(LX) FROM HIGHEST TO LOWEST
      DO 15 LX=1,4
      ALL(LX)=LX
      IHSW=HSW(LX)
      IF (HSW(LX).EQ.0.) GOTO 16
      CAP(LX)=TABLE(1,IHSW)*HDATA(LX,3)
      TPR(LX)=CAP(LX)*OCP(LX)
      PRS=TPR(LX)/50.
      INDX=LX
      CALL AVCOST
      TAC(LX)=AC(LX)
      AC(LX)=0.
      GOTO 15
   16 CAP(LX)=0.
      AC(LX)=0.
      TAC(LX)=0.
   15 CONTINUE
      DO 17 I=1,3
      L=4-I
      DO 17 J=1,L
      IF (CAP(J).GT.CAP(J+1)) GOTO 17
      T=CAP(J)
      T1=ALL(J)
      CAP(J)=CAP(J+1)
      CAP(J+1)=T
      ALL(J)=ALL(J+1)
      ALL(J+1)=T1
   17 CONTINUE
      DO 200 JT=1,4
      TALL(JT)=ALL(JT)
```

```
  200 CONTINUE
      DO 41 L=NO3,NO4
      DO 57 Y=1,II
      DO 20 LL=1,4
      IN(LL)=1
      ALL(LL)=TALL(LL)
      AC(LL)=0.
   20 CONTINUE
      X1=PVOL(Y)
      IF (HSW(4).EQ.0.) IN(4)=0.
      IF(HSW(3).EQ.0.) IN(3)=0
      IF (L.EQ.1) GOTO 90
      IF (Y.LT.ICYR) GOTO 90
      IF (PRSW.NE.0.) GOTO 70
      IF (Y.LT.IEYR) GOTO 60
      IF (HSW(3).EQ.0.) GOTO 70
      IN(2)=0
      GOTO 70
   60 IN(3)=0
   70 IF (EXSW.EQ.0.) GOTO 95
      IF (EXSW-2.) 75,80,85
   75 IN(1)=0
      GOTO 95
   80 IN(4)=0
      GOTO 95
   85 IN(1)=0
      IN(4)=0
      GOTO 95
   90 IN(2)=0
      IN(3)=0
   95 DO 100 K=1,5
      IF (K.EQ.5) IN(K)=1
      IHW(K,Y,L)=IN(K)
      IF (K.EQ.5) GOTO 100
      IF (ALL(K).EQ.0.) GOTO 100
      IALL=ALL(K)
      IF (IN(IALL).EQ.0) ALL(K)=0.
  100 CONTINUE
C     INITIALLY ALLOCATE ALL TRAFFIC TO ROUTE WITH HIGHEST CAPACITY
      DO 300 LL3=1,4
      IALL=ALL(LL3)
      IF (ALL(LL3).EQ.0.) GOTO 300
      DEMAND(IALL,Y,L)=X1
      PRS=X1
      INDX=ALL(LL3)
      CALL AVCOST
      CMAX=AC(INDX)
      CMIN=AC(INDX)
      IMAX=INDX
```

```
      IMIN=INDX
      GOTO 310
  300 CONTINUE
C     TAKE TRAFFIC FROM HIGHEST COST ROUTE TO LOWEST COST ROUTE
C     UNTIL TRAFFFIC BEING ALLOCATED IS LESS THAN 50
  310 NHY=IHW(1,Y,L)+IHW(2,Y,L)+IHW(3,Y,L)+IHW(4,Y,L)
  315 DO 320 L3=1,4
      IT=ALL(L3)
      IF (IT.EQ.0) GOTO 320
      IF (AC(IT).LE.CMAX) GOTO 330
      CMAX=AC(IT)
      IMAX=IT
  330 IF (AC(IT).GE.CMIN) GOTO 320
      CMIN=AC(IT)
      IMIN=IT
  320 CONTINUE
      DEMAND(IMAX,Y,L)=DEMAND(IMAX,Y,L)-X1/NHY
      PRS=DEMAND(IMAX,Y,L)
      INDX=IMAX
      CALL AVCOST
      CMAX=AC(IMAX)
      DEMAND(IMIN,Y,L)=DEMAND(IMIN,Y,L)+X1/NHY
      PRS=DEMAND(IMIN,Y,L)
      INDX=IMIN
      CALL AVCOST
      CMIN=AC(IMIN)
      IF (X1.LT.50.) GOTO 340
      X1=X1*(1.-1./NHY)
      GOTO 315
C     MAKE ADJUSTMENT FOR TRAFFIC ABOVE CAPACITY
  340 STAB=0.
      DO 350 L4=1,2
      DO 350 L5=1,4
      L3=ALL(L5)
      IF (ALL(L5).EQ.0.) GOTO 350
      DEMAND(L3,Y,L)=DEMAND(L3,Y,L)+STAB
      STAB=0.
      IF (DEMAND(L3,Y,L).LE.TPR(L3)) GOTO 360
      STAB=DEMAND(L3,Y,L)-TPR(L3)
      DEMAND(L3,Y,L)=TPR(L3)
  360 IF (DEMAND(L3,Y,L).GT.0.) GOTO 350
      STAB=DEMAND(L3,Y,L)
      DEMAND(L3,Y,L)=0.
  350 CONTINUE
C     ALL THAT FALLS THROUGH IS DIVERTED
      DEMAND(5,Y,L)=STAB
      DO 57 L1=1,5
      DMAND(L1,Y,L)=DEMAND(L1,Y,L)/OCP(L1)
   57 CONTINUE
```

```
41 CONTINUE
   L=NO4
   RETURN
   END
```

```
      SUBROUTINE AVCOST
      COMMON /LABA/ASSUMP(9),TABLE(11,70),HDATA(5,5),VOLUME(41),
     1DMAND(7,41,2),XMAINT(7,41,2),SPEED(7,41,2),CYCLE(7,41,2),
     2XSPEED(7,41,2,2),XTIME(7,41,2,2),OCOST(7,41,2,2),DIFF(6,41),
     3PVAL(6,41),ADJCON(7),ALL(4),ACCNUM(7,41,2),ACCICO(7,41,2),
     4STORE(10),WSPCP1(7,41,2),WSPCP2(7,41,2),TPVAL(8),ICYR3,ICYR4,
     5XVTIME(7,41,2,2),XMN,SP,WSP1,WSP2,CY,XV(2),XT(2),XSP(2)
      COMMON/LABB/OCP(5),PVOL(41),IHW(5,41,2),PRS,INDX,AC(4),TPR(4),
     6XVT(2),XRN(2),XCY(2),OC(2),HSW(5),ACCNO,ACCOST,COST1,
     7COST2,X1,ITRIAL,Y,NO1,NO2,NO3,NO4,EXSW,ALTSW,ANS,IASW,TAC(4),
     8ISW,ICYR,ICYR2,IEYR2,IEYR,X,L1,L,EXSTOR(10),CCOST,ECOST,TBLE(5,4),
     9WP1(7,41,2),WP2(7,41,2),RATIO,RATIO2,II,CINC(2),ASMSEG(5,3),
     *BYPS(4),PBYPS(4),PRSW,IN(5),CAP(4),VOL(41,2),DEMAND(6,41,2)
      INTEGER X
      L1=INDX
      X=HSW(L1)
      V=PRS/OCP(L1)
C     CHECK IF TOTAL PERSONS IS LESS THAN 2% CAPACITY
      BPR=TPR(L1)/50.
      IF(PRS.GE.BPR) GOTO 5
      AC(L1)=TAC(L1)/BPR*PRS
      GOTO 60
C     CALCULATE AVERAGE SPEED
    5 IF (V.GT.TABLE(2,X)) GOTO 10
      SP=HDATA(L1,3)*(TBLE(3,L1)+(TBLE(4,L1)-TBLE(3,L1))*V/TABLE(2,X))
      GOTO 30
   10 IF (V.GT.TABLE(1,X)*HDATA(L1,3)) GOTO 20
      SP=HDATA(L1,3)*(TBLE(4,L1)+(TBLE(5,L1)-TBLE(4,L1))/
     *(TABLE(1,X)-TABLE(2,X))*(V-TABLE(2,X)))
      GOTO 30
   20 SP=TBLE(5,L1)/10.
C     NUMBER OF CYCLES PER VEHICLE MILE
   30 CY=(TABLE(6,X)+TABLE(7,X)*V)/HDATA(L1,3)
      IF (CY.GT.8.7) CY=8.7
      IF (X.LT.29..OR.(X.GT.33..AND.X.LT.38.).OR.(X.GT.39..AND.X.LT.64.)
     *) GOTO 40
      IF (CY.GT.3.1) CY=3.1
C     PERCENTAGE CARS (PC) PERCENTAGE TRUCKS (PT)
   40 PC=1.-ASMSEG(L1,1)
      PT=ASMSEG(L1,1)
C     DAILY TIME COST PER PERSON
      PVT=HDATA(L1,1)*60./SP*(ASSUMP(2)*PC/1.3+ASSUMP(3)*PT/.9)
C     CALCULATE TIME COST WITH HOV BYPASS
      IF (BYPS(L1).EQ.0.) GOTO 50
      IF (V.LE.TABLE(2,X)) GOTO 50
      BSP=HDATA(L1,3)*(TBLE(4,L1)+(V-TABLE(2,X))*((144.*TBLE(5,L1)-
     *TBLE(4,L1)*(180.-TBLE(5,L1)))/((180.-TBLE(5,L1))*(TABLE(1,X)-
     *TABLE(2,X)))))
      PVT=PVT*(1.-PBYPS(L)*(1.-SP/BSP))
```

```
C     RUNNING COSTS PER PERSON
   50 RC=1.91*HDATA(L1,1)/1000.*(152.0616+1.939548*SP-.0085822*(SP)**2-
     *38.91707*ALOG(SP))*PC/ASMSEG(L1,2)
      RT=2.26*HDATA(L1,1)/1000.*(429.381938+5.598752*SP*.9-.003013*
     *(SP*.9)**2-131.592*ALOG(SP*.9))*PT/ASMSEG(L1,3)
      PR=RC+RT
C     CYCLING COSTS PER PERSON
      CCY=1.87*HDATA(L1,1)*CY/1000.*(3.9499-13.8413/SP)*PC/ASMSEG(L1,2)
      TCY=2.04*HDATA(L1,1)*CY/1000.*(47.2458-428.198/(SP*.9)*PT/
     *ASMSEG(L1,3))
      PCY=CCY+TCY
C     ACCIDENT COST PER PERSON
      PAC=HDATA(L1,1)*TABLE(8,X)/(1.0E+6*HDATA(L1,2))*
     *(.47/OCP(L1)+.414)*(TABLE(9,X)+TABLE(10,X)*V/1000.)
C     TOTAL DAILY COST PER PERSON INCLUDING INCONVENIENCE COST IF ANY
      AC(L1)=PVT+PR+PCY+PAC
      IF (HSW(L1).LT.42..OR.HSW(L1).GT.50.) GOTO 60
      AC(L1)=AC(L1)+(PC*CINC(1)+PT*CINC(2))*HDATA(L1,1)
   60 RETURN
      END
```

```
      SUBROUTINE CALCO3
      COMMON /LABA/ASSUMP(9),TABLE(11,70),HDATA(5,5),VOLUME(41),
     1DMAND(7,41,2),XMAINT(7,41,2),SPEED(7,41,2),CYCLE(7,41,2),
     2XSPEED(7,41,2,2),XTIME(7,41,2,2),OCOST(7,41,2,2),DIFF(6,41),
     3PVAL(6,41),ADJCON(7),ALL(4),ACCNUM(7,41,2),ACCICO(7,41,2),
     4STORE(10),WSPCP1(7,41,2),WSPCP2(7,41,2),TPVAL(8),ICYR3,ICYR4,
     5XVTIME(7,41,2,2),XMN,SP,WSP1,WSP2,CY,XV(2),XT(2),XSP(2)
      COMMON/LABB/OCP(5),PVOL(41),IHW(5,41,2),PRS,INDX,AC(4),TPR(4),
     6XVT(2),XRN(2),XCY(2),OC(2),HSW(5),ACCNO,ACCOST,COST1,
     7COST2,X1,ITRIAL,Y,NO1,NO2,NO3,NO4,EXSW,ALTSW,ANS,IASW,TAC(4),
     8ISW,ICYR,ICYR2,IEYR2,IEYR,X,L1,L,EXSTOR(10),CCOST,ECOST,TBLE(5,4),
     9WP1(7,41,2),WP2(7,41,2),RATIO,RATIO2,II,CINC(2),ASMSEG(5,3),
     *BYPS(4),PBYPS(4),PRSW,IN(5),CAP(4),VOL(41,2),DEMAND(6,41,2)
      DIMENSION VT(2)
      INTEGER Y,X
      DO 11 Y=1,II
      DO 11 L1=1,5
   33 X=HSW(L1)
      IF (HSW(L1).EQ.0.) GOTO 20
      IF (IHW(L1,Y,L).EQ.0) GOTO 29
C     SET DIVERSION LENGTH EQUAL TO EXISTING OR ALTERNATE, WHICHEVER
C     IS GREATER
   10 IF (L1.EQ.5) HDATA(L1,1)=AMAX1(HDATA(1,1),HDATA(4,1))
C     MAINTENANCE COSTS
   32 XMN=HDATA(L1,1)*TABLE(11,X)*(1.+ASSUMP(4))**(Y-1)
      GOTO 30
   29 XMN=0.
   30 IF (DMAND(L1,Y,L).EQ.0.) GOTO 27
      IF (L1.NE.5) GOTO 22
      IF (HSW(5).EQ.1.) SP=ASSUMP(8)
      IF  (HSW(5).EQ.2.) SP=ASSUMP(7)
      GOTO 23
C     AVERAGE SPEED
   22 SLOP1=(TBLE(4,L1)-TBLE(3,L1))/TABLE(2,X)
      IF (DMAND(L1,Y,L).LE.TABLE(2,X)) SP=HDATA(L1,3)*(TBLE(3,L1)
     1+SLOP1*DMAND(L1,Y,L))
      SLOP2=(TBLE(5,L1)-TBLE(4,L1))/(TABLE(1,X)-TABLE(2,X))
      XNTCP=-SLOP2*TABLE(2,X)+TBLE(4,L1)
      IF (DMAND(L1,Y,L).GT.TABLE(2,X)) SP=HDATA(L1,3)
     1*(XNTCP+SLOP2*DMAND(L1,Y,L))
C     WEIGHTED AVG SPEED COMPONENTS
   23 WSP1=DMAND(L1,Y,L)*HDATA(L1,1)*SP
      WSP2=DMAND(L1,Y,L)*HDATA(L1,1)
C     NUMBER OF CYCLES PER VEHICLE MILE
C     SET DIVERSION TECH FACTOR TO 1
      IF (L1.EQ.5) HDATA(L1,3)=1.
      CY=(TABLE(6,X)+TABLE(7,X)*DMAND(L1,Y,L))/HDATA(L1,3)
      IF (CY.GT.8.7) CY=8.7
      IF (HSW(L1).LT.29..OR.(HSW(L1).GT.33..AND.HSW(L1).LT.38.).OR.
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     1(HSW(L1).GT.39..AND.HSW(L1).LT.64.)) GOTO 45
   40 IF(CY.GT.3.1) CY = 3.1
   45 CONTINUE
C     CAR AND TRUCK COSTS: CAR=1,TRUCK=2
      DO 15 L2=1,2
C     DEMAND & SPEED
      IF (L2.EQ.2) GOTO 16
      XV(L2)=(1.-ASMSEG(L1,1))*DMAND(L1,Y,L)
      XSP(L2)=SP
      VT(1)=ASSUMP(2)*ASMSEG(L1,2)/1.3
      GOTO 17
   16 XV(L2)=ASMSEG(L1,1)*DMAND(L1,Y,L)
      XSP(L2)=.9*SP
      IF (X.GE.42..AND.X.LE.50.) GOTO 34
      GOTO 35
   34 VT(2)=ASSUMP(2)*ASMSEG(L1,3)/1.3
      GOTO 17
   35 VT(2)=ASSUMP(3)*ASMSEG(L1,3)
C     ELAPSED TIME
   17 IF (XSP(L2).EQ.0..OR.XV(L2).EQ.0.) GOTO 24
      XT(L2)=(HDATA(L1,1)/(XSP(L2))*365.*XV(L2))
C     VALUE OF TIME
      XVT(L2)=XT(L2)*VT(L2)*60.*(1.+ASSUMP(4))**(Y-1)
      GOTO 25
   24 XT(L2)=0.
      XVT(L2)=0.
      GOTO 21
C     CALCULATE VALUE OF TIME WITH HOV BYPASS
   25 IF (L1.GT.4) GOTO 21
      IF (BYPS(L1).EQ.0.) GOTO 21
      IF (DMAND(L1,Y,L).LE.TABLE(2,X)) GOTO 21
      BSP=HDATA(L1,3)*(TBLE(4,L1)+(DMAND(L1,Y,L)-TABLE(2,X))*
     *((144.*TBLE(5,L1)-TBLE(4,L1)*(180.-TBLE(5,L1)))/((180.-TBLE(5,L1))
     **(TABLE(1,X)-TABLE(2,X)))))
      IF (L2.EQ.2) BSP=BSP*.9
      XVT(L2)=XVT(L2)*(1.-PBYPS(L)*(1.-XSP(L2)/BSP))
      XT(L2)=XVT(L2)/VT(L2)/60./(1.+ASSUMP(4))**(Y-1)
C CAR & TRUCK RUN COSTS
   21 IF(L2.EQ.2) GO TO 18
C AVERAGE DAILY CAR RUN COSTS
      IF (XSP(L2).LE.25.AND.XSP(L2).NE.0)
     X XRN(L2)=(HDATA(L1,1)*XV(L2)/1000.)*
     X (XSP(L2)/(-3.4048E-2+1.577E-2*XSP(L2)))*
     X ((1.+ASSUMP(4))**(Y-1))*1.91
      IF (XSP(L2).GT.25) XRN(L2)=(HDATA(L1,1)*XV(L2)/1000.)*
     X (1./(1.579E-2-5.012E-5*XSP(L2)))*((1.+ASSUMP(4))**(Y-1))*1.91
C AVERAGE DAILY CYCLING COSTS - CARS
      XCY(L2)=(1.87)*((1.+ASSUMP(4))**(Y-1))*
     X          ((HDATA(L1,1)*XV(L2)*CY)/1000.)*
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     X (3.9499-13.8413/XSP(L2))
      GO TO 19
C AVERAGE DAILY TRUCK RUN COSTS
   18 IF(XSP(L2).LE.25.AND.XSP(L2).NE.0)
     XXRN(L2)=(HDATA(L1,1)*XV(L2)/1000.)*
     X(XSP(L2)/(-2.59E-2+8.094E-3*XSP(L2)))*((1.+ASSUMP(4))**(Y-1))
     X *2.26
      IF (XSP(L2).GT.25) XRN(L2)=(HDATA(L1,1)*XV(L2)/1000.)*
     X (1./(9.033E-3-7.342E-5*XSP(L2)))*((1.+ASSUMP(4))**(Y-1))*2.26
C AVERAGE DAILY CYCLING COSTS - TRKS
      XCY(L2)=(2.04)*((1.+ASSUMP(4))**(Y-1))*
     X((HDATA(L1,1)*XV(L2)*CY)/1000.)*
     X (47.2458-428.198/XSP(L2))
C ANNUAL OPERATING COSTS
   19 OC(L2) = (XRN(L2)+XCY(L2))*(365.)
C     ADD INCONVENIENCE COST, IF ANY
      IF (HSW(L1).LT.42..OR.HSW(L1).GT.50.) GOTO 15
      OC(L2)=OC(L2)+CINC(L2)*XV(L2)*ASMSEG(L1,L2+1)*365.*
     *HDATA(L1,1)*(1.+ASSUMP(4))**(Y-1)
   15 CONTINUE
C     ACCIDENT NO.
C     SET DIVERSION SAFETY INDEX TO 1
      IF (L1.EQ.5) HDATA(L1,2)=1.
      ACCNO=((TABLE(9,X)+(TABLE(10,X)*DMAND(L1,Y,L)/1000.))/HDATA(L1,2))
     1*(HDATA(L1,1)*DMAND(L1,Y,L)/1.0E+6)*(365.)
      ACCOST=(TABLE(8,X)*ACCNO*(1.+ASSUMP(4))**(Y-1))*
     *(.414*OCP(L1)+.47)
      GO TO 26
C     CLEAR PREVIOUS TOTALS  IF NO ROAD OF THIS TYPE -L1
   20 XMN=0.
   27 WSP1=0.
      WSP2=0.
      CY=0.
      XV(1)=0.
      XV(2)=0.
      XSP(1)=0.
      XSP(2)=0.
      XT(1)=0.
      XT(2)=0.
      XVT(1)=0.
      XVT(2)=0.
      XCY(1)=0.
      XCY(2)=0.
      OC(1)=0.
      OC(2)=0.
      ACCNO=0.
      ACCOST=0.
      SP=0.
      XRN(1)=0.
```

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      XRN(2)=0.
C     SKIP EQUATE IF OPTIMUM TRIALS
   26 IF (ITRIAL.EQ.1) GOTO 5
C     EQUATE PATH
C     THIS SECTION WILL MOVE VALUES TO FINAL ARRAYS IN ALL CASES
C     DURING REGULAR RUN AND WILL
C     MOVE VALUES TO FINAL ARRAYS WHEN BEST NPV
C     REACHED IN OPTIMUM YEAR
      X=L1
      XMAINT(X,Y,L)=XMN
      SPEED(X,Y,L)=SP
      WSPCP1(X,Y,L)=WSP1
      WSPCP2(X,Y,L)=WSP2
      CYCLE(X,Y,L)=CY
      DO 99 L2=1,2
      XSPEED(X,Y,L,L2)=XSP(L2)
      XTIME(X,Y,L,L2)=XT(L2)
      XVTIME(X,Y,L,L2)=XVT(L2)
      OCOST(X,Y,L,L2)=OC(L2)
   99 CONTINUE
      ACCNUM(X,Y,L)=ACCNO
      ACCICO(X,Y,L)=ACCOST
      IF (L.NE.2) GOTO 11
      IF (X.GT.1.OR.Y.GT.1) GOTO 11
      ECOST=COST2*((1.+ASSUMP(5))**(IEYR-1))
      CCOST=COST1*(1.+ASSUMP(5))**(ICYR-1)
      ADJCON(X)=CCOST*(1./(1.+ASSUMP(6))**(ICYR-1))+
     1ECOST*(1./(1.+ASSUMP(6))**(IEYR-1))
      GOTO 11
C     DIFFERENCES ONLY CALCULATED HERE FOR OPTIMUM TRIALS
C     THIS SECTION IS SKIPPED DURING REGULAR RUN
C     THE CONTROL VARIABLE IS ITRIAL
    5 X=L1
      DIFF(1,Y)=(DIFF(1,Y)+XTIME(X,Y,1,1)-XT(1)
     *+XTIME(X,Y,1,2)-XT(2))/1000.
      DIFF(2,Y)=(DIFF(2,Y)+XVTIME(X,Y,1,1)-XVT(1)
     *+XVTIME(X,Y,1,2)-XVT(2))/1000.
      DIFF(4,Y)=(DIFF(4,Y)+ACCICO(X,Y,1)-ACCOST)/1000.
      DIFF(5,Y)=(DIFF(5,Y)+XMAINT(X,Y,1)-XMN)/1000.
      DIFF(3,Y)=(DIFF(3,Y)+OCOST(X,Y,1,1)-OC(1)
     *+OCOST(X,Y,1,2)-OC(2))/1000.
      DIFF(6,Y)=DIFF(2,Y)+DIFF(3,Y)+DIFF(4,Y)+DIFF(5,Y)
C     CALCULATE NET PRESENT VALUE
      DO 41 J=1,6
      IF (J.EQ.1) GOTO 50
      PVAL(J,Y)=DIFF(J,Y)/((1.+ASSUMP(6))**(Y-1))
      GOTO 41
   50 PVAL(J,Y)=DIFF(J,Y)
   41 CONTINUE
```

```
 11 CONTINUE
    IF (ITRIAL.EQ.0) GOTO 999
    DO 91 J=1,6
    TPVAL(J)=0.
    DO 91 Y=1,II
    TPVAL(J)=TPVAL(J)+PVAL(J,Y)
 91 CONTINUE
999 RETURN
    END
```

```
      SUBROUTINE DIFFER
      COMMON /LABA/ASSUMP(9),TABLE(11,70),HDATA(5,5),VOLUME(41),
     1DMAND(7,41,2),XMAINT(7,41,2),SPEED(7,41,2),CYCLE(7,41,2),
     2XSPEED(7,41,2,2),XTIME(7,41,2,2),OCOST(7,41,2,2),DIFF(6,41),
     3PVAL(6,41),ADJCON(7),ALL(4),ACCNUM(7,41,2),ACCICO(7,41,2),
     4STORE(10),WSPCP1(7,41,2),WSPCP2(7,41,2),TPVAL(8),ICYR3,ICYR4,
     5XVTIME(7,41,2,2),XMN,SP,WSP1,WSP2,CY,XV(2),XT(2),XSP(2)
      COMMON/LABB/OCP(5),PVOL(41),IHW(5,41,2),PRS,INDX,AC(4),TPR(4),
     6XVT(2),XRN(2),XCY(2),OC(2),HSW(5),ACCNO,ACCOST,COST1,
     7COST2,X1,ITRIAL,Y,NO1,NO2,NO3,NO4,EXSW,ALTSW,ANS,IASW,TAC(4),
     8ISW,ICYR,ICYR2,IEYR2,IEYR,X,L1,L,EXSTOR(10),CCOST,ECOST,TBLE(5,4),
     9WP1(7,41,2),WP2(7,41,2),RATIO,RATIO2,II,CINC(2),ASMSEG(5,3),
     *BYPS(4),PBYPS(4),PRSW,IN(5),CAP(4),VOL(41,2),DEMAND(6,41,2)
      INTEGER Y,X
  200 X=X1
      DO 15 Y=1,II
C     CALCS THE DIFFERENCE BETWEEN THE DO NOTHING CASE
C     AND THE CONSTRUCTION CASE
      DIFF(1,Y)=(XTIME(X,Y,1,1)-XTIME(X,Y,2,1)
     *+XTIME(X,Y,1,2)-XTIME(X,Y,2,2))/1000.
      DIFF(2,Y)=(XVTIME(X,Y,1,1)-XVTIME(X,Y,2,1)
     *+XVTIME(X,Y,1,2)-XVTIME(X,Y,2,2))/1000.
      DIFF(4,Y)=(ACCICO(X,Y,1)-ACCICO(X,Y,2))/1000.
      DIFF(5,Y)=(XMAINT(X,Y,1)-XMAINT(X,Y,2))/1000.
      DIFF(3,Y)=(OCOST(X,Y,1,1)-OCOST(X,Y,2,1)
     *+OCOST(X,Y,1,2)-OCOST(X,Y,2,2))/1000.
      DIFF(6,Y)=DIFF(2,Y)+DIFF(3,Y)+DIFF(4,Y)+DIFF(5,Y)
C     CALCULATE NET PRESENT VALUE
      DO 15 J=1,6
      IF (J.EQ.1) GOTO 50
      PVAL(J,Y)=DIFF(J,Y)/((1.+ASSUMP(6))**(Y-1))
      GOTO 15
   50 PVAL(J,Y)=DIFF(J,Y)
   15 CONTINUE
      DO 12 J=1,6
      TPVAL(J)=0.
      DO 12 Y=1,II
      TPVAL(J)=TPVAL(J)+PVAL(J,Y)
   12 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE TOTAL
      COMMON /LABA/ASSUMP(9),TABLE(11,70),HDATA(5,5),VOLUME(41),
     1DMAND(7,41,2),XMAINT(7,41,2),SPEED(7,41,2),CYCLE(7,41,2),
     2XSPEED(7,41,2,2),XTIME(7,41,2,2),OCOST(7,41,2,2),DIFF(6,41),
     3PVAL(6,41),ADJCON(7),ALL(4),ACCNUM(7,41,2),ACCICO(7,41,2),
     4STORE(10),WSPCP1(7,41,2),WSPCP2(7,41,2),TPVAL(8),ICYR3,ICYR4,
     5XVTIME(7,41,2,2),XMN,SP,WSP1,WSP2,CY,XV(2),XT(2),XSP(2)
      COMMON/LABB/OCP(5),PVOL(41),IHW(5,41,2),PRS,INDX,AC(4),TPR(4),
     6XVT(2),XRN(2),XCY(2),OC(2),HSW(5),ACCNO,ACCOST,COST1,
     7COST2,X1,ITRIAL,Y,NO1,NO2,NO3,NO4,EXSW,ALTSW,ANS,IASW,TAC(4),
     8ISW,ICYR,ICYR2,IEYR2,IEYR,X,L1,L,EXSTOR(10),CCOST,ECOST,TBLE(5,4),
     9WP1(7,41,2),WP2(7,41,2),RATIO,RATIO2,II,CINC(2),ASMSEG(5,3),
     *BYPS(4),PBYPS(4),PRSW,IN(5),CAP(4),VOL(41,2),DEMAND(6,41,2)
      INTEGER Y,X
      X=X1
  200 DO 105 Y=1,II
      DO 100 L1=NO1,NO2
      IF (Y.GT.1) GOTO 10
      IF (NO1.GT.1.AND.NO1.LT.5) GOTO 10
      ADJCON(X)=ADJCON(X)+ADJCON(L1)
   10 DO 100 L2=1,2
      DMAND(X,Y,L2)=DMAND(X,Y,L2)+DMAND(L1,Y,L2)
      WSPCP1(X,Y,L2)=WSPCP1(X,Y,L2)+WSPCP1(L1,Y,L2)
      WSPCP2(X,Y,L2)=WSPCP2(X,Y,L2)+WSPCP2(L1,Y,L2)
      ACCNUM(X,Y,L2)=ACCNUM(X,Y,L2)+ACCNUM(L1,Y,L2)
      ACCICO(X,Y,L2)=ACCICO(X,Y,L2)+ACCICO(L1,Y,L2)
      XMAINT(X,Y,L2)=XMAINT(X,Y,L2)+XMAINT(L1,Y,L2)
      CYCLE(X,Y,L2)=CYCLE(X,Y,L2)+CYCLE(L1,Y,L2)
      IF(L1.GE.5) GO TO 75
      WP1(L1,Y,L2) = WSPCP1(L1,Y,L2)
      WP2(L1,Y,L2) = WSPCP2(L1,Y,L2)
   75 CONTINUE
      IF(L1.GT.2.AND.L1.LT.5) GO TO 99
      IF(L1.EQ.1.AND.L2.EQ.2.AND.Y.GE.ICYR) GO TO 99
      WP1(X,Y,L2)=WP1(X,Y,L2)+WP1(L1,Y,L2)
      WP2(X,Y,L2)=WP2(X,Y,L2)+WP2(L1,Y,L2)
   99 DO 100 L3=1,2
      XTIME(X,Y,L2,L3)=XTIME(X,Y,L2,L3)+XTIME(L1,Y,L2,L3)
      XVTIME(X,Y,L2,L3)=XVTIME(X,Y,L2,L3)+XVTIME(L1,Y,L2,L3)
      OCOST(X,Y,L2,L3)=OCOST(X,Y,L2,L3)+OCOST(L1,Y,L2,L3)
  100 CONTINUE
  105 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE INIT
      COMMON /LABA/ASSUMP(9),TABLE(11,70),IDUM(9784)
      COMMON /LABB/KDUM(2298)
      DO 100 I=1,9784
      IDUM(I)=0
  100 CONTINUE
      DO 200 J=1,2298
      KDUM(J)=0
  200 CONTINUE
      RETURN
      END
```

APPENDIX C

Sample Output

```
***** H E E M II *****
REVISED HIGHWAY ECONOMIC EVALUATION MODEL
VERSION(12-31-82)
```

PROBLEM 1 SAMPLE PROBLEM 1

PROBLEM CONTROL DATA -

CURRENT YEAR - 1983

ASSUMPTIONS -

1. PERCENTAGE TRUCKS %	11.00
2. VALUE CAR TIME $/MIN	0.17
3. VALUE TRUCK TIME $/MIN	0.32
4. INFLATION RATE %	0.00
5. CONST COST ESCALATION RATE %	0.00
6. DISCOUNT RATE %	8.00
7. RURAL DIVERSION ROUTE SPEED	25.00
8. URBAN DIVERSION ROUTE SPEED	15.00

PLANNING HORIZON - 20 YEARS

```
PROBLEM    1                                      SAMPLE PROBLEM 1

SEGMENT    1         DESCRIPTION - 4-LN FRWY  NEW LOCATION

       TRAFFIC DATA - CURRENT YEAR     1983   VOLUME (1,000)     22.00
                      PROJECTED YEAR1 1990   VOLUME (1,000)     45.00
                      PROJECTED YEAR2 2000   VOLUME (1,000)     65.00

       SEGMENT RUN TYPE - REGULAR RUN

       EXISTING  HIGHWAY DATA - HIGHWAY TYPE    U4C
                                LENGTH     2.30 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     90.00    100.00
                                SPEED LIMIT  40. MPH
                                PERCENT TRUCKS(BUSES)      11.00
                                CAR(VAN) OCCUPANCY RATE     1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00

       PROPOSED  HIGHWAY DATA - HIGHWAY TYPE    U4F
                                LENGTH     2.50 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     95.00    100.00
                                CONSTRUCTION YEAR   1986
                                CONSTRUCTION COST (MILLIONS)  $ 50.00
                                PERCENT TRUCKS(BUSES)      11.00
                                CAR(VAN) OCCUPANCY RATE     1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00

       ALTERNATE HIGHWAY DATA - HIGHWAY TYPE    U2C
                                LENGTH     2.90 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     90.00     95.00
                                SPEED LIMIT  40. MPH
                                PERCENT TRUCKS(BUSES)      11.00
                                CAR(VAN) OCCUPANCY RATE     1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00
```

PROBLEM 1 SAMPLE PROBLEM 1

SEGMENT 1 DESCRIPTION - 4-LN FRWY NEW LOCATION

*** DO-NOTHING CORRIDOR TRAFFIC ALLOCATION ***

```
 YEAR                                                   VEHICLES (1,000)                     (SQUARE-ROOT SCALE)
       0         0         2         4         8        12        18        24        32        40        49        60        71
       I         I         I         I         I         I         I         I         I         I         I         I         I
      ---------------------------------------------------------------------------------------------------------------------------
 1983 I         A                                                        ET
 1984 I         A                                                                ET
 1985 I                 A                                                            E T
 1986 I                      A                                                          E  T
 1987 I                          A                                                        E   T
 1988 I                             A                                                       E    T
 1989 I                                A                                                      E     T
 1990 I                                  A                                                      E     T
 1991 I                                     A                                                     E      T
 1992 I                                       A                                                    E       T
 1993 I                                         A                                                   E        T
 1994 I                                           A                                                   E        T
 1995 I                                              A                                                E          T
 1996 I                                                  A                                            E            T
 1997 I                                                      A                                        E              T
 1998 I                                                         A                                     E                T
 1999 I                                                             A                                 E                 T
 2000 I                                                               A                               E                   T
 2001 I        D                                                         A                            E                    T
 2002 I                    D                                             A                            E                      T
 2003 I                            D                                     A                            E                       T
         * INDICATES MULTIPLE LETTERS AT SAME POINT
```

YEAR	EXISTING (E) VEHICLES	PERSONS	ALTERNATE (A) VEHICLES	PERSONS	PROPOSED (P) VEHICLES	PERSONS	EXPANSION (X) VEHICLES	PERSONS	DIVERTED (D) VEHICLES	PERSONS	TOTAL (T) VEHICLES	PERSONS
1983	21603.	27370.	397.	504.	0.	0.	0.	0.	0.	0.	22000.	27874.
1984	27383.	34694.	448.	568.	0.	0.	0.	0.	0.	0.	27832.	35263.
1985	30015.	38029.	1492.	1891.	0.	0.	0.	0.	0.	0.	31507.	39920.
1986	32201.	40798.	2454.	3109.	0.	0.	0.	0.	0.	0.	34654.	43907.
1987	34150.	43267.	3351.	4246.	0.	0.	0.	0.	0.	0.	37500.	47513.
1988	35928.	45520.	4214.	5339.	0.	0.	0.	0.	0.	0.	40142.	50860.
1989	37541.	47565.	5089.	6448.	0.	0.	0.	0.	0.	0.	42631.	54013.
1990	39078.	49512.	5922.	7503.	0.	0.	0.	0.	0.	0.	45000.	57015.
1991	40520.	51338.	6751.	8554.	0.	0.	0.	0.	0.	0.	47271.	59892.
1992	41889.	53073.	7571.	9593.	0.	0.	0.	0.	0.	0.	49460.	62665.
1993	43179.	54707.	8399.	10641.	0.	0.	0.	0.	0.	0.	51578.	65349.
1994	44402.	56258.	9231.	11696.	0.	0.	0.	0.	0.	0.	53634.	67954.
1995	45000.	57015.	10636.	13475.	0.	0.	0.	0.	0.	0.	55636.	70490.
1996	45000.	57015.	12589.	15950.	0.	0.	0.	0.	0.	0.	57589.	72965.
1997	44987.	56998.	14511.	18386.	0.	0.	0.	0.	0.	0.	59498.	75384.
1998	44992.	57005.	16376.	20748.	0.	0.	0.	0.	0.	0.	61367.	77753.
1999	45000.	57015.	18200.	23060.	0.	0.	0.	0.	0.	0.	63200.	80075.
2000	44989.	57001.	20011.	25354.	0.	0.	0.	0.	0.	0.	65000.	82355.
2001	45000.	57015.	21375.	27082.	0.	0.	0.	0.	394.	499.	66769.	84596.
2002	45000.	57015.	21375.	27082.	0.	0.	0.	0.	2133.	2703.	68508.	86800.
2003	45000.	57015.	21375.	27082.	0.	0.	0.	0.	3846.	4874.	70221.	88971.

PROBLEM 1 SAMPLE PROBLEM 1

SEGMENT 1 DESCRIPTION - 4-LN FRWY NEW LOCATION

*** IF-CONSTRUCT CORRIDOR TRAFFIC ALLOCATION ***

```
 YEAR                                                   VEHICLES (1,000)                     (SQUARE-ROOT SCALE)
       0         0         2         4         8        12        18        24        32        40        49        60        71
       I         I         I         I         I         I         I         I         I         I         I         I         I
      ------------------------------------------------------------------------------------------------------------------------------
 1983 I         A                                                        ET
 1984 I         A                                                                ET
 1985 I                 A                                                            E T
 1986 I       A     E                                                                    P T
 1987 I        A    E                                                                        PT
 1988 I        A    E                                                                           PT
 1989 I        A    E                                                                              PT
 1990 I        A    E                                                                                PT
 1991 I        A          E                                                                           P  T
 1992 I        A               E                                                                        P  T
 1993 I        A                   E                                                                     P   T
 1994 I        A                       E                                                                  P    T
 1995 I        A                          E                                                                P     T
 1996 I        A                            E                                                               P      T
 1997 I        A                               E                                                             P       T
 1998 I        A                                 E                                                            P        T
 1999 I        A                                   E                                                           P        T
 2000 I        A                                     E                                                          P         T
 2001 I        A                                       E                                                        P          T
 2002 I        A                                         E                                                       P           T
 2003 I        A                                          E                                                       P           T
         * INDICATES MULTIPLE LETTERS AT SAME POINT
```

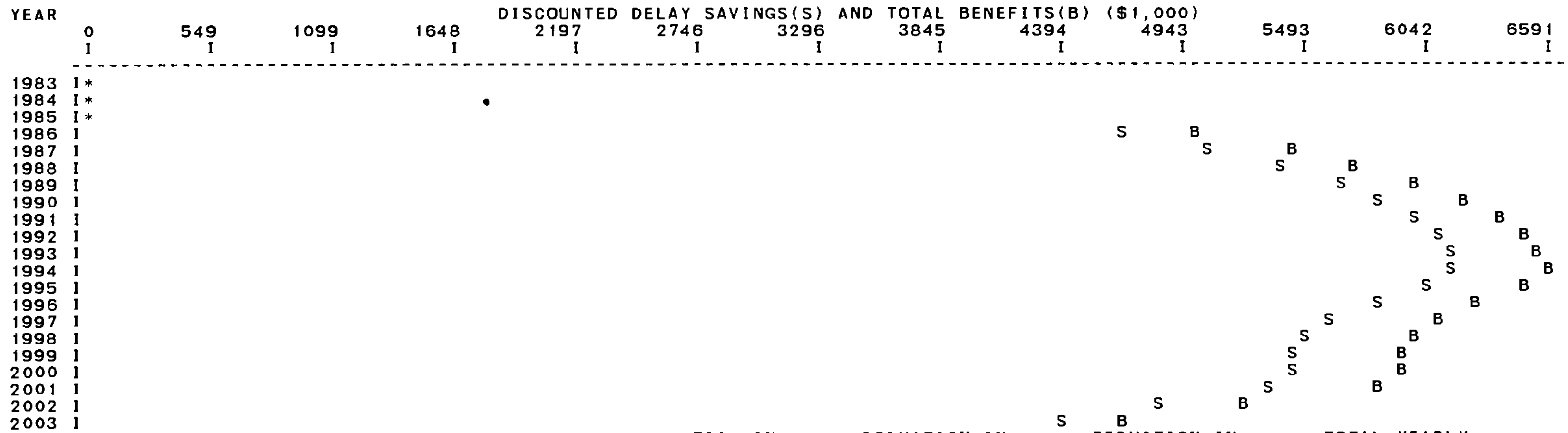
YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	21603.	27370.	397.	504.	0.	0.	0.	0.	0.	0.	22000.	27874.
1984	27383.	34694.	448.	568.	0.	0.	0.	0.	0.	0.	27832.	35263.
1985	30015.	38029.	1492.	1891.	0.	0.	0.	0.	0.	0.	31507.	39920.
1986	827.	1048.	313.	396.	33515.	42463.	0.	0.	0.	0.	34654.	43907.
1987	851.	1079.	313.	397.	36336.	46038.	0.	0.	0.	0.	37500.	47513.
1988	863.	1093.	322.	408.	38958.	49359.	0.	0.	0.	0.	40142.	50860.
1989	888.	1125.	332.	421.	41411.	52468.	0.	0.	0.	0.	42631.	54013.
1990	908.	1150.	340.	431.	43752.	55434.	0.	0.	0.	0.	45000.	57015.
1991	1935.	2452.	344.	436.	44992.	57005.	0.	0.	0.	0.	47271.	59892.
1992	3021.	3827.	345.	437.	46094.	58401.	0.	0.	0.	0.	49460.	62665.
1993	4063.	5148.	348.	441.	47167.	59760.	0.	0.	0.	0.	51578.	65349.
1994	5078.	6433.	346.	439.	48210.	61082.	0.	0.	0.	0.	53634.	67954.
1995	6065.	7684.	347.	439.	49224.	62366.	0.	0.	0.	0.	55636.	70490.
1996	7010.	8882.	359.	455.	50220.	63628.	0.	0.	0.	0.	57589.	72965.
1997	7952.	10075.	362.	459.	51184.	64850.	0.	0.	0.	0.	59498.	75384.
1998	8866.	11233.	364.	461.	52137.	66058.	0.	0.	0.	0.	61367.	77753.
1999	9770.	12378.	363.	460.	53067.	67236.	0.	0.	0.	0.	63200.	80075.
2000	10648.	13491.	364.	461.	53988.	68403.	0.	0.	0.	0.	65000.	82355.
2001	11509.	14581.	374.	473.	54886.	69541.	0.	0.	0.	0.	66768.	84596.
2002	12366.	15668.	365.	462.	55777.	70670.	0.	0.	0.	0.	68508.	86800.
2003	13197.	16720.	374.	474.	56651.	71776.	0.	0.	0.	0.	70221.	88971.

PROBLEM 1 SAMPLE PROBLEM 1

SEGMENT 1 DESCRIPTION - 4-LN FRWY NEW LOCATION

CURRENT YEAR 1983
CONSTRUCTION YEAR 1986

*** SEGMENT DISCOUNTED YEARLY BENEFITS ***



YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	519.8	4657.0	-737.3	1150.8	-51.6	5018.9
1987	609.2	5054.0	-757.9	1167.3	-47.8	5415.6
1988	700.2	5378.9	-770.1	1168.7	-44.2	5733.4
1989	792.5	5636.4	-740.0	1159.3	-41.0	6014.7
1990	888.5	5851.3	-725.0	1141.5	-37.9	6229.8
1991	980.6	5979.5	-669.5	1095.1	-35.1	6370.1
1992	1075.9	6074.6	-613.8	1046.4	-32.5	6474.7
1993	1174.5	6140.1	-561.7	998.4	-30.1	6546.7
1994	1276.7	6180.3	-513.0	951.4	-27.9	6590.8
1995	1346.7	6036.0	-457.0	910.5	-25.8	6463.6
1996	1397.2	5798.4	-400.0	874.7	-23.9	6249.2
1997	1465.5	5631.4	-347.1	838.6	-22.1	6100.8
1998	1550.3	5516.2	-298.6	802.5	-20.5	5999.6
1999	1654.3	5450.0	-243.7	766.6	-19.0	5953.9
2000	1781.9	5435.6	-196.7	731.4	-17.6	5952.7
2001	1893.0	5346.8	-181.0	687.9	-16.3	5837.4
2002	1856.3	4854.9	-246.2	619.4	-15.1	5213.0
2003	1820.0	4407.2	-299.9	557.3	-13.9	4650.6
TOTAL	22782.9	99428.4	-8758.3	16667.6	-522.3	106815.4

PROBLEM 1 SAMPLE PROBLEM 1

SEGMENT 1 DESCRIPTION - 4-LN FRWY NEW LOCATION

*** MOBILITY ***

	CORRIDOR				STATE FACILITY			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	33.3	50.8	33.3	50.8	33.2	49.7	33.2	49.7
1984	30.3	64.3	30.3	64.3	30.2	63.0	30.2	63.0
1985	29.0	73.4	29.0	73.4	28.7	69.0	28.7	69.0
1986	28.0	81.2	57.9	86.6	27.4	74.1	58.7	83.8
1987	27.1	88.3	57.9	93.7	26.2	78.5	58.6	90.8
1988	26.3	94.9	57.8	100.3	25.2	82.6	58.5	97.4
1989	25.6	101.1	57.7	106.5	24.2	86.3	58.4	103.5
1990	24.9	107.1	57.7	112.5	23.3	89.9	58.3	109.4
1991	24.3	112.8	57.2	117.9	22.5	93.2	58.2	112.5
1992	23.7	118.3	56.8	123.2	21.7	96.3	58.2	115.2
1993	23.2	123.7	56.4	128.3	20.9	99.3	58.1	117.9
1994	22.7	128.9	56.0	133.2	20.2	102.1	58.1	120.5
1995	22.6	134.3	55.6	138.0	19.9	103.5	58.0	123.1
1996	22.5	140.0	55.3	142.7	19.9	103.5	58.0	125.5
1997	22.2	145.6	55.0	147.3	19.9	103.5	58.0	128.0
1998	21.7	151.0	54.7	151.8	19.9	103.5	57.9	130.3
1999	21.2	156.3	54.5	156.2	19.9	103.5	57.9	132.7
2000	20.5	161.5	54.2	160.5	19.9	103.5	57.9	135.0
2001	20.0	165.5	54.0	164.8	19.9	103.5	57.8	137.2
2002	20.0	165.5	53.8	168.9	19.9	103.5	57.8	139.4
2003	20.0	165.5	53.6	173.1	19.9	103.5	57.7	141.6

SEGMENT TOTALS

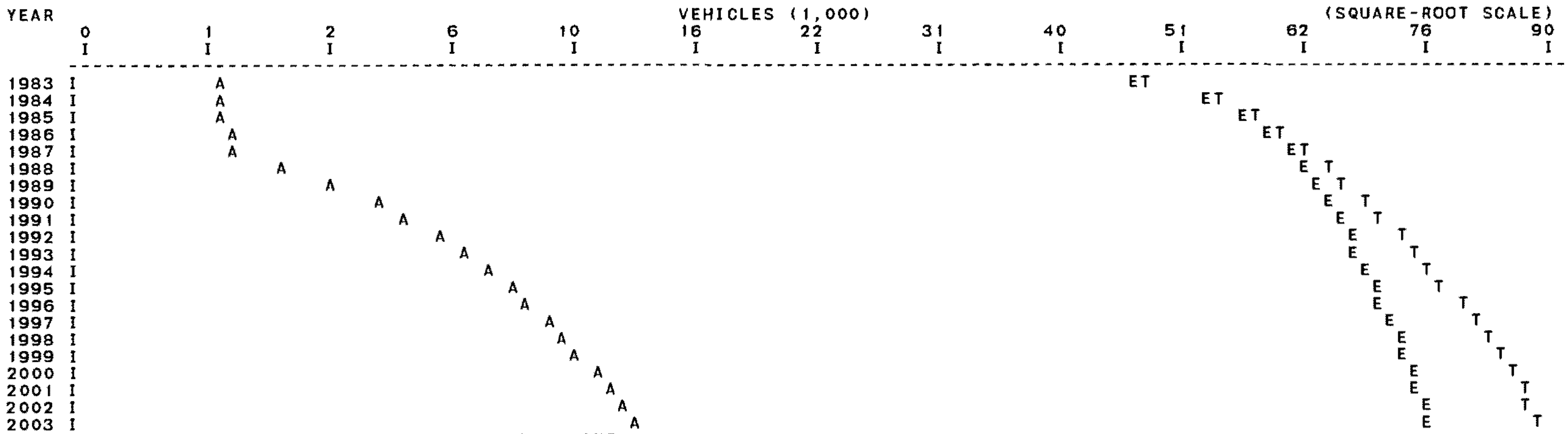
PRESENT VALUE OF BENEFITS ($000) = 106815.4
PRESENT VALUE OF CONSTRUCTION COST ($000) = 39691.6
NET PRESENT VALUE ($000) = 67123.7
BENEFIT/COST RATIO = 2.69
INTERNAL RATE OF RETURN (%) = 25.27

```
PROBLEM    1                                          SAMPLE PROBLEM 1

SEGMENT    2          DESCRIPTION - 4-LN/6-LN FRWY W/ALT U4C

       TRAFFIC DATA - CURRENT YEAR     1983   VOLUME (1,000)     47.00
                      PROJECTED YEAR1 1990   VOLUME (1,000)     69.00
                      PROJECTED YEAR2 2000   VOLUME (1,000)     85.00

       SEGMENT RUN TYPE - REGULAR RUN

       EXISTING  HIGHWAY DATA - HIGHWAY TYPE    U4F
                                LENGTH     1.60 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     95.00    100.00
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00

       PROPOSED  HIGHWAY DATA - HIGHWAY TYPE    U6F
                                LENGTH     1.60 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     90.00     95.00
                                CONSTRUCTION YEAR   1986
                                CONSTRUCTION COST (MILLIONS)  $  8.00
                                BUILDOVER OF EXISTING ROUTE
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00

       ALTERNATE HIGHWAY DATA - HIGHWAY TYPE    U4C
                                LENGTH     1.70 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     90.00    100.00
                                SPEED LIMIT  40. MPH
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00
```

PROBLEM 1 SAMPLE PROBLEM 1

SEGMENT 2 DESCRIPTION - 4-LN/6-LN FRWY W/ALT U4C

*** DO-NOTHING CORRIDOR TRAFFIC ALLOCATION ***



* INDICATES MULTIPLE LETTERS AT SAME POINT

YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	46208.	58546.	792.	1003.	0.	0.	0.	0.	0.	0.	47000.	59549.
1984	52784.	66878.	851.	1078.	0.	0.	0.	0.	0.	0.	53635.	67956.
1985	56318.	71355.	851.	1079.	0.	0.	0.	0.	0.	0.	57169.	72434.
1986	59160.	74956.	894.	1133.	0.	0.	0.	0.	0.	0.	60054.	76089.
1987	61684.	78153.	902.	1142.	0.	0.	0.	0.	0.	0.	62585.	79296.
1988	63123.	79977.	1758.	2228.	0.	0.	0.	0.	0.	0.	64882.	82205.
1989	64275.	81436.	2732.	3461.	0.	0.	0.	0.	0.	0.	67007.	84898.
1990	65344.	82791.	3656.	4632.	0.	0.	0.	0.	0.	0.	69000.	87423.
1991	66369.	84089.	4517.	5723.	0.	0.	0.	0.	0.	0.	70886.	89812.
1992	67342.	85322.	5341.	6767.	0.	0.	0.	0.	0.	0.	72683.	92090.
1993	68283.	86515.	6122.	7756.	0.	0.	0.	0.	0.	0.	74405.	94272.
1994	69173.	87642.	6889.	8729.	0.	0.	0.	0.	0.	0.	76062.	96371.
1995	70059.	88765.	7603.	9633.	0.	0.	0.	0.	0.	0.	77662.	98398.
1996	70916.	89850.	8296.	10512.	0.	0.	0.	0.	0.	0.	79212.	100362.
1997	71711.	90858.	9006.	11410.	0.	0.	0.	0.	0.	0.	80716.	102268.
1998	72519.	91882.	9661.	12240.	0.	0.	0.	0.	0.	0.	82180.	104123.
1999	73289.	92857.	10318.	13073.	0.	0.	0.	0.	0.	0.	83607.	105930.
2000	74053.	93825.	10947.	13869.	0.	0.	0.	0.	0.	0.	85000.	107695.
2001	74797.	94767.	11565.	14653.	0.	0.	0.	0.	0.	0.	86361.	109420.
2002	75502.	95660.	12193.	15448.	0.	0.	0.	0.	0.	0.	87694.	111109.
2003	76148.	96480.	12853.	16284.	0.	0.	0.	0.	0.	0.	89001.	112764.

PROBLEM 1 SAMPLE PROBLEM 1

SEGMENT 2 DESCRIPTION - 4-LN/6-LN FRWY W/ALT U4C

*** IF-CONSTRUCT CORRIDOR TRAFFIC ALLOCATION ***

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YEAR                                                   VEHICLES (1,000)                                     (SQUARE-ROOT SCALE)
      0         1         2         6        10        16        22        31        40        51        62        76        90
      I         I         I         I         I         I         I         I         I         I         I         I         I
      ----------------------------------------------------------------------------------------------------------------------------
1983 I           A                                                                          ET
1984 I           A                                                                                ET
1985 I           A                                                                                   ET
1986 I          A                                                                                      PT
1987 I          A                                                                                        PT
1988 I           A                                                                                         PT
1989 I           A                                                                                           *
1990 I           A                                                                                            PT
1991 I           A                                                                                              *
1992 I           A                                                                                               PT
1993 I           A                                                                                                PT
1994 I           A                                                                                                  *
1995 I           A                                                                                                   *
1996 I           A                                                                                                    PT
1997 I           A                                                                                                     PT
1998 I           A                                                                                                      PT
1999 I           A                                                                                                       PT
2000 I           A                                                                                                        PT
2001 I           A                                                                                                         PT
2002 I           A                                                                                                          *
2003 I           A                                                                                                           *
        * INDICATES MULTIPLE LETTERS AT SAME POINT
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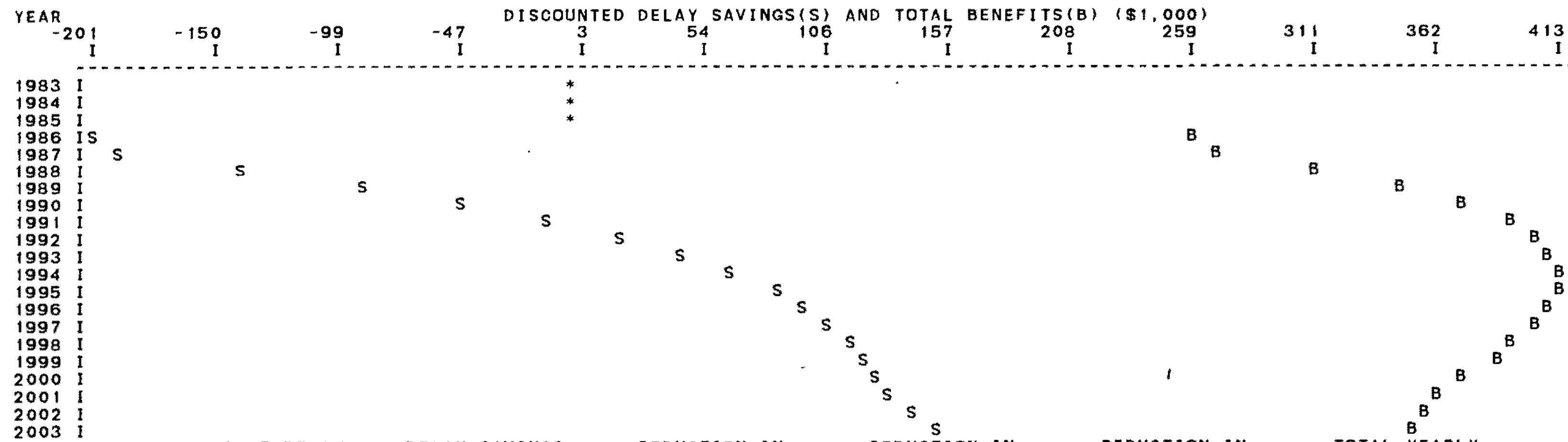
YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	46208.	58546.	792.	1003.	0.	0.	0.	0.	0.	0.	47000.	59549.
1984	52784.	66878.	851.	1078.	0.	0.	0.	0.	0.	0.	53635.	67956.
1985	56318.	71355.	851.	1079.	0.	0.	0.	0.	0.	0.	57169.	72434.
1986	0.	0.	748.	947.	59307.	75142.	0.	0.	0.	0.	60054.	76089.
1987	0.	0.	749.	949.	61837.	78347.	0.	0.	0.	0.	62585.	79296.
1988	0.	0.	776.	983.	64106.	81222.	0.	0.	0.	0.	64882.	82205.
1989	0.	0.	769.	974.	66238.	83924.	0.	0.	0.	0.	67007.	84898.
1990	0.	0.	792.	1003.	68208.	86420.	0.	0.	0.	0.	69000.	87423.
1991	0.	0.	813.	1031.	70072.	88782.	0.	0.	0.	0.	70886.	89812.
1992	0.	0.	799.	1012.	71885.	91078.	0.	0.	0.	0.	72683.	92090.
1993	0.	0.	817.	1036.	73588.	93236.	0.	0.	0.	0.	74405.	94272.
1994	0.	0.	836.	1059.	75227.	95312.	0.	0.	0.	0.	76062.	96371.
1995	0.	0.	815.	1033.	76847.	97365.	0.	0.	0.	0.	77662.	98398.
1996	0.	0.	832.	1054.	78380.	99308.	0.	0.	0.	0.	79212.	100362.
1997	0.	0.	847.	1074.	79869.	101194.	0.	0.	0.	0.	80716.	102268.
1998	0.	0.	853.	1080.	81327.	103042.	0.	0.	0.	0.	82180.	104123.
1999	0.	0.	847.	1073.	82760.	104857.	0.	0.	0.	0.	83607.	105930.
2000	0.	0.	861.	1091.	84138.	106603.	0.	0.	0.	0.	85000.	107695.
2001	0.	0.	854.	1082.	85508.	108338.	0.	0.	0.	0.	86361.	109420.
2002	0.	0.	867.	1099.	86827.	110010.	0.	0.	0.	0.	87694.	111109.
2003	0.	0.	880.	1115.	88121.	111649.	0.	0.	0.	0.	89001.	112764.

PROBLEM 1 SAMPLE PROBLEM 1

SEGMENT 2 DESCRIPTION - 4-LN/6-LN FRWY W/ALT U4C

CURRENT YEAR 1983
CONSTRUCTION YEAR 1986

*** SEGMENT DISCOUNTED YEARLY BENEFITS ***



YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	-22.5	-201.2	453.8	17.9	-10.4	260.1
1987	-23.1	-191.4	452.4	17.3	-9.6	268.6
1988	-18.3	-140.4	422.8	35.2	-8.9	308.6
1989	-12.3	-87.8	389.1	53.5	-8.3	346.5
1990	-6.8	-44.6	358.0	67.4	-7.7	373.1
1991	-1.5	-9.0	329.4	77.7	-7.1	391.1
1992	3.9	22.1	302.4	86.2	-6.6	404.2
1993	8.9	46.6	278.1	91.8	-6.1	410.3
1994	13.9	67.4	255.3	95.8	-5.6	412.8
1995	18.9	84.5	234.2	98.6	-5.2	412.2
1996	23.5	97.6	215.2	99.8	-4.8	407.8
1997	28.4	109.1	197.1	100.4	-4.5	402.1
1998	33.0	117.4	180.8	99.9	-4.1	393.9
1999	37.8	124.4	165.4	99.0	-3.8	385.0
2000	42.3	128.9	151.7	97.3	-3.5	374.3
2001	46.9	132.4	138.7	95.4	-3.3	363.3
2002	54.6	142.8	124.0	93.2	-3.0	356.8
2003	63.6	154.1	109.4	91.0	-2.8	351.6
TOTAL	291.2	552.8	4757.8	1417.2	-105.4	6622.4

PROBLEM 1 SAMPLE PROBLEM 1

SEGMENT 2 DESCRIPTION - 4-LN/6-LN FRWY W/ALT U4C

*** MOBILITY ***

	CORRIDOR				STATE FACILITY			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	57.8	75.3	57.8	75.3	58.2	73.9	58.2	73.9
1984	57.5	85.9	57.5	85.9	57.9	84.5	57.9	84.5
1985	57.4	91.6	57.4	91.6	57.8	90.1	57.8	90.1
1986	57.3	96.2	55.3	96.2	57.6	94.7	55.5	94.9
1987	57.2	100.2	55.2	100.2	57.5	98.7	55.4	98.9
1988	56.9	104.0	55.2	103.9	57.5	101.0	55.4	102.6
1989	56.5	107.5	55.1	107.3	57.4	102.8	55.3	106.0
1990	56.2	110.8	55.1	110.5	57.4	104.6	55.3	109.1
1991	55.9	113.9	55.0	113.5	57.4	106.2	55.2	112.1
1992	55.7	116.8	55.0	116.4	57.3	107.7	55.2	115.0
1993	55.4	119.7	54.9	119.1	57.3	109.3	55.1	117.7
1994	55.2	122.4	54.9	121.8	57.3	110.7	55.1	120.4
1995	55.0	125.0	54.9	124.3	57.2	112.1	55.1	123.0
1996	54.8	127.6	54.8	126.8	57.2	113.5	55.0	125.4
1997	54.6	130.0	54.8	129.2	57.2	114.7	55.0	127.8
1998	54.4	132.5	54.8	131.6	57.1	116.0	55.0	130.1
1999	54.2	134.8	54.7	133.9	57.1	117.3	54.9	132.4
2000	54.1	137.1	54.7	136.1	57.1	118.5	54.9	134.6
2001	53.9	139.3	54.7	138.3	57.0	119.7	54.8	136.8
2002	53.6	141.5	54.6	140.4	56.8	120.8	54.8	138.9
2003	53.2	143.7	54.6	142.5	56.5	121.8	54.8	141.0

SEGMENT TOTALS

PRESENT VALUE OF BENEFITS ($000) = 6622.4
PRESENT VALUE OF CONSTRUCTION COST ($000) = 6350.7
NET PRESENT VALUE ($000) = 271.7
BENEFIT/COST RATIO = 1.04
INTERNAL RATE OF RETURN (%) = 8.52

**** PROBLEM DISCOUNTED YEARLY BENEFITS ****

YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	497.3	4455.8	-283.5	1168.7	-62.0	5279.0
1987	586.1	4862.6	-305.5	1184.6	-57.4	5684.3
1988	682.0	5238.5	-347.3	1203.9	-53.2	6042.0
1989	780.1	5548.6	-351.0	1212.8	-49.2	6361.2
1990	881.7	5806.7	-367.1	1208.8	-45.6	6602.9
1991	979.1	5970.5	-340.0	1172.9	-42.2	6761.2
1992	1079.8	6096.7	-311.4	1132.6	-39.1	6878.9
1993	1183.4	6186.7	-283.7	1090.2	-36.2	6957.0
1994	1290.6	6247.6	-257.7	1047.2	-33.5	7003.6
1995	1365.5	6120.5	-222.8	1009.1	-31.0	6875.8
1996	1420.7	5896.0	-184.7	974.4	-28.7	6657.0
1997	1493.9	5740.5	-150.0	938.9	-26.6	6502.9
1998	1583.3	5633.6	-117.7	902.3	-24.6	6393.6
1999	1692.0	5574.4	-78.3	865.6	-22.8	6338.9
2000	1824.1	5564.5	-45.0	828.7	-21.1	6327.1
2001	1939.9	5479.2	-42.2	783.3	-19.5	6200.7
2002	1910.9	4997.6	-122.2	712.5	-18.1	5569.9
2003	1883.6	4561.2	-190.5	648.2	-16.8	5002.1
TOTAL	23074.1	99981.2	-4000.5	18084.8	-627.7	113437.7

*** MOBILITY ***

	---------- CORRIDOR ----------				------- STATE FACILITY -------			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	47.9	126.1	47.9	126.1	48.1	123.6	48.1	123.6
1984	45.9	150.2	45.9	150.2	46.1	147.4	46.1	147.4
1985	44.8	164.9	44.8	164.9	45.1	159.1	45.1	159.1
1986	43.9	177.4	56.5	182.8	44.4	168.7	57.0	178.7
1987	43.1	188.5	56.5	193.9	43.7	177.2	56.9	189.8
1988	42.3	198.8	56.5	204.2	43.0	183.6	56.9	200.0
1989	41.5	208.6	56.4	213.8	42.3	189.2	56.8	209.5
1990	40.8	217.8	56.4	222.9	41.7	194.4	56.8	218.5
1991	40.2	226.6	56.1	231.4	41.1	199.4	56.7	224.6
1992	39.6	235.1	55.9	239.6	40.5	204.1	56.7	230.3
1993	39.0	243.3	55.7	247.4	40.0	208.6	56.6	235.7
1994	38.5	251.3	55.5	255.0	39.5	212.8	56.6	240.9
1995	38.2	259.4	55.3	262.4	39.3	215.6	56.6	246.0
1996	37.9	267.6	55.1	269.5	39.4	217.0	56.5	251.0
1997	37.5	275.6	54.9	276.5	39.5	218.2	56.5	255.8
1998	37.0	283.4	54.8	283.4	39.6	219.5	56.4	260.5
1999	36.5	291.1	54.6	290.0	39.6	220.8	56.4	265.1
2000	35.9	298.6	54.4	296.6	39.7	222.0	56.4	269.6
2001	35.5	304.8	54.3	303.0	39.8	223.2	56.3	274.0
2002	35.5	307.0	54.2	309.3	39.8	224.3	56.3	278.4
2003	35.4	309.2	54.0	315.6	39.7	225.3	56.3	282.6

PROBLEM TOTALS

PRESENT VALUE OF BENEFITS ($000) =	113437.7
PRESENT VALUE OF CONSTRUCTION COST ($000) =	46042.3
NET PRESENT VALUE ($000) =	67395.4
BENEFIT/COST RATIO =	2.46

PROBLEM 2 SAMPLE PROBLEM 2

PROBLEM CONTROL DATA -

CURRENT YEAR - 1983

ASSUMPTIONS -

1. PERCENTAGE TRUCKS %	11.00
2. VALUE CAR TIME $/MIN	0.17
3. VALUE TRUCK TIME $/MIN	0.32
4. INFLATION RATE %	0.00
5. CONST COST ESCALATION RATE %	0.00
6. DISCOUNT RATE %	8.00
7. RURAL DIVERSION ROUTE SPEED	25.00
8. URBAN DIVERSION ROUTE SPEED	15.00

PLANNING HORIZON - 20 YEARS

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PROBLEM   2                                   SAMPLE PROBLEM 2

SEGMENT   1         DESCRIPTION - 6-LN FRWY ADD BUSWAY

       TRAFFIC DATA - CURRENT YEAR     1983   VOLUME (1,000)     151.00
                      PROJECTED YEAR1 1990   VOLUME (1,000)     180.00
                      PROJECTED YEAR2 2000   VOLUME (1,000)     235.00

       SEGMENT RUN TYPE - REGULAR RUN

       EXISTING  HIGHWAY DATA - HIGHWAY TYPE    U6F
                                LENGTH     4.10 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     95.00     100.00
                                PERCENT TRUCKS(BUSES)      11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00

       PROPOSED  HIGHWAY DATA - HIGHWAY TYPE    U1S
                                LENGTH     4.10 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     90.00      98.00
                                CONSTRUCTION YEAR    1986
                                CONSTRUCTION COST (MILLIONS)  $ 17.52
                                PERCENT TRUCKS(BUSES)      23.60
                                CAR(VAN) OCCUPANCY RATE    8.90
                                TRUCK(BUS) OCCUPANCY RATE 42.60

       SEGMENT HOV ASSUMPTIONS -
           INCONVENIENCE COST ($/MILE) - BUS           0.446
                                         CARPOOL/VAN  0.064
```

PROBLEM 2 SAMPLE PROBLEM 2

SEGMENT 1 DESCRIPTION - 6-LN FRWY ADD BUSWAY

*** DO-NOTHING CORRIDOR TRAFFIC ALLOCATION ***

```
YEAR                                                   VEHICLES (1,000)                                     (SQUARE-ROOT SCALE)
      0         2         7        16        28        44        63        86       113       143       176       213       254
      I         I         I         I         I         I         I         I         I         I         I         I         I
     ----------------------------------------------------------------------------------------------------------------------------
1983 I                                                                                             *
1984 I                                                                                              *
1985 I                                                                                               *
1986 I                                                                                                 *
1987 I                                                                                                  *
1988 I                                                                                                   *
1989 I                                                                                                     *
1990 I                                                                                                      *
1991 I                D                                                                                     ET
1992 I                        D                                                                             E  T
1993 I                             D                                                                        E   T
1994 I                                  D                                                                   E     T
1995 I                                      D                                                               E      T
1996 I                                          D                                                           E        T
1997 I                                              D                                                       E         T
1998 I                                                 D                                                    E          T
1999 I                                                    D                                                 E            T
2000 I                                                        D                                             E             T
2001 I                                                           D                                          E               T
2002 I                                                             D                                        E                T
2003 I                                                                D                                     E                  T
        * INDICATES MULTIPLE LETTERS AT SAME POINT
```

YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	151000.	191317.	0.	0.	0.	0.	0.	0.	0.	0.	151000.	191317.
1984	153815.	194883.	0.	0.	0.	0.	0.	0.	0.	0.	153815.	194883.
1985	157461.	199503.	0.	0.	0.	0.	0.	0.	0.	0.	157461.	199503.
1986	161504.	204625.	0.	0.	0.	0.	0.	0.	0.	0.	161504.	204625.
1987	165828.	210105.	0.	0.	0.	0.	0.	0.	0.	0.	165828.	210105.
1988	170375.	215866.	0.	0.	0.	0.	0.	0.	0.	0.	170375.	215866.
1989	175108.	221861.	0.	0.	0.	0.	0.	0.	0.	0.	175108.	221861.
1990	180000.	228060.	0.	0.	0.	0.	0.	0.	0.	0.	180000.	228060.
1991	180000.	228060.	0.	0.	0.	0.	0.	0.	5034.	6378.	185034.	234437.
1992	180000.	228060.	0.	0.	0.	0.	0.	0.	10194.	12916.	190194.	240976.
1993	180000.	228060.	0.	0.	0.	0.	0.	0.	15470.	19600.	195470.	247660.
1994	180000.	228060.	0.	0.	0.	0.	0.	0.	20851.	26419.	200851.	254479.
1995	180000.	228060.	0.	0.	0.	0.	0.	0.	26331.	33362.	206331.	261422.
1996	180000.	228060.	0.	0.	0.	0.	0.	0.	31903.	40421.	211903.	268481.
1997	180000.	228060.	0.	0.	0.	0.	0.	0.	37560.	47589.	217560.	275648.
1998	180000.	228060.	0.	0.	0.	0.	0.	0.	43298.	54859.	223298.	282919.
1999	180000.	228060.	0.	0.	0.	0.	0.	0.	49113.	62226.	229113.	290286.
2000	180000.	228060.	0.	0.	0.	0.	0.	0.	55000.	69685.	235000.	297745.
2001	180000.	228060.	0.	0.	0.	0.	0.	0.	60957.	77232.	240957.	305292.
2002	180000.	228060.	0.	0.	0.	0.	0.	0.	66979.	84863.	246979.	312923.
2003	180000.	228060.	0.	0.	0.	0.	0.	0.	73065.	92574.	253065.	320634.

PROBLEM 2 SAMPLE PROBLEM 2

SEGMENT 1 DESCRIPTION - 6-LN FRWY ADD BUSWAY

*** IF-CONSTRUCT CORRIDOR TRAFFIC ALLOCATION ***

```
YEAR                                        VEHICLES (1,000)                                          (SQUARE-ROOT SCALE)
      0         2         7        16        28        44        63        86       113       143       176       213       254
      I         I         I         I         I         I         I         I         I         I         I         I         I
-----------------------------------------------------------------------------------------------------------------------------------
1983 I                                                                                                   *
1984 I                                                                                                    *
1985 I                                                                                                     *
1986 I            P                                                                             ET
1987 I             P                                                                             ET
1988 I             P                                                                             ET
1989 I              P                                                                             ET
1990 I              P                                                                             ET
1991 I               P                                                                             ET
1992 I               P                                                                             E T
1993 I                P                                                                             ET
1994 I                P                                                                             E T
1995 I                 P                                                                             ET
1996 I                 P                                                                             E T
1997 I                  P                                                                             E T
1998 I                  P                                                                             E T
1999 I                   P                                                                             E T
2000 I                   P                                                                             E T
2001 I                   P                                                                              E T
2002 I                    P                                                                             E  T
2003 I                    P                                                                              E T
      * INDICATES MULTIPLE LETTERS AT SAME POINT
```

YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	151000.	191317.	0.	0.	0.	0.	0.	0.	0.	0.	151000.	191317.
1984	153815.	194883.	0.	0.	0.	0.	0.	0.	0.	0.	153815.	194883.
1985	157461.	199503.	0.	0.	0.	0.	0.	0.	0.	0.	157461.	199503.
1986	116692.	147848.	0.	0.	3369.	56776.	0.	0.	0.	0.	120061.	204625.
1987	117944.	149435.	0.	0.	3600.	60669.	0.	0.	0.	0.	121544.	210105.
1988	119265.	151108.	0.	0.	3842.	64757.	0.	0.	0.	0.	123107.	215866.
1989	120632.	152841.	0.	0.	4095.	69020.	0.	0.	0.	0.	124727.	221861.
1990	122025.	154605.	0.	0.	4358.	73454.	0.	0.	0.	0.	126383.	228060.
1991	123472.	156439.	0.	0.	4628.	77998.	0.	0.	0.	0.	128100.	234437.
1992	124942.	158302.	0.	0.	4905.	82673.	0.	0.	0.	0.	129848.	240976.
1993	126451.	160214.	0.	0.	5189.	87446.	0.	0.	0.	0.	131640.	247660.
1994	127971.	162140.	0.	0.	5479.	92338.	0.	0.	0.	0.	133450.	254479.
1995	129498.	164074.	0.	0.	5776.	97347.	0.	0.	0.	0.	135274.	261422.
1996	131081.	166080.	0.	0.	6076.	102401.	0.	0.	0.	0.	137157.	268481.
1997	132642.	168057.	0.	0.	6384.	107591.	0.	0.	0.	0.	139026.	275648.
1998	134259.	170107.	0.	0.	6694.	112811.	0.	0.	0.	0.	140953.	282919.
1999	135854.	172127.	0.	0.	7011.	118159.	0.	0.	0.	0.	142865.	290286.
2000	137480.	174187.	0.	0.	7331.	123557.	0.	0.	0.	0.	144811.	297745.
2001	139112.	176255.	0.	0.	7657.	129037.	0.	0.	0.	0.	146768.	305292.
2002	140750.	178330.	0.	0.	7986.	134592.	0.	0.	0.	0.	148736.	312923.
2003	142426.	180454.	0.	0.	8318.	140179.	0.	0.	0.	0.	150744.	320634.

PROBLEM 2 SAMPLE PROBLEM 2

SEGMENT 1 DESCRIPTION - 6-LN FRWY ADD BUSWAY

CURRENT YEAR 1983
CONSTRUCTION YEAR 1986

*** SEGMENT DISCOUNTED YEARLY BENEFITS ***

```
YEAR                                 DISCOUNTED DELAY SAVINGS(S) AND TOTAL BENEFITS(B) ($1,000)
  -6955     -4786     -2617      -447      1721      3890      6060      8229     10398     12567     14737     16906     19075
      I         I         I         I         I         I         I         I         I         I         I         I         I
     ------------------------------------------------------------------------------------------------------------------------------
1983 I                                *
1984 I                                *
1985 I                                *
1986 I                                                                                       B             S
1987 I                                                                                           B             S
1988 I                                                                                                B             S
1989 I                                                                                                     B             S
1990 I                                                                                                          B             S
1991 I                                                                                           B                 S
1992 I                                                                             B                     S
1993 I                                                                *                         S
1994 I                                                     B                            S
1995 I                                           B                              S
1996 I                                   B                                S
1997 I                           B                                  S
1998 I                     B                                  S
1999 I               B                                   S
2000 I          B                                    S
2001 I      B                                    S
2002 I  B                                     S
2003 IB                                    S
```

YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	2666.6	15004.5	-3361.3	370.4	-44.3	11969.3
1987	2974.4	15876.7	-3342.4	366.5	-41.0	12859.9
1988	3325.9	16846.4	-3327.3	362.2	-37.9	13843.4
1989	3726.4	17910.9	-3316.4	357.5	-35.1	14916.9
1990	4183.1	19074.7	-3311.4	352.3	-32.5	16083.0
1991	4105.1	16694.6	-4195.2	249.2	-30.1	12718.5
1992	4024.5	14533.8	-4957.5	157.8	-27.9	9706.1
1993	3940.3	12573.7	-5606.5	76.9	-25.8	7018.3
1994	3854.0	10802.6	-6152.3	6.0	-23.9	4632.4
1995	3765.7	9205.7	-6604.1	-55.8	-22.1	2523.6
1996	3672.6	7762.9	-6968.7	-109.6	-20.5	664.1
1997	3578.9	6470.6	-7257.3	-155.7	-19.0	-961.4
1998	3480.1	5306.9	-7474.8	-195.3	-17.6	-2380.8
1999	3380.6	4269.5	-7631.4	-228.6	-16.3	-3606.7
2000	3277.2	3341.5	-7732.0	-256.6	-15.1	-4662.1
2001	3171.3	2515.9	-7783.7	-279.5	-14.0	-5561.3
2002	3062.8	1783.3	-7792.4	-298.1	-12.9	-6320.1
2003	2949.5	1132.2	-7762.6	-312.8	-12.0	-6955.2
TOTAL	63139.1	181105.8	-104577.1	406.9	-448.0	76487.7

PROBLEM 2 SAMPLE PROBLEM 2

SEGMENT 1 DESCRIPTION - 6-LN FRWY ADD BUSWAY

*** MOBILITY ***

	CORRIDOR				STATE FACILITY			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	44.6	619.1	44.6	619.1	44.6	619.1	44.6	619.1
1984	43.7	630.6	43.7	630.6	43.7	630.6	43.7	630.6
1985	42.6	645.6	42.6	645.6	42.6	645.6	42.6	645.6
1986	41.3	662.2	55.7	492.2	41.3	662.2	58.3	13.8
1987	39.9	679.9	55.4	498.3	39.9	679.9	58.2	14.8
1988	38.4	698.5	54.9	504.7	38.4	698.5	58.2	15.8
1989	36.9	717.9	54.5	511.4	36.9	717.9	58.2	16.8
1990	35.3	738.0	54.1	518.2	35.3	738.0	58.1	17.9
1991	35.3	738.0	53.7	525.2	35.3	738.0	58.1	19.0
1992	35.3	738.0	53.2	532.4	35.3	738.0	58.0	20.1
1993	35.3	738.0	52.7	539.7	35.3	738.0	58.0	21.3
1994	35.3	738.0	52.3	547.1	35.3	738.0	57.9	22.5
1995	35.3	738.0	51.8	554.6	35.3	738.0	57.9	23.7
1996	35.3	738.0	51.3	562.3	35.3	738.0	57.9	24.9
1997	35.3	738.0	50.9	570.0	35.3	738.0	57.8	26.2
1998	35.3	738.0	50.4	577.9	35.3	738.0	57.8	27.4
1999	35.3	738.0	49.9	585.7	35.3	738.0	57.7	28.7
2000	35.3	738.0	49.4	593.7	35.3	738.0	57.7	30.1
2001	35.3	738.0	48.9	601.7	35.3	738.0	57.6	31.4
2002	35.3	738.0	48.4	609.8	35.3	738.0	57.6	32.7
2003	35.3	738.0	47.9	618.0	35.3	738.0	57.5	34.1

SEGMENT TOTALS

PRESENT VALUE OF BENEFITS ($000) = 76487.7
PRESENT VALUE OF CONSTRUCTION COST ($000) = 13908.0
NET PRESENT VALUE ($000) = 62579.7
BENEFIT/COST RATIO = 5.50
INTERNAL RATE OF RETURN (%) = 732.60

PROBLEM 2 SAMPLE PROBLEM 2

SEGMENT 2 DESCRIPTION - 6-LN FRWY CNTRFLW TO BUSWAY

TRAFFIC DATA - CURRENT YEAR 1983 VOLUME (1,000) 173.00
PROJECTED YEAR1 1990 VOLUME (1,000) 269.90
PROJECTED YEAR2 2000 VOLUME (1,000) 319.50

SEGMENT RUN TYPE - REGULAR RUN

EXISTING HIGHWAY DATA - HIGHWAY TYPE U5F
LENGTH 4.50 MILES
SAFETY/TECHNICAL FACTORS (BASE=100) 85.00 95.00
PERCENT TRUCKS(BUSES) 11.00
CAR(VAN) OCCUPANCY RATE 1.30
TRUCK(BUS) OCCUPANCY RATE 1.00

PROPOSED HIGHWAY DATA - HIGHWAY TYPE U6F
LENGTH 4.50 MILES
SAFETY/TECHNICAL FACTORS (BASE=100) 95.00 100.00
CONSTRUCTION YEAR 1986
CONSTRUCTION COST (MILLIONS) $ 19.23
BUILDOVER OF EXISTING AND ALTERNATE ROUTES
PERCENT TRUCKS(BUSES) 11.00
CAR(VAN) OCCUPANCY RATE 1.30
TRUCK(BUS) OCCUPANCY RATE 1.00

EXPANDED HIGHWAY DATA - HIGHWAY TYPE U1S
LENGTH 4.50 MILES
SAFETY/TECHNICAL FACTORS (BASE=100) 90.00 98.00
EXPANSION YEAR 1986
EXPANSION COST (MILLIONS) $ 0.00
PROPOSED HIGHWAY NOT BUILTOVER WITH EXPANSION
PERCENT TRUCKS(BUSES) 23.60
CAR(VAN) OCCUPANCY RATE 8.90
TRUCK(BUS) OCCUPANCY RATE 42.60

ALTERNATE HIGHWAY DATA - HIGHWAY TYPE U1T
LENGTH 4.50 MILES
SAFETY/TECHNICAL FACTORS (BASE=100) 80.00 90.00
PERCENT TRUCKS(BUSES) 23.60
CAR(VAN) OCCUPANCY RATE 8.90
TRUCK(BUS) OCCUPANCY RATE 42.60

SEGMENT HOV ASSUMPTIONS -
INCONVENIENCE COST ($/MILE) - BUS 0.446
CARPOOL/VAN 0.064

PROBLEM 2 SAMPLE PROBLEM 2

SEGMENT 2 DESCRIPTION - 6-LN FRWY CNTRFLW TO BUSWAY

*** DO-NOTHING CORRIDOR TRAFFIC ALLOCATION ***

```
YEAR                                                   VEHICLES (1,000)                                     (SQUARE-ROOT SCALE)
      0         1         5        11        20        31        44        60        78        99       122       148       176
      I         I         I         I         I         I         I         I         I         I         I         I         I
     ------------------------------------------------------------------------------------------------------------------------------
1983 I                     A                                                                     E T
1984 I                         A                                                                     E   T
1985 I                          A                                                                     E   T
1986 I                           A                                                                     E   T
1987 I                            A                                                                     E   T
1988 I                             A                                                                     E   T
1989 I                             A                                                                      E   T
1990 I                              A                                                                     E    T
1991 I                              A                                                                      E   T
1992 I                               A                                                                     E    T
1993 I                               A                                                                      E    T
1994 I                               A                                                                      E    T
1995 I                                A                                                                      E    T
1996 I                                A                                                                      E    T
1997 I                                A                                                                       E    T
1998 I                                 A                                                                      E    T
1999 I                                 A                                                                      E     T
2000 I                                 A                                                                       E    T
2001 I                                  A                                                                      E    T
2002 I                                  A                                                                      E     T
2003 I                                  A                                                                       E    T
        * INDICATES MULTIPLE LETTERS AT SAME POINT
```

YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	100427.	127241.	5456.	91949.	0.	0.	0.	0.	0.	0.	105883.	219191.
1984	109916.	139264.	7685.	129519.	0.	0.	0.	0.	0.	0.	117601.	268783.
1985	113433.	143719.	8542.	143965.	0.	0.	0.	0.	0.	0.	121975.	287684.
1986	116080.	147073.	9188.	154850.	0.	0.	0.	0.	0.	0.	125268.	301924.
1987	118253.	149827.	9729.	163961.	0.	0.	0.	0.	0.	0.	127982.	313789.
1988	120129.	152203.	10203.	171948.	0.	0.	0.	0.	0.	0.	130331.	324152.
1989	121810.	154333.	10628.	179122.	0.	0.	0.	0.	0.	0.	132438.	333456.
1990	123336.	156267.	11018.	185696.	0.	0.	0.	0.	0.	0.	134354.	341963.
1991	124762.	158074.	11379.	191768.	0.	0.	0.	0.	0.	0.	136141.	349843.
1992	126048.	159703.	11719.	197508.	0.	0.	0.	0.	0.	0.	137767.	357212.
1993	127270.	161251.	12039.	202903.	0.	0.	0.	0.	0.	0.	139310.	364155.
1994	128427.	162717.	12343.	208018.	0.	0.	0.	0.	0.	0.	140770.	370736.
1995	129509.	164088.	12634.	212916.	0.	0.	0.	0.	0.	0.	142143.	377005.
1996	130573.	165435.	12909.	217565.	0.	0.	0.	0.	0.	0.	143482.	383001.
1997	131560.	166687.	13177.	222067.	0.	0.	0.	0.	0.	0.	144737.	388755.
1998	132523.	167906.	13433.	226386.	0.	0.	0.	0.	0.	0.	145956.	394293.
1999	133434.	169060.	13681.	230577.	0.	0.	0.	0.	0.	0.	147115.	399638.
2000	134301.	170160.	13923.	234646.	0.	0.	0.	0.	0.	0.	148224.	404806.
2001	135144.	171227.	14157.	238587.	0.	0.	0.	0.	0.	0.	149301.	409815.
2002	135948.	172246.	14385.	242430.	0.	0.	0.	0.	0.	0.	150333.	414677.
2003	136750.	173263.	14605.	246141.	0.	0.	0.	0.	0.	0.	151355.	419405.

PROBLEM 2 SAMPLE PROBLEM 2

SEGMENT 2 DESCRIPTION - 6-LN FRWY CNTRFLW TO BUSWAY

*** IF-CONSTRUCT CORRIDOR TRAFFIC ALLOCATION ***

```
YEAR                                                   VEHICLES (1,000)                                    (SQUARE-ROOT SCALE)
      0         1         5        11        20        31        44        60        78        99       122       148       176
      I         I         I         I         I         I         I         I         I         I         I         I         I
     ------------------------------------------------------------------------------------------------------------------------------
1983 I                     A                                                                     E T
1984 I                         A                                                                     E  T
1985 I                          A                                                                     E   T
1986 I                        X                                                                                 P  T
1987 I                         X                                                                                 P  T
1988 I                          X                                                                                 P  T
1989 I                           X                                                                                 P  T
1990 I                           X                                                                                  P  T
1991 I                            X                                                                                 P   T
1992 I                            X                                                                                  P  T
1993 I                             X                                                                                 P   T
1994 I                             X                                                                                  P   T
1995 I                             X                                                                                  P   T
1996 I                              X                                                                                  P   T
1997 I                              X                                                                                  P   T
1998 I                              X                                                                                   P   T
1999 I                               X                                                                                  P   T
2000 I                               X                                                                                  P    T
2001 I                               X                                                                                   P   T
2002 I                                X                                                                                  P   T
2003 I                                X                                                                                  P    T
        * INDICATES MULTIPLE LETTERS AT SAME POINT
```

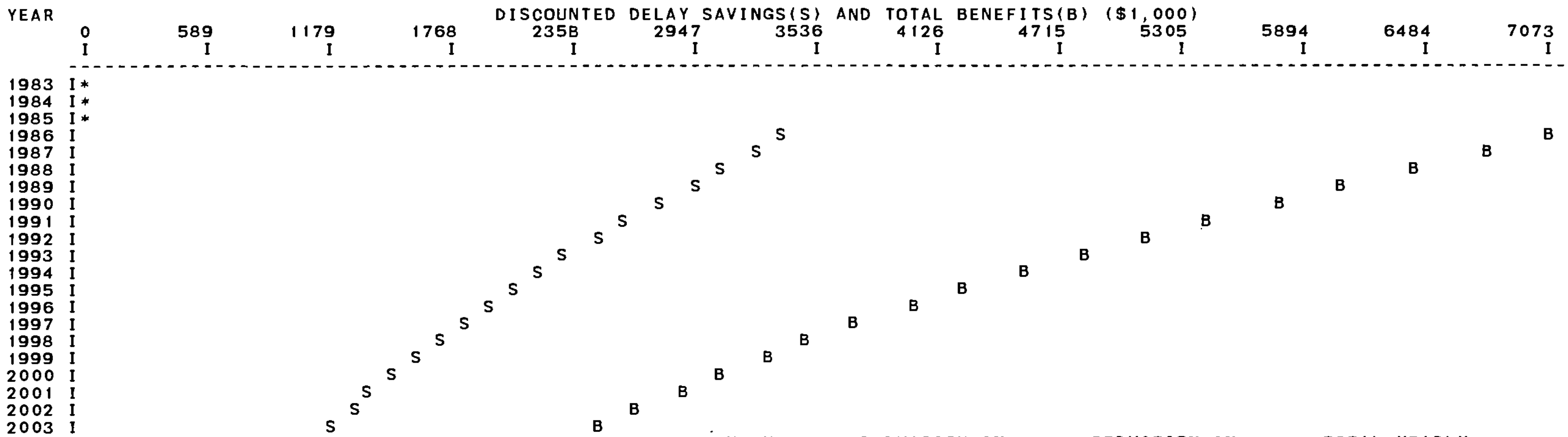
YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	100427.	127241.	5456.	91949.	0.	0.	0.	0.	0.	0.	105883.	219191.
1984	109916.	139264.	7685.	129519.	0.	0.	0.	0.	0.	0.	117601.	268783.
1985	113433.	143719.	8542.	143965.	0.	0.	0.	0.	0.	0.	121975.	287684.
1986	0.	0.	0.	0.	138392.	175342.	7511.	126582.	0.	0.	145902.	301924.
1987	0.	0.	0.	0.	140958.	178593.	8022.	135195.	0.	0.	148980.	313789.
1988	0.	0.	0.	0.	143177.	181405.	8470.	142746.	0.	0.	151647.	324152.
1989	0.	0.	0.	0.	145134.	183885.	8875.	149570.	0.	0.	154009.	333456.
1990	0.	0.	0.	0.	146926.	186155.	9245.	155808.	0.	0.	156171.	341963.
1991	0.	0.	0.	0.	148592.	188266.	9587.	161576.	0.	0.	158180.	349843.
1992	0.	0.	0.	0.	150105.	190183.	9911.	167028.	0.	0.	160016.	357212.
1993	0.	0.	0.	0.	151549.	192012.	10214.	172142.	0.	0.	161763.	364155.
1994	0.	0.	0.	0.	152895.	193718.	10504.	177018.	0.	0.	163398.	370736.
1995	0.	0.	0.	0.	154209.	195382.	10777.	181622.	0.	0.	164985.	377005.
1996	0.	0.	0.	0.	155407.	196900.	11042.	186100.	0.	0.	166449.	383001.
1997	0.	0.	0.	0.	156580.	198387.	11296.	190367.	0.	0.	167876.	388755.
1998	0.	0.	0.	0.	157709.	199818.	11539.	194475.	0.	0.	169249.	394293.
1999	0.	0.	0.	0.	158769.	201160.	11777.	198477.	0.	0.	170546.	399638.
2000	0.	0.	0.	0.	159808.	202477.	12005.	202329.	0.	0.	171814.	404806.
2001	0.	0.	0.	0.	160808.	203744.	12227.	206070.	0.	0.	173036.	409815.
2002	0.	0.	0.	0.	161758.	204947.	12445.	209730.	0.	0.	174202.	414677.
2003	0.	0.	0.	0.	162692.	206131.	12655.	213273.	0.	0.	175347.	419405.

PROBLEM 2 SAMPLE PROBLEM 2

SEGMENT 2 DESCRIPTION - 6-LN FRWY CNTRFLW TO BUSWAY

CURRENT YEAR 1983
CONSTRUCTION YEAR 1986
EXPANSION YEAR 1986

*** SEGMENT DISCOUNTED YEARLY BENEFITS ***



YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	-453.9	3369.5	2760.0	714.8	227.9	7072.2
1987	-468.0	3232.4	2631.7	687.0	211.0	6762.1
1988	-480.9	3081.4	2498.6	656.4	195.4	6431.7
1989	-490.5	2935.1	2363.0	624.8	180.9	6103.8
1990	-500.4	2782.3	2230.9	592.9	167.5	5773.6
1991	-509.3	2632.7	2102.4	561.3	155.1	5451.5
1992	-518.2	2484.9	1978.3	530.4	143.6	5137.2
1993	-527.3	2339.3	1860.0	500.3	133.0	4832.6
1994	-534.3	2204.7	1746.1	471.5	123.1	4545.5
1995	-545.4	2062.4	1640.1	443.5	114.0	4260.1
1996	-549.0	1947.9	1535.9	417.3	105.6	4006.6
1997	-557.3	1825.0	1439.5	391.9	97.7	3754.2
1998	-564.3	1711.3	1348.1	368.0	90.5	3517.8
1999	-570.2	1605.6	1261.3	345.2	83.8	3295.9
2000	-578.4	1500.2	1180.4	323.6	77.6	3081.8
2001	-585.8	1402.4	1104.1	303.2	71.8	2881.5
2002	-592.4	1311.5	1031.9	284.0	66.5	2694.0
2003	-598.0	1227.4	964.1	265.9	61.6	2519.0
TOTAL	-9623.6	39655.8	31676.6	8482.0	2306.8	82121.1

PROBLEM 2 SAMPLE PROBLEM 2

SEGMENT 2 DESCRIPTION - 6-LN FRWY CNTRFLW TO BUSWAY

*** MOBILITY ***

	CORRIDOR				STATE FACILITY			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	51.8	476.5	51.8	476.5	51.7	451.9	51.7	451.9
1984	48.5	529.2	48.5	529.2	48.2	494.6	48.2	494.6
1985	47.4	548.9	47.4	548.9	46.9	510.4	46.9	510.4
1986	46.5	563.7	49.1	656.6	46.0	522.4	48.7	622.8
1987	45.7	575.9	48.4	670.4	45.2	532.1	47.9	634.3
1988	45.1	586.5	47.7	682.4	44.5	540.6	47.1	644.3
1989	44.6	596.0	47.1	693.0	43.9	548.1	46.5	653.1
1990	44.1	604.6	46.6	702.8	43.3	555.0	45.9	661.2
1991	43.6	612.6	46.1	711.8	42.8	561.4	45.4	668.7
1992	43.2	620.0	45.7	720.1	42.3	567.2	44.9	675.5
1993	42.8	626.9	45.3	727.9	41.9	572.7	44.5	682.0
1994	42.4	633.5	44.9	735.3	41.4	577.9	44.0	688.0
1995	42.0	639.6	44.5	742.4	41.1	582.8	43.6	693.9
1996	41.7	645.7	44.1	749.0	40.7	587.6	43.2	699.3
1997	41.4	651.3	43.8	755.4	40.3	592.0	42.8	704.6
1998	41.1	656.8	43.5	761.6	39.9	596.4	42.5	709.7
1999	40.8	662.0	43.2	767.5	39.6	600.5	42.1	714.5
2000	40.5	667.0	42.9	773.2	39.3	604.4	41.8	719.1
2001	40.2	671.9	42.6	778.7	39.0	608.1	41.5	723.6
2002	40.0	676.5	42.3	783.9	38.7	611.8	41.2	727.9
2003	39.7	681.1	42.0	789.1	38.4	615.4	40.9	732.1

SEGMENT TOTALS

PRESENT VALUE OF BENEFITS ($000) =	82121.1
PRESENT VALUE OF CONSTRUCTION COST ($000) =	15265.4
NET PRESENT VALUE ($000) =	66855.6
BENEFIT/COST RATIO =	5.38
INTERNAL RATE OF RETURN (%) =	91.58

PROBLEM 2 SAMPLE PROBLEM 2

**** PROBLEM DISCOUNTED YEARLY BENEFITS ****

YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	2212.7	18373.9	-601.3	1085.3	183.6	19041.6
1987	2506.4	19109.1	-710.7	1053.5	170.0	19622.0
1988	2845.0	19927.8	-828.7	1018.6	157.4	20275.2
1989	3235.9	20846.0	-953.3	982.3	145.8	21020.8
1990	3682.7	21857.1	-1080.6	945.2	135.0	21856.6
1991	3595.8	19327.3	-2092.8	810.5	125.0	18170.0
1992	3506.3	17018.7	-2979.2	688.1	115.7	14843.3
1993	3413.1	14912.9	-3746.4	577.3	107.2	11850.9
1994	3319.7	13007.3	-4406.2	477.5	99.2	9177.8
1995	3220.3	11268.2	-4964.0	387.7	91.9	6783.7
1996	3123.6	9710.8	-5432.8	307.7	85.1	4670.7
1997	3021.6	8295.6	-5817.7	236.2	78.8	2792.8
1998	2915.9	7018.2	-6126.7	172.7	72.9	1137.0
1999	2810.4	5875.1	-6370.0	116.6	67.5	-310.8
2000	2698.8	4841.7	-6551.5	67.1	62.5	-1580.3
2001	2585.5	3918.3	-6679.7	23.7	57.9	-2679.8
2002	2470.4	3094.8	-6760.4	-14.1	53.6	-3626.1
2003	2351.5	2359.6	-6798.4	-46.9	49.6	-4436.1
TOTAL	53515.5	220761.8	-72900.5	8888.8	1858.8	158608.7

*** MOBILITY ***

	CORRIDOR				STATE FACILITY			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	47.7	1095.6	47.7	1095.6	47.6	1071.0	47.6	1071.0
1984	45.9	1159.8	45.9	1159.8	45.7	1125.3	45.7	1125.3
1985	44.8	1194.5	44.8	1194.5	44.5	1156.0	44.5	1156.0
1986	43.7	1225.9	52.0	1148.8	43.3	1184.5	48.9	636.6
1987	42.6	1255.8	51.4	1168.7	42.2	1212.0	48.1	649.1
1988	41.5	1285.0	50.8	1187.1	41.1	1239.1	47.4	660.0
1989	40.4	1313.9	50.3	1204.4	39.9	1266.1	46.8	669.9
1990	39.2	1342.6	49.8	1220.9	38.7	1293.0	46.3	679.0
1991	39.1	1350.6	49.3	1237.0	38.5	1299.4	45.8	687.6
1992	38.9	1358.0	48.9	1252.4	38.4	1305.2	45.3	695.6
1993	38.7	1364.9	48.4	1267.7	38.2	1310.7	44.9	703.2
1994	38.6	1371.5	48.0	1282.4	38.0	1315.9	44.5	710.5
1995	38.4	1377.6	47.6	1297.1	37.8	1320.8	44.1	717.6
1996	38.3	1383.7	47.2	1311.4	37.7	1325.6	43.7	724.2
1997	38.1	1389.3	46.8	1325.4	37.5	1330.0	43.4	730.8
1998	38.0	1394.8	46.4	1339.5	37.4	1334.4	43.0	737.1
1999	37.9	1400.0	46.1	1353.2	37.2	1338.4	42.7	743.2
2000	37.8	1405.0	45.7	1366.9	37.1	1342.4	42.4	749.2
2001	37.6	1409.9	45.3	1380.4	37.0	1346.1	42.1	755.0
2002	37.5	1414.5	45.0	1393.7	36.8	1349.8	41.9	760.7
2003	37.4	1419.1	44.6	1407.1	36.7	1353.4	41.6	766.2

PROBLEM TOTALS

PRESENT VALUE OF BENEFITS ($000) = 158608.7
PRESENT VALUE OF CONSTRUCTION COST ($000) = 29173.3
NET PRESENT VALUE ($000) = 129435.4
BENEFIT/COST RATIO = 5.44

PROBLEM 3 SAMPLE PROBLEM 3

PROBLEM CONTROL DATA -

CURRENT YEAR - 1983

ASSUMPTIONS -

1.	PERCENTAGE TRUCKS %	11.00
2.	VALUE CAR TIME $/MIN	0.17
3.	VALUE TRUCK TIME $/MIN	0.32
4.	INFLATION RATE %	0.00
5.	CONST COST ESCALATION RATE %	0.00
6.	DISCOUNT RATE %	8.00
7.	RURAL DIVERSION ROUTE SPEED	25.00
8.	URBAN DIVERSION ROUTE SPEED	15.00

PLANNING HORIZON - 20 YEARS

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PROBLEM   3                                        SAMPLE PROBLEM 3

SEGMENT  01          DESCRIPTION - OPTIMIZE  EXPANSION 4E-6E-8F

       TRAFFIC DATA - CURRENT YEAR     1983   VOLUME (1,000)     16.00
                      PROJECTED YEAR1 1992   VOLUME (1,000)     36.00
                      PROJECTED YEAR2 2003   VOLUME (1,000)    110.00

       SEGMENT RUN TYPE - OPTIMIZE EXPANSION YEAR ONLY

       EXISTING  HIGHWAY DATA - HIGHWAY TYPE    R4E
                                LENGTH     3.00 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     80.00     90.00
                                PERCENT TRUCKS(BUSES)      11.00
                                CAR(VAN) OCCUPANCY RATE     1.30
                                TRUCK(BUS) OCCUPANCY RATE   1.00

       PROPOSED  HIGHWAY DATA - HIGHWAY TYPE    R6E
                                LENGTH     3.00 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     90.00     95.00
                                CONSTRUCTION YEAR   1986
                                CONSTRUCTION COST (MILLIONS)  $  5.00
                                BUILDOVER OF EXISTING ROUTE
                                PERCENT TRUCKS(BUSES)      11.00
                                CAR(VAN) OCCUPANCY RATE     1.30
                                TRUCK(BUS) OCCUPANCY RATE   1.00

       EXPANDED  HIGHWAY DATA - HIGHWAY TYPE    R8F
                                LENGTH     3.00 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     95.00    100.00
                                EXPANSION COST (MILLIONS)  $ 19.20
                                PERCENT TRUCKS(BUSES)      11.00
                                CAR(VAN) OCCUPANCY RATE     1.30
                                TRUCK(BUS) OCCUPANCY RATE   1.00
```

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 01 DESCRIPTION - OPTIMIZE EXPANSION 4E-6E-8F

*** DO-NOTHING CORRIDOR TRAFFIC ALLOCATION ***

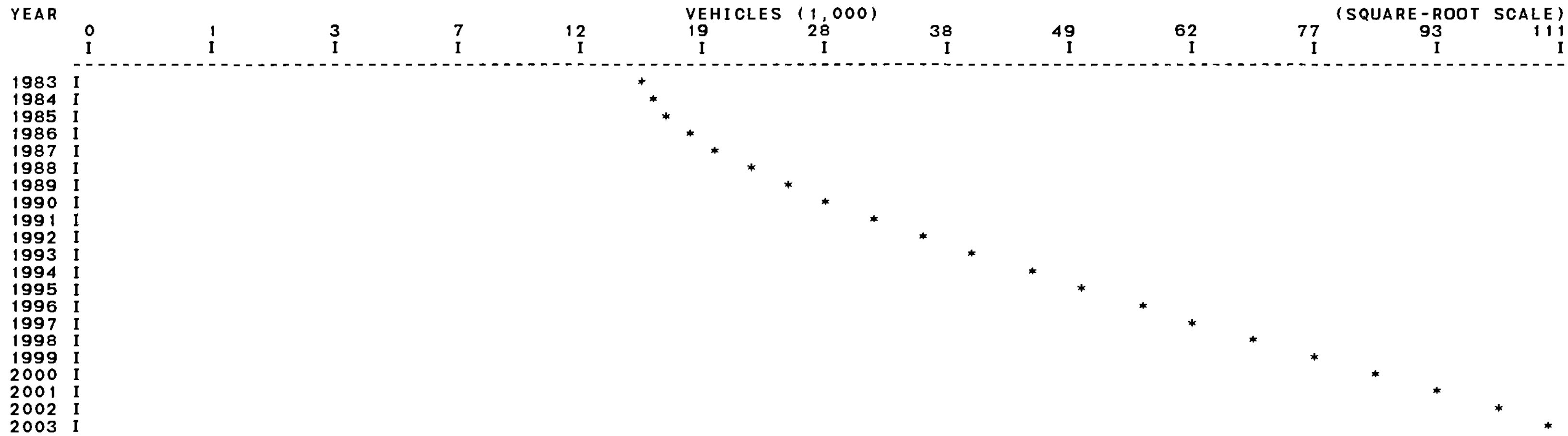
```
YEAR                                                   VEHICLES (1,000)                                    (SQUARE-ROOT SCALE)
      0         1         3         7        12        19        28        38        49        62        77        93       111
      I         I         I         I         I         I         I         I         I         I         I         I         I
     -----------------------------------------------------------------------------------------------------------------------------
1983 I                                             *
1984 I                                              *
1985 I                                               *
1986 I                                                 *
1987 I                                                   *
1988 I                                                      *
1989 I                                                         *
1990 I                                                            *
1991 I                                                                *
1992 I                                                                    *
1993 I                                                                        *
1994 I                                                                             *
1995 I                                                                                 *
1996 I                                                                                      *
1997 I                                                                                          *
1998 I                                                                                               *
1999 I                                                                                                    *
2000 I                                                                                                         *
2001 I                                                                                                              *
2002 I                D                                                                                                E T
2003 I                                     D                                                                           E     T
        * INDICATES MULTIPLE LETTERS AT SAME POINT
```

YEAR	EXISTING (E) VEHICLES	EXISTING (E) PERSONS	ALTERNATE (A) VEHICLES	ALTERNATE (A) PERSONS	PROPOSED (P) VEHICLES	PROPOSED (P) PERSONS	EXPANSION (X) VEHICLES	EXPANSION (X) PERSONS	DIVERTED (D) VEHICLES	DIVERTED (D) PERSONS	TOTAL (T) VEHICLES	TOTAL (T) PERSONS
1983	16000.	20272.	0.	0.	0.	0.	0.	0.	0.	0.	16000.	20272.
1984	16283.	20630.	0.	0.	0.	0.	0.	0.	0.	0.	16283.	20630.
1985	17084.	21646.	0.	0.	0.	0.	0.	0.	0.	0.	17084.	21646.
1986	18379.	23286.	0.	0.	0.	0.	0.	0.	0.	0.	18379.	23286.
1987	20154.	25535.	0.	0.	0.	0.	0.	0.	0.	0.	20154.	25535.
1988	22402.	28383.	0.	0.	0.	0.	0.	0.	0.	0.	22402.	28383.
1989	25115.	31821.	0.	0.	0.	0.	0.	0.	0.	0.	25115.	31821.
1990	28289.	35842.	0.	0.	0.	0.	0.	0.	0.	0.	28289.	35842.
1991	31918.	40440.	0.	0.	0.	0.	0.	0.	0.	0.	31918.	40440.
1992	36000.	45612.	0.	0.	0.	0.	0.	0.	0.	0.	36000.	45612.
1993	40531.	51352.	0.	0.	0.	0.	0.	0.	0.	0.	40531.	51352.
1994	45508.	57658.	0.	0.	0.	0.	0.	0.	0.	0.	45508.	57658.
1995	50928.	64525.	0.	0.	0.	0.	0.	0.	0.	0.	50928.	64525.
1996	56789.	71951.	0.	0.	0.	0.	0.	0.	0.	0.	56789.	71951.
1997	63089.	79933.	0.	0.	0.	0.	0.	0.	0.	0.	63089.	79933.
1998	69825.	88469.	0.	0.	0.	0.	0.	0.	0.	0.	69825.	88469.
1999	76997.	97555.	0.	0.	0.	0.	0.	0.	0.	0.	76997.	97555.
2000	84602.	107191.	0.	0.	0.	0.	0.	0.	0.	0.	84602.	107191.
2001	92638.	117373.	0.	0.	0.	0.	0.	0.	0.	0.	92638.	117373.
2002	99000.	125433.	0.	0.	0.	0.	0.	0.	2105.	2667.	101105.	128100.
2003	99000.	125433.	0.	0.	0.	0.	0.	0.	11000.	13937.	110000.	139370.

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 01 DESCRIPTION - OPTIMIZE EXPANSION 4E-6E-8F

*** IF-CONSTRUCT CORRIDOR TRAFFIC ALLOCATION ***



* INDICATES MULTIPLE LETTERS AT SAME POINT

YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	16000.	20272.	0.	0.	0.	0.	0.	0.	0.	0.	16000.	20272.
1984	16283.	20630.	0.	0.	0.	0.	0.	0.	0.	0.	16283.	20630.
1985	17084.	21646.	0.	0.	0.	0.	0.	0.	0.	0.	17084.	21646.
1986	0.	0.	0.	0.	0.	0.	18379.	23286.	0.	0.	18379.	23286.
1987	0.	0.	0.	0.	0.	0.	20154.	25535.	0.	0.	20154.	25535.
1988	0.	0.	0.	0.	0.	0.	22402.	28383.	0.	0.	22402.	28383.
1989	0.	0.	0.	0.	0.	0.	25115.	31821.	0.	0.	25115.	31821.
1990	0.	0.	0.	0.	0.	0.	28289.	35842.	0.	0.	28289.	35842.
1991	0.	0.	0.	0.	0.	0.	31918.	40440.	0.	0.	31918.	40440.
1992	0.	0.	0.	0.	0.	0.	36000.	45612.	0.	0.	36000.	45612.
1993	0.	0.	0.	0.	0.	0.	40531.	51352.	0.	0.	40531.	51352.
1994	0.	0.	0.	0.	0.	0.	45508.	57658.	0.	0.	45508.	57658.
1995	0.	0.	0.	0.	0.	0.	50928.	64525.	0.	0.	50928.	64525.
1996	0.	0.	0.	0.	0.	0.	56789.	71951.	0.	0.	56789.	71951.
1997	0.	0.	0.	0.	0.	0.	63089.	79933.	0.	0.	63089.	79933.
1998	0.	0.	0.	0.	0.	0.	69825.	88469.	0.	0.	69825.	88469.
1999	0.	0.	0.	0.	0.	0.	76997.	97555.	0.	0.	76997.	97555.
2000	0.	0.	0.	0.	0.	0.	84602.	107191.	0.	0.	84602.	107191.
2001	0.	0.	0.	0.	0.	0.	92638.	117373.	0.	0.	92638.	117373.
2002	0.	0.	0.	0.	0.	0.	101105.	128100.	0.	0.	101105.	128100.
2003	0.	0.	0.	0.	0.	0.	110000.	139370.	0.	0.	110000.	139370.

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 01 DESCRIPTION - OPTIMIZE EXPANSION 4E-6E-8F

CURRENT YEAR 1983
CONSTRUCTION YEAR 1986
EXPANSION YEAR 1986

*** SEGMENT DISCOUNTED YEARLY BENEFITS ***

```
 YEAR                                        DISCOUNTED DELAY SAVINGS(S) AND TOTAL BENEFITS(B) ($1,000)
       0        517       1035      1552      2069      2587      3104      3621      4139      4656      5173      5691      6208
       I         I         I         I         I         I         I         I         I         I         I         I         I
      ------------------------------------------------------------------------------------------------------------------------------
 1983 I*
 1984 I*
 1985 I*
 1986 I        S                  B
 1987 I         S                  B
 1988 I         S                   B
 1989 I          S                    B
 1990 I           S                     B
 1991 I            S                       B
 1992 I              S                        B
 1993 I               S                          B
 1994 I                 S                           B
 1995 I                   S                             B
 1996 I                     S                               B
 1997 I                       S                                B
 1998 I                             S                                  B
 1999 I                                       S                                  B
 2000 I                                                   S                                  B
 2001 I                                                                  S                                  B
 2002 I                                                                                  S                                 B
 2003 I                                                                                      S                                 B
```

YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	51.4	460.8	-14.8	994.0	-28.1	1412.0
1987	57.9	480.5	-6.4	1009.3	-26.0	1457.5
1988	66.6	511.3	4.6	1038.8	-24.1	1530.5
1989	77.6	551.9	18.7	1078.3	-22.3	1626.7
1990	91.4	601.9	36.5	1124.6	-20.7	1742.3
1991	108.4	660.8	58.2	1174.9	-19.1	1874.9
1992	129.0	728.5	84.4	1227.0	-17.7	2022.2
1993	153.9	804.8	115.0	1279.1	-16.4	2182.5
1994	183.9	890.0	150.2	1329.8	-15.2	2354.8
1995	219.5	984.0	189.9	1378.0	-14.1	2537.8
1996	262.0	1087.3	233.9	1422.7	-13.0	2730.9
1997	312.3	1200.0	282.0	1463.5	-12.1	2933.4
1998	428.7	1525.3	292.7	1499.8	-11.2	3306.5
1999	612.8	2019.0	282.4	1531.3	-10.3	3822.3
2000	864.6	2637.4	264.1	1557.9	-9.6	4449.9
2001	1212.0	3423.4	233.6	1579.5	-8.9	5227.7
2002	1615.5	4225.0	155.3	1626.1	-8.2	5998.2
2003	1831.9	4436.1	26.5	1752.7	-7.6	6207.7
TOTAL	8279.4	27227.9	2406.7	24067.5	-284.4	53417.6

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 01 DESCRIPTION - OPTIMIZE EXPANSION 4E-6E-8F

*** MOBILITY ***

	CORRIDOR				STATE FACILITY			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	52.1	48.0	52.1	48.0	52.1	48.0	52.1	48.0
1984	52.0	48.8	52.0	48.8	52.0	48.8	52.0	48.8
1985	52.0	51.3	52.0	51.3	52.0	51.3	52.0	51.3
1986	51.8	55.1	59.6	55.1	51.8	55.1	0.0	0.0
1987	51.6	60.5	59.6	60.5	51.6	60.5	0.0	0.0
1988	51.3	67.2	59.5	67.2	51.3	67.2	0.0	0.0
1989	51.0	75.3	59.4	75.3	51.0	75.3	0.0	0.0
1990	50.6	84.9	59.4	84.9	50.6	84.9	0.0	0.0
1991	50.2	95.8	59.3	95.8	50.2	95.8	0.0	0.0
1992	49.7	108.0	59.2	108.0	49.7	108.0	0.0	0.0
1993	49.1	121.6	59.1	121.6	49.1	121.6	0.0	0.0
1994	48.5	136.5	59.0	136.5	48.5	136.5	0.0	0.0
1995	47.9	152.8	58.9	152.8	47.9	152.8	0.0	0.0
1996	47.2	170.4	58.7	170.4	47.2	170.4	0.0	0.0
1997	46.4	189.3	58.6	189.3	46.4	189.3	0.0	0.0
1998	44.2	209.5	58.4	209.5	44.2	209.5	0.0	0.0
1999	41.1	231.0	58.3	231.0	41.1	231.0	0.0	0.0
2000	37.8	253.8	58.1	253.8	37.8	253.8	0.0	0.0
2001	34.4	277.9	57.9	277.9	34.4	277.9	0.0	0.0
2002	31.6	303.3	57.8	303.3	31.7	297.0	0.0	0.0
2003	31.0	330.0	57.6	330.0	31.7	297.0	0.0	0.0

SEGMENT TOTALS

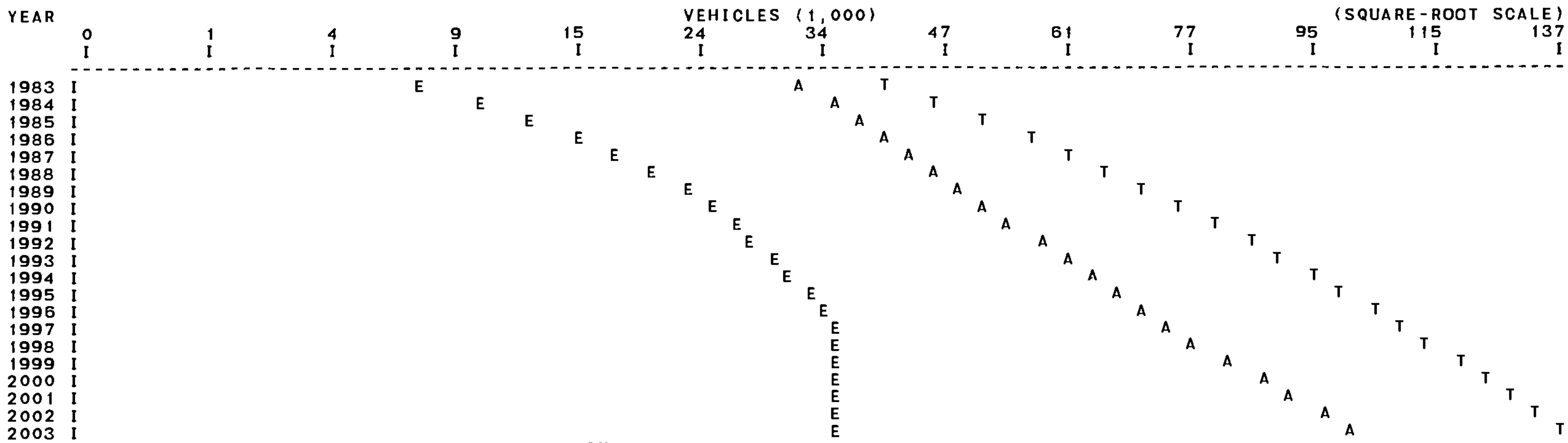
PRESENT VALUE OF BENEFITS ($000) =	53417.6
PRESENT VALUE OF CONSTRUCTION COST ($000) =	19210.7
NET PRESENT VALUE ($000) =	34206.9
BENEFIT/COST RATIO =	2.78
INTERNAL RATE OF RETURN (%) =	20.25

```
PROBLEM   3                                         SAMPLE PROBLEM 3

SEGMENT   2         DESCRIPTION - IMPR BUS RT EXIST FRWY BYPASS

       TRAFFIC DATA - CURRENT YEAR     1983   VOLUME (1,000)     40.00
                      PROJECTED YEAR1 1992   VOLUME (1,000)     85.80
                      PROJECTED YEAR2 2003   VOLUME (1,000)    137.00

       SEGMENT RUN TYPE - REGULAR RUN

       EXISTING  HIGHWAY DATA - HIGHWAY TYPE    U4C
                                LENGTH     2.00 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     75.00     80.00
                                SPEED LIMIT  40. MPH
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00

       PROPOSED  HIGHWAY DATA - HIGHWAY TYPE    U4C
                                LENGTH     2.00 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     90.00    100.00
                                SPEED LIMIT  40. MPH
                                CONSTRUCTION YEAR   1986
                                CONSTRUCTION COST (MILLIONS)  $  1.20
                                BUILDOVER OF EXISTING ROUTE
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00

       ALTERNATE HIGHWAY DATA - HIGHWAY TYPE    U4F
                                LENGTH     3.00 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     95.00    100.00
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00
```

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 2 DESCRIPTION - IMPR BUS RT EXIST FRWY BYPASS

*** DO-NOTHING CORRIDOR TRAFFIC ALLOCATION ***



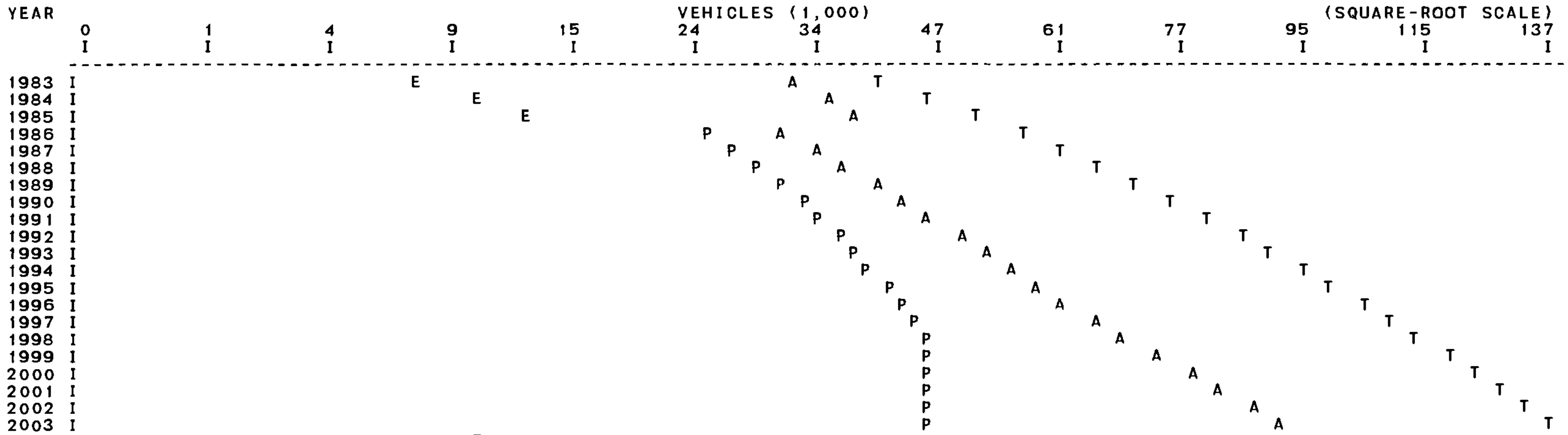
* INDICATES MULTIPLE LETTERS AT SAME POINT

YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	7168.	9082.	32832.	41598.	0.	0.	0.	0.	0.	0.	40000.	50680.
1984	10166.	12880.	35643.	45159.	0.	0.	0.	0.	0.	0.	45809.	58040.
1985	12898.	16342.	38245.	48456.	0.	0.	0.	0.	0.	0.	51143.	64798.
1986	15521.	19665.	40790.	51680.	0.	0.	0.	0.	0.	0.	56311.	71346.
1987	18116.	22952.	43259.	54809.	0.	0.	0.	0.	0.	0.	61374.	77761.
1988	20624.	26131.	45737.	57948.	0.	0.	0.	0.	0.	0.	66361.	84080.
1989	22956.	29086.	48332.	61236.	0.	0.	0.	0.	0.	0.	71288.	90322.
1990	24824.	31453.	51341.	65049.	0.	0.	0.	0.	0.	0.	76165.	96502.
1991	26608.	33712.	54393.	68915.	0.	0.	0.	0.	0.	0.	81001.	102628.
1992	28331.	35896.	57469.	72813.	0.	0.	0.	0.	0.	0.	85800.	108709.
1993	29994.	38002.	60573.	76746.	0.	0.	0.	0.	0.	0.	90567.	114748.
1994	31610.	40049.	63696.	80703.	0.	0.	0.	0.	0.	0.	95305.	120752.
1995	33172.	42029.	66845.	84693.	0.	0.	0.	0.	0.	0.	100018.	126723.
1996	34676.	43935.	70030.	88728.	0.	0.	0.	0.	0.	0.	104707.	132664.
1997	36000.	45612.	73374.	92965.	0.	0.	0.	0.	0.	0.	109374.	138577.
1998	36000.	45612.	78021.	98853.	0.	0.	0.	0.	0.	0.	114021.	144465.
1999	35992.	45602.	82658.	104727.	0.	0.	0.	0.	0.	0.	118649.	150329.
2000	36000.	45612.	87261.	110559.	0.	0.	0.	0.	0.	0.	123260.	156171.
2001	36000.	45612.	91855.	116381.	0.	0.	0.	0.	0.	0.	127855.	161993.
2002	36000.	45612.	96435.	122183.	0.	0.	0.	0.	0.	0.	132435.	167795.
2003	36000.	45612.	101000.	127967.	0.	0.	0.	0.	0.	0.	137000.	173579.

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 2 DESCRIPTION - IMPR BUS RT EXIST FRWY BYPASS

*** IF-CONSTRUCT CORRIDOR TRAFFIC ALLOCATION ***



* INDICATES MULTIPLE LETTERS AT SAME POINT

YEAR	EXISTING (E) VEHICLES	EXISTING (E) PERSONS	ALTERNATE (A) VEHICLES	ALTERNATE (A) PERSONS	PROPOSED (P) VEHICLES	PROPOSED (P) PERSONS	EXPANSION (X) VEHICLES	EXPANSION (X) PERSONS	DIVERTED (D) VEHICLES	DIVERTED (D) PERSONS	TOTAL (T) VEHICLES	TOTAL (T) PERSONS
1983	7168.	9082.	32832.	41598.	0.	0.	0.	0.	0.	0.	40000.	50680.
1984	10166.	12880.	35643.	45159.	0.	0.	0.	0.	0.	0.	45809.	58040.
1985	12898.	16342.	38245.	48456.	0.	0.	0.	0.	0.	0.	51143.	64798.
1986	0.	0.	31276.	39627.	25035.	31719.	0.	0.	0.	0.	56311.	71346.
1987	0.	0.	34178.	43304.	27196.	34457.	0.	0.	0.	0.	61374.	77761.
1988	0.	0.	37118.	47028.	29244.	37052.	0.	0.	0.	0.	66361.	84080.
1989	0.	0.	40082.	50784.	31206.	39538.	0.	0.	0.	0.	71288.	90322.
1990	0.	0.	43085.	54588.	33081.	41913.	0.	0.	0.	0.	76165.	96502.
1991	0.	0.	46107.	58417.	34894.	44211.	0.	0.	0.	0.	81001.	102628.
1992	0.	0.	49174.	62303.	36626.	46405.	0.	0.	0.	0.	85800.	108709.
1993	0.	0.	52281.	66241.	38285.	48508.	0.	0.	0.	0.	90567.	114748.
1994	0.	0.	55459.	70267.	39846.	50485.	0.	0.	0.	0.	95305.	120752.
1995	0.	0.	58665.	74329.	41353.	52394.	0.	0.	0.	0.	100018.	126723.
1996	0.	0.	61901.	78429.	42806.	54235.	0.	0.	0.	0.	104707.	132664.
1997	0.	0.	65194.	82601.	44180.	55975.	0.	0.	0.	0.	109374.	138577.
1998	0.	0.	69022.	87451.	44999.	57013.	0.	0.	0.	0.	114021.	144465.
1999	0.	0.	73649.	93314.	45000.	57015.	0.	0.	0.	0.	118649.	150329.
2000	0.	0.	78261.	99156.	45000.	57015.	0.	0.	0.	0.	123260.	156171.
2001	0.	0.	82859.	104983.	44996.	57010.	0.	0.	0.	0.	127855.	161993.
2002	0.	0.	87444.	110791.	44991.	57004.	0.	0.	0.	0.	132435.	167795.
2003	0.	0.	92000.	116564.	45000.	57015.	0.	0.	0.	0.	137000.	173579.

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 2 DESCRIPTION - IMPR BUS RT EXIST FRWY BYPASS

CURRENT YEAR 1983
CONSTRUCTION YEAR 1986

*** SEGMENT DISCOUNTED YEARLY BENEFITS ***

```
YEAR                                    DISCOUNTED DELAY SAVINGS(S) AND TOTAL BENEFITS(B) ($1,000)
   -463      -348      -233      -118        -2       112       227       342       457       572       688       803       918
      I         I         I         I         I         I         I         I         I         I         I         I         I
     ---------------------------------------------------------------------------------------------------------------------------
1983 I                                        *
1984 I                                        *
1985 I                                        *
1986 I                                                     S                                                                  B
1987 I                                              S                                                                B
1988 I                                      S                                                             B
1989 I                              S                                                            B
1990 I                          S                                                          B
1991 I                      S                                                          B
1992 I                  S                                                       B
1993 I              S                                                      B
1994 I           S                                                    B
1995 I         S                                                 B
1996 I      S                                               B
1997 I S                                              B
1998 IS                                         B
1999 I                      S                                  B
2000 I                                  S                              B
2001 I                                          S                            B
2002 I                                                 S                          B
2003 I                                                        S                        B
```

YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	16.8	150.2	843.0	-76.1	0.0	917.1
1987	8.3	68.9	782.6	-39.7	0.0	811.8
1988	-3.4	-26.4	726.2	-8.4	0.0	691.4
1989	-16.4	-116.5	681.1	15.5	0.0	580.1
1990	-24.1	-158.8	646.9	26.6	0.0	514.8
1991	-33.8	-206.4	638.9	35.1	0.0	467.6
1992	-44.5	-251.5	605.4	42.2	0.0	396.1
1993	-56.4	-294.9	577.5	47.9	0.0	330.5
1994	-67.8	-328.1	547.7	52.8	0.0	272.5
1995	-80.5	-360.6	519.1	56.6	0.0	215.1
1996	-94.9	-393.7	491.9	59.2	0.0	157.4
1997	-115.3	-443.2	470.9	59.5	0.0	87.1
1998	-130.2	-463.3	444.0	47.7	0.0	28.4
1999	-63.3	-208.6	359.1	44.0	0.0	194.6
2000	-22.4	-68.3	318.8	40.9	0.0	291.3
2001	7.0	19.7	296.9	37.9	0.0	354.5
2002	40.3	105.5	275.8	35.1	0.0	416.4
2003	77.8	188.3	255.6	32.4	0.0	476.4
TOTAL	-602.9	-2787.5	9481.4	509.3	0.0	7203.2

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 2 DESCRIPTION - IMPR BUS RT EXIST FRWY BYPASS

*** MOBILITY ***

	CORRIDOR				STATE FACILITY			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	54.9	112.8	54.9	112.8	28.6	14.3	28.6	14.3
1984	53.7	127.3	53.7	127.3	28.2	20.3	28.2	20.3
1985	52.8	140.5	52.8	140.5	27.8	25.8	27.8	25.8
1986	52.1	153.4	49.3	143.9	27.4	31.0	31.6	50.1
1987	51.5	166.0	48.8	156.9	27.1	36.2	30.3	54.4
1988	50.9	178.5	48.4	169.8	26.7	41.2	29.1	58.5
1989	50.4	190.9	48.0	182.7	26.2	45.9	28.0	62.4
1990	50.0	203.7	47.6	195.4	25.4	49.6	26.9	66.2
1991	49.6	216.4	47.3	208.1	24.5	53.2	25.8	69.8
1992	49.3	229.1	47.0	220.8	23.7	56.7	24.8	73.3
1993	49.0	241.7	46.7	233.4	22.9	60.0	23.8	76.6
1994	48.7	254.3	46.5	246.1	22.2	63.2	22.9	79.7
1995	48.4	266.9	46.3	258.7	21.4	66.3	22.0	82.7
1996	48.2	279.4	46.1	271.3	20.7	69.4	21.2	85.6
1997	48.0	292.1	45.9	283.9	20.1	72.0	20.4	88.4
1998	47.2	306.1	45.9	297.1	20.1	72.0	19.9	90.0
1999	45.9	320.0	46.3	310.9	20.1	72.0	19.9	90.0
2000	44.4	333.8	45.6	324.8	20.1	72.0	19.9	90.0
2001	42.9	347.6	44.4	338.6	20.1	72.0	19.9	90.0
2002	41.4	361.3	43.1	352.3	20.1	72.0	19.9	90.0
2003	39.8	375.0	41.7	366.0	20.1	72.0	19.9	90.0

SEGMENT TOTALS

PRESENT VALUE OF BENEFITS ($000) = 7203.2
PRESENT VALUE OF CONSTRUCTION COST ($000) = 952.6
NET PRESENT VALUE ($000) = 6250.6
BENEFIT/COST RATIO = 7.56
INTERNAL RATE OF RETURN (%) = 2462.86

```
PROBLEM    3                                           SAMPLE PROBLEM 3

SEGMENT    3          DESCRIPTION - CONC FLOW LANE ON CITY STREET

       TRAFFIC DATA - CURRENT YEAR     1983   VOLUME (1,000)     25.00
                      PROJECTED YEAR1 2000   VOLUME (1,000)     60.00
                      PROJECTED YEAR2 1990   VOLUME (1,000)     40.00

       SEGMENT RUN TYPE - REGULAR RUN

       EXISTING  HIGHWAY DATA - HIGHWAY TYPE    U4C
                                LENGTH     1.00 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     95.00    100.00
                                SPEED LIMIT  25. MPH
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00

       PROPOSED  HIGHWAY DATA - HIGHWAY TYPE    U1AN
                                LENGTH     1.00 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     80.00     90.00
                                SPEED LIMIT  25. MPH
                                CONSTRUCTION YEAR   1986
                                CONSTRUCTION COST (MILLIONS)  $100.00
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    3.70
                                TRUCK(BUS) OCCUPANCY RATE 40.00

       SEGMENT HOV ASSUMPTIONS -
           INCONVENIENCE COST ($/MILE) - BUS          0.446
                                         CARPOOL/VAN  0.064
```

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 3 DESCRIPTION - CONC FLOW LANE ON CITY STREET

*** DO-NOTHING CORRIDOR TRAFFIC ALLOCATION ***

```
YEAR                                                   VEHICLES (1,000)                                     (SQUARE-ROOT SCALE)
      0         0         2         4         7        11         16        22        29        37        46        55        66
      I         I         I         I         I         I         I         I         I         I         I         I         I
     -------------------------------------------------------------------------------------------------------------------------------
1983 I                                                                          *
1984 I                                                                             *
1985 I                                                                                *
1986 I                                                                                   *
1987 I                                                                                      *
1988 I                                                                                        *
1989 I                                                                                           *
1990 I                                                                                             *
1991 I                     D                                                                       E  T
1992 I                             D                                                               E    T
1993 I                                    D                                                        E      T
1994 I                                          D                                                  E        T
1995 I                                               D                                             E          T
1996 I                                                   D                                         E             T
1997 I                                                       D                                     E               T
1998 I                                                           D                                 E                 T
1999 I                                                              D                              E                  T
2000 I                                                                  D                          E                    T
2001 I                                                                     D                       E                      T
2002 I                                                                        D                    E                        T
2003 I                                                                           D                 E                          T
        * INDICATES MULTIPLE LETTERS AT SAME POINT
```

YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	25000.	31675.	0.	0.	0.	0.	0.	0.	0.	0.	25000.	31675.
1984	27339.	34639.	0.	0.	0.	0.	0.	0.	0.	0.	27339.	34639.
1985	29535.	37421.	0.	0.	0.	0.	0.	0.	0.	0.	29535.	37421.
1986	31679.	40137.	0.	0.	0.	0.	0.	0.	0.	0.	31679.	40137.
1987	33790.	42813.	0.	0.	0.	0.	0.	0.	0.	0.	33790.	42813.
1988	35878.	45458.	0.	0.	0.	0.	0.	0.	0.	0.	35878.	45458.
1989	37947.	48079.	0.	0.	0.	0.	0.	0.	0.	0.	37947.	48079.
1990	40000.	50680.	0.	0.	0.	0.	0.	0.	0.	0.	40000.	50680.
1991	40000.	50680.	0.	0.	0.	0.	0.	0.	2040.	2585.	42040.	53265.
1992	40000.	50680.	0.	0.	0.	0.	0.	0.	4068.	5155.	44068.	55835.
1993	40000.	50680.	0.	0.	0.	0.	0.	0.	6087.	7712.	46087.	58392.
1994	40000.	50680.	0.	0.	0.	0.	0.	0.	8096.	10258.	48096.	60938.
1995	40000.	50680.	0.	0.	0.	0.	0.	0.	10097.	12793.	50097.	63473.
1996	40000.	50680.	0.	0.	0.	0.	0.	0.	12090.	15319.	52090.	65999.
1997	40000.	50680.	0.	0.	0.	0.	0.	0.	14077.	17836.	54077.	68516.
1998	40000.	50680.	0.	0.	0.	0.	0.	0.	16057.	20344.	56057.	71024.
1999	40000.	50680.	0.	0.	0.	0.	0.	0.	18031.	22846.	58031.	73526.
2000	40000.	50680.	0.	0.	0.	0.	0.	0.	20000.	25340.	60000.	76020.
2001	40000.	50680.	0.	0.	0.	0.	0.	0.	21963.	27828.	61963.	78508.
2002	40000.	50680.	0.	0.	0.	0.	0.	0.	23922.	30309.	63922.	80989.
2003	40000.	50680.	0.	0.	0.	0.	0.	0.	25876.	32785.	65876.	83465.

```
PROBLEM    3                                    SAMPLE PROBLEM 3

SEGMENT    3         DESCRIPTION - CONC FLOW LANE ON CITY STREET

                                   *** IF-CONSTRUCT CORRIDOR TRAFFIC ALLOCATION ***

 YEAR                                         VEHICLES (1,000)                                    (SQUARE-ROOT SCALE)
      0         0         2         4         7         11        16        22        29        37        46        55        66
      I         I         I         I         I         I         I         I         I         I         I         I         I
     ------------------------------------------------------------------------------------------------------------------------------
 1983 I                                                                            *
 1984 I                                                                               *
 1985 I                                                                                  *
 1986 I    P                                                                               *
 1987 I    P                                                                                 ET
 1988 I    P                                                                                      *
 1989 I    P                                                                                         *
 1990 I     P                                                                                          *
 1991 I       P                                                                                         ET
 1992 I           P                                                                                     ET
 1993 I             P                                                                                   ET
 1994 I                P                                                                                E T
 1995 I                  P                                                                              E T
 1996 I                   P                                                                             E  T
 1997 I                     P                                                                           E  T
 1998 I                       P                                                                         E  T
 1999 I                        P                                                                        E   T
 2000 I                         P                                                                       E   T
 2001 I                           P                                                                     E   T
 2002 I                            P                                                                    E    T
 2003 I                             P                                                                   E    T
         * INDICATES MULTIPLE LETTERS AT SAME POINT
```

YEAR	EXISTING (E) VEHICLES	EXISTING (E) PERSONS	ALTERNATE (A) VEHICLES	ALTERNATE (A) PERSONS	PROPOSED (P) VEHICLES	PROPOSED (P) PERSONS	EXPANSION (X) VEHICLES	EXPANSION (X) PERSONS	DIVERTED (D) VEHICLES	DIVERTED (D) PERSONS	TOTAL (T) VEHICLES	TOTAL (T) PERSONS
1983	25000.	31675.	0.	0.	0.	0.	0.	0.	0.	0.	25000.	31675.
1984	27339.	34639.	0.	0.	0.	0.	0.	0.	0.	0.	27339.	34639.
1985	29535.	37421.	0.	0.	0.	0.	0.	0.	0.	0.	29535.	37421.
1986	30735.	38942.	0.	0.	155.	1195.	0.	0.	0.	0.	30891.	40137.
1987	32817.	41579.	0.	0.	160.	1233.	0.	0.	0.	0.	32977.	42813.
1988	34915.	44237.	0.	0.	159.	1221.	0.	0.	0.	0.	35073.	45458.
1989	36965.	46834.	0.	0.	162.	1244.	0.	0.	0.	0.	37127.	48079.
1990	39004.	49418.	0.	0.	164.	1262.	0.	0.	0.	0.	39168.	50680.
1991	39998.	50677.	0.	0.	336.	2588.	0.	0.	0.	0.	40334.	53265.
1992	39991.	50668.	0.	0.	672.	5166.	0.	0.	0.	0.	40662.	55835.
1993	40000.	50679.	0.	0.	1003.	7712.	0.	0.	0.	0.	41002.	58392.
1994	40000.	50680.	0.	0.	1333.	10258.	0.	0.	0.	0.	41333.	60938.
1995	40000.	50680.	0.	0.	1663.	12793.	0.	0.	0.	0.	41663.	63473.
1996	39996.	50675.	0.	0.	1992.	15323.	0.	0.	0.	0.	41988.	65999.
1997	39990.	50667.	0.	0.	2320.	17848.	0.	0.	0.	0.	42310.	68516.
1998	40000.	50680.	0.	0.	2645.	20344.	0.	0.	0.	0.	42645.	71024.
1999	39996.	50675.	0.	0.	2970.	22851.	0.	0.	0.	0.	42966.	73526.
2000	40000.	50680.	0.	0.	3294.	25340.	0.	0.	0.	0.	43294.	76020.
2001	40000.	50680.	0.	0.	3617.	27828.	0.	0.	0.	0.	43617.	78508.
2002	39998.	50678.	0.	0.	3940.	30312.	0.	0.	0.	0.	43938.	80989.
2003	39998.	50678.	0.	0.	4262.	32787.	0.	0.	0.	0.	44260.	83465.

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 3 DESCRIPTION - CONC FLOW LANE ON CITY STREET

CURRENT YEAR 1983
CONSTRUCTION YEAR 1986

*** SEGMENT DISCOUNTED YEARLY BENEFITS ***

```
YEAR                                    DISCOUNTED DELAY SAVINGS(S) AND TOTAL BENEFITS(B) ($1,000)
  -1974     -1803     -1632     -1461     -1290     -1119      -949      -778      -607      -436      -265        -94        76
      I         I         I         I         I         I         I         I         I         I         I         I         I
     ------------------------------------------------------------------------------------------------------------------------------
1983 I                                                                                                                     *
1984 I                                                                                                                     *
1985 I                                                                                                                     *
1986 I                                                                                                                      B  S
1987 I                                                                                                                       B S
1988 I                                                                                                                       B S
1989 I                                                                                                                       B S
1990 I                                                                                                                       B S
1991 I                                                                                              B         S
1992 I                                                                            B                S
1993 I                                                            B                      S
1994 I                                               B                           S
1995 I                                    B                                S
1996 I                          B                                    S
1997 I                  B                                       S
1998 I            B                                          S
1999 I        B                                           S
2000 I    B                                            S
2001 I  B                                             S
2002 IB                                             S
2003 IB                                             S
```

YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	21.1	68.5	-32.0	4.1	-12.5	28.0
1987	22.5	71.9	-30.1	3.9	-11.6	34.1
1988	23.1	72.1	-27.2	3.6	-10.8	37.7
1989	24.4	74.1	-25.3	3.4	-10.0	42.2
1990	25.7	75.4	-23.4	3.2	-9.2	46.0
1991	-6.3	-216.4	-127.5	-23.6	-8.5	-376.0
1992	-12.5	-402.7	-235.5	-43.5	-7.9	-689.6
1993	-19.2	-563.2	-326.2	-60.3	-7.3	-957.0
1994	-25.7	-699.5	-401.8	-74.3	-6.8	-1182.3
1995	-32.3	-814.5	-464.2	-85.8	-6.3	-1370.7
1996	-39.0	-910.5	-514.9	-95.1	-5.8	-1526.3
1997	-45.6	-989.7	-555.4	-102.5	-5.4	-1652.9
1998	-52.7	-1054.5	-586.7	-108.3	-5.0	-1754.5
1999	-59.6	-1105.7	-610.3	-112.6	-4.6	-1833.2
2000	-66.8	-1145.5	-627.0	-115.6	-4.3	-1892.3
2001	-74.0	-1174.8	-637.7	-117.5	-4.0	-1934.0
2002	-81.3	-1195.0	-643.4	-118.5	-3.7	-1960.7
2003	-88.7	-1207.4	-644.6	-118.7	-3.4	-1974.1
TOTAL	-486.9	-11117.4	-6513.4	-1157.9	-127.0	-18915.6

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 3 DESCRIPTION - CONC FLOW LANE ON CITY STREET

*** MOBILITY ***

	CORRIDOR				STATE FACILITY			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	18.7	25.0	18.7	25.0	18.7	25.0	18.7	25.0
1984	18.4	27.3	18.4	27.3	18.4	27.3	18.4	27.3
1985	18.1	29.5	18.1	29.5	18.1	29.5	18.1	29.5
1986	17.8	31.7	17.9	30.9	17.8	31.7	19.7	0.2
1987	17.5	33.8	17.7	33.0	17.5	33.8	19.7	0.2
1988	17.2	35.9	17.4	35.1	17.2	35.9	19.7	0.2
1989	17.0	37.9	17.1	37.1	17.0	37.9	19.7	0.2
1990	16.7	40.0	16.8	39.2	16.7	40.0	19.7	0.2
1991	16.7	40.0	16.7	40.3	16.7	40.0	19.6	0.3
1992	16.7	40.0	16.7	40.7	16.7	40.0	19.5	0.7
1993	16.7	40.0	16.8	41.0	16.7	40.0	19.3	1.0
1994	16.7	40.0	16.8	41.3	16.7	40.0	19.2	1.3
1995	16.7	40.0	16.8	41.7	16.7	40.0	19.0	1.7
1996	16.7	40.0	16.8	42.0	16.7	40.0	18.8	2.0
1997	16.7	40.0	16.8	42.3	16.7	40.0	18.7	2.3
1998	16.7	40.0	16.8	42.6	16.7	40.0	18.5	2.6
1999	16.7	40.0	16.8	43.0	16.7	40.0	18.4	3.0
2000	16.7	40.0	16.8	43.3	16.7	40.0	18.2	3.3
2001	16.7	40.0	16.8	43.6	16.7	40.0	18.1	3.6
2002	16.7	40.0	16.8	43.9	16.7	40.0	17.9	3.9
2003	16.7	40.0	16.8	44.3	16.7	40.0	17.7	4.3

SEGMENT TOTALS

PRESENT VALUE OF BENEFITS ($000) = -18915.6
PRESENT VALUE OF CONSTRUCTION COST ($000) = 79383.2
NET PRESENT VALUE ($000) = -98298.9
BENEFIT/COST RATIO = -0.24
INTERNAL RATE OF RETURN (%) = NO SOLUTION FOUND

```
PROBLEM    3                                        SAMPLE PROBLEM 3

SEGMENT    4          DESCRIPTION - OPTIMIZE U2E - U4E - U6E

       TRAFFIC DATA - CURRENT YEAR     1983   VOLUME (1,000)      20.00
                      PROJECTED YEAR1 1992   VOLUME (1,000)      81.80
                      PROJECTED YEAR2 2003   VOLUME (1,000)     140.00

       SEGMENT RUN TYPE - OPTIMIZE CONSTRUCTION & EXPANSION YEARS

       EXISTING  HIGHWAY DATA - HIGHWAY TYPE    U2E
                                LENGTH     3.50 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     90.00     95.00
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00

       PROPOSED  HIGHWAY DATA - HIGHWAY TYPE    U4E
                                LENGTH     3.50 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     95.00    100.00
                                CONSTRUCTION COST (MILLIONS)  $  6.00
                                BUILDOVER OF EXISTING ROUTE
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00

       EXPANDED  HIGHWAY DATA - HIGHWAY TYPE    U6E
                                LENGTH     3.50 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     95.00    100.00
                                EXPANSION COST (MILLIONS)  $  1.00
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00
```

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 4 DESCRIPTION - OPTIMIZE U2E - U4E - U6E

*** DO-NOTHING CORRIDOR TRAFFIC ALLOCATION ***

```
YEAR                                                   VEHICLES (1,000)                                     (SQUARE-ROOT SCALE)
      0         1         4         9        16        24        35        48        63        79        98       118      141
      I         I         I         I         I         I         I         I         I         I         I         I         I
     ----------------------------------------------------------------------------------------------------------------------------
1983 I                                              *
1984 I                                                        *
1985 I                                                               *
1986 I                          D                                    E    T
1987 I                                      D                        E         T
1988 I                                              D                E              T
1989 I                                                    D          E                  T
1990 I                                                          D    E                     T
1991 I                                                               *                         T
1992 I                                                               E    D                       T
1993 I                                                               E        D                      T
1994 I                                                               E            D                     T
1995 I                                                               E               D                     T
1996 I                                                               E                   D                    T
1997 I                                                               E                      D                    T
1998 I                                                               E                         D                   T
1999 I                                                               E                            D                   T
2000 I                                                               E                               D                  T
2001 I                                                               E                                  D                 T
2002 I                                                               E                                    D                 T
2003 I                                                               E                                       D                 T
        * INDICATES MULTIPLE LETTERS AT SAME POINT
```

YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	20000.	25340.	0.	0.	0.	0.	0.	0.	0.	0.	20000.	25340.
1984	29954.	37951.	0.	0.	0.	0.	0.	0.	0.	0.	29954.	37951.
1985	37707.	47775.	0.	0.	0.	0.	0.	0.	0.	0.	37707.	47775.
1986	38000.	48146.	0.	0.	0.	0.	0.	0.	6802.	8618.	44802.	56764.
1987	38000.	48146.	0.	0.	0.	0.	0.	0.	13500.	17105.	51500.	65251.
1988	38000.	48146.	0.	0.	0.	0.	0.	0.	19918.	25236.	57918.	73382.
1989	38000.	48146.	0.	0.	0.	0.	0.	0.	26122.	33096.	64122.	81242.
1990	38000.	48146.	0.	0.	0.	0.	0.	0.	32152.	40736.	70152.	88882.
1991	38000.	48146.	0.	0.	0.	0.	0.	0.	38038.	48194.	76038.	96340.
1992	38000.	48146.	0.	0.	0.	0.	0.	0.	43800.	55495.	81800.	103641.
1993	38000.	48146.	0.	0.	0.	0.	0.	0.	49455.	62660.	87455.	110806.
1994	38000.	48146.	0.	0.	0.	0.	0.	0.	55015.	69704.	93015.	117850.
1995	38000.	48146.	0.	0.	0.	0.	0.	0.	60490.	76641.	98490.	124787.
1996	38000.	48146.	0.	0.	0.	0.	0.	0.	65889.	83481.	103889.	131628.
1997	38000.	48146.	0.	0.	0.	0.	0.	0.	71218.	90233.	109218.	138379.
1998	38000.	48146.	0.	0.	0.	0.	0.	0.	76483.	96904.	114483.	145050.
1999	38000.	48146.	0.	0.	0.	0.	0.	0.	81689.	103499.	119689.	151646.
2000	38000.	48146.	0.	0.	0.	0.	0.	0.	86840.	110026.	124840.	158172.
2001	38000.	48146.	0.	0.	0.	0.	0.	0.	91940.	116488.	129940.	164634.
2002	38000.	48146.	0.	0.	0.	0.	0.	0.	96992.	122889.	134992.	171035.
2003	38000.	48146.	0.	0.	0.	0.	0.	0.	102000.	129234.	140000.	177380.

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 4 DESCRIPTION - OPTIMIZE U2E - U4E - U6E

*** IF-CONSTRUCT CORRIDOR TRAFFIC ALLOCATION ***

```
YEAR                                                   VEHICLES (1,000)                                     (SQUARE-ROOT SCALE)
      0         1         4         9        16        24        35        48        63        79        98       118       141
      I         I         I         I         I         I         I         I         I         I         I         I         I
     ----------------------------------------------------------------------------------------------------------------------------
1983 I                                              *
1984 I                                                        *
1985 I                                                               *
1986 I                          D                                    E    T
1987 I                                      D                        E         T
1988 I                                              D                E              T
1989 I                                                    D          E                  T
1990 I                                                         D     E                     T
1991 I                                                               *                         T
1992 I                                                                                            *
1993 I                                                                                               *
1994 I                                                                                                  *
1995 I                                                                                                     *
1996 I                                                                                                        *
1997 I                                                                                                           *
1998 I                                                                                                             *
1999 I                                                                                                                *
2000 I                      D                                                                                         X T
2001 I                               D                                                                                X   T
2002 I                                       D                                                                        X     T
2003 I                                             D                                                                  X        T
        * INDICATES MULTIPLE LETTERS AT SAME POINT
```

YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	20000.	25340.	0.	0.	0.	0.	0.	0.	0.	0.	20000.	25340.
1984	29954.	37951.	0.	0.	0.	0.	0.	0.	0.	0.	29954.	37951.
1985	37707.	47775.	0.	0.	0.	0.	0.	0.	0.	0.	37707.	47775.
1986	38000.	48146.	0.	0.	0.	0.	0.	0.	6802.	8618.	44802.	56764.
1987	38000.	48146.	0.	0.	0.	0.	0.	0.	13500.	17105.	51500.	65251.
1988	38000.	48146.	0.	0.	0.	0.	0.	0.	19918.	25236.	57918.	73382.
1989	38000.	48146.	0.	0.	0.	0.	0.	0.	26122.	33096.	64122.	81242.
1990	38000.	48146.	0.	0.	0.	0.	0.	0.	32152.	40736.	70152.	88882.
1991	38000.	48146.	0.	0.	0.	0.	0.	0.	38038.	48194.	76038.	96340.
1992	0.	0.	0.	0.	0.	0.	81800.	103641.	0.	0.	81800.	103641.
1993	0.	0.	0.	0.	0.	0.	87455.	110806.	0.	0.	87455.	110806.
1994	0.	0.	0.	0.	0.	0.	93015.	117850.	0.	0.	93015.	117850.
1995	0.	0.	0.	0.	0.	0.	98490.	124787.	0.	0.	98490.	124787.
1996	0.	0.	0.	0.	0.	0.	103889.	131628.	0.	0.	103889.	131628.
1997	0.	0.	0.	0.	0.	0.	109218.	138379.	0.	0.	109218.	138379.
1998	0.	0.	0.	0.	0.	0.	114483.	145050.	0.	0.	114483.	145050.
1999	0.	0.	0.	0.	0.	0.	119689.	151646.	0.	0.	119689.	151646.
2000	0.	0.	0.	0.	0.	0.	120000.	152040.	4840.	6132.	124840.	158172.
2001	0.	0.	0.	0.	0.	0.	120000.	152040.	9940.	12594.	129940.	164634.
2002	0.	0.	0.	0.	0.	0.	120000.	152040.	14992.	18995.	134992.	171035.
2003	0.	0.	0.	0.	0.	0.	120000.	152040.	20000.	25340.	140000.	177380.

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 4 DESCRIPTION - OPTIMIZE U2E - U4E - U6E

CURRENT YEAR 1983
CONSTRUCTION YEAR 1992
EXPANSION YEAR 1992

*** SEGMENT DISCOUNTED YEARLY BENEFITS ***

```
YEAR                                    DISCOUNTED DELAY SAVINGS(S) AND TOTAL BENEFITS(B) ($1,000)
      0      1472      2945      4417      5890      7362      8834     10307     11779     13252     14724     16197     17669
      I         I         I         I         I         I         I         I         I         I         I         I         I
     -------------------------------------------------------------------------------------------------------------------------------
1983 I*
1984 I*
1985 I*
1986 I*
1987 I*
1988 I*
1989 I*
1990 I*
1991 I*
1992 I                                                                                                     S                  B
1993 I                                                                                                    S                   B
1994 I                                                                                                  S                  B
1995 I                                                                                               S                  B
1996 I                                                                                           S                 B
1997 I                                                                                      S                 B
1998 I                                                                                 S                B
1999 I                                                                           S                B
2000 I                                                                     S                B
2001 I                                                                S               B
2002 I                                                           S              B
2003 I                                                       S             B
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YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	0.0	0.0	0.0	0.0	0.0	0.0
1987	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0
1992	2646.7	14943.8	1716.5	1014.2	-5.8	17668.7
1993	2828.5	14787.2	1790.8	1030.1	-5.3	17602.8
1994	2985.5	14452.1	1761.8	1036.7	-5.0	17245.7
1995	3116.9	13970.2	1724.0	1035.5	-4.6	16725.1
1996	3221.1	13367.9	1680.1	1027.8	-4.2	16071.6
1997	3296.5	12667.5	1632.3	1014.7	-3.9	15310.6
1998	3341.1	11887.7	1582.3	997.2	-3.6	14463.6
1999	3352.2	11043.9	1531.8	976.2	-3.4	13548.5
2000	3351.8	10224.4	1518.5	906.8	-3.1	12646.6
2001	3351.8	9467.1	1477.4	839.6	-2.9	11781.2
2002	3351.8	8765.8	1412.2	777.4	-2.7	10952.8
2003	3351.8	8116.5	1329.0	719.8	-2.5	10162.9
TOTAL	38195.5	143694.1	19156.6	11376.2	-47.0	174179.9

PROBLEM 3 SAMPLE PROBLEM 3

SEGMENT 4 DESCRIPTION - OPTIMIZE U2E - U4E - U6E

*** MOBILITY ***

	CORRIDOR				STATE FACILITY			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	38.1	70.0	38.1	70.0	38.1	70.0	38.1	70.0
1984	33.4	104.8	33.4	104.8	33.4	104.8	33.4	104.8
1985	28.5	132.0	28.5	132.0	28.5	132.0	28.5	132.0
1986	26.3	156.8	26.3	156.8	28.3	133.0	28.3	133.0
1987	24.8	180.3	24.8	180.3	28.3	133.0	28.3	133.0
1988	23.7	202.7	23.7	202.7	28.3	133.0	28.3	133.0
1989	22.9	224.4	22.9	224.4	28.3	133.0	28.3	133.0
1990	22.2	245.5	22.2	245.5	28.3	133.0	28.3	133.0
1991	21.6	266.1	21.6	266.1	28.3	133.0	28.3	133.0
1992	21.2	286.3	36.9	286.3	28.3	133.0	0.0	0.0
1993	20.8	306.1	35.7	306.1	28.3	133.0	0.0	0.0
1994	20.4	325.6	34.4	325.6	28.3	133.0	0.0	0.0
1995	20.1	344.7	33.2	344.7	28.3	133.0	0.0	0.0
1996	19.9	363.6	32.0	363.6	28.3	133.0	0.0	0.0
1997	19.6	382.3	30.8	382.3	28.3	133.0	0.0	0.0
1998	19.4	400.7	29.7	400.7	28.3	133.0	0.0	0.0
1999	19.2	418.9	28.5	418.9	28.3	133.0	0.0	0.0
2000	19.0	436.9	27.9	436.9	28.3	133.0	0.0	0.0
2001	18.9	454.8	27.4	454.8	28.3	133.0	0.0	0.0
2002	18.7	472.5	27.0	472.5	28.3	133.0	0.0	0.0
2003	18.6	490.0	26.5	490.0	28.3	133.0	0.0	0.0

SEGMENT TOTALS

PRESENT VALUE OF BENEFITS ($000) = 174179.9
PRESENT VALUE OF CONSTRUCTION COST ($000) = 3501.8
NET PRESENT VALUE ($000) = 170678.1
BENEFIT/COST RATIO = 49.74
INTERNAL RATE OF RETURN (%) = NO SOLUTION FOUND

PROBLEM 3 SAMPLE PROBLEM 3

**** PROBLEM DISCOUNTED YEARLY BENEFITS ****

YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	89.3	679.5	796.2	922.1	-40.6	2357.1
1987	88.8	621.3	746.1	973.5	-37.6	2303.3
1988	86.2	557.0	703.5	1034.0	-34.8	2259.6
1989	85.6	509.5	674.5	1097.3	-32.3	2249.0
1990	92.9	518.6	659.9	1154.5	-29.9	2303.1
1991	68.3	238.0	569.6	1186.5	-27.7	1966.5
1992	2718.7	15018.1	2170.7	2239.9	-31.4	19397.4
1993	2906.9	14734.0	2157.1	2296.8	-29.1	19158.8
1994	3075.9	14314.6	2057.9	2345.1	-26.9	18690.6
1995	3223.6	13779.1	1968.8	2384.3	-24.9	18107.3
1996	3349.2	13151.0	1891.0	2414.7	-23.1	17433.6
1997	3447.8	12434.6	1829.7	2435.2	-21.4	16678.2
1998	3586.8	11895.2	1732.3	2436.4	-19.8	16044.2
1999	3842.1	11748.6	1563.0	2439.0	-18.3	15732.2
2000	4127.1	11648.1	1474.3	2390.0	-17.0	15495.5
2001	4496.7	11735.4	1370.2	2339.5	-15.7	15429.4
2002	4926.3	11901.3	1199.9	2320.1	-14.5	15406.8
2003	5172.7	11533.6	966.4	2386.3	-13.5	14872.8
TOTAL	45385.1	157017.2	24531.3	34795.0	-458.4	215885.1

*** MOBILITY ***

	---------- CORRIDOR ----------				------- STATE FACILITY -------			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	46.2	255.8	46.2	255.8	38.4	157.3	38.4	157.3
1984	43.4	308.3	43.4	308.3	35.3	201.4	35.3	201.4
1985	40.7	353.3	40.7	353.3	32.2	238.6	32.2	238.6
1986	39.1	397.0	38.9	386.7	32.0	250.9	29.2	183.2
1987	38.0	440.5	37.9	430.6	32.1	263.5	28.9	187.6
1988	37.1	484.3	37.1	474.8	32.2	277.3	28.5	191.6
1989	36.4	528.6	36.6	519.6	32.4	292.2	28.2	195.6
1990	35.9	574.1	36.2	565.0	32.5	307.5	27.8	199.3
1991	35.5	618.3	36.0	610.3	32.7	322.0	27.4	203.1
1992	35.3	663.4	42.7	655.7	33.0	337.7	24.7	73.9
1993	35.0	709.4	42.3	702.1	33.2	354.6	23.8	77.6
1994	34.8	756.4	41.9	749.5	33.4	372.7	22.8	81.0
1995	34.6	804.4	41.5	797.9	33.6	392.1	22.0	84.4
1996	34.4	853.4	41.1	847.3	33.7	412.7	21.1	87.6
1997	34.3	903.6	40.8	897.8	33.8	434.3	20.3	90.7
1998	33.6	956.2	40.5	949.9	33.3	454.5	19.8	92.6
1999	32.6	1009.9	40.4	1003.8	32.3	476.0	19.8	93.0
2000	31.4	1064.5	40.1	1058.8	31.0	498.8	19.8	93.3
2001	30.1	1120.3	39.8	1114.9	29.5	522.9	19.8	93.6
2002	28.9	1177.1	39.4	1172.0	28.2	542.0	19.8	93.9
2003	28.3	1235.0	39.0	1230.3	28.2	542.0	19.8	94.3

PROBLEM TOTALS

PRESENT VALUE OF BENEFITS ($000) =	215885.1
PRESENT VALUE OF CONSTRUCTION COST ($000) =	103048.4
NET PRESENT VALUE ($000) =	112836.7
BENEFIT/COST RATIO =	2.09

PROBLEM 4 SAMPLE PROBLEM 4

PROBLEM CONTROL DATA -

CURRENT YEAR - 1983

ASSUMPTIONS -

1. PERCENTAGE TRUCKS %	11.00
2. VALUE CAR TIME $/MIN	0.17
3. VALUE TRUCK TIME $/MIN	0.32
4. INFLATION RATE %	0.00
5. CONST COST ESCALATION RATE %	0.00
6. DISCOUNT RATE %	8.00
7. RURAL DIVERSION ROUTE SPEED	25.00
8. URBAN DIVERSION ROUTE SPEED	15.00

PLANNING HORIZON - 20 YEARS

PROBLEM 4 SAMPLE PROBLEM 4

SEGMENT 1 DESCRIPTION - R2C - R6C

TRAFFIC DATA - CURRENT YEAR 1983 VOLUME (1,000) 17.00
PROJECTED YEAR1 1992 VOLUME (1,000) 30.80
PROJECTED YEAR2 2003 VOLUME (1,000) 70.00

SEGMENT RUN TYPE - REGULAR RUN

EXISTING HIGHWAY DATA - HIGHWAY TYPE R2C
LENGTH 7.00 MILES
SAFETY/TECHNICAL FACTORS (BASE=100) 80.00 90.00
SPEED LIMIT 55. MPH
PERCENT TRUCKS(BUSES) 11.00
CAR(VAN) OCCUPANCY RATE 1.30
TRUCK(BUS) OCCUPANCY RATE 1.00

PROPOSED HIGHWAY DATA - HIGHWAY TYPE R6C
LENGTH 7.00 MILES
SAFETY/TECHNICAL FACTORS (BASE=100) 75.00 80.00
SPEED LIMIT 55. MPH
CONSTRUCTION YEAR 1986
CONSTRUCTION COST (MILLIONS) $ 8.50
BUILDOVER OF EXISTING ROUTE
PERCENT TRUCKS(BUSES) 11.00
CAR(VAN) OCCUPANCY RATE 1.30
TRUCK(BUS) OCCUPANCY RATE 1.00

PROBLEM 4 SAMPLE PROBLEM 4

SEGMENT 1 DESCRIPTION - R2C - R6C

*** DO-NOTHING CORRIDOR TRAFFIC ALLOCATION ***

```
YEAR                                                   VEHICLES (1,000)                                     (SQUARE-ROOT SCALE)
      0         0         2         4         8        12        18        24        32        40        49        60        71
      I         I         I         I         I         I         I         I         I         I         I         I         I
     --------------------------------------------------------------------------------------------------------------------------------
1983 I                                                          *
1984 I                                                           *
1985 I                                                            *
1986 I                                                              *
1987 I                                                                *
1988 I                                                                   *
1989 I                                                                      *
1990 I                                                                        *
1991 I         D                                                                 ET
1992 I                        D                                                  E   T
1993 I                                 D                                         E      T
1994 I                                         D                                 E          T
1995 I                                                D                          E             T
1996 I                                                      D                    E                 T
1997 I                                                            D              E                     T
1998 I                                                                  D        E                        T
1999 I                                                                        D  E                            T
2000 I                                                                           E D                              T
2001 I                                                                           E      D                             T
2002 I                                                                           E           D                           T
2003 I                                                                           E                D                          T
        * INDICATES MULTIPLE LETTERS AT SAME POINT
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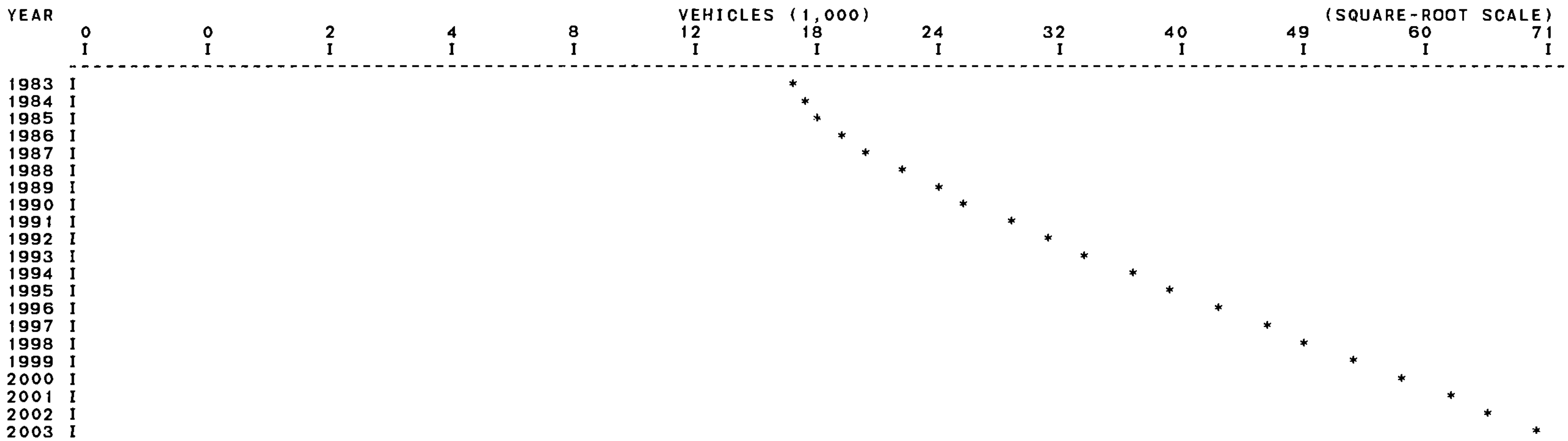
YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	17000.	21539.	0.	0.	0.	0.	0.	0.	0.	0.	17000.	21539.
1984	17340.	21970.	0.	0.	0.	0.	0.	0.	0.	0.	17340.	21970.
1985	18094.	22925.	0.	0.	0.	0.	0.	0.	0.	0.	18094.	22925.
1986	19167.	24285.	0.	0.	0.	0.	0.	0.	0.	0.	19167.	24285.
1987	20519.	25997.	0.	0.	0.	0.	0.	0.	0.	0.	20519.	25997.
1988	22125.	28032.	0.	0.	0.	0.	0.	0.	0.	0.	22125.	28032.
1989	23968.	30368.	0.	0.	0.	0.	0.	0.	0.	0.	23968.	30368.
1990	26035.	32987.	0.	0.	0.	0.	0.	0.	0.	0.	26035.	32987.
1991	27900.	35349.	0.	0.	0.	0.	0.	0.	416.	527.	28316.	35876.
1992	27900.	35349.	0.	0.	0.	0.	0.	0.	2900.	3674.	30800.	39024.
1993	27900.	35349.	0.	0.	0.	0.	0.	0.	5581.	7071.	33481.	42421.
1994	27900.	35349.	0.	0.	0.	0.	0.	0.	8453.	10710.	36353.	46059.
1995	27900.	35349.	0.	0.	0.	0.	0.	0.	11509.	14582.	39409.	49931.
1996	27900.	35349.	0.	0.	0.	0.	0.	0.	14745.	18682.	42645.	54031.
1997	27900.	35349.	0.	0.	0.	0.	0.	0.	18156.	23004.	46056.	58353.
1998	27900.	35349.	0.	0.	0.	0.	0.	0.	21739.	27543.	49639.	62892.
1999	27900.	35349.	0.	0.	0.	0.	0.	0.	25489.	32294.	53389.	67643.
2000	27900.	35349.	0.	0.	0.	0.	0.	0.	29403.	37253.	57303.	72603.
2001	27900.	35349.	0.	0.	0.	0.	0.	0.	33478.	42416.	61378.	77766.
2002	27900.	35349.	0.	0.	0.	0.	0.	0.	37711.	47780.	65611.	83129.
2003	27900.	35349.	0.	0.	0.	0.	0.	0.	42100.	53341.	70000.	88690.

PROBLEM 4 SAMPLE PROBLEM 4

SEGMENT 1 DESCRIPTION - R2C - R6C

*** IF-CONSTRUCT CORRIDOR TRAFFIC ALLOCATION ***



* INDICATES MULTIPLE LETTERS AT SAME POINT

YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	17000.	21539.	0.	0.	0.	0.	0.	0.	0.	0.	17000.	21539.
1984	17340.	21970.	0.	0.	0.	0.	0.	0.	0.	0.	17340.	21970.
1985	18094.	22925.	0.	0.	0.	0.	0.	0.	0.	0.	18094.	22925.
1986	0.	0.	0.	0.	19167.	24285.	0.	0.	0.	0.	19167.	24285.
1987	0.	0.	0.	0.	20519.	25997.	0.	0.	0.	0.	20519.	25997.
1988	0.	0.	0.	0.	22125.	28032.	0.	0.	0.	0.	22125.	28032.
1989	0.	0.	0.	0.	23968.	30368.	0.	0.	0.	0.	23968.	30368.
1990	0.	0.	0.	0.	26035.	32987.	0.	0.	0.	0.	26035.	32987.
1991	0.	0.	0.	0.	28316.	35876.	0.	0.	0.	0.	28316.	35876.
1992	0.	0.	0.	0.	30800.	39024.	0.	0.	0.	0.	30800.	39024.
1993	0.	0.	0.	0.	33481.	42421.	0.	0.	0.	0.	33481.	42421.
1994	0.	0.	0.	0.	36353.	46059.	0.	0.	0.	0.	36353.	46059.
1995	0.	0.	0.	0.	39409.	49931.	0.	0.	0.	0.	39409.	49931.
1996	0.	0.	0.	0.	42645.	54031.	0.	0.	0.	0.	42645.	54031.
1997	0.	0.	0.	0.	46056.	58353.	0.	0.	0.	0.	46056.	58353.
1998	0.	0.	0.	0.	49639.	62892.	0.	0.	0.	0.	49639.	62892.
1999	0.	0.	0.	0.	53389.	67643.	0.	0.	0.	0.	53389.	67643.
2000	0.	0.	0.	0.	57303.	72603.	0.	0.	0.	0.	57303.	72603.
2001	0.	0.	0.	0.	61378.	77766.	0.	0.	0.	0.	61378.	77766.
2002	0.	0.	0.	0.	65611.	83129.	0.	0.	0.	0.	65611.	83129.
2003	0.	0.	0.	0.	70000.	88690.	0.	0.	0.	0.	70000.	88690.

PROBLEM 4 SAMPLE PROBLEM 4

SEGMENT 1 DESCRIPTION - R2C - R6C

CURRENT YEAR 1983
CONSTRUCTION YEAR 1986

*** SEGMENT DISCOUNTED YEARLY BENEFITS ***

```
YEAR                                    DISCOUNTED DELAY SAVINGS(S) AND TOTAL BENEFITS(B) ($1,000)
 -15175    -13499    -11824    -10148     -8472     -6796     -5121     -3445     -1769       -93      1582      3257      4933
      I         I         I         I         I         I         I         I         I         I         I         I         I
     ----------------------------------------------------------------------------------------------------------------------------
1983 I                                                                                          *
1984 I                                                                                          *
1985 I                                                                                          *
1986 I                                                                                                S         B
1987 I                                                                                                 S         B
1988 I                                                                                                  S          B
1989 I                                                                                                      S          B
1990 I                                                                                                          S           B
1991 I                                                                                                              S         B
1992 I                                                                                                      S  B
1993 I                                                                                          B     S
1994 I                                                                             B           S
1995 I                                                                B                   S
1996 I                                                     B                        S
1997 I                                           B                             S
1998 I                                 B                                   S
1999 I                         B                                      S
2000 I                 B                                          S
2001 I           B                                            S
2002 I     B                                               S
2003 IB                                                 S
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YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	98.7	884.2	1144.5	563.1	-28.9	2562.9
1987	128.9	1069.2	1204.7	558.1	-26.8	2805.3
1988	170.3	1308.3	1284.2	557.2	-24.8	3124.9
1989	260.5	1852.6	1341.3	559.0	-22.9	3729.9
1990	399.1	2628.3	1388.4	562.2	-21.2	4557.6
1991	527.5	3216.8	1278.9	456.1	-19.7	4932.2
1992	356.4	2012.1	502.3	-140.4	-18.2	2355.9
1993	169.0	883.3	-223.1	-692.3	-16.9	-49.0
1994	-34.9	-169.1	-896.5	-1198.6	-15.6	-2279.8
1995	-255.7	-1145.9	-1517.6	-1659.4	-14.5	-4337.2
1996	-493.6	-2048.6	-2087.0	-2075.2	-13.4	-6224.2
1997	-749.4	-2879.6	-2606.1	-2447.4	-12.4	-7945.4
1998	-1023.5	-3641.7	-3076.2	-2777.4	-11.5	-9506.7
1999	-1316.8	-4338.1	-3499.2	-3067.3	-10.6	-10915.2
2000	-1630.0	-4972.2	-3877.2	-3319.1	-9.8	-12178.3
2001	-1964.1	-5547.5	-4212.3	-3535.0	-9.1	-13303.9
2002	-2320.1	-6067.7	-4506.7	-3717.3	-8.4	-14300.1
2003	-2699.3	-6536.4	-4762.6	-3868.3	-7.8	-15175.1
TOTAL	-10376.9	-23492.0	-23120.1	-25241.8	-292.5	-72146.2

PROBLEM 4 SAMPLE PROBLEM 4

SEGMENT 1 DESCRIPTION - R2C - R6C

*** MOBILITY ***

	CORRIDOR				STATE FACILITY			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	39.8	119.0	39.8	119.0	39.8	119.0	39.8	119.0
1984	39.6	121.4	39.6	121.4	39.6	121.4	39.6	121.4
1985	39.2	126.7	39.2	126.7	39.2	126.7	39.2	126.7
1986	38.6	134.2	41.8	134.2	38.6	134.2	41.8	134.2
1987	37.8	143.6	41.7	143.6	37.8	143.6	41.7	143.6
1988	36.9	154.9	41.5	154.9	36.9	154.9	41.5	154.9
1989	35.2	167.8	41.3	167.8	35.2	167.8	41.3	167.8
1990	33.0	182.2	41.0	182.2	33.0	182.2	41.0	182.2
1991	31.1	195.3	40.8	198.2	31.1	195.3	40.8	198.2
1992	31.1	195.3	40.5	215.6	31.1	195.3	40.5	215.6
1993	31.1	195.3	40.2	234.4	31.1	195.3	40.2	234.4
1994	31.1	195.3	39.9	254.5	31.1	195.3	39.9	254.5
1995	31.1	195.3	39.5	275.9	31.1	195.3	39.5	275.9
1996	31.1	195.3	39.2	298.5	31.1	195.3	39.2	298.5
1997	31.1	195.3	38.8	322.4	31.1	195.3	38.8	322.4
1998	31.1	195.3	38.4	347.5	31.1	195.3	38.4	347.5
1999	31.1	195.3	37.9	373.7	31.1	195.3	37.9	373.7
2000	31.1	195.3	37.5	401.1	31.1	195.3	37.5	401.1
2001	31.1	195.3	37.0	429.6	31.1	195.3	37.0	429.6
2002	31.1	195.3	36.5	459.3	31.1	195.3	36.5	459.3
2003	31.1	195.3	36.0	490.0	31.1	195.3	36.0	490.0

SEGMENT TOTALS

PRESENT VALUE OF BENEFITS ($000) = -72146.2
PRESENT VALUE OF CONSTRUCTION COST ($000) = 6747.6
NET PRESENT VALUE ($000) = -78893.8
BENEFIT/COST RATIO = -10.69
INTERNAL RATE OF RETURN (%) = 32.56

```
PROBLEM   4                                        SAMPLE PROBLEM 4

SEGMENT   2         DESCRIPTION - R2E - R6D  ALT R4F

       TRAFFIC DATA - CURRENT YEAR    1983   VOLUME (1,000)     17.50
                      PROJECTED YEAR1 1992   VOLUME (1,000)     45.00
                      PROJECTED YEAR2 2003   VOLUME (1,000)    165.00

       SEGMENT RUN TYPE - REGULAR RUN

       EXISTING  HIGHWAY DATA - HIGHWAY TYPE    R2E
                                LENGTH     6.00 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     90.00     95.00
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00

       PROPOSED  HIGHWAY DATA - HIGHWAY TYPE    R6D
                                LENGTH     6.00 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     95.00    100.00
                                CONSTRUCTION YEAR   1986
                                CONSTRUCTION COST (MILLIONS)  $ 10.80
                                BUILDOVER OF EXISTING ROUTE
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00

       ALTERNATE HIGHWAY DATA - HIGHWAY TYPE    R4F
                                LENGTH     8.30 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     95.00    100.00
                                PERCENT TRUCKS(BUSES)     11.00
                                CAR(VAN) OCCUPANCY RATE    1.30
                                TRUCK(BUS) OCCUPANCY RATE  1.00
```

PROBLEM 4 SAMPLE PROBLEM 4

SEGMENT 2 DESCRIPTION - R2E - R6D ALT R4F

*** DO-NOTHING CORRIDOR TRAFFIC ALLOCATION ***

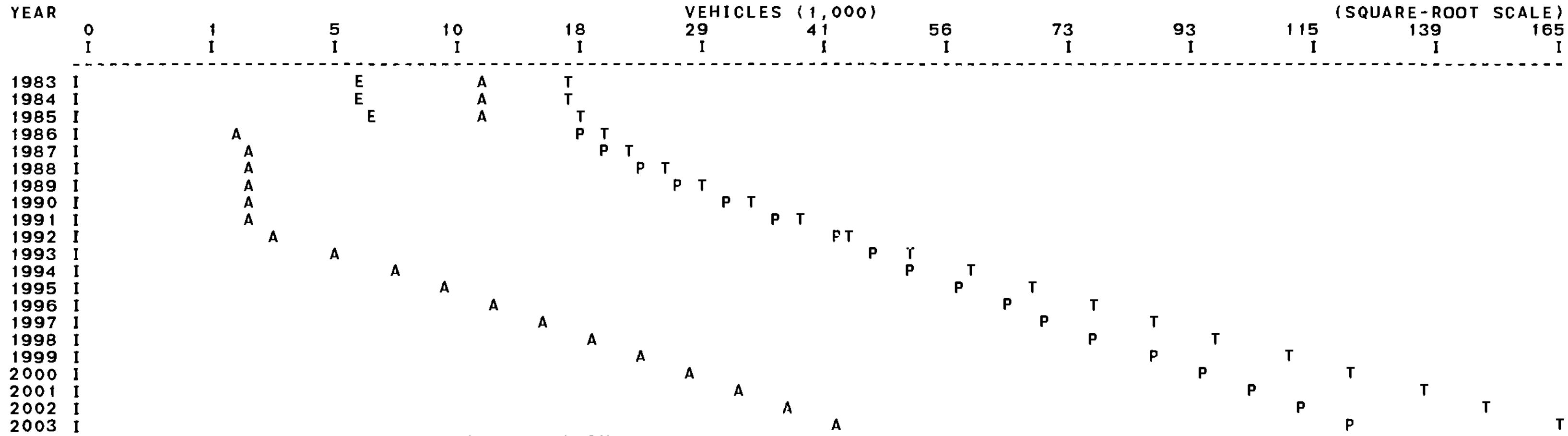
```
YEAR                                                   VEHICLES (1,000)                                    (SQUARE-ROOT SCALE)
      0         1         5        10        18        29        41        56        73        93       115       139       165
      I         I         I         I         I         I         I         I         I         I         I         I         I
     ------------------------------------------------------------------------------------------------------------------------------
1983 I                      E         A      T
1984 I                      E         A      T
1985 I                       E        A       T
1986 I                        E         A       T
1987 I                          E        A        T
1988 I                            E         A        T
1989 I                              E         A         T
1990 I                                E          A          T
1991 I                                   E          A           T
1992 I                                      E          A            T
1993 I                                         E           A             T
1994 I                                            E           A               T
1995 I                                               E            A                T
1996 I                                                   E            A                 T
1997 I                                                      E             A                  T
1998 I                                                         E               A                  T
1999 I                                                            E                A                    T
2000 I                                                               E                 A                     T
2001 I                                                                  E                   A                      T
2002 I                                                                   E                        A                     T
2003 I               D                                                   E                              A                     T
        * INDICATES MULTIPLE LETTERS AT SAME POINT
```

YEAR	EXISTING (E) VEHICLES	EXISTING (E) PERSONS	ALTERNATE (A) VEHICLES	ALTERNATE (A) PERSONS	PROPOSED (P) VEHICLES	PROPOSED (P) PERSONS	EXPANSION (X) VEHICLES	EXPANSION (X) PERSONS	DIVERTED (D) VEHICLES	DIVERTED (D) PERSONS	TOTAL (T) VEHICLES	TOTAL (T) PERSONS
1983	5793.	7340.	11707.	14832.	0.	0.	0.	0.	0.	0.	17500.	22173.
1984	5918.	7498.	11853.	15017.	0.	0.	0.	0.	0.	0.	17770.	22515.
1985	6288.	7966.	12375.	15679.	0.	0.	0.	0.	0.	0.	18662.	23645.
1986	6904.	8747.	13323.	16881.	0.	0.	0.	0.	0.	0.	20227.	25628.
1987	7809.	9895.	14685.	18606.	0.	0.	0.	0.	0.	0.	22495.	28501.
1988	8998.	11400.	16489.	20892.	0.	0.	0.	0.	0.	0.	25487.	32292.
1989	10487.	13287.	18733.	23735.	0.	0.	0.	0.	0.	0.	29220.	37022.
1990	12295.	15578.	21414.	27131.	0.	0.	0.	0.	0.	0.	33709.	42709.
1991	14403.	18248.	24563.	31121.	0.	0.	0.	0.	0.	0.	38965.	49369.
1992	16798.	21283.	28202.	35732.	0.	0.	0.	0.	0.	0.	45000.	57015.
1993	19522.	24734.	32301.	40925.	0.	0.	0.	0.	0.	0.	51823.	65659.
1994	22567.	28592.	36876.	46721.	0.	0.	0.	0.	0.	0.	59442.	75313.
1995	25897.	32812.	41969.	53175.	0.	0.	0.	0.	0.	0.	67866.	85986.
1996	29572.	37468.	47530.	60220.	0.	0.	0.	0.	0.	0.	77102.	97688.
1997	33460.	42394.	53696.	68032.	0.	0.	0.	0.	0.	0.	87156.	110427.
1998	37254.	47201.	60781.	77010.	0.	0.	0.	0.	0.	0.	98035.	124211.
1999	41436.	52499.	68309.	86548.	0.	0.	0.	0.	0.	0.	109745.	139047.
2000	46113.	58425.	76178.	96518.	0.	0.	0.	0.	0.	0.	122291.	154943.
2001	50963.	64569.	84717.	107336.	0.	0.	0.	0.	0.	0.	135679.	171906.
2002	52246.	66196.	97667.	123744.	0.	0.	0.	0.	0.	0.	149914.	189941.
2003	52250.	66201.	110000.	139370.	0.	0.	0.	0.	2749.	3484.	164999.	209055.

PROBLEM 4 SAMPLE PROBLEM 4

SEGMENT 2 DESCRIPTION - R2E - R6D ALT R4F

*** IF-CONSTRUCT CORRIDOR TRAFFIC ALLOCATION ***



* INDICATES MULTIPLE LETTERS AT SAME POINT

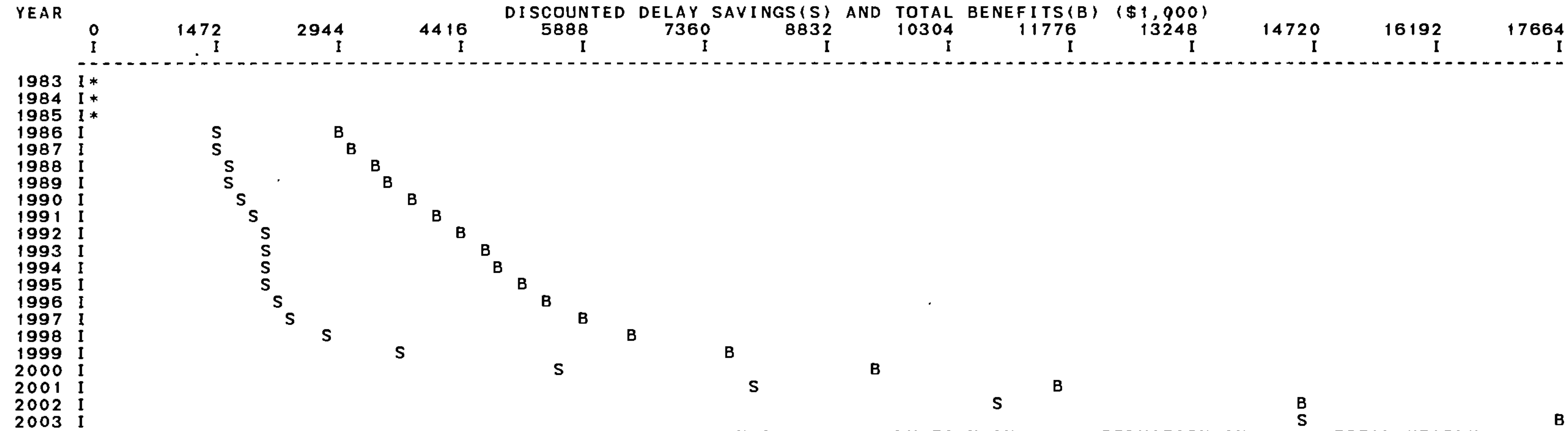
YEAR	EXISTING (E) VEHICLES	EXISTING (E) PERSONS	ALTERNATE (A) VEHICLES	ALTERNATE (A) PERSONS	PROPOSED (P) VEHICLES	PROPOSED (P) PERSONS	EXPANSION (X) VEHICLES	EXPANSION (X) PERSONS	DIVERTED (D) VEHICLES	DIVERTED (D) PERSONS	TOTAL (T) VEHICLES	TOTAL (T) PERSONS
1983	5793.	7340.	11707.	14832.	0.	0.	0.	0.	0.	0.	17500.	22173.
1984	5918.	7498.	11853.	15017.	0.	0.	0.	0.	0.	0.	17770.	22515.
1985	6288.	7966.	12375.	15679.	0.	0.	0.	0.	0.	0.	18662.	23645.
1986	0.	0.	1906.	2415.	18321.	23213.	0.	0.	0.	0.	20227.	25628.
1987	0.	0.	1922.	2435.	20573.	26066.	0.	0.	0.	0.	22495.	28501.
1988	0.	0.	1954.	2475.	23533.	29816.	0.	0.	0.	0.	25487.	32292.
1989	0.	0.	2012.	2549.	27208.	34473.	0.	0.	0.	0.	29220.	37022.
1990	0.	0.	2057.	2607.	31651.	40102.	0.	0.	0.	0.	33709.	42709.
1991	0.	0.	2150.	2724.	36815.	46645.	0.	0.	0.	0.	38965.	49369.
1992	0.	0.	2714.	3438.	42286.	53577.	0.	0.	0.	0.	45000.	57015.
1993	0.	0.	4896.	6204.	46926.	59456.	0.	0.	0.	0.	51823.	65659.
1994	0.	0.	7358.	9322.	52084.	65991.	0.	0.	0.	0.	59442.	75313.
1995	0.	0.	10057.	12743.	57809.	73243.	0.	0.	0.	0.	67866.	85986.
1996	0.	0.	13045.	16528.	64057.	81160.	0.	0.	0.	0.	77102.	97688.
1997	0.	0.	16267.	20611.	70889.	89816.	0.	0.	0.	0.	87156.	110427.
1998	0.	0.	19782.	25063.	78253.	99147.	0.	0.	0.	0.	98035.	124211.
1999	0.	0.	23565.	29856.	86180.	109190.	0.	0.	0.	0.	109745.	139047.
2000	0.	0.	27632.	35010.	94659.	119933.	0.	0.	0.	0.	122291.	154943.
2001	0.	0.	32346.	40983.	103333.	130923.	0.	0.	0.	0.	135679.	171906.
2002	0.	0.	37716.	47787.	112197.	142154.	0.	0.	0.	0.	149914.	189941.
2003	0.	0.	43556.	55186.	121443.	153869.	0.	0.	0.	0.	165000.	209055.

PROBLEM 4 SAMPLE PROBLEM 4

SEGMENT 2 DESCRIPTION - R2E - R6D ALT R4F

CURRENT YEAR 1983
CONSTRUCTION YEAR 1986

*** SEGMENT DISCOUNTED YEARLY BENEFITS ***



YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	170.2	1525.1	1725.4	-172.5	-15.7	3062.3
1987	189.6	1573.0	1801.2	-176.0	-14.6	3183.6
1988	214.8	1650.3	1920.2	-183.0	-13.5	3374.1
1989	245.6	1746.9	2073.6	-191.7	-12.5	3616.2
1990	282.0	1857.1	2257.3	-202.1	-11.6	3900.8
1991	323.4	1971.8	2464.8	-213.3	-10.7	4212.5
1992	365.7	2064.8	2671.2	-216.8	-9.9	4509.2
1993	399.8	2090.2	2823.2	-190.6	-9.2	4713.6
1994	439.2	2125.9	2999.5	-165.5	-8.5	4951.4
1995	484.9	2173.6	3203.3	-143.4	-7.9	5225.6
1996	537.2	2229.6	3427.3	-121.8	-7.3	5527.9
1997	617.6	2373.3	3662.1	-105.1	-6.7	5923.6
1998	787.0	2800.3	3881.5	-99.5	-6.2	6576.1
1999	1143.4	3766.9	3966.5	-92.1	-5.8	7635.6
2000	1865.9	5691.9	3841.0	-80.8	-5.4	9446.7
2001	2825.5	7980.7	3741.8	-69.4	-5.0	11648.2
2002	4194.4	10969.6	3760.3	-126.2	-4.6	14599.1
2003	6047.6	14644.7	3295.3	-272.5	-4.2	17663.3
TOTAL	21133.9	69235.7	53515.6	-2822.5	-159.1	119769.6

PROBLEM 4 SAMPLE PROBLEM 4

SEGMENT 2 DESCRIPTION - R2E - R6D ALT R4F

*** MOBILITY ***

	CORRIDOR				STATE FACILITY			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	58.4	131.9	58.4	131.9	55.5	34.8	55.5	34.8
1984	58.4	133.9	58.4	133.9	55.5	35.5	55.5	35.5
1985	58.4	140.4	58.4	140.4	55.4	37.7	55.4	37.7
1986	58.3	152.0	58.5	125.7	55.3	41.4	58.3	109.9
1987	58.1	168.7	58.3	139.4	55.0	46.9	58.1	123.4
1988	58.0	190.8	58.0	157.4	54.7	54.0	57.8	141.2
1989	57.8	218.4	57.7	179.9	54.3	62.9	57.4	163.2
1990	57.5	251.5	57.3	207.0	53.9	73.8	57.0	189.9
1991	57.3	290.3	56.8	238.7	53.4	86.4	56.5	220.9
1992	56.9	334.9	56.3	276.2	52.8	100.8	56.0	253.7
1993	56.6	385.2	56.1	322.2	52.1	117.1	55.6	281.6
1994	56.2	441.5	55.8	373.6	51.3	135.4	55.1	312.5
1995	55.8	503.7	55.5	430.3	50.5	155.4	54.6	346.9
1996	55.3	571.9	55.2	492.6	49.5	177.4	54.0	384.3
1997	54.6	646.4	54.8	560.3	47.9	200.8	53.3	425.3
1998	53.4	728.0	54.3	633.7	44.5	223.5	52.6	469.5
1999	50.8	815.6	53.8	712.7	40.7	248.6	51.9	517.1
2000	46.3	909.0	53.3	797.3	36.5	276.7	51.1	568.0
2001	41.6	1008.9	51.8	888.5	32.1	305.8	48.9	620.0
2002	36.1	1124.1	49.9	986.2	31.0	313.5	45.9	673.2
2003	31.0	1226.5	47.9	1090.2	31.0	313.5	42.9	728.7

SEGMENT TOTALS

PRESENT VALUE OF BENEFITS ($000) = 119769.6
PRESENT VALUE OF CONSTRUCTION COST ($000) = 8573.4
NET PRESENT VALUE ($000) = 111196.1
BENEFIT/COST RATIO = 13.97
INTERNAL RATE OF RETURN (%) = 77.72

```
PROBLEM    4                                         SAMPLE PROBLEM 4

SEGMENT    3          DESCRIPTION - FREEWAY - U4F TO U6F

       TRAFFIC DATA - CURRENT YEAR     1983   VOLUME (1,000)      50.00
                      PROJECTED YEAR1 1992   VOLUME (1,000)      78.00
                      PROJECTED YEAR2 2003   VOLUME (1,000)     110.00

       SEGMENT RUN TYPE - REGULAR RUN

       EXISTING  HIGHWAY DATA - HIGHWAY TYPE    U4F
                                LENGTH     1.60 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     90.00     95.00
                                PERCENT TRUCKS(BUSES)      11.00
                                CAR(VAN) OCCUPANCY RATE     1.30
                                TRUCK(BUS) OCCUPANCY RATE   1.00

       PROPOSED  HIGHWAY DATA - HIGHWAY TYPE    U6F
                                LENGTH     1.60 MILES
                                SAFETY/TECHNICAL FACTORS (BASE=100)     90.00     95.00
                                CONSTRUCTION YEAR   1986
                                CONSTRUCTION COST (MILLIONS)  $  7.00
                                BUILDOVER OF EXISTING ROUTE
                                PERCENT TRUCKS(BUSES)      11.00
                                CAR(VAN) OCCUPANCY RATE     1.30
                                TRUCK(BUS) OCCUPANCY RATE   1.00
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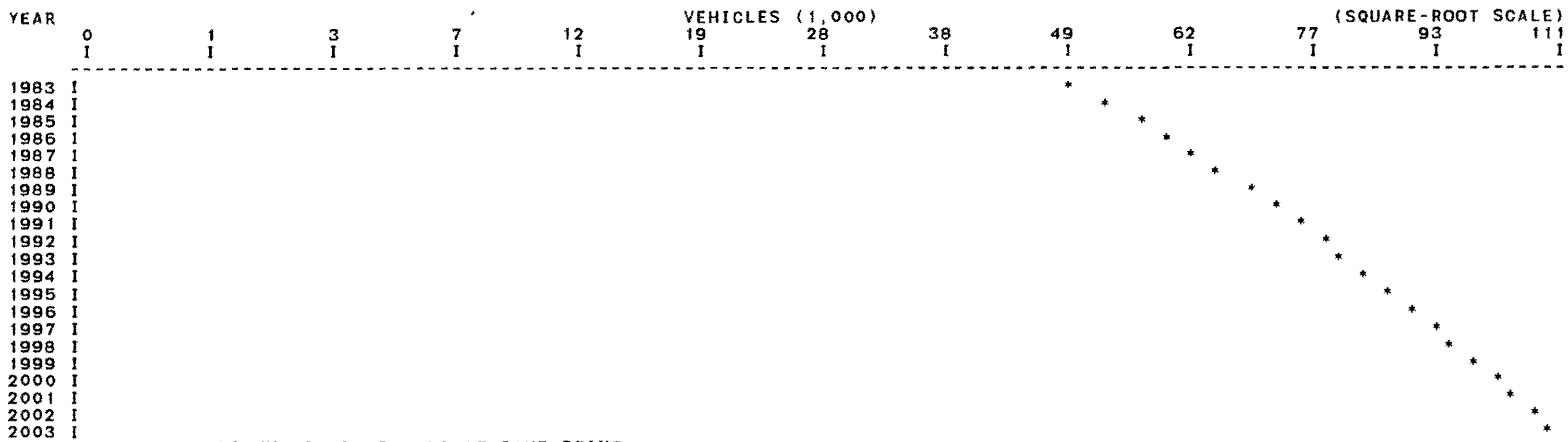
PROBLEM 4 SAMPLE PROBLEM 4

SEGMENT 3 DESCRIPTION - FREEWAY - U4F TO U6F

*** DO-NOTHING CORRIDOR TRAFFIC ALLOCATION ***



* INDICATES MULTIPLE LETTERS AT SAME POINT

YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	50000.	63350.	0.	0.	0.	0.	0.	0.	0.	0.	50000.	63350.
1984	53439.	67707.	0.	0.	0.	0.	0.	0.	0.	0.	53439.	67707.
1985	56663.	71793.	0.	0.	0.	0.	0.	0.	0.	0.	56663.	71793.
1986	59812.	75782.	0.	0.	0.	0.	0.	0.	0.	0.	59812.	75782.
1987	62913.	79710.	0.	0.	0.	0.	0.	0.	0.	0.	62913.	79710.
1988	65978.	83594.	0.	0.	0.	0.	0.	0.	0.	0.	65978.	83594.
1989	69015.	87441.	0.	0.	0.	0.	0.	0.	0.	0.	69015.	87441.
1990	72029.	91260.	0.	0.	0.	0.	0.	0.	0.	0.	72029.	91260.
1991	75023.	95054.	0.	0.	0.	0.	0.	0.	0.	0.	75023.	95054.
1992	78000.	98826.	0.	0.	0.	0.	0.	0.	0.	0.	78000.	98826.
1993	80962.	102579.	0.	0.	0.	0.	0.	0.	0.	0.	80962.	102579.
1994	83911.	106315.	0.	0.	0.	0.	0.	0.	0.	0.	83911.	106315.
1995	86847.	110036.	0.	0.	0.	0.	0.	0.	0.	0.	86847.	110036.
1996	89773.	113742.	0.	0.	0.	0.	0.	0.	0.	0.	89773.	113742.
1997	92688.	117435.	0.	0.	0.	0.	0.	0.	0.	0.	92688.	117435.
1998	95593.	121117.	0.	0.	0.	0.	0.	0.	0.	0.	95593.	121117.
1999	98490.	124787.	0.	0.	0.	0.	0.	0.	0.	0.	98490.	124787.
2000	101379.	128447.	0.	0.	0.	0.	0.	0.	0.	0.	101379.	128447.
2001	104260.	132097.	0.	0.	0.	0.	0.	0.	0.	0.	104260.	132097.
2002	107133.	135738.	0.	0.	0.	0.	0.	0.	0.	0.	107133.	135738.
2003	110000.	139370.	0.	0.	0.	0.	0.	0.	0.	0.	110000.	139370.

PROBLEM 4 SAMPLE PROBLEM 4

SEGMENT 3 DESCRIPTION - FREEWAY - U4F TO U6F

*** IF-CONSTRUCT CORRIDOR TRAFFIC ALLOCATION ***

```
YEAR                                                  VEHICLES (1,000)                                     (SQUARE-ROOT SCALE)
      0         1         3         7        12        19        28        38        49        62        77        93       111
      I         I         I         I         I         I         I         I         I         I         I         I         I
     -------------------------------------------------------------------------------------------------------------------------------
1983 I                                                                                *
1984 I                                                                                   *
1985 I                                                                                      *
1986 I                                                                                        *
1987 I                                                                                          *
1988 I                                                                                            *
1989 I                                                                                               *
1990 I                                                                                                 *
1991 I                                                                                                   *
1992 I                                                                                                     *
1993 I                                                                                                      *
1994 I                                                                                                        *
1995 I                                                                                                          *
1996 I                                                                                                            *
1997 I                                                                                                              *
1998 I                                                                                                               *
1999 I                                                                                                                 *
2000 I                                                                                                                   *
2001 I                                                                                                                    *
2002 I                                                                                                                      *
2003 I                                                                                                                       *
        * INDICATES MULTIPLE LETTERS AT SAME POINT
```

YEAR	EXISTING (E)		ALTERNATE (A)		PROPOSED (P)		EXPANSION (X)		DIVERTED (D)		TOTAL (T)	
	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS	VEHICLES	PERSONS
1983	50000.	63350.	0.	0.	0.	0.	0.	0.	0.	0.	50000.	63350.
1984	53439.	67707.	0.	0.	0.	0.	0.	0.	0.	0.	53439.	67707.
1985	56663.	71793.	0.	0.	0.	0.	0.	0.	0.	0.	56663.	71793.
1986	0.	0.	0.	0.	59812.	75782.	0.	0.	0.	0.	59812.	75782.
1987	0.	0.	0.	0.	62913.	79710.	0.	0.	0.	0.	62913.	79710.
1988	0.	0.	0.	0.	65978.	83594.	0.	0.	0.	0.	65978.	83594.
1989	0.	0.	0.	0.	69015.	87441.	0.	0.	0.	0.	69015.	87441.
1990	0.	0.	0.	0.	72029.	91260.	0.	0.	0.	0.	72029.	91260.
1991	0.	0.	0.	0.	75023.	95054.	0.	0.	0.	0.	75023.	95054.
1992	0.	0.	0.	0.	78000.	98826.	0.	0.	0.	0.	78000.	98826.
1993	0.	0.	0.	0.	80962.	102579.	0.	0.	0.	0.	80962.	102579.
1994	0.	0.	0.	0.	83911.	106315.	0.	0.	0.	0.	83911.	106315.
1995	0.	0.	0.	0.	86847.	110036.	0.	0.	0.	0.	86847.	110036.
1996	0.	0.	0.	0.	89773.	113742.	0.	0.	0.	0.	89773.	113742.
1997	0.	0.	0.	0.	92688.	117435.	0.	0.	0.	0.	92688.	117435.
1998	0.	0.	0.	0.	95593.	121117.	0.	0.	0.	0.	95593.	121117.
1999	0.	0.	0.	0.	98490.	124787.	0.	0.	0.	0.	98490.	124787.
2000	0.	0.	0.	0.	101379.	128447.	0.	0.	0.	0.	101379.	128447.
2001	0.	0.	0.	0.	104260.	132097.	0.	0.	0.	0.	104260.	132097.
2002	0.	0.	0.	0.	107133.	135738.	0.	0.	0.	0.	107133.	135738.
2003	0.	0.	0.	0.	110000.	139370.	0.	0.	0.	0.	110000.	139370.

PROBLEM 4 SAMPLE PROBLEM 4

SEGMENT 3 DESCRIPTION - FREEWAY - U4F TO U6F

CURRENT YEAR 1983
CONSTRUCTION YEAR 1986

*** SEGMENT DISCOUNTED YEARLY BENEFITS ***

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YEAR                                    DISCOUNTED DELAY SAVINGS(S) AND TOTAL BENEFITS(B) ($1,000)
      0       115       230       345       460       575       689       804       919      1034      1149      1264      1379
      I         I         I         I         I         I         I         I         I         I         I         I         I
     ------------------------------------------------------------------------------------------------------------------------------
1983 I*
1984 I*
1985 I*
1986 I      S                                         B
1987 I       S                                         B
1988 I       S                                         B
1989 I       S                                          B
1990 I       S                                          B
1991 I       S                                          B
1992 I                 S                                       B
1993 I                           S                                    B
1994 I                                    S                                 B
1995 I                                             S                               B
1996 I                                                      S                            B
1997 I                                                              S                          B
1998 I                                                                       S                      B
1999 I                                                                              S                     B
2000 I                                                                                      S                  B
2001 I                                                                                             S                B
2002 I                                                                                                    S              B
2003 I                                                                                                           S            B
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YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	8.8	78.5	429.9	53.7	-10.4	551.7
1987	9.7	80.7	439.5	52.3	-9.6	562.9
1988	10.7	82.4	446.8	50.8	-8.9	571.2
1989	11.8	83.8	452.0	49.2	-8.3	576.8
1990	12.9	84.8	455.2	47.6	-7.7	579.9
1991	14.2	86.4	456.3	45.9	-7.1	581.5
1992	35.6	201.0	421.5	44.2	-6.6	660.2
1993	59.7	312.2	388.2	42.4	-6.1	736.8
1994	86.7	419.7	356.2	40.7	-5.6	811.1
1995	116.8	523.5	325.7	39.0	-5.2	883.1
1996	150.3	623.6	296.6	37.4	-4.8	952.7
1997	187.3	719.9	268.9	35.7	-4.5	1020.0
1998	228.4	812.6	242.4	34.1	-4.1	1085.0
1999	273.7	901.7	217.2	32.5	-3.8	1147.7
2000	323.7	987.6	193.2	31.0	-3.5	1208.3
2001	378.9	1070.3	170.3	29.5	-3.3	1266.8
2002	439.7	1150.0	148.5	28.1	-3.0	1323.6
2003	506.8	1227.2	127.7	26.7	-2.8	1378.7
TOTAL	2855.7	9445.9	5836.3	721.1	-105.4	15897.9

PROBLEM 4 SAMPLE PROBLEM 4

SEGMENT 3 DESCRIPTION - FREEWAY - U4F TO U6F

*** MOBILITY ***

	CORRIDOR				STATE FACILITY			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	55.1	80.0	55.1	80.0	55.1	80.0	55.1	80.0
1984	55.0	85.5	55.0	85.5	55.0	85.5	55.0	85.5
1985	54.9	90.7	54.9	90.7	54.9	90.7	54.9	90.7
1986	54.7	95.7	55.5	95.7	54.7	95.7	55.5	95.7
1987	54.6	100.7	55.4	100.7	54.6	100.7	55.4	100.7
1988	54.5	105.6	55.3	105.6	54.5	105.6	55.3	105.6
1989	54.4	110.4	55.3	110.4	54.4	110.4	55.3	110.4
1990	54.3	115.2	55.2	115.2	54.3	115.2	55.2	115.2
1991	54.2	120.0	55.1	120.0	54.2	120.0	55.1	120.0
1992	52.8	124.8	55.0	124.8	52.8	124.8	55.0	124.8
1993	51.4	129.5	55.0	129.5	51.4	129.5	55.0	129.5
1994	50.1	134.3	54.9	134.3	50.1	134.3	54.9	134.3
1995	48.7	139.0	54.8	139.0	48.7	139.0	54.8	139.0
1996	47.4	143.6	54.7	143.6	47.4	143.6	54.7	143.6
1997	46.1	148.3	54.7	148.3	46.1	148.3	54.7	148.3
1998	44.7	152.9	54.6	152.9	44.7	152.9	54.6	152.9
1999	43.4	157.6	54.5	157.6	43.4	157.6	54.5	157.6
2000	42.1	162.2	54.4	162.2	42.1	162.2	54.4	162.2
2001	40.8	166.8	54.4	166.8	40.8	166.8	54.4	166.8
2002	39.4	171.4	54.3	171.4	39.4	171.4	54.3	171.4
2003	38.1	176.0	54.2	176.0	38.1	176.0	54.2	176.0

SEGMENT TOTALS

PRESENT VALUE OF BENEFITS ($000) = 15897.9
PRESENT VALUE OF CONSTRUCTION COST ($000) = 5556.8
NET PRESENT VALUE ($000) = 10341.1
BENEFIT/COST RATIO = 2.86
INTERNAL RATE OF RETURN (%) = 22.21

PROBLEM 4 SAMPLE PROBLEM 4

**** PROBLEM DISCOUNTED YEARLY BENEFITS ****

YEAR	HOURS OF DELAY SAVING PER YEAR (1000)	DELAY SAVINGS (S) IN DOLLARS ($1000)	REDUCTION IN OPERATING COSTS ($1000)	REDUCTION IN ACCIDENT COSTS ($1000)	REDUCTION IN MAINTENANCE COSTS ($1000)	TOTAL YEARLY BENEFITS (B) ($1000)
1983	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0
1986	277.7	2487.9	3299.7	444.3	-55.0	6176.9
1987	328.2	2722.9	3445.5	434.4	-51.0	6551.8
1988	395.9	3041.0	3651.2	425.1	-47.2	7070.2
1989	517.8	3683.2	3866.9	416.4	-43.7	7922.8
1990	694.0	4570.2	4100.9	407.6	-40.4	9038.4
1991	865.1	5275.0	4200.0	288.7	-37.5	9726.2
1992	757.7	4277.9	3595.1	-313.0	-34.7	7525.3
1993	628.5	3285.7	2988.2	-840.5	-32.1	5401.4
1994	490.9	2376.5	2459.3	-1323.4	-29.7	3482.7
1995	346.1	1551.3	2011.5	-1763.8	-27.5	1771.5
1996	193.9	804.6	1636.9	-2159.6	-25.5	256.4
1997	55.6	213.6	1324.9	-2516.7	-23.6	-1001.8
1998	-8.1	-28.8	1047.7	-2842.8	-21.9	-1845.7
1999	100.3	330.5	684.5	-3126.8	-20.2	-2132.0
2000	559.7	1707.3	157.0	-3368.9	-18.7	-1523.3
2001	1240.4	3503.4	-300.1	-3574.8	-17.3	-388.9
2002	2314.0	6051.9	-597.9	-3815.4	-16.1	1622.6
2003	3855.1	9335.5	-1339.6	-4114.1	-14.9	3866.9
TOTAL	13612.7	55189.7	36231.8	-27343.2	-557.0	63521.3

*** MOBILITY ***

	---------- CORRIDOR ----------				------- STATE FACILITY -------			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	50.9	330.9	50.9	330.9	47.4	233.8	47.4	233.8
1984	50.9	340.8	50.9	340.8	47.4	242.4	47.4	242.4
1985	50.7	357.8	50.7	357.8	47.2	255.0	47.2	255.0
1986	50.5	381.9	51.4	355.6	46.8	271.3	51.0	339.8
1987	50.2	413.0	51.3	383.7	46.4	291.1	50.9	367.7
1988	49.9	451.3	51.2	417.9	45.9	314.4	50.9	401.6
1989	49.4	496.6	51.1	458.1	44.9	341.1	50.8	441.5
1990	48.7	549.0	50.9	504.5	43.8	371.3	50.6	487.4
1991	48.2	605.6	50.7	557.0	42.8	401.8	50.4	539.1
1992	48.4	655.0	50.5	616.6	42.7	420.9	50.2	594.1
1993	48.6	710.1	50.5	686.1	42.6	442.0	49.9	645.5
1994	48.8	771.0	50.3	762.3	42.4	465.0	49.5	701.2
1995	48.8	838.0	50.2	845.1	42.2	489.6	49.2	761.7
1996	48.9	910.9	50.0	934.8	41.9	516.4	48.8	826.5
1997	48.7	990.0	49.7	1031.0	41.4	544.4	48.3	896.0
1998	48.1	1076.3	49.5	1134.1	40.0	571.8	47.8	969.9
1999	46.5	1168.5	49.1	1244.0	38.3	601.5	47.3	1048.4
2000	43.4	1266.5	48.8	1360.6	36.3	634.2	46.7	1131.3
2001	40.0	1371.0	47.8	1484.9	34.0	667.9	45.4	1216.5
2002	35.9	1490.8	46.6	1616.9	33.1	680.2	43.7	1303.9
2003	31.8	1597.8	45.2	1756.2	32.8	684.8	41.9	1394.7

PROBLEM TOTALS

PRESENT VALUE OF BENEFITS ($000) =	63521.3
PRESENT VALUE OF CONSTRUCTION COST ($000) =	20877.8
NET PRESENT VALUE ($000) =	42643.5
BENEFIT/COST RATIO =	3.04

PROBLEM(S) PROCESSED THIS RUN -- 4

SAMPLE PROBLEM 1 SAMPLE PROBLEM 2 SAMPLE PROBLEM 3 SAMPLE PROBLEM 4

*** SYSTEM CONSTRUCTION COST (MILLIONS) = 253.45 ***

*** SYSTEM MOBILITY ***

	CORRIDORS				STATE FACILITIES			
	DO-NOTHING		IF CONSTRUCT		DO-NOTHING		IF CONSTRUCT	
YEAR	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)	MPH	DVM(000)
1983	48.1	1808.4	48.1	1808.4	46.7	1585.7	46.7	1585.7
1984	46.4	1959.1	46.4	1959.1	44.8	1716.4	44.8	1716.4
1985	45.1	2070.4	45.1	2070.4	43.3	1808.8	43.3	1808.8
1986	44.0	2182.1	49.8	2073.9	42.4	1875.4	47.8	1338.3
1987	43.1	2297.9	49.1	2177.0	41.6	1943.9	47.5	1394.1
1988	42.2	2419.4	48.5	2284.0	40.8	2014.5	47.2	1453.3
1989	41.4	2547.7	48.0	2395.9	39.9	2088.6	46.9	1516.4
1990	40.6	2683.5	47.6	2513.3	39.0	2166.2	46.7	1584.3
1991	40.4	2801.2	47.1	2635.8	38.7	2222.5	46.5	1654.5
1992	40.3	2911.4	48.4	2764.4	38.6	2267.9	47.8	1593.9
1993	40.2	3027.7	48.1	2903.3	38.4	2315.8	47.5	1661.9
1994	40.2	3150.2	47.7	3049.2	38.3	2366.4	47.2	1733.6
1995	40.1	3279.4	47.4	3202.4	38.2	2418.1	46.9	1809.7
1996	40.1	3415.5	47.1	3362.9	38.1	2471.6	46.6	1889.3
1997	40.0	3558.6	46.8	3530.8	37.9	2526.9	46.3	1973.2
1998	39.7	3710.7	46.5	3706.9	37.4	2580.1	45.9	2060.2
1999	39.0	3869.4	46.2	3891.0	36.8	2636.7	45.7	2149.6
2000	37.7	4034.6	45.9	4082.9	36.0	2697.3	45.3	2243.4
2001	36.2	4206.0	45.4	4283.3	35.1	2760.1	44.6	2339.1
2002	34.5	4389.4	44.7	4492.0	34.5	2796.3	43.7	2436.8
2003	32.8	4561.1	44.0	4709.1	34.4	2805.5	42.6	2537.8

SYSTEM TOTALS

DELAY SAVING ($000) =	532949.3
REDUCTION IN OPERATING COSTS ($000) =	-16137.7
REDUCTION IN ACCIDENT COSTS ($000) =	34425.5
REDUCTION IN MAINTENANCE COSTS ($000) =	215.7
PRESENT VALUE OF BENEFITS ($000) =	551452.8
PRESENT VALUE OF CONSTRUCTION COST ($000) =	199141.6
NET PRESENT VALUE ($000) =	352311.2
BENEFIT/COST RATIO =	2.77