Models and Estimates of Los Angeles DPM Demand

LOS ANGELES DOWNTOWN PEOPLE MOVER

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Los Angeles Community Redevelopment Agency
727 West Seventh Street
Los Angeles, California 90017

Prepared by

CAMBRIDGE SYSTEMATICS, INC.
238 Main Street
Cambridge, Massachusetts 02142

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I. Introduction

A. The Role of Travel Demand Models in DPM Planning

The purpose of the Los Angeles Circulation/Distribution System Program is "to provide decision-makers with necessary information to make near-term investment decisions regarding public transportation improvements in downtown Los Angeles" (CRA, Moving People in Los Angeles, 1977, p. ii). Patronage has been and will continue to be an important criterion in the decision-making process. A few of the most important questions that have been asked by the Los Angeles City Council, UMTA, and other groups include:

- How will alternative route and station locations affect DPM patronage?
- Will alternative regional transit systems, including the proposed Starter Line and Freeway Transit Programs, have a significant impact on the demand for the DPM?
- How will different fare policies affect DPM ridership?

A travel demand model is particularly useful in seeking answers to questions of this type. Based on observations of actual travel behavior, these models provide a method of predicting changes in travel patterns in different situations. The following types of behavior are most frequently of interest to the transportation planner:

- Trip Frequency - How often will the traveller make a trip?
- Destination Choice - Where will the traveller go?
- Mode Choice - How will the traveller go to her/his destination? (Typical modes are bus, auto, and walk.)

Transportation planners are interested in these types of behavior for a wide variety of reasons. For DPM planning, these reasons are especially varied:

- Predicted total daily DPM patronage is important in estimating the revenues of a proposed DPM system, and in evaluating its importance as indicated by the number of people it serves.

- The predicted number of DPM users on the section of guideway having the maximum flow in the peak hour must be used to determine the system's headway, passenger capacity per vehicle or train, and number of vehicles required.

- The predicted number of DPM users of each station in the peak hour is used to determine if individual stations are warranted; and if so, what their passenger and vehicle capacities should be. These capacities will depend on platform lengths and areas, on number and lengths of stairs and escalators, and on the number and location of fare collection equipment.

- The predicted number of DPM users boarding and deboarding at each station in the peak hour determines system dwell time requirements in the stations, and therefore both station-to-station and terminal-to-terminal travel times. These predictions also indicate increases in pedestrian volumes in the vicinity of the stations.

- Predicted diversions from walk trips indicate reductions in pedestrian travel, and possibly in sidewalk congestion.

- Predicted diversions from on-street vehicular trips indicate reductions in CBD street congestion, travel time and noise; in air pollution; and in gasoline consumption.

- Increases in intra-CBD mobility for areas near DPM stations are important indicators of the ability to induce new downtown development and of the increased attractiveness of existing activities.

- Predictions of the number of DPM users who choose parking facilities integrated into DPM stations help to evaluate the revenues of these facilities, and their ability to relieve the pressure of demands greater than capacity at more centrally-located parking facilities.

Not only are there many reasons for finding travel demand models useful in DPM planning, but also the predictions of these models must be combined in a wide variety of ways to provide each of the required indicators: daily trips, peak hour trips, maximum link volumes, etc. This wide range of "outputs" is only possible under the following circumstances:

- The underlying models must deal in small elements: the trips by type of traveller, by time of day, by origin, by destination, and by mode.
- Procedures must then be available to aggregate these small elements in various ways, to obtain the desired outputs.

This report describes a set of travel demand models which have these characteristics. These models represent the travel behavior of those who make trips in downtown areas, and can be used to predict the responses of these travellers to various characteristics of proposed DPM systems. Although these models existed before the current preliminary engineering phase of the Los Angeles DPM planning project began, they were adjusted and improved during this phase. This adjustment process is also described in this report. Finally, the model predictions, for various DPM system alternatives, are summarized. A companion report, DPM Travel Prediction System: Users' Manual, describes the computerized procedures used to apply the models and to obtain the desired outputs based on their predictions.

The remainder of this section summarizes the major findings and conclusions of the report.

B. Report Summary

1. The Refined DPM Travel Models

In Section II.B, four travel models are presented, after their development process is briefly described. These models represent travel by four groups of CBD travellers:

- Regional transit users, who must use a CBD access mode to travel between their regional transit stop or station and their CBD destination. Although this access mode is most often walking, it can also be transferring to another regional transit vehicle, riding on a CBD circulator bus (minibus), or riding on the DPM system.

- Regional auto users, who park in or near the CBD and then use one of the same access modes that transit users do to reach their CBD destination. In addition to choosing an access mode, these travellers must also choose a parking location.

- CBD workers, who must decide, first of all, whether or not to make a midday intra-CBD trip. If they do make a trip, they must also choose a destination and mode of travel.

- Non-CBD workers (shoppers, visitors, those on personal business), who must make the same decisions that the CBD workers must make.

The intra-CBD travel by each of these groups (or "market segments") is likely to be quite different - in time of day, in trip length, in origin and destination. Trips by the first two groups can be classed as "distribution" travel - the CBD access portion of a regional trip - most frequently made in the 7-10 AM or 4-6 PM period. Trips by the last two groups can be classed as "circulation," or entirely intra-CBD, travel. The peak period for these trips is typically in the 12-1 noon hour.

2. The Model Refinement Process

Following presentation of the refined models themselves, the process used to refine them is described, in Section II.C. These refinements were carried out to eliminate the following deficiencies of the original models:

- As estimated, the models did not explicitly include a DPM mode, because none was available in the Los Angeles CBD when travel data was collected. This mode was added to each of the models by assuming that the travellers would consider the DPM system to be most like an on-street circulator transit service, but with differences like those which have been observed in other areas between buses and new fixed guideway transit systems such as subways.

- The original models of circulation travel predicted trips by walk and regional bus which, on average, were too long. This was corrected by adding an additional distance-related variable to these models.

- The sensitivity of the original parking facility choice model to changes in the times and costs of travelling to various destinations was unrealistically high. This was corrected by changing the relative weights assigned to times, costs, and distances.

- The original models were based on awkward definitions of the worker and non-worker groups, which led to logical inconsistencies in their predictions. These definitions were changed to those given above, and the models were restructured to be consistent with the changed definitions.

- Following all of the changes previously described, a final set of adjustments were required to ensure that each new model would predict the observed mode shares. Modal constants were changed to accomplish this.

3. Patronage Analysis Results

The final major section (III) discusses the use of the travel models to estimate DPM patronage for a number of alternatives. Because some results were needed prior to the completion of the model adjustment process, the original models were first used to test seven DPM alignment alternatives, providing input to the process which ultimately led to the selection of the alignment designated AFCE (see Figure 3) as the final one. This exercise of the original models also helped to point out the needs for model adjustments.

Following the completion of the model adjustment process, and the updating of the forecasts of all required model inputs, the refined models were used to obtain patronage results for a base case involving DPM alignment AFCE and the TSM regional transit system. Daily ridership for the base case is estimated to be 72,400 trips. Results by market segment for their respective peak hours are summarized in Table 13 in Section III, which is repeated on the next page.

Finally, two sets of sensitivity analysis runs were made. In the first set, variations in the regional transit system were compared with the TSM base case. These variations were the following:

- Freeway transit, involving the addition of regional express buses on freeways serving the CBD.
- Starter rail line, in the Wilshire Boulevard corridor, replacing a number of CBD buses and providing an alternate to the DPM system for some intra-CBD travel.

The changes in DPM patronage for these two alternatives were predicted to be very small, with most of the differences traceable to differences in the distribution and number of regional trips, due to the changed regional transit systems. These results did indicate that the DPM system would be compatible with any of the regional transit alternatives now being considered in Los Angeles.

(TABLE 13)

Base Case Results:

Passengers and Mode Shares by Market Segment and Mode

	Mode					
Market Segment	Walk	Circulator	Regional Bus	DPM	Auto	Total
Distribution Trips (PM Peak Hour)						
Regional Transit	47,023 82.1%	1985 3.5%	3194 5.6%	5062 8.8%	-	57,264
Regional Auto	62,145 95.5%	164 0.3%	341 0.5%	2382 3.7%	-	65,032
Total	109,168 89.3%	2149 1.8%	3535 2.9%	7444 6.1%	-	122,296
Circulation Trips (Noon Hour)						
Workers	21,084 49.1%	1360 3.2%	686 1.6%	2312 5.4%	17,456 40.7%	42,898
Non-Workers	13,059 64.4%	114 0.6%	251 1.2%	260 1.3%	6582 32.5%	20,266
Total	34,143 54.1%	1474 2.3%	937 1.5%	2572 4.1%	24,038 38.1%	63,164

In the second set of sensitivity analysis runs, the DPM fare was varied from 15 cents (in 1978 dollars) to 25 cents. The resulting predicted change in DPM patronage was quite small; DPM mode share for distribution travel changed from 6.1 to 5.9 percent, and for circulation travel the change was from 4.1 to 3.9 percent. The implied elasticities of DPM demand with respect to DPM fare varied by model, with that for total daily travel being -0.071.

II. The Los Angeles CBD Travel Models

A. Introduction

This section of the report presents the CBD travel models which have been used to forecast DPM patronage in the preliminary engineering phase of the Los Angeles DPM demonstration program. These models represent refinements of models first developed in the alternatives analysis phase of this program. Complete information on the survey data used in model development is provided in the report "Los Angeles Central Business District Internal Travel Survey", prepared for the Los Angeles Bunker Hill and CBD/CDS Project, prepared by Barton-Aschman Associates, Inc., October, 1975. The model development effort, and the use of the models in alternatives analysis, is described in the report "Internal CBD Travel Demand Modelling," Task 45 Termination Report, prepared for the Los Angeles Bunker Hill and CBD/CDS Project, prepared by Barton-Aschman Associates, Inc., in association with Cambridge Systematics, Inc., August, 1976.

Section B, below, summarizes the modelling background discussed in detail in the previous reports referenced above, and then presents the refined models and discusses the kinds of policies which can be tested using the models. Next, the model refinement process is discussed in Section C, and important characteristics of the models, such as their implied values of time and predicted average trip lengths by mode, are presented. These characteristics are measures of the success of the model refinement process.

B. Presentation of the Refined Models

1. Modelling Background

a. Travel Behavior Data

The DPM travel demand models were originally developed to represent observed travel decisions made in the Los Angeles downtown area in 1975. At that time the local transit agency, the Southern California Rapid Transit District, was operating shuttle bus service (named the Minibus) with 20-passenger vehicles functioning to provide circulation and distribution service in the downtown area. A single route, shown in Figure 1, was operated. It criss-crossed the downtown area, providing service within approximately three blocks of the entire area. The fare was ten cents per trip.

At the time of the travel survey, the alternatives to Minibus service for travel in the downtown area were the following:

- walking
- using the downtown portion of any of the many regional bus routes serving the area
- travelling by private auto or taxi

Travel behavior data was collected by means of two mail-back surveys: one of pedestrians leaving any of 15 downtown buildings and one of auto drivers using any of five parking facilities. The survey locations were chosen to represent varying types of downtown buildings (office buildings, retail stores, restaurants, etc.), and a range of parking facility types (public and private garages and lots) and of daily parking costs. A total of 1,629 forms from the downtown building surveys were coded and available for editing and potential use in model development; the survey at parking facilities resulted in 325 coded forms.

In the downtown building survey, the following information was requested:

- the destination, if the trip was within the downtown area
- the point of transfer to regional bus or private auto if the final destination was outside the downtown area

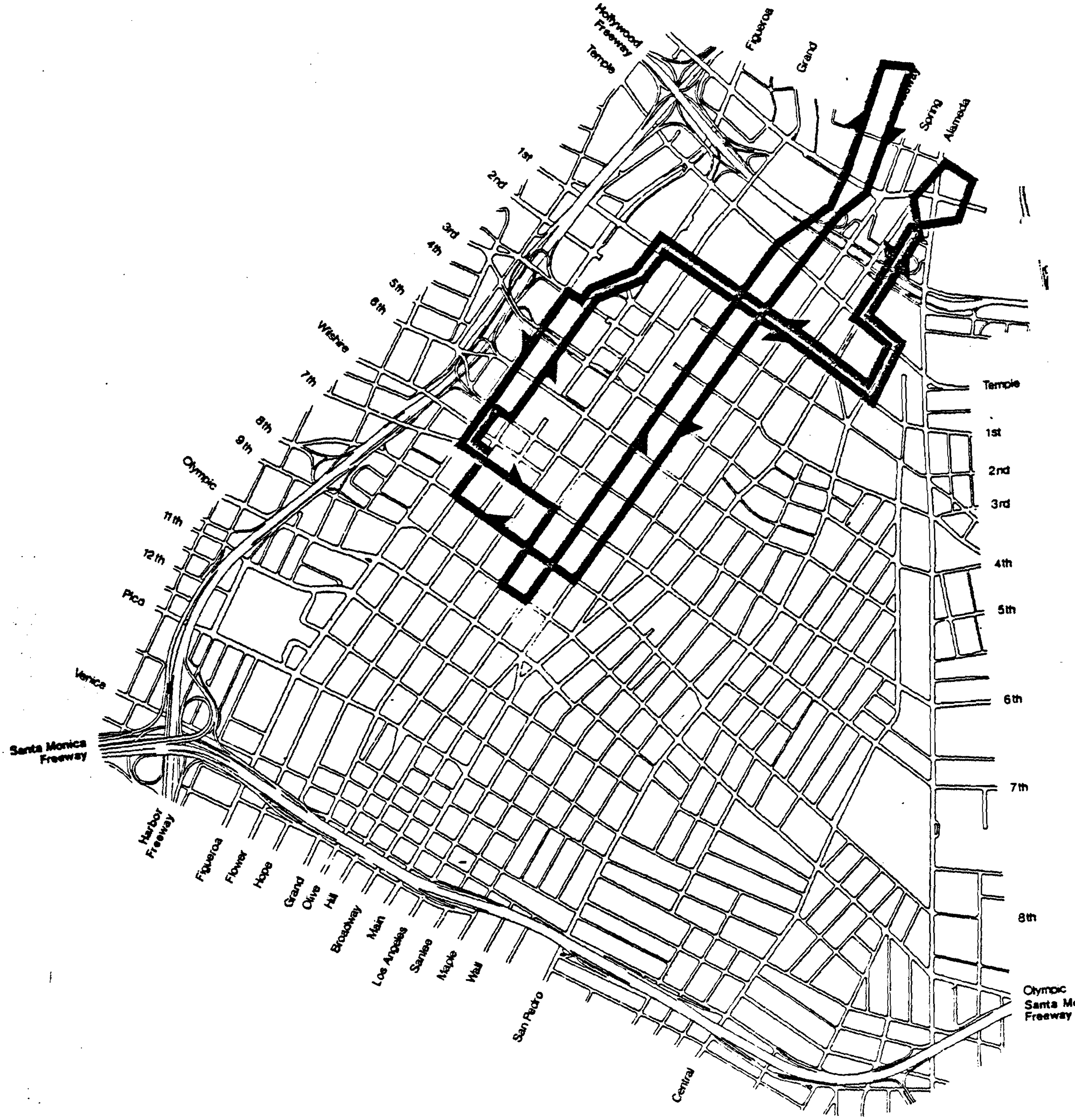

FIGURE 1

1975 Los Angeles Minibus Route

- trip purpose (shopping, work, etc.)
- travel modes within the downtown area
- whether or not the traveller would return to the survey location (the trip origin)
- total number of stops planned on the downtown portion of the entire tour of which the surveyed trip is a part
- whether or not the traveller worked in the survey location building

In the parking facility survey, auto drivers were asked the following questions as they left their parked vehicle:

- corridor of approach to the downtown area
- the final trip destination in the downtown area
- trip purpose
- travel mode for the remainder of the trip
- number of passengers in the driver's vehicle

The results of these surveys were used as the observations of travel behavior for which travel demand models were statistically estimated.

b. Segmentation of Potential DPM Travellers

Downtown travel is composed of many types of trips, each having differing characteristics which uniquely affect the likelihood of using a downtown transportation system such as DPM. An initial segmentation can be made based on the location of the ends of trips which pass through downtown areas. These trips fall into three primary groups:

- Internal-internal - trips which both begin and end within the downtown; for example, a noon hour trip from office to restaurant.
- Internal-external - trips which have one end in the downtown, either an origin or destination. For internal trip forecasting purposes, only the secondary portion of the trip is important, that is, that portion of trip between a transit stop or parking facility and the downtown destination.
- External-external - trips which have neither end within the downtown area, yet travel through using its street system. While these trips certainly impact the transportation system in downtown, they are not candidates for any internal modes of travel.

As a result, the candidate internal trips comprise two primary types: internal-internal or circulation trips, and the secondary portion of internal-external or distribution trips. These two types of trips are characterized by marked differences in terms of peaking, activity linkages, consistency, and purpose. These differences are described in detail in the reports listed in Section A, above.

For modelling purposes, the travellers who make each of these two primary types of downtown trips can be subdivided into two market segments, reflecting groups of tripmakers which face unique travel choices. Distribution tripmakers are divided into two groups based on the major vehicular mode - auto or transit - used for the regional portion of the trip:

- Regional transit users are primarily downtown workers who most often enter and leave the downtown area during the regional AM and PM peak periods. In the morning these travellers must choose both a transit stop at which to leave the transit vehicle which takes them to the downtown area, and a mode of travel (walk, circulator system[1] or a portion of another regional transit route) from transit stop to final destination. In the evening, the same basic choices must be made in getting from their downtown location to the transit vehicle which will take them home.

- Regional auto users (drivers and passengers) who also most commonly travel in the regional peaks. These travellers must choose both a parking facility in or near the downtown area and a mode of travel between the parking facility and their final downtown destination.

Circulation tripmakers are also divided into two groups, based on whether their major purpose for being downtown is work or non-work (shopping, personal business, etc.). This division was made mainly because of the difference in readily available knowledge on how many individuals are downtown for each of these purposes. Downtown employment at any given time can be relatively easily estimated and predicted by subareas as small as blocks or buildings. The number of downtown visitors and the average number of stops

[1]Circulator system is used to refer to any transit service which is specifically oriented to providing downtown circulation and distribution. This service may be provided by either shuttle buses or a downtown people mover system.

each will make while downtown, on the other hand, is much more difficult to estimate or predict. The demand models described in the next section reflect this difference, making maximum use, for both market segments, of the readily available information.

For both workers and non-workers, three interrelated choices concerning downtown circulation trips are modelled:

- How many downtown circulation trips will be made during the noon period, which is the peak period for this type of trip.
- What destination will be chosen for each trip made.
- What travel mode (walk, circulator system, regional transit, or auto) will be chosen for each trip.

To summarize this subsection, potential DPM users have been divided into four market segments:

- Regional transit users in the peak period
- Regional auto users in the peak period
- Downtown workers in the noon period
- Other people who are downtown in the noon period (non-workers)

The CBD travel made by each of these market segments is modelled separately. The individual models reflect the different travel choices and information availability for each segment.

c. Use of the Logit Model

Most of the tripmaking choices which affect the demand for downtown circulator systems have been modelled using a specific mathematical form, the logit model.[1] This mathematical form is well suited to modelling choice behavior for a number of reasons:

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[1] A number of publications provide further background on the logit model. See, for example, Richards and Ben-Akiva, A Disaggregate Travel Demand Model, Saxon House/Lexington Books, Lexington, MA 1975.

- The logit model directly predicts shares, or fractions, which make each available choice. For example, for the trips between two specified downtown zones, a logit model can predict the fraction which will choose to walk, the fraction which will choose to ride on a circulator system, and the fractions which will choose to use regional transit routes or private autos. The logit model always predicts a fraction choosing each alternative which is between zero and one, and the sum of these fractions, for all available alternatives, is always exactly equal to one.

- The logit model can be estimated cheaply using as few as 200 observations of the choices actually made by tripmakers. Estimation is the statistical process which involves determining the relative importance of each of the factors which are considered by tripmakers in making their travel choices. Continuing the mode choice example begun above, estimation would involve the use of data for the choices actually made by a sample of downtown travellers, as well as the travel times, costs, and other characteristics of travel by each available mode, to obtain the relative weights which each of these factors has on the decision of which mode to use.

- The logit model can be extended beyond a single choice, such as what mode to use, to a multiple (or joint) choice situation. An example would be the joint choice of destination and mode for a downtown trip. A joint model of these two choices would predict the fractions of tripmakers in a given zone who will go to each of the available destinations by each of the available modes. Such a model has the advantage of reflecting the competition which may exist between walking to a nearby destination, or using the circulator system to reach a destination far away.

Mathematically, the logit model can best be described by introducing, first of all, the concept of travel utilities. A utility, U_c, is the relative value of a choice c to a given tripmaker. All of the factors affecting either positively or negatively the utility of a given choice are assumed to be linear in their estimated parameters, $b_o, b_1, b_2, \ldots b_n$:

$$U_c = b_o + b_1X_{c1} + b_2X_{c2} + \ldots + b_nX_{cn}$$

where X_{ci} is a characteristic of the tripmaker making a choice, a characteristic of the choice being made, or a combined characteristic of both. Examples of these characteristics are the following:

- Tripmaker characteristics: annual income, mode used to reach the downtown area.
- Choice characteristics: for the choice of using a circulator system to travel between two downtown zones, the travel time and travel cost required to make this trip using the circulator system.
- Combined characteristics: for the same modal choice, the travel cost divided by the tripmaker's hourly wage.

Once the relevant variables (X's) have been chosen for a given choice situation, and their relative importances have been determined using a statistical estimation technique, then utilities, U_c, can be obtained for each available choice. Although it might be assumed that each tripmaker would make the choice having the highest utility, observed data always shows that neither individuals nor groups of individuals behave quite that simply. Instead, higher utilities can only be related, on the average, to higher fractions of choice. This relationship is captured in the mathematical form of the logit model:

$$P_c = \frac{e^{U_c}}{\sum\limits_{\substack{\text{all available} \\ \text{choices, } i}} e^{U_i}}$$

where:

P_c is the probability, or fraction of trip-makers expected to make choice c;

e is the base of natural logarithms, 2.718.

For each of the logit models developed to represent downtown area travel, the model descriptions given in the following section provide details on the relevant choices being modelled, and the components of the utility functions for each of these choices. These utility function components include the variables (X's) and their corresponding parameters (b's).

2. Model Descriptions

a. Regional Transit Users in the Peak Period

Regional transit users must make two choices which impact strongly on their travel characteristics in the downtown area. These choices are:

- The transit stop at which they will leave the route which brings them into the downtown area.
- The mode of travel which they will use to get from the chosen transit stop to their final downtown destination.

The approaches used to model each of these choices are discussed in this section.

i) Transit Stop Choice

The allocation of transit users to downtown zones in which they will leave their regional transit line can be accomplished in a number of ways, depending on the level of detail of the modelling process and on the availability of data from the regional transportation planning process. If this process provides transit stop-to-destination summaries of regional work trips from transit assignments, and if the size of the destination zones is compatible with the circulator system planning process, then this information can be used directly.

If, on the other hand, the regional transportation planning process only provides transit work trip tables (number of trips by zone of production or residence and by zone of attraction or workplace), then a manual allocation process, preferably on a compressed version of this trip table (from major corridor of approach to downtown area zone of attraction), must be used. This manual process should take into account which zones in the downtown area are served directly by transit vehicles using each corridor, and which zones are only served indirectly, by transit vehicles stopping in other downtown zones. This process was used to specify the transit stop choice of regional transit users in Los Angeles. The result of the allocation process is a table of regional transit users by zone of departure from regional transit to zone of final destination. Although in many cases this trip table will remain constant for different circulation systems, it must vary to reflect changed assumptions concerning the location of downtown transit stops, especially as these might be affected by changes in the routing of regional transit in the downtown area to provide coordination with the circulation system.

ii) Mode Choice Model for Downtown Distribution Travel

A logit model of mode choice was developed which can be used for regional transit users faced with the following alternative modes of travel between their regional transit stop and their CBD origin or destination:

- walking
- transferring to another regional transit vehicle
- riding on the downtown shuttle bus system
- riding on the DPM system

The utility functions for each of these alternatives are the following:

U(walk)	= 2.473 -0.07419*walk time -1.461*grade
U(regional transit)	= .1031 -0.07419*transit time -.00636*transit fare
U(shuttle)	= -0.07419*shuttle time -.00636*shuttle fare
U(DPM)	= -0.2703 -0.07419*DPM time -0.00636*DPM fare +2.311*station integration

Some of these variables require further explanation. Each variable represents information for the one-way trip between a given transit stop zone and a given final destination zone. All times, measured in minutes, include the total time from origin to destination including, where applicable, walk to and from transit stops, waiting for a transit vehicle, and on-vehicle time. The grade variable has a value of zero if there is no significant grade between origin and destination, and a value of one if there is a significant grade. The station integration variable represents the fraction of the DPM trips which will use a DPM station that includes provision for direct transfer between regional buses and the DPM system. The fare variables are measured in equivalent 1975 cents.[1]

The coefficients of these variables also require some explanation. It is readily apparent that both the time coefficients and the cost coefficients remain the same in each of the utility functions. This equality exists because the estimation process was carried out in a way which constrained these coefficients to be equal. Although such constraints could have been relaxed, many travel model estimation efforts have shown such constraints to be accurate in representing traveller behavior.

As described in Section 1 above, these utilities, for each mode which is available for a given origin-destination pair, are used in the logit equation to obtain predictions of the fraction of trips which will use each available mode. Mode availability depends both on distance (walk is assumed to be the only available mode for short, intra-zonal trips, and walk may not be assumed to be available for trips longer than one mile) and on whether or not the transit modes provide a reasonable travel path from origin to destination.

b. Regional Auto Users in the Peak Period

Regional auto users also face two travel decisions which affect their travel in the downtown area. These choices are:

- The parking facility in which their vehicle will be left during their stay downtown.
- The mode of travel which they will use to travel between the chosen parking facility and their final downtown destination.

The second choice - mode of travel - is modelled using the same logit mode choice model discussed above, for regional transit users. This model

[1] When any monetary values are available for a year, Y, other than 1975, they can be converted to equivalent 1975 cents using the ratio CPI (1975)/CPI(Y), where CPI is the Consumer Price Index.

is used for trips between a given parking facility and a given final destination zone, with the station integration variable depending on the provision of parking within the DPM station structure itself. The first choice - parking location - is also modelled using a logit model. In the parking location model, each downtown zone which has parking capacity represents an alternative. Before presenting the single utility function which holds for each of these zones, however, a new variable, <u>logsum</u>, must be defined:

$$\text{logsum} = \ln\left[\sum_{\substack{\text{all available}\\ \text{modes, } i}} e^{U_i}\right]$$

where the U_i's represent the utilities of the available modes for a given origin-destination pair. Logsum is a variable unique to each origin-destination pair.

When the definition of the logsum variable is compared with the definition of the logit model, it is obvious that logsum is the natural logarithm of the denominator of the logit mode choice model. It is a variable which can be interpreted as a weighted sum of the utilities by each mode for a given zone pair.[1] As such, it is useful to represent the expected utility of travelling from a parking facility to a final destination, before the specific mode to be used for this trip is known. The logsum variable is used in this way in the parking facility choice model.

The utility function for each potential parking zone, given a corridor of approach and a final CBD origin or destination, has the following form:

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[1] More formally, it is the expected value of the maximum modal utility. (See Ben-Akiva and Lerman, "Disaggregate Travel and Mobility Choice Models and measures of Accessibility", paper prepared for presentation at the Third International Conference on Behavioral Modelling, Australia, April,1977.)

U(parking zone) = -0.01613*auto cost
-9.37*walk distance
+1.0*ln(parking capacity)
+1.0*logsum
+4.13*station integration

The auto cost variable, measured in equivalent 1975 cents, is further defined as follows:

$$\text{auto cost} = \frac{\text{6*miles from cordon to lot + daily parking cost}}{\text{auto occupancy}}$$

where daily parking cost is also measured in equivalent 1975 cents. The constant, 6, represents out-of-pocket auto operating costs per mile, expressed in equivalent 1975 cents.

Walk distance, measured in miles, is the distance from the parking facility to the CBD origin or destination of the trip.

For a given corridor of approach and final destination, utilities can be determined using this function for each zone having parking capacity. These utilities can then be used in the logit model to determine the share of auto users who will park in each downtown zone. After parking locations are predicted, the mode choice model can be used to predict the fractions of auto users at each parking facility which will use each available mode.

c. Downtown Workers in the Noon Period

As discussed in Section 1, downtown workers make three choices which affect their downtown travel in the noon period. These choices are how often to travel (trip frequency), what destination to choose (trip distribution), and what mode to choose. Each of these choices has its own set of possible alternatives. For trip frequency, these alternatives are:

- make no trips (zero frequency)
- make one round trip (frequency of one)[1]

[1] Workers making multiple-stop noon period trips are not ignored; their trips which do not begin or end at their workplace are treated as non-worker trips. Similarly, workers making more than one round trip are represented by increasing the average trip rate per worker.

For trip distribution, or destination choice, each downtown zone is a possible alternative. For mode choice, the alternatives are:

- walking
- riding on a regional transit vehicle
- riding on the shuttle bus system
- riding on the DPM
- using an automobile

The relevant combinations of alternatives are:

- make no trips (f=0)
- make one round trip to a given destination, d, by walking (f=1,d,walk)
- make one round trip to a given destination, d, on a regional transit vehicle (f=1,d,regional transit)
- make one round trip to a given destination, d, on the shuttle bus system (f=1,d,shuttle)
- make one round trip to a given destination, d, on the DPM system (f=1,d,DPM)
- make one round trip to a given destination, d, by automobile (f=1,d,auto)

Each of these combinations of alternatives has its own utility function, which takes on unique values for each origin zone, and in the case of all but the first, also for each destination zone. These functions are:

U(f=0) = 9.589 + 0.0008552*origin employment density

U(f=1,d,walk) = 2.922
-0.05226*walk time
-1.520*grade
-3.0*trip distance
+0.00767*worker trip attraction density of zone d
+1.0*ln(zonal area)

U(f=1,d,regional transit) = 2.204
-0.05226*transit time
-.00448*transit fare
-4.2*trip distance
+0.00767*worker trip attraction density of zone d
+1.0*ln(zonal area)

U(f=1,d,shuttle) = -1.498
-0.05226*shuttle time
-.00448*shuttle fare
+0.00767*worker trip attraction density of zone d
+1.0*ln(zonal area)

U(f=1,d,DPM) = -0.516
-0.05226*DPM time
-0.00448*DPM fare
+0.00767*worker trip attraction density of zone d
+1.0*ln(zonal area)

U(f=1,d,auto) = -0.05226*auto time
-.00448*auto operating cost
+0.00767*worker trip attraction density of zone d
+1.0*ln(zonal area)

where the variables are defined as follows:

- origin employment density is the total employment of the origin zone divided by its area measured in acres.
- all time variables represent the one-way trip from origin to destination, measured in minutes.
- grade is an "on/off" switch, with a value of zero if there is no significant grade between origin and destination, and a value of one if there is a significant grade.
- trip distance represents the one-way trip from origin to destination, measured in miles.
- worker trip attraction density is a destination zone variable which represents expected worker trip attractions (for round trips) in the destination zone divided by its area measured in acres. Trip attractions are estimated by using the following equation:

  Worker trip attractions = 0.17*total office floor area
  +0.81*retail floor area
  +0.21*service and institutional floor area
  +0.042*manufacturing and wholesale floor area

  Each of the floor area variables is measured in thousands of square feet.
- zonal area is measured in acres.
- all fare variables represent the one-way trip from origin to destination, measured in cents.
- auto operating cost, measured in cents, is obtained by multiplying a cost of six cents per mile by the one-way distance from origin to destination, measured in miles.

The utilities shown above are used in the logit model to obtain fractions of employees who make no noon-period trips, and fractions who travel to and from each destination by each mode. The maximum number of alternatives (if all modes are available to all destinations) is one (for zero frequency) plus five times the number of downtown destinations (for each destination and mode combination). This number must be reduced to account for destination and mode combinations which are not availalbe, such as walk trips longer than some threshhold value.

d. Non-workers in the Downtown Area in the Noon Period

Non-workers who are downtown in the noon period must make the same three choices as downtown workers: how often to travel, what destination to choose, and what mode to choose. However, since the total population of non-workers is much more difficult to predict than the number of downtown workers, a different approach was taken to predict trip frequency for non-workers. Total non-worker trips in the noon period are predicted using the following trip production equation:

Non-worker one-way trips produced = 0.23*total office floor area
+1.09*retail floor area
+0.29*service and institutional floor area
+0.058*manufacturing and wholesale floor area

Each of the floor area variables is measured in thousands of square feet.

Following the prediction of non-worker downtown trips using this equation, the choice of destination and mode are handled using a simplification of the logit model form developed for workers, as described in the previous section. For non-workers, the frequency choice is omitted from the logit model, but the same destination and mode choices are represented: every downtown zone is a possible destination choice, and five modal alternatives exist - walk, regional transit, shuttle bus, DPM, and automobile. Therefore, the following combinations of alternatives exist, each involving travel to a given destination, d, for available modes:

- walking (d, walk)
- on a regional transit vehicle (d, regional transit)
- on the downtown shuttle bus system (d, shuttle)
- on the DPM system (d, DPM)
- by automobile (d, auto)

Each of these combinations of alternatives has its own utility function, which takes on unique values for each origin-destination zone pair. These functions are:

U(d,walk) = 3.123
-0.169*walk time
-0.540*grade
-3.0*trip distance
+0.00378*nonworker trip attraction density
+1.0*ln(zonal area)

U(d,regional transit) = 2.548
-0.169*transit time
-0.0145*transit fare
-4.2*trip distance
+0.00378*nonworker trip attraction density
+1.0*ln(zonal area)

U(d,shuttle) = -2.001
-0.169*shuttle time
-0.0145*shuttle fare
+0.00378*nonworker trip attraction density
+1.0*ln(zonal area)

U(d,DPM) = -0.880
-0.169*DPM time
-0.0145*DPM fare
+0.00378*nonworker trip attraction density
+1.0*ln(zonal area)

U(d,auto) = -0.169*auto time
-0.0145*auto operating cost
-0.00964*hourly parking cost
-0.113*trip distance
+0.00378*nonworker trip attraction density
=1.0*ln(zonal data)

where:

- all variables also used in the worker models have the same definitions (see Section c above)
- non-worker trip attraction density is a destination zone variable which represents expected non-worker trip attractions (for one-way trips) in the destination zone divided by its area measured in acres. Because trip attractions are assumed to equal trip productions in the noon-hour peak period, this variable can be expressed as:

$$\text{Non-worker trip attraction density} = \frac{\text{Non-worker one-way trips produced}}{\text{Zonal area (acres)}}$$

- hourly parking cost is the cost of parking for one hour in the destination zone, measured in equivalent 1975 cents.

These utilities are used in the logit model to obtain fractions of non-worker trips to each destination by each mode. The maximum number of alternatives (if all modes are available to all destinations) is five times the number of downtown destinations - for each destination and mode combination. This number must be reduced to account for destination and mode combinations which are not available.

3. Policy Sensitivity of the Models

The DPM patronage models are sensitive to a wide range of variations, which can be divided into three general classes:

- the characteristics of the downtown area
- the physical characteristics of the DPM system which is proposed
- the policies which are proposed for the operation of the DPM system

Before discussing the variations in each of these classes to which the models are sensitive - those which will cause variations in predicted DPM patronage - it is useful to summarize the variables which are required to exercise the models. Then, each type of variation can be related directly to the model variables which are affected.

a. Data Requirements

The models require, first of all, the division of the downtown area into a number of zones which can vary in size from as large as one-fourth of the downtown area to as small as a single block face: the buildings on one side of a downtown street between two adjacent cross streets. Once a downtown zone system has been developed, then the data described below must be collected:

i) For each Downtown Zone

- acreage
- total employment in the analysis year
- floor areas by building type: office, retail, service and institutional, and manufacturing and wholesale
- parking capacity
- parking costs: daily and hourly

ii) For Each Downtown Origin Zone/Destination Zone Pair

- travel times by mode: walk, regional transit, shuttle bus, DPM, auto
- fares by mode: regional transit, shuttle bus, DPM
- existence of grades
- auto distances

iii) For Each External Corridor to Downtown Destination Zone Pair

- regional auto users
- regional transit users
- downtown zone at which regional transit users will leave the regional transit vehicle bringing them into the downtown area

Appendix B discusses each of these data requirements in further detail.

b. Sensitivity to the Characteristics of the Downtown Area

Many of the model's variables are descriptors of features of the downtown area for which a DPM system is proposed, rather than of the system itself, and in the models, each of these descriptors has a direct impact on the predicted level of DPM patronage. These variables can be classified as follows:

i) Measures of Downtown Size and Activity

- zonal acreage
- employment
- floor area
- parking capacity
- regional auto and transit users who travel to the area

ii) Measures of the Non-DPM Transportation System

- parking capacity and costs
- travel times by non-DPM modes
- fares for non-DPM modes
- grades
- auto distances
- regional transit routes and stops

Depending on the scope of the DPM planning process and its time frame, each of these characteristics may be considered to remain fixed or to vary either with or without some measure of control by the DPM planners.

c. Sensitivity to System Options

i) System Technology - The unique features of DPM systems as downtown circulators are that they are automated and that they operate on an exclusive guideway. In these models, these features affect patronage predictions in the following ways:

- The use of exclusive guideways, usually either above or below ground level, has two opposing impacts on door-to-door travel time, which is an important variable in demand prediction. The on-vehicle portion of trips on a DPM system are likely to have a relatively high speed, tending to increase demand. The need to use stairs or escalators to access the DPM stations from street level adds additional travel time, tending to decrease demand.

- As a new, automated technology whose route and stations in the downtown area will be well known and fixed, DPM systems can be expected to have an enhanced modal image, relative to shuttle bus systems. The result is likely to be increased demand levels.

ii) Route Location - Changes in location and length of route within the downtown area impact DPM demand levels by changing the amount of downtown activity which will be accessible using the system, and the ease of transfer to other transit services. Changes in route circuity will impact travel times on the system: more circuitous routes will have longer travel times, tending to attract fewer trips. These two effects of route location have opposing impacts on demand.

iii) Station Location - The number of stations and their locations, with respect to downtown activities and other transit services, will impact system accessibility just as route location will. However, increased numbers of stations will decrease the system speed, unless off-line stations are used.

iv) Vehicle Characteristics - The number and capacity of DPM vehicles will place an upper limit on the travel demand which can be served and will also affect demand by changing minimum waiting times.

d. Sensitivity to Operating Policies

Even when the major system options discussed above have been fixed, a number of variations in operating policies can be made which will significantly affect DPM demand levels, as predicted by the models. Policy options which directly affect travel times are system speeds, station stopping strategies (stopping at all stations, skip-station stopping, or direct service from boarding to departure station), single vs. multiple-vehicle trains, and vehicle or train headways. Additional policy options affect user costs directly: DPM fares and DPM-regional transit transfer charges.

Several sensitivity tests were conducted during the 1978 Preliminary Engineering Phase of the Los Angeles Downtown People Mover Program. The tests are described in detail in Section III.D of this report.

C. Model Refinements

1. The Reasons for Deficiencies of the Estimated Models

The models presented in the previous section include a number of modifications of the models estimated in the alternative analysis phase of the Los Angeles DPM planning process (1975-1976). Modifications were necessary because of the lack of sufficient data on travel behavior for completely satisfactory model estimations. This basic reason underlies each of the following specific causes for model deficiencies:

- No DPM system existed when the travel data were collected, and therefore DPM patronage can only be estimated after making assumptions about the similarity of DPM systems and other modes available for intra-CBD travel.
- Although out-of-pocket travel costs are different for each available intra-CBD travel mode in Los Angeles, they are the same for each user of regional bus, minibus, and the walk mode. Only auto operating costs vary with distance, but trip lengths are so short that these costs are negligible. Because of these nearly constant costs by mode, model estimation programs cannot distinguish between modal constants and the cost coefficient, leading to unrealistic values of time implied by the estimated coefficients.
- Surveyed trips were not identified as being made by CBD workers or others; instead, they were identified as being made by those who work in the building at which questionnaires were distributed, or by others. As a result, worker/non-worker models had to be developed for the latter two groups rather than the former two.

These insufficiencies of the survey data were, to a large extent, unavoidable. This is true regardless of whether the data were collected in Los Angeles or elsewhere. Therefore, the resulting deficiencies of the CBD travel models as estimated can only be corrected by adjusting the models based on other information, in addition to that which could be used for model estimation. Examples of such information are typical implied values of time, and typical relationships of the relative coefficients and constants for bus and fixed guideway transit modes in other travel demand models.

In each of the sections which follow, the model refinement process is described by stating a problem with the models as estimated, describing the adjustments made to solve this problem, and presenting data showing the impacts of these adjustments on the predictions and implications of the models.

2. Addition of the DPM Mode

a. The Problem

Although the main reason for using the models is to predict DPM patronage, this mode was not an available alternative when survey data were collected. The most similar available mode was minibus. Minibus (or termed more generally "shuttle bus") service has several features which clearly distinguish it from regional buses which have portions of their routes in the CBD:

- the minibus provides a circulation/distribution service strictly for CBD travel;
- the minibus uses smaller vehicles and has a lower fare;
- the minibus system has special publicity, with special bus stop signs which include full route maps.

Because a DPM system would also have each of these characteristics, it originally seemed logical to generalize the shuttle bus mode, calling it a CBD circulator, and to assume that this mode would represent DPM systems also. Doing this, however, amounted to ignoring the following distinctions between DPM and bus circulator systems:

- due to its fixed, above-ground guideway, it will be easier for CBD travelers to become familiar with the system;
- as a new, modern technology, the DPM system can be expected to be more readily accepted than buses are;
- the DPM will operate on an exclusive guideway; thus, travel times will be more predictable;
- the DPM terminal stations will be designed as integrated transfer facilities between DPM and regional bus services, and also will incorporate parking facilities at the edges of the CBD directly connected via DPM to the high-activity CBD areas where parking is scarce and expensive.

b. Model Adjustments

The distinctive characteristics of DPM systems called for the availability of the DPM mode as an alternative for CBD travellers. The utility function for this mode represents a modification of the function estimated for the shuttle bus mode, since both are examples of the broader class of CBD circulator systems. Each of the features specific to DPM presented above can be combined into one of two additions to the minibus utility function to obtain the complete DPM utility function:

- the DPM terminal facilities can be represented by an "integrated transfer facility" variable labelled LOCVAR. This variable is used only in models which are applied to the CBD access portion of regional travel, and is defined as the fraction of trips between a given origin and destination which will use the integrated transfer facility either as the boarding/alighting point from regional transit, or as their parking location;
- the remaining DPM features can only be combined, termed "DPM modal image", and represented by a revised constant in the DPM utility functions of each of the CBD models.

Both of these factors must be determined by analyzing:

- the differences between fixed guideway modes and bus modes in other travel models;
- the resulting predictions of DPM mode choice as they vary by trip distance;
- the adjustments to constants which must be made to correct model predictions of fixed guideway patronage in cities having both bus and rail available for intra-CBD travel.

The resulting factors which were finally selected as components of the adjusted models vary by model. For each model, however, they can be stated as additions to the shuttle bus utilities to obtain the final form of the DPM utility functions. These changes are:

- Model of mode choice for CBD distribution travel: the change in utility function is:

  $$-0.2703 + 2.311 * LOCVAR$$

  where LOCVAR is the fraction of total trips from origin to destination which use integrated transfer facilities at either the origin or destination end of their trips.

  The negative constant term in this expression reflects the decreased likelihood of transferring to the DPM at stations which provide no special transfer facilities for parkers and regional bus users. The positive coefficient for the LOCVAR variable reflects the increased likelihood of transfers where special facilities are provided.

- Parking facility choice model: the existence of parking facilities which are integrated with DPM stations, and therefore are likely to have an increased probability of being selected by regional auto users is represented by the following change in the utility function of this model:

  $$+ 4.13 * PRKVAR$$

  where PRKVAR is the fraction of a zone's parking capacity which exists in a facility integrated into a DPM station.

- Worker model for CBD circulation travel: only the constant changes, reflecting the enhanced modal image for DPM. This change is +0.982.

- Non-worker model for CBD circulation travel: again, only the constant changes by +1.121.

Each of these model changes to incorporate the DPM mode and to take into account the special features of integrated transfer facilities was based on a combination of empirical data and reasonable assumptions about the expected travel behavior in response to a new mode such as DPM. As an example of empirical data, tests using Washington, D.C., travel data on the relative use of the Metro system and shuttle buses for intra-CBD travel indicated that the Metro mode required a constant change of +0.95 from the shuttle mode constant to replicate the observed non-work mode shares for these two modes. Since the Metro system is not oriented specifically to intra-CBD travel, the changes presented above for the CBD models seem realistic.

c. Refined Model Characteristics

Because no DPM-specific changes have been made in the coefficients of times, costs, and destination attraction variables, the utilities for the DPM mode have the same sensitivity to these variables as the utilities for other modes do. The changes, therefore, affect the levels of predicted DPM patronage, but not the sensitivities of these levels to critical variables.

Predicted DPM mode shares can be analyzed for reasonableness. Table 1 shows, for the final DPM alternative, DPM trips predicted by model, as a percentage of total trips. These results appear reasonable;

TABLE 1

DPM Mode Shares

by Model for the Final Alternative

Model	Mode Share
Distribution Trips (PM Peak Hour)	
Regional Auto Users	3.7%
Regional Transit Users	8.8%
Circulation Trips (Noon Hour)	
Workers	5.4%
Non-Workers	1.3%
Daily Total Travel	5.3%

longer distribution travel makes the most use of the DPM system, followed by workers in the noon hour, with non-workers who are less likely to be familiar with the system haveing the smallest DPM mode share.

3. Sensitivities to Travel Costs

a. The Problem

In past applications, each of the CBD models has been found to have an unduly large sensitivity to minor variations in modal travel costs. Two measures of this sensitivity can be obtained by analyzing the utility functions -- specifically the time and cost coefficients of the models.

When an alternative's utility function includes both travel time and travel cost variables, then the corresponding coefficients imply a value of time for those choosing the alternative. This value of time can be stated:

$$VOT = 0.6 * b_t/b_c$$

where:

VOT is the implied value of time, in dollars per hour

b_t is the coefficient of travel time, in minutes

b_c is the coefficient of travel cost, in cents

For the estimated CBD models, these implied values of time range from .13 to .41 cents per hour. Compared with other travel demand models which have typical values of time in the range of 60 to 100 percent of wage rates, these values are unduly low. A further analysis of the comparable coefficients of time and cost indicated that the time coefficients in the CBD models were consistent with those in other models, but that the cost coefficients were significantly higher. Problems with the cost coefficients were also indicated by the unduly large sensitivity, as measured by cost elasticities, of the models to travel costs. These elasticities can be computed from the following relationship:

$$e_i(p/c) = b_c\ c(1-p)$$

where:

$e_i(p/c)$ is the elasticity of the probability, p, of choosing alternative, i, with respect to the cost, c, of alternative i.

Although a typical cost elasticity of a transit mode is -0.3, the elasticities of the shuttle mode in the CBD models as calibrated range from -2.1 to -2.4.

b. Model Adjustments

Having isolated the cost coefficients as the cause for the unrealistic sensitivity of the models to cost variations, a rationale for adjusting these coefficients was sought. Study of the calibration data indicated a very close correlation between travel mode and travel cost. This close correlation was due to the constant fares of 00, 10 and 25 cents for the walk, shuttle, and regional bus modes, respectively. Only auto operating costs varied by trip (depending on distance), and these costs were relatively low — rarely more than $.20. The result of this close correlation appears to be that the logit estimation program cannot distinguish well between variations in modes and variations in costs and therefore neither modal constants or cost coefficients are reliably estimated.

Given the additional information on values of time and elasticities, and given a rationale for the estimated coefficients in the light of data limitations, the post-estimation adjustment of modal constants and cost coefficients was justified. Analysis of other disaggregate destination and mode choice models indicated that a value of time approximately equal to the average wage rate was most appropriate. This led, for the models based on 1975 Los Angeles data, to the choice of VOT = $7.00/hour. Using this value, plus the estimated time coefficients, the following adjusted cost coefficients were found for the three models which include mode choice:

- mode choice for CBD distribution travel: $b_c = -0.00636$
- worker model for CBD circulation travel: $b_c = -0.00448$
- non-worker model for CBD circulation travel: $b_c = -0.0145$

Compensating changes were also made in the modal constants to maintain the observed mode shares. These values are not reported, because subsequent model adjustments resulted in additional changes in these constants.

c. Refined Model Characteristics

The revisions in cost coefficients imply a value of time of $7.00/hour (1975 values) in each model, because this value served as the basis for the adjustment process. The resulting elasticities of DPM shares with respect to DPM costs, and comparable time elasticities, both evaluated at the average values of the variables in the final alternative, appear in Table 2. This table shows time elasticities in the usual range for urban models and transit data, but cost elasticities which are quite low. However, elasticities vary directly with average fares, and the proposed DPM fare of $.127 (in 1975 values) is very low. By comparison, the cost elasticities for a $.50 fare range from -0.21 to -0.72. For this reason, and because both time elasticities and values of time are reasonable, the adjusted cost coefficients were judged to be satisfactory. Additional information on the characteristics of the refined models when DPM fares are varied are discussed in Section III.D.2.

TABLE 2

Adjusted Model Characteristics:
Elasticities of DPM Shares with Respect to DPM
Costs and Times

Model	Cost Elasticity	Time Elasticity
Distribution Travel Mode Choice	-0.076	-0.51
Worker Circulation Travel	-0.054	-0.42
Non-Worker Circulation Travel	-0.182	-1.22

4. Mode Choice Variations with Distance

At the beginning of the preliminary engineering phase, it was suspected that the limits placed on mode availability in the previous modelling effort may not have been valid -- that they were "forcing" mode choices at short and/or long distances which might not be realistic.

These limits were the following:

- all trips with walk times less than 5.6 minutes would always be made by walking
- all trips with walk times greater than 23.4 minutes would never be made by walking.

Careful analysis of 1975 trips as predicted by the mode choice model, and as observed in the survey data indicated both that these limits are appropriate, and that the predicted variation in mode choice by distance group closely matches the observed variation. Figure 2 shows this comparison. Walk trips as a percentage of total CBD trips decrease gradually from 100 for very short trips to about 85 for 1.1 mile trips. Beyond this distance no walk trips were reported, resulting in an abrupt change from 85 percent walk to zero walk trips. This phenomenon indicates that the long-trip cut-off of walk trips is both accurate and required.

Based on this analysis of the variation in walk mode shares by distance, the mode choice model for distribution travel as used in the previous DPM planning phases was found to perform satisfactorily. Both the cutoffs on mode availability and the existing utility functions were retained for incorporation into the set of adjusted models.

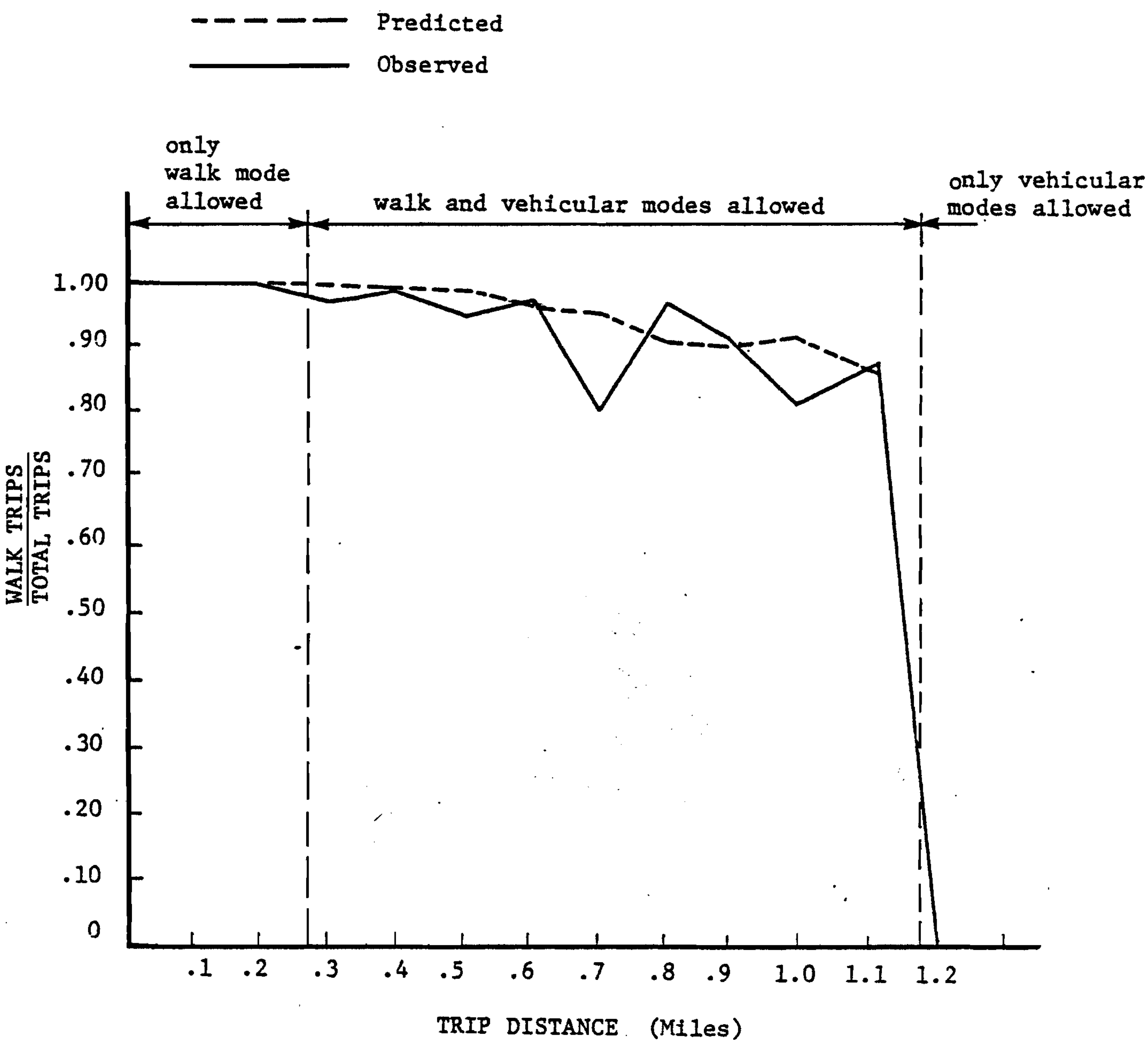


FIGURE 2

Variation in 1975 Predicted and Observed Walk Mode Shares by Distance

5. Average Trip Lengths for Noon-Hour Travel

a. The Problem

The performance of the noon-hour models of worker and non-worker circulation travel can be tested by comparing their average trip lengths (ATL's) by mode with survey data. This was done using the combined worker and non-worker model results, and comparing with the averages of all noon-hour surveyed travel. This comparison is shown in the first two columns of Table 3. The predicted ATL for all modes is 22 percent higher than the observed, with the walk and regional bus ATL's both more than 50 percent high.

Results such as these commonly occur in logit destination choice models which do not include trip distance explicitly as a variable, and point to the need for the inclusion of this variable when these models are estimated. This is sometimes difficult to do, however, because of the collinearity of distances and times by mode.

b. Model Adjustments

The noon hour models were adjusted to improve their prediction of ATL's by mode by adding a trip distance variable to the utility functions of those modes requiring it, and iteratively setting the coefficients of this variable in both noon-hour models with the goal of matching the observed noon-hour ATL's. This process led to the selection of the following coefficients of trip distance in miles:

TABLE 3

Average Trip Lengths for Noon Hour Travel:

1975 Model Predictions vs. Survey Observations

Mode	Average Trip Lengths in Miles		
	Survey Data	Estimated Models	Refined Models
Walk	.384	.613	.366
Shuttle Bus	1.005	1.156	.993
Regional Bus	.687	1.165	.690
Auto	.909	.842	.926
All Modes	.595	.724	.590

- Walk -- $b_{dist} = -3.0$
- Regional Bus -- $b_{dist} = -4.2$
- Auto -- $b_{dist} = -0.113$ (non-worker model only)

c. Refined Model Characteristics

The third column of Table 3 shows the ATL's for the refined models. The average for all modes is within 1 percent of the observed value, and the ATL's by mode are all within 5 percent of the observed values.

6. Parking Facility Choice Sensitivity

a. The Problem

In early runs of the parking facility choice models for alternatives involving minor changes in DPM travel times, the prediction of changes in the number of travellers entering the CBD by auto and choosing to park at one of the planned interceptor facilities (Convention Center and Union Station) was unreasonably high. When the total travel time between these two termini increased from 11.8 to 12.45 minutes (+ 5.5 percent) and some stations were relocated, for example, the number of peak hour auto travellers choosing to park at these locations decreased by 32 percent.

Study of the original form of the parking facility choice model showed that the large estimated value of the coefficient of the LOGSUM variable, 14.36, was the cause of this unreasonably large sensitivity to DPM level of service. In addition, study of the theoretical basis for sequential logit demand models linked by

LOGSUM variables (such as the mode choice and parking facility choice models) indicated that the maximum value of this coefficient should be 1.0.[1]

b. Model Adjustments

To prevent these problems, the parking facility choice model was adjusted initially by reducing the coefficient of the LOGSUM variable to its theoretically maximum value, 1.0. A compensating change was then required to keep the average trip length between parking facilities and CBD zones at their observed values. The total adjustment involved replacing 14.36 * LOGSUM in the utility function of the parking facility choice model by the expression:

1.0 * LOGSUM - 9.37 * trip distance,

where trip distance is measured in miles.

c. Refined Model Characteristics

The elasticities of the probability of choosing a given parking facility in the original and refined parking facility choice models, with respect to DPM travel time, are -6.07 and -0.42, respectively. Each of these values is based on a probability of 0.05 of parking facility choice and a 50 percent DPM mode share (typical for the planned facilities at Convention Center and Union Station), and a DPM travel time of 12 minutes. The value for the adjusted model, -0.42, is consistent with the time elasticities obtained

[1] Higher values of the coefficient of the LOGSUM variable can result in anomalous results, such as the prediction of more trips by walking between a given parking location and CBD destination, when the level of service by DPM for these trips is increased. Further theoretical background on this issue is provided in "Urban Travel Demand Forecasting Project: Phase I Final Report Series," Volume V, by D. McFadden, et al, University of California, Berkeley, 1977 (pages 360-362).

directly from estimated coefficients for the mode choice and circulation travel models (see Table 2).

Both predicted and observed average lengths of travel between parking facilities and CBD zones are .151 miles, when the adjusted model and base year (1975) data are used to obtain the predicted value. Thus, both the observed trip length behavior, and a consistent sensitivity to DPM level of service, are exhibited by the adjustments made to the parking facility choice model.

7. Definitions of Worker and Non-Worker Trips

a. The Problem

As discussed in Section I above, limitations in the survey data necessitated the estimation of circulation travel models for two market segments defined as follows:

- all CBD workers making a noon-hour trip from the building where they work
- all other circulation travel; including both trips by CBD workers not starting at their workplace, and all trips by those who do not work downtown.

Although these market segment definitions were appropriate for model development, they led to a problem when the models are used for forecasting. The problem is that a single CBD worker's noon-hour travel must be predicted using two models - one for her/his first trip (from workplace), and one for all subsequent trips. The result can be an excessive number of implied uses of different modes for different trips by a single worker in a given noon hour. For example, total DPM trips predicted in the worker model may exceed the total predicted in the non-worker model, which could be interpreted as implying that fewer workers return to their workplaces by DPM than those who leave by this mode, and that no non-workers use DPM. This phenomenon did occur when the models were used in Phase II of the DPM planning program. For the final DPM alternative, 1,390 noon-hour trips were predicted for workers, and 1,080 by non-workers.

b. Model Adjustments

Considering the worker model to represent noon-hour round trips rather than one-way trips provides the key to preventing the logical problems caused by the original worker/non-worker definitions. Then, the non-worker model becomes more nearly a model of travel by non-workers, although it must continue to include workers' trips not to or from their workplace.

Although only incidental changes to utility functions were made for this adjustment, the following changes were required:

- after the worker model is used to predict round trips, these must be doubled and divided into from and to components to obtain one-way trips consistent with the results of other models.

- non-worker trips generated using trip rates based on building floor areas must be reduced to reflect the removal of return-to-workplace trips by workers.

Using base year data, this reduction, shown in Table 4, keeps the total number of noon-hour trips constant by reducing non-worker trips from 30,365 to 17,490, to compensate for the doubling of worker trips. Because the ratio of new to old non-worker trips is 0.576, new non-worker trip rates by type of floor area were obtained by applying this factor to the previous rates. Both are shown in columns 1 and 2 of Table 5.

Changes to the utility functions of the noon-hour model

TABLE 4

1975 Noon-Hour Trip Totals for

Original and Revised Market Segments

	Original Definition*	Revised Definition
Worker Trips	12,875	25,750
Non-Worker Trips	30,365	17,490
Total Noon-Hour Trips	43,240	43,240

* Source: Task 45 Report, Table 11.

TABLE 5

Original and Revised Circulation Travel Trip Rates

Floor Area Usage	Noon-Hour Trips per 1000 Square Feet of Floor Area		
	Original Non-Worker Trips	Revised Non-Worker One-Way Trips [1]	Revised Worker Round Trips [2]
Office	0.4	0.23	0.17
Retail	1.9	1.09	0.81
Service, institutional	0.5	0.29	0.21
Manufacturing, wholesale	0.1	0.058	0.042

[1] .576 * original values

[2] .424 * original values

were made to maintain consistency between the new market segment definitions and the trip density variables used in the models. In each case, however, a compensating change was made in the coefficient of the newly-defined density variable, to ensure that there would be no change in utilities predicted with the old and new variable definitions. For example, because the non-worker trip attraction density was reduced by a factor of .576, the coefficient of this variable in the non-worker model, 0.0218, was divided by .576, becoming 0.0378.

c. Refined Model Characteristics

The changed market segment definitions prevent logical difficulties in the revised models without changing their sensitivities in any way. Although in so doing they disturb total noon-hour mode shares, these have been corrected as described in the next section.

8. Final Mode Shares and Trip Frequency

a. The Problem

Each of the model adjustments described in Section 2 through 7 above has impacts on predicted mode shares and (in the case of the worker circulation model) on trip frequency, at the same time as they have the other impacts which have been described. For that reason, changes in modal and zero frequency constants were required at each step of the adjustment process, to ensure that observed data for the base year could continue to be replicated. This section presents the net effect of all of these constant adjustments.

b. Model Adjustments

Table 6 summarizes the changes made in modal constants to

TABLE 6

Adjustments of Modal Constants

Model	Mode							
	Walk		Shuttle Bus		Regional Bus		Auto	
	Before	After	Before	After	Before	After	Before	After
Distribution Mode Choice	0.3237	2.473	0.0	0.0	3.383	0.1031	-	-
Worker Circulation Travel	0.3750	2.922	-0.710	-1.498	3.710	2.204	0.0	0.0
Non-worker Circulation Travel	0.115	3.123	-0.347	-2.001	2.841	2.548	0.0	0.0

compensate for each of the utility function modifications described previously. Each of these was obtained as the result of an iterative process, adjusting the constants and comparing the resulting mode shares with those predicted for the base year using the unadjusted models. A similar process was used to adjust the zero-frequency constant in the worker circulation model, which changed from 10.88 to 9.589.

c. Refined Model Characteristics

Because the criterion for making adjustments to constants was to match the predictions of the unadjusted models for the base year, these predictions are duplicated by the revised models (see Task 45 report, Table I1). In the case of the noon-hour models, however, the change of definitions prevented a matching of trips by mode and by model. Total noon-hour trips by mode were matched, however. Table 7 shows the resulting noon-hour trips by mode and model. Both the changed definitions and the other changes to the non-worker model result in lower total non-worker trips for the two transit modes - down from 1295 to 554. This same phenomenon can be seen in the DPM predictions discussed in the next section: few of the DPM trips are predicted to be made by non-workers. A comparison of total worker trips in Tables 4 and 7 indicates that these match within 0.2 percent.

TABLE 7

Predicted Base Year (1975) Noon-Hour Travel by Mode

Model	Mode				
	Walk	Shuttle Bus	Regional Bus	Auto	Total
Workers	13.952 54.1%	832 3.2%	894 3.5%	10,116 39.2%	25,794 100%
Non-Workers	11,573 66.2%	98 0.6%	456 2.6%	5,347 30.6%	17,474 100%
Total	25,525 59.0%	930 2.1%	1,350 3.1%	15,463 35.7%	43,268 100%

III. Patronage Analysis Results

A. Introduction

The ultimate goal of the transportation planning project carried out by Cambridge Systematics, Inc., in support of the Preliminary Engineering and Draft Environmental Impact Report Phase of the Los Angeles Downtown People Mover Program was to provide estimates of patronage on the proposed DPM system. The patronage estimates developed in the previous alternatives analysis phase of the project required refinement for the following reasons:

- With the passage of two years following the alternatives analysis phase, other planning efforts in Los Angeles had served to refine future expectations with respect to downtown development, regional and downtown transportation system changes, and regional population levels. Each of these actual and planned changes had implications for DPM patronage which had to be taken into account to maintain the validity of the DPM planning process.
- The need to continue the search for an improved DPM system proposal was also recognized. In addition to reflecting the changes mentioned in the previous point, the system could be improved to reflect the concerns and desires of the City Council; of other city agencies; of downtown developers, property owners, and businessmen; and of the general public in the Los Angeles area.
- Finally, the need to obtain DPM patronage estimates based on improved travel models was recognized. The previous section discusses in detail the areas where improvements were required and the nature of the refinements which were made.

This final major section of the report presents the DPM patronage estimates which were made in support of the preliminary engineering process. Because the travel models provide these estimates in their most basic form (by market segment, mode, origin zone, and destination zone) as over 200,000 numbers per alternative, the results presented here must be aggregate ones. Both the aggregate and detailed results have been provided, however, in the form of computer listings for each alternative.

These listings can be consulted to determine disaggregations of the material presented in this report.

The sections which follow are organized generally as the process of analyzing DPM alternatives was. Prior to model and data refinement, the previous versions of the models were used to assist in choosing a final DPM alignment. These alternatives and their patronage forecasts are presented in Section B. As the models were being refined, revisions were being made by others to each of the data items required for model input. The summation of all of these changes defined a new "Base Case" DPM alternative. Section C describes this alternative in detail - the assumptions underlying it, the input data, and the resulting patronage estimates. Finally, two kinds of sensitivity tests of this base case alternative were carried out, as described in Section D. The sensitivity of DPM patronage with respect to both alternative regional transit systems and to alternative DPM fare levels are described in that section.

B. DPM Alignment Alternatives

1. Description of Alternatives

The limited time available for the preliminary engineering phase necessitated an immediate evaluation of alternative DPM alignments, prior to the completion of model and input data refinement. Therefore, as soon as the previous versions of the models were made operational using the previous input data, seven DPM alignment alternatives were developed and tested. These alternatives were generally defined in response to ideas which originated either within the CRA staff or by others in response to the previous alternatives analysis phase.

Figures 3 and 4 show each of these seven alternatives. Their identifying labels and a brief description of each follows:

- Alternative A - The final alignment proposed at the completion of the alternatives analysis phase (labelled Alternative I, AGT & Bus, and/or 230-AGT at that time). This alignment follows Figueroa Street from the Convention Center to Fifth Street, passes under Bunker Hill on a single alignment in tunnel, follows Hill Street from Third to First Streets, then First Street to San Pedro, crossing the Santa Ana Freeway, and finally terminating at Union Station.

- Alternative B shifts the southern portion of the system one block nearer the center of the CBD area, in an attempt to serve a greater number of CBD travellers (from Figueroa to Flower Street).

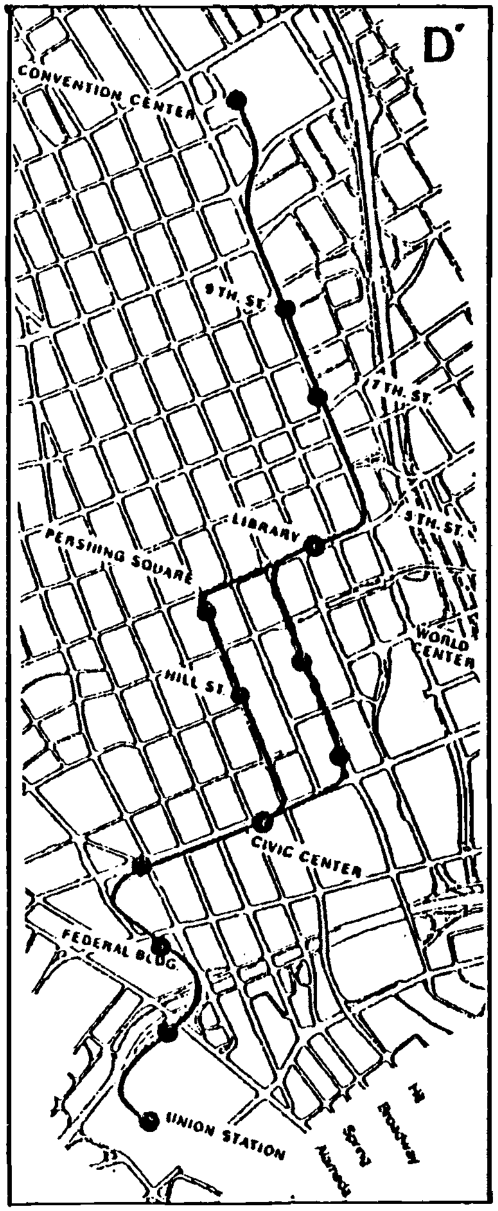
- Alternative C provides a one-way split alignment in the Bunker Hill area to minimize tunnelling costs (more already-constructed tunnel can be used), maintain a high level of service to the Bunker Hill redevelopment area, and improve service to the high-employment and shopping area near Pershing Square, just south of Bunker Hill.

- Alternative D runs north-south through the Bunker Hill area rather than east-west, to tie in this area - and the entire DPM system - with the Civic Center Mall near First Street and Grand Avenue.

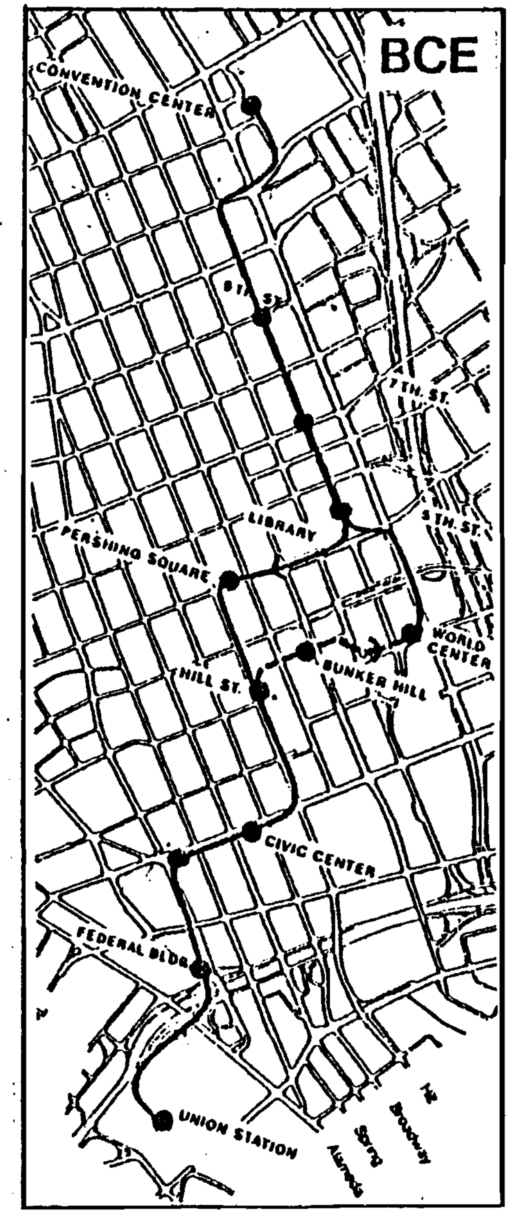
- Alternative D' uses the Alternate D alignment for southbound travel through Bunker Hill, and the northbound alternate C alignment for northbound travel, in an attempt to serve both the Civic Center area and the high-activity shopping area near Hill Street.

- Alternative BCE combines a Flower Street route at the southern end (B) with a split alignment through Bunker Hill(C), and a shift from San Pedro Street to Los Angeles Street between First Street and the Santa Ana Freeway.

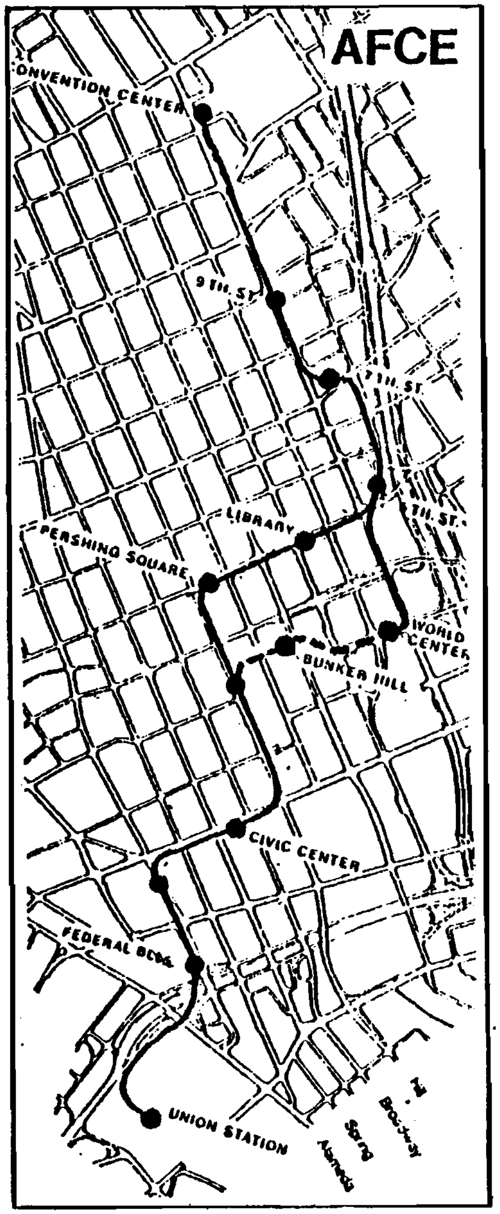
- Alternative AFCE combines the Figueroa Street route from the Convention Center to Seventh Street (A) with a route on Francisco Street from Seventh to Fifth Street (F), a split alignment through Bunker Hill (C), and Los Angeles Street (E). This route avoids a historically critical portion of Figueroa Street while providing significant joint development opportunities at the Seventh Street and Library Stations. Also, one station, at the Federal Building, can serve both that building and the Olvera Street area north of the Santa Ana Freeway.



GRAND AVENUE/HILL STREET
(Serves both Civic Center Mall and Hill Street)



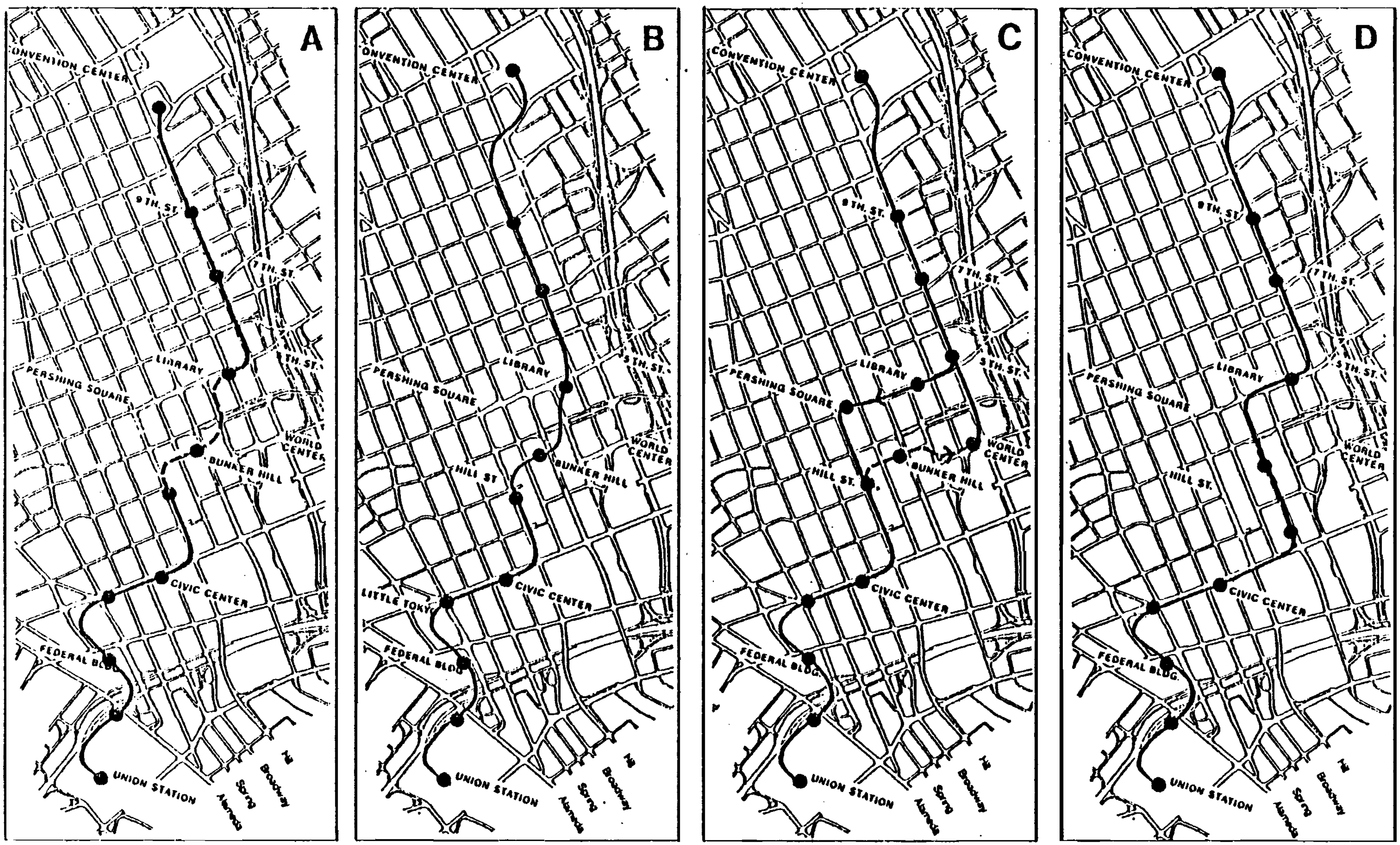
FLOWER ST./5th and 3rd SPLIT/
LOS ANGELES ST.



FINAL ALTERNATIVE

FIGURE 4

<u>Alignment Alternatives D', BCE, AFCE</u>



Alignment Proposed at the Completion of Phase II Alternative Analysis

FLOWER ST. (5th St. to the Convention Center via Flower)

5th and 3rd ONE WAY SPLIT ALIGNMENT (Integrates Olive/Hill Sts. and Bunker Hill)

GRAND AVENUE (Connects Bunker Hill with the Civic Center Mall)

FIGURE 3

Alignment Alternatives A, B, C, D

2. Patronage Forecasts

Table 8 shows the 1990 DPM patronage by market segment which was forecast for each of the seven alignment alternatives.

When Alternative A is taken as a base and changes in DPM patronage predicted for each market segment are compared, it can be seen that the changes in regional transit, worker, and non-worker trips are generally correlated — small increases in one of these market segments generally implies small increases in each of the others. Some difference can be detected for the split alignment alternatives — for these, the ratio of the regional transit percentage increase to the noon hour percentage increase is larger than this ratio is for non-split alternatives. This probably occurs because shorter noon-hour trips find the transfers required to make some trips more critical than the longer regional transit trips do.

The changes in regional auto DPM trips indicate a wider variation than those in other trips. Increases occur for the two non-split alignments (B and D), but decreases as high as 36 percent (for AFCE) occur for the split alignments. These imply that DPM travel time, rather than DPM station accessibility, is the most critical factor in attracting regional auto users to the DPM system. However, because the maximum change in terminal-to-terminal time on the DPM system is only 5.5 percent (also for AFCE), the magnitude of the resulting change in DPM travel was judged to be unrealistically high. A study of the mode choice and parking facility choice models which jointly predict these trips showed that the parking facility choice model was the basic cause of this unrealistic sensitivity. This led to the adjustments of this model previously described in Section II.C.6, and to the use of the adjusted model to predict DPM trips by regional auto users in the final alternative analyses.

TABLE 8

Model Results for Alignment Alternatives

	Alignment Alternative[1]						
	A	B	C	D	D'	BCD	AFCE
DPM Patronage							
Distribution Trips (PM Peak)							
Regional Transit	6,368	6,402	6,676	6,470	6,645	6,900	6,563
Regional Auto	4,184	4,437	3,953	4,240	3,503	3,915	2,679
Total	10,552	10,839	10,629	10,710	10,148	10,815	9,242
Circulation Trips (Noon Hour)							
Workers	1,380	1,460	1,588	1,478	1,477	1,629	1,474
Non-workers	1,085	1,097	1,258	1,175	1,165	1,334	1,152
Total	2,456	2,557	2,846	2,653	2,653	2,642	2,626
Worker Trips							
all modes, noon hour	19,995	20,055	20,169	20,072	20,068	20,209	20,063

[1] See Figures 3 and 4

TABLE 9

Total Daily DPM Patronage for Alignment Alternatives

	Alignment Alternative[1]						
	A	B	C	D	D'	BCE	AFCE
Total Daily DPM Patronage	78,300	79,500	84,700	81,000	82,400	87,700	84,200

[1] See Figures 3 and 4

NOTE: Daily patronage was obtained by:

1. Adjusting the results of the regional auto models to correct for its oversensitivity to DPM times, and

2. Expanding hourly trips by the following factors:

Regional auto	4.94
Regional transit	5.25
Circulation trips	10.00

Because the parking facility choice model in its original form was found to be deficient, the daily DPM patronage estimates shown in Table 9 were obtained by adjusting the DPM patronage by regional auto users to reflect the same percentage changes as those predicted for regional transit uers. These estimates of total daily DPM patronage indicate that Alternative A is dominated by each of the other alternatives. If only patronage were important in selecting an alignment, Alternative BCE should be chosen. When other factors, such as the relative environmental and developmental impacts, were considered, however, Alternative AFCE was selected as the final alignment alterantive. This alternative was developed as a modification of Alternative BCE which mitigates its adverse environmental impacts (by avoiding the relatively narrow Flower Street right-of-way and the historically critical section of Figueroa Street between Seventh and Fifth Streets, and by reducing the impacts on the Pershing Square Park), and also ties in directly with more potential joint development sites. In doing so, however, additional travel time is added, causing some reduction in predicted patronage. In the final trade-off between DPM patronage on the one hand, and environmental and developmental impacts on the other, Alternative AFCE was chosen.

Although the magnitude of the changes in regional auto travel predicted by the models is suspect, the direction of these changes relative to those for the other market segments are not. The results indicate a trade-off between service to regional auto users, most of whom park at the DPM terminals, and service to all other market segments. This appears to be due to the more basic trade-off on the DPM system between lack of circuity (and therefore greater origin to destination speed), and station accessibility. Overall speed is more important for regional auto users, while station accessibility is more important for the remaining market segments. Finally, the results show that the alignment variations have a very small impact on the number of induced trips by CBD workers in the noon hour. The changes in these trips, from the Alternative A results, vary only between +0.3 and +1.1 percent; as for DPM travel for all market segments except regional auto, station accessibility to downtown activities appears to be the most important factor in the small level of variation which is predicted.

C. The New Base Case

Following the use of the original travel models to assist in evaluating alignment alternatives, a new alternative was developed as the base case for the remainder of the project. This base case involved the chosen DPM alignment (AFCE; see previous section), entirely refined input data, and the refined models. This section provides a detailed definition of this alternative, and of its predicted patronage. In addition to being described in this section, the input data requirements for the travel demand models are summarized in Appendix B. The units shown there are consistent with the models as implemented in the DPM Travel Prediction System (DTPS) described in a separate Users' Manual. That manual should be consulted for further information on data formats.

A number of data items must be specified for each analysis zone. Figure 5 shows the internal zone system of 101 zones defined for use in this project. To these were added nine zones representing CBD approach corridors (102-110), and seven zones which could be used for special purposes, such as fringe parking facilities and bus-DPM transfer locations (111-117).

1. CBD Activity Forecasts

Revised 1990 employment and floor space projections were developed by the financial analysis contractor and by the CRA staff members. These

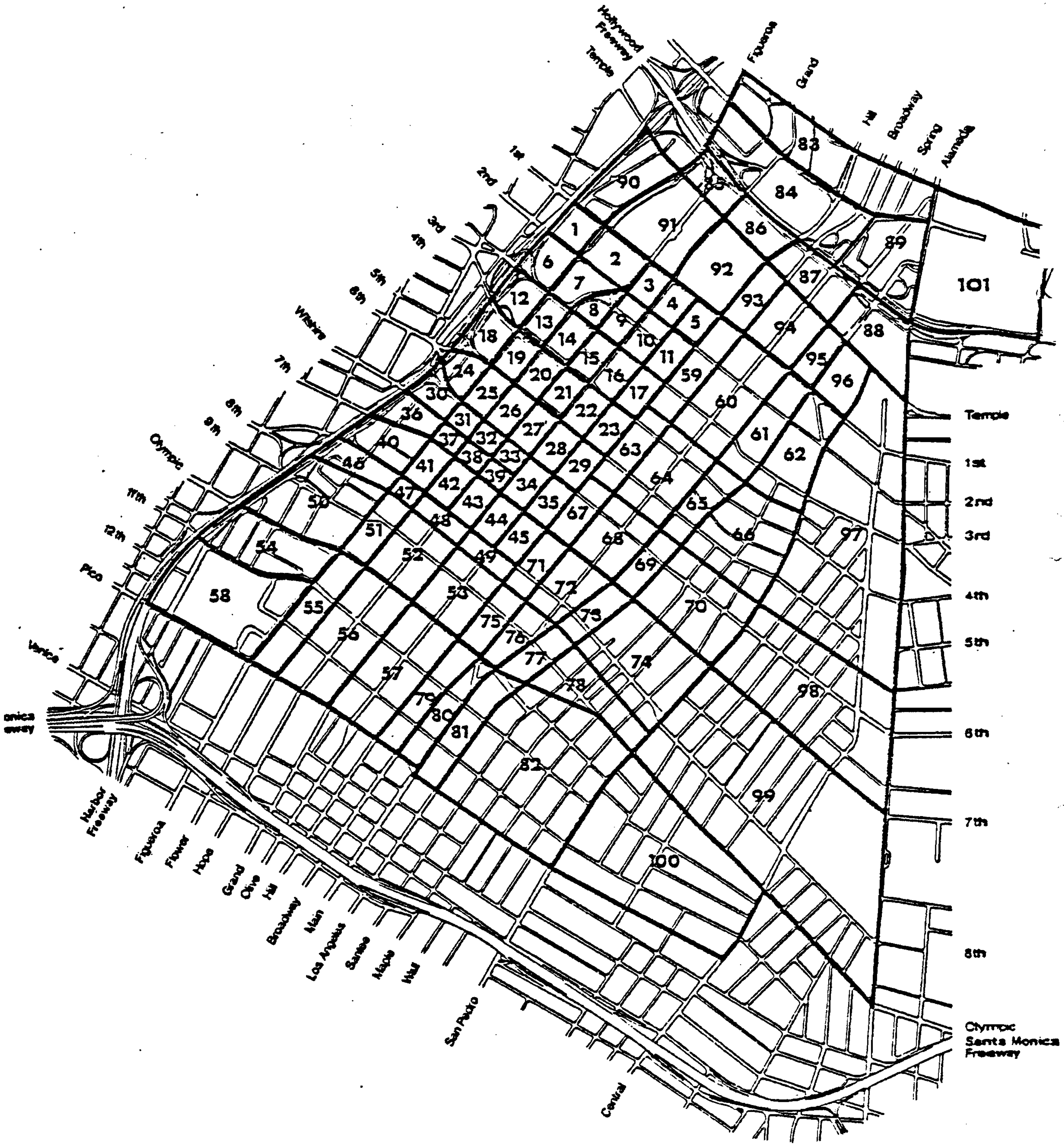


FIGURE 5

The CBD DPM Travel Zone System

are tabulated in Appendix C for each of the 117 analysis zones. Of the extra zones (111-117), only 115 (Convention Center) and 117 (Union Station) are used to represent the parking available at these DPM terminals. The totals for each activity variable are presented in Table 10. Also shown is the total land area. Land areas by zone remained as specified in the alternatives analysis phase except where zone boundaries were changed.

2. Regional Transit System

In the base case, the implementation of the TSM element of Los Angeles' transit improvement program was assumed. This is equivalent to assuming that two parts (TSM and the DPM system) of the Los Angeles area's total four-part transit plan will be implemented in 1990. Region-wide, the TSM element involves identifying and taking advantage of opportunities for improvements in the existing bus services, including improved routing, scheduling, and maintenance; additional freeway express bus services; park-and-ride lots; parking strategy; designation of downtown streets for the use of transit vehicles; and pedestrian malls.

In the CBD, the TSM regional transit element includes the following changes from the existing regional transit system:

- an increase of 12 percent in the number of local buses leaving the CBD during the PM peak hour, from 421 to 473 buses.

- an increase of 32 percent in the number of express buses leaving the CBD during the PM peak hour, from 207 to 273 buses.

The CRA and Southern California Rapid Transit District (SCRTD) planning staffs cooperated to specify the locations, frequencies, and degree of interaction with the DPM system of each CBD bus route. Table 11 summarizes this information, showing by CBD approach corridor the number of

TABLE 10

Total Los Angeles CBD Employment and Floor Space Forecast for 1990

Measure	CBD Total[1]
Employment	221,180
Floor Area	
- Private Office	32,640
- Government Office	10,260
- Retail	6,285
- Service, hotel, institutional	8,375
- Manufacturing, wholesale	19,300
- TOTAL	76,860
Land Area	1,370.3

[1] Employment is shown in employees; all floor areas are shown in thousands of square feet; land area is shown in acres.

Source: Wilbur Smith and Associates, Inc., "Environmental Baseline Update," prepared for CRA, 1978.

TABLE 11

The TSM Regional Transit System:

Transit Service From the CBD to Regional Corridors, 1990

Corridor	Total Buses[1]	Interface		Local	Express[3]	Intercept	
		Number[2]	Per Cent			Number	Per Cent[4]
1. Harbor Freeway	78	68	87.2	46	32	6	18.8
2. Santa Monica Freeway	83	70	84.3	58	25	5	20.0
3. Wilshire/Olympic	97	66	68.0	97	0	0	0
4. Hollywood Freeway	115	99	86.1	62	53	0	0
5. Golden State Freeway	57	46	80.7	34	23	0	0
6. Pasadena Freeway	60	60	100.0	40	20	0	0
7. San Bernadino	133	95	71.4	64	69	32	46.4
8. Santa Ana Freeway	75	14	18.7	24	51	0	0
9. South Central	48	24	50.0	48	0	0	0
TOTAL	746	542	72.7	473	273	43	15.8

Source: Community Redevelopment Agency and Southern California Rapid Transit District, June 1978.

[1] Number of outbound express and local buses serving the corridor in the PM peak hour.

[2] Number of buses which "interface" with at least one of the following DPM stations: Union Station, Civic Center, 7th and Figueroa, Convention Center.

[3] Including intercept buses.

[4] Intercept buses as a percentage of express buses.

Note: PM Peak Hour is 4:30 - 5:30

buses which are intercepted at either the Convention Center or Union Station DPM terminals, and also the number which interface with the DPM system by providing stops near the major DPM stations. (The buses classed as providing interface service do not include the buses providing intercept service.) As the Table indicates, the total number of intercepted buses in the PM peak hour is 43, nearly 16 percent of all outbound express buses. Also, another 542 buses would stop close to at least one of four major DPM stations: Union Station, Civic Center, Seventh and Figueroa, and the Convention Center. All corridors except the Santa Ana Freeway corridor show a high degree of interface between buses and the DPM. Only 19 percent of the Santa Ana buses would be routed close enough to DPM stations to allow transfers.

3. Regional Trip Tables

Trip tables of regional auto and transit users were obtained by processing LARTS regional forecast data for the TSM alternative. This processing involved the following steps:

- LARTS auto vehicle and transit passenger trips by zone of production and attraction at the 1325 zone level were compressed to 27 zones, representing nine corridors of approach to the CBD and 18 LARTS zones which are wholly or partially within the CBD study area shown in Figure 5.
- The 18 LARTS CBD zones were expanded to the 101 zones shown in Figure 4 by assuming that the fraction of trips to each large LARTS zone which would go to a small CBD zone included within it would equal the corresponding employment fraction.
- The resulting table of LARTS regional trips was converted from production/attraction format to origin/destination format, and factored to effect the following conversions:
    - 24 hour to PM peak hour
    - .55 PM peak hour distribution trips per CBD employee
    - 9.7 percent of daily auto trips and 14.5 percent of daily transit trips in the peak hour

- 1.35 persons per auto
- auto directional splits of 23 percent inbound and 77 percent outbound in the PM peak hour
- transit directional splits of 18 percent inbound and 82 percent outbound in the PM peak hour

Each of these factors was developed in the previous phase of the DPM program. The requirement of .55 P.M. peak hour trips per CBD employee is based on observed values of CBD cordon crossings in 1974 and 1976, adjusted to exclude through trips. The 1990 projection of LARTS trips (with through trips excluded) resulted in only .306 trips per employee. It was felt that a control total of .55 trips per employee should be used, since it is based on actual counts. This resulted in the expansion of the LARTS trips by a factor of 1.796.

Further details of the processing of LARTS regional trip tables are provided in the DTPS Users' Manual.

The resulting regional trip tables are summarized in Table 12, by CBD approach corridor and by mode. In total, the transit mode share is 47 percent.

Information on regional bus routes and frequencies were used by the CRA staff to specify the CBD zones at which regional transit trips would board or alight from the RTD bus used to go to or from their non-CBD trip end. Using this information, a trip matrix representing the internal portion of regional transit travel was developed.

4. Parking Facilities and Costs

Revised forecasts of 1990 parking capacities and daily costs by analysis zone were developed by the CRA staff. These values are shown in Appendix C.

Total parking capacity is 93,352 spaces. Average daily parking costs are $2.59, in 1975 dollars. Fringe parking is provided at both DPM terminals: 1,750 spaces at the Convention Center and 2,000 spaces at Union

TABLE 12

1990 Two-Way PM Peak Hour CBD Cordon Crossings for the

TSM Regional Transit System

Corridor	Auto Person Trips[1]	Per Cent	Transit Person Trips	Per Cent	Total	Per Cent
1. Harbor Freeway	9,324	14.3	8,416	14.7	17,740	14.5
2. Santa Monica Freeway	6,036	9.3	6,792	11.9	12,828	10.5
3. Wilshire/Olympic	12,356	19.0	8,745	15.3	21,101	17.3
4. Hollywood Freeway	9,056	13.9	6,842	11.9	15,898	13.0
5. Golden State Freeway	4,796	7.4	4,494	7.8	9,290	7.6
6. Pasadena Freeway	4,437	6.8	4,298	7.5	8,735	7.1
7. San Bernardino Freeway	8,195	12.6	7,845	13.7	16,040	13.1
8. Santa Ana Freeway	9,198	14.1	8,045	14.1	17,243	14.1
9. South Central	1,634	2.6	1,787	3.1	3,421	2.8
TOTAL	65,032	100.0	57,264	100.0	122,296	100.0
Mode Split	53.2%		46.8%		100.0%	

[1]Calculated by multiplying auto driver trips by an average occupancy of 1.35

Source: Based on LARTS trip tables for RTD Benchmark #11.

Station. At both locations, the daily parking fee is forecast to be $1.00.

5. CBD Transit Fares

All CBD transit fares were assumed to remain at June, 1978, levels in real dollar terms. These levels are:

- RTD bus - first boarding: 40 cents
  - transfer: 10 cents
- Minibus - 15 cents
- DPM - 15 cents

6. CBD Networks

The multimodal (walk, minibus, regional bus, and DPM) and auto networks developed in the previous phase were used as the starting points for developing the networks needed to obtain zone-to-zone levels of service. Because round trips are now predicted by the worker circulation model, walk grades were specified for all links having a significant grade, whether this grade is uphill or downhill.

Changes were made to the multimodal network to include lines for the RTD regional bus routes and the DPM route described previously. Also, the minibus route shown in Figure 6 was added.

7. Predicted DPM Patronage

Following the definition of all of the data described above and the calculation of travel times for all zone pairs and all modes, the refined demand models were run. Trip and mode shares predicted by mode and by market segment are shown in Table 13. The DPM system attracts 7444 peak hour passengers, 6.1 percent of the total. Also 2572 noon-hour trips (4.1 percent) are made on the DPM system. Expanding to an estimate of total daily DPM travel, a value of 72,400 is obtained. On an annual basis, 21.2 million riders are predicted (See Appendix A).

TABLE 13

Base Case Results:

Passengers and Mode Shares by Market Segment and Mode

	Mode					
Market Segment	Walk	Circulator	Regional Bus	DPM	Auto	Total
Distribution Trips (PM Peak Hour)						
Regional Transit	47,023 82.1%	1985 3.5%	3194 5.6%	5062 8.8%	-	57,264
Regional Auto	62,145 95.5%	164 0.3%	341 0.5%	2382 3.7%	-	65,032
Total	109,168 89.3%	2149 1.8%	3535 2.9%	7444 6.1%	-	122,296
Circulation Trips (Noon Hour)						
Workers	21,084 49.1%	1360 3.2%	686 1.6%	2312 5.4%	17,456 40.7%	42,898
Non-Workers	13,059 64.4%	114 0.6%	251 1.2%	260 1.3%	6582 32.5%	20,266
Total	34,143 54.1%	1474 2.3%	937 1.5%	2572 4.1%	24,038 38.1%	63,164

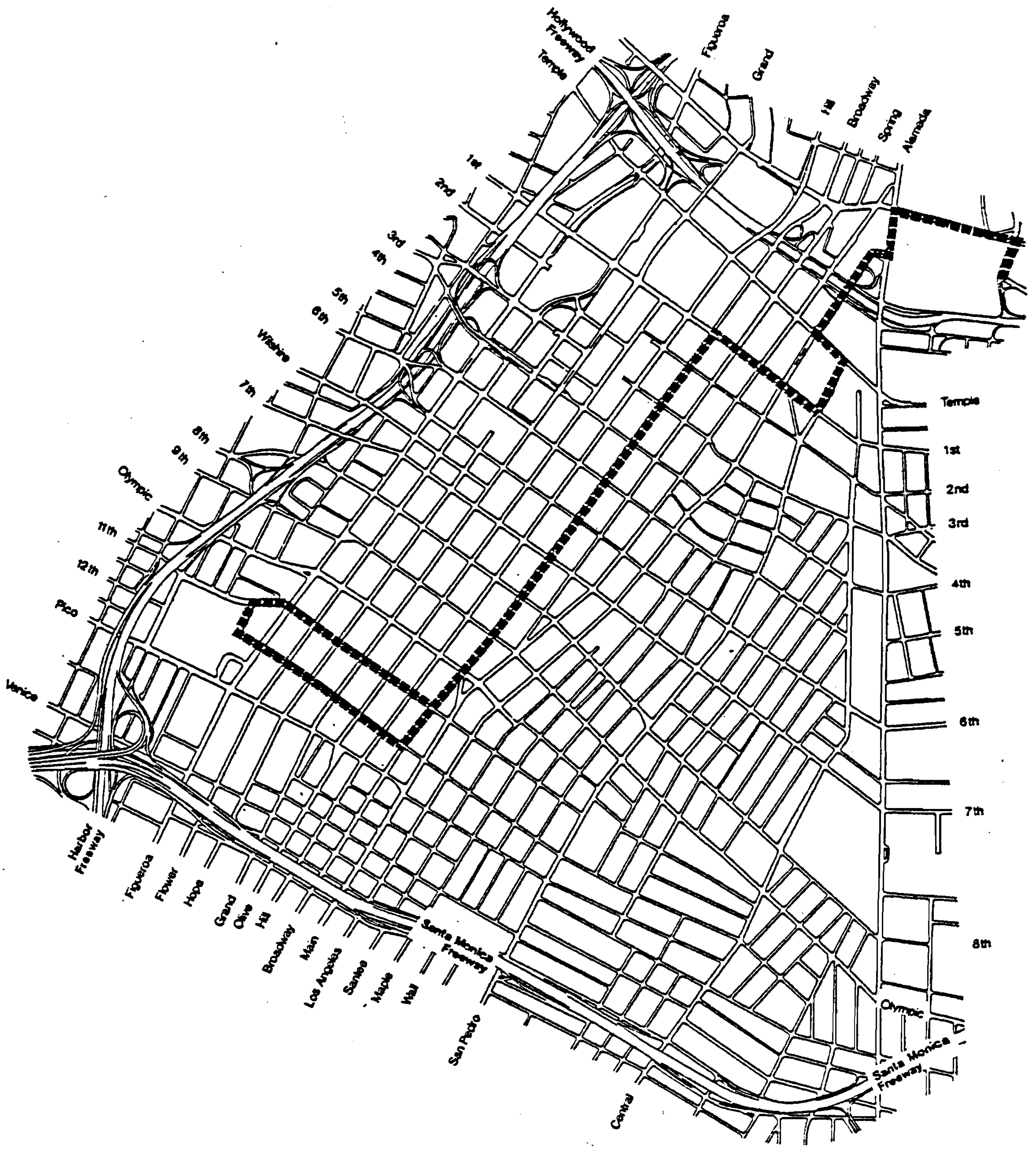
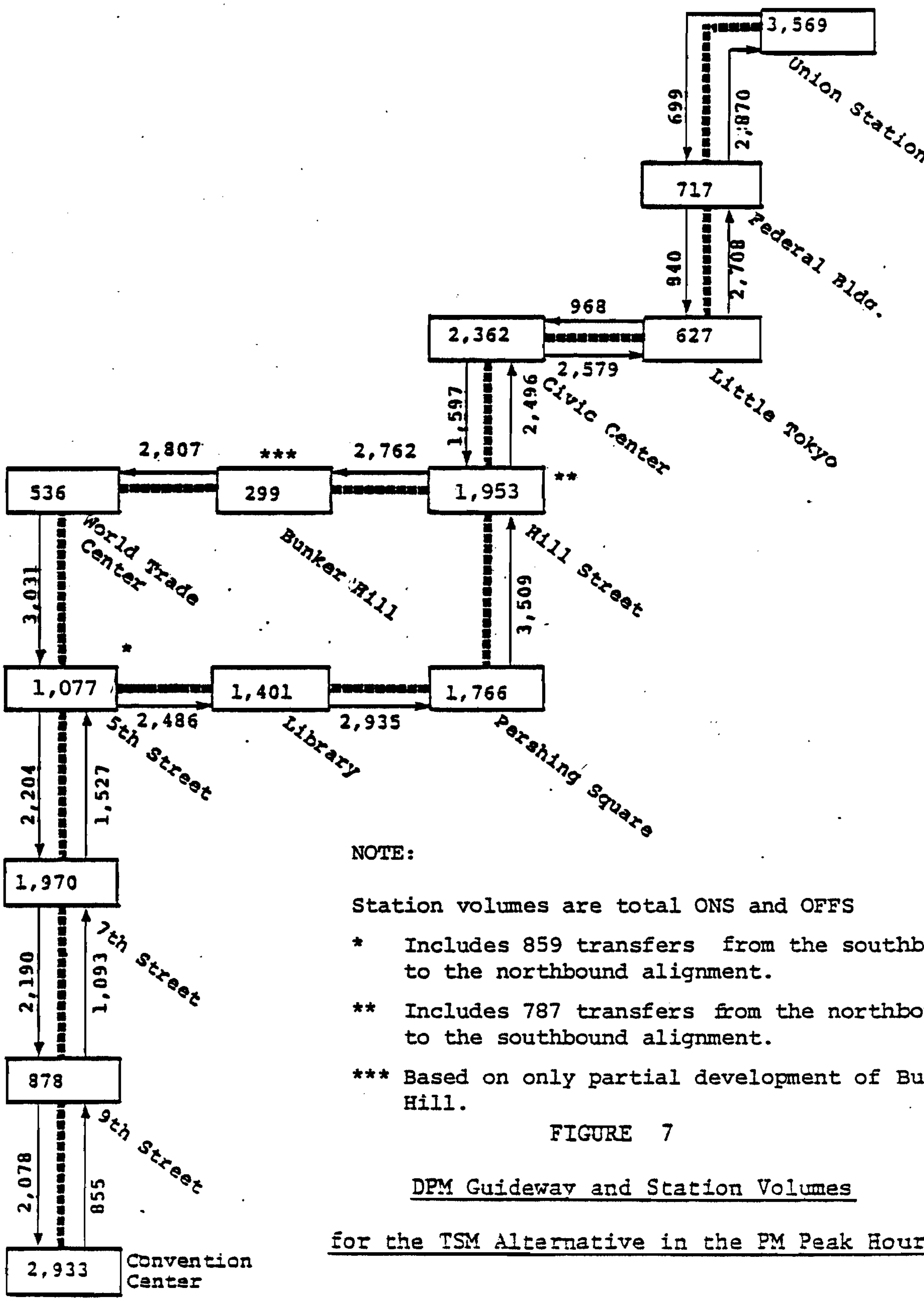


FIGURE 6

<u>RTD East Side Minibus Route Projected to Operate in 1990</u>

By assigning DPM trips to the CBD network, link volumes can be obtained. This was done both for PM peak hour travel (the results of the PM peak models, plus 70 percent of the noon-hour models) and for noon-hour travel (noon-hour models only). Volumes will be highest in the PM peak hour; these are shown in Figure 7. The maximum link volume is 3,509 passengers per hour, occuring on the northbound link connecting the Pershing Square and Hill Street Stations. The maximum station volume, 3,569, occurs at Union Station.

Of the 3,569 DPM users at Union Station in the PM peak, 2,171 are transferring to or from regional transit, and 1,398 use their autos, which are parked at the station, for the remainder of their regional trip. During this same peak, 2,933 DPM passengers use the Convention Center Station. Of these, 1,352 are transferring to or from regional transit, and 950 use their autos, which are parked at the station, for the remainder of their regional trip. The remaining 631 passengers are making circulation (intra-CBD) trips.



NOTE:

Station volumes are total ONS and OFFS

* Includes 859 transfers from the southbound to the northbound alignment.

** Includes 787 transfers from the northbound to the southbound alignment.

*** Based on only partial development of Bunker Hill.

FIGURE 7

DPM Guideway and Station Volumes

for the TSM Alternative in the PM Peak Hour

D. Sensitivity Tests

1. Alternative Regional Transit Systems

In the base case described in the previous section, the implementation of Los Angeles' TSM transit improvement program was assumed. This is equivalent to assuming that two parts (TSM, and the DPM system) of the Los Angeles area's total four part transit plan will be implemented in 1990.

Two additional DPM alternatives were tested, which correspond to cumulatively adding to the assumed regional transit system the two remaining parts of the four part plan. These alternatives are the following:

- Freeway Transit/TSM/DPM - In addition to the regional transit system assumed in the base case, a freeway transit element is added. This element involves improving express bus services over the freeway network by such techniques as ramp metering, preferential bus and carpool lanes, and the construction of bus stations at key points. This program provides 230 miles of free-flowing freeway for the joint use of all vehicles, including buses and carpools, and an additional 50 to 70 miles of exclusive lanes for high-occupancy vehicles only. The major impacts of this element on the CBD will be an increase of 54 express buses outbound from the CBD in the PM peak. Table 14 shows peak hour CBD buses by corridor and type of service. The number of buses intercepted at the DPM termini is reduced by just one, and the total number of buses which interface with the major DPM stations increases both absolutely (+ 44) and in percentage terms (+ 0.6 percent). This additional service results in a higher regional transit mode split for CBD distribution travellers. The percentage of peak hour CBD cordon crossings made by transit increases from 46.8 to 48.6.[1] Because the increased transit service is not available for intra-CBD travel, no changes occur in circulation travel.

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1 A number of detailed tabulations of the results of the regional transit sensitivity analysis are included in Appendix D.

TABLE 14

The Freeway Transit System:

Transit Service From the CBD to Regional Corridors, 1990

Corridor	Total Buses[1]	Interface		Local	Express[3]	Intercept	
		Number[2]	Percent			Number	Percent[4]
1. Harbor Freeway	95	81	85.3	46	49	10	20.4
2. Santa Monica Freeway	101	85	84.2	58	43	8	18.6
3. Wilshire/Olympic	97	66	68.0	97	0	0	0
4. Hollywood Freeway	126	98	77.8	62	64	0	0
5. Golden State Freeway	63	53	84.1	34	29	0	0
6. Pasadena Freeway	55	55	100.0	40	15	0	0
7. San Bernardino Freeway	140	110	78.6	64	76	24	31.6
8. Santa Ana Freeway	75	14	18.7	24	51	0	0
9. South Central	48	24	50.0	48	0	0	0
TOTAL	800	586	73.3	473	327	42	12.8

Source: Community Redevelopment Agency and Southern California Rapid Transit District, June 1978.

[1] Total Number of outbound express and local buses serving the corridor in the PM peak hour.

[2] Number of buses which "interface" with at least one of the following DPM stations: Union Station, Civic Center, 7th and Figueroa, Convention Center.

[3] Including intercept buses.

[4] Intercept buses as a percentage of express buses.

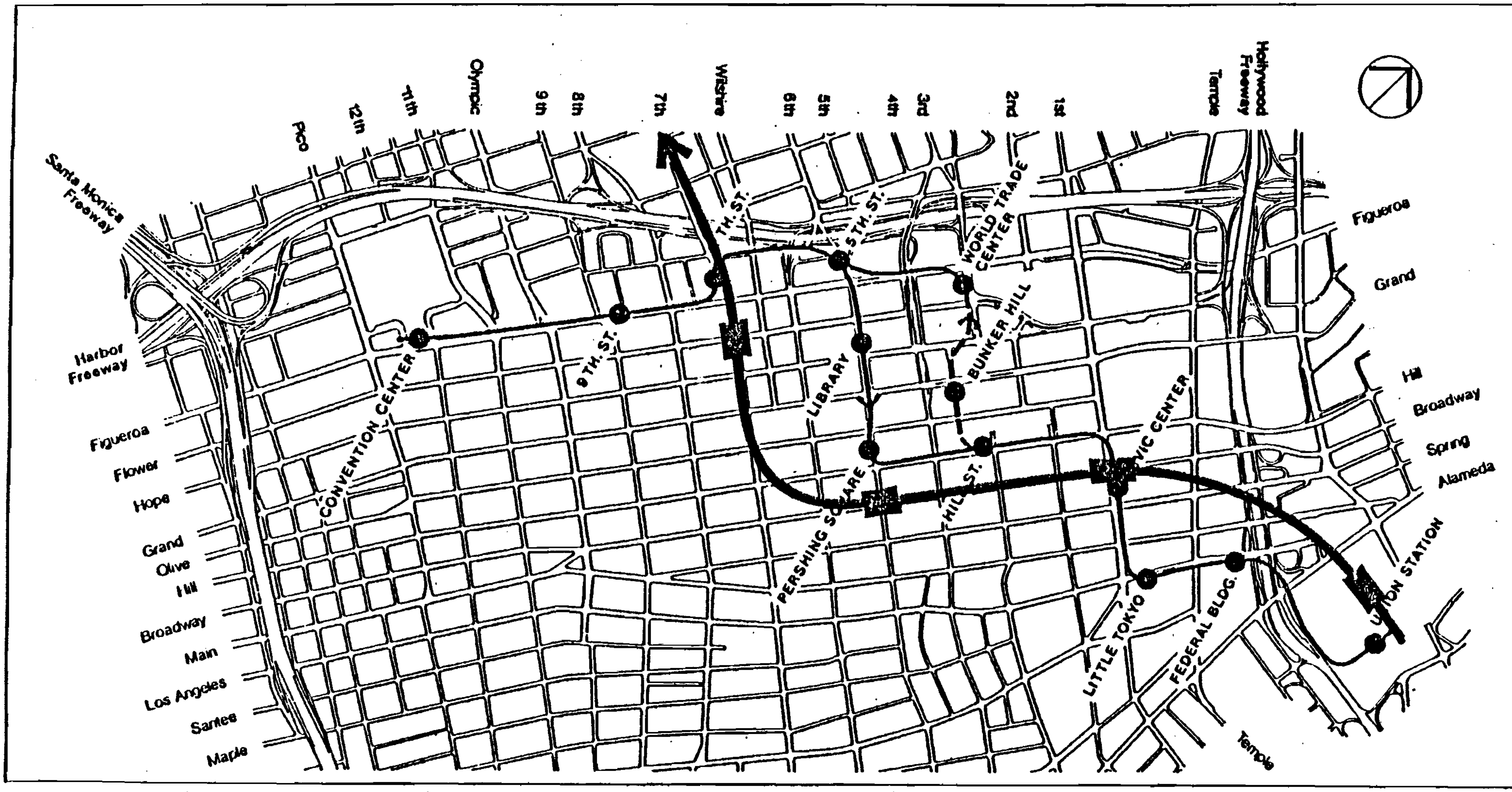
Note: PM Peak Hour is 4:30 - 5:30

- Rail/Freeway Transit/TSM/DPM - The final element of the four-part program is a grade-separated rail rapid transit system in the most densely populated sector of Los Angeles, from downtown, west along the Wilshire Boulevard corridor, through Hollywood and into the San Fernando Valley.

  The alignment and stations proposed for the rail line in the downtown area are shown in Figure 8. If this system is built, then the freeway transit and TSM elements would be cut back in the rail corridor. The result would be a decrease (from the TSM base case) of 93 local buses outbound from the CBD in the PM peak hour, and an increase of only 8 express buses during this period. Table 15 shows these changes for each corridor. The number of buses intercepted at the DPM termini is the same as in the Freeway Transit alternative, one less than in the TSM base case, and the total number of buses which interface with the major DPM stations decreases by 83, a percentage decrease of 3.3 percent. These changes are predicted by LARTS to result in a higher regional transit mode split for CBD distribution travellers (from 46.8 to 50.8 percent), a shift of the intercept point with the DPM system for a number of regional transit users from either the Union Station or the Convention Center DPM Station to the stations at Seventh and Figueroa Streets, or at First Street and Broadway, both of which are also planned as rail line stations. The rail route, with four CBD stations and headways of four minutes in the peak and six minutes at midday, also provides an alternative for intra-CBD distribution and circulation travel, replacing some of the bus service available in the base case.

Table 16 displays the DPM patronage results for each alternative. Because total person trips by distribution travel market segment differ due to changes in regional mode shares, both DPM patronage and mode share figures are especially relevant for these trips.

These results indicate that alternative assumptions concerning the regional transit system have relatively minor impacts on DPM patronage, or on total circulation trips by CBD workers. For the freeway transit alternative, the changes are basically due to changes in the regional trip tables - mode shares by market segment remain nearly the same. However, because the DPM mode share for regional transit users is twice that for



Rail Transit Alignment
DPM Alignment
Stations

FIGURE 8

Proposed CBD Alignment for Los Angeles' Regional Rail Transit Line

TABLE 15

The Starter Line Regional Transit System:

Transit Service From the CBD To Regional Corridors, 1990

Corridor	Total Buses[1]	Interface[2]		Local	Express[3]	Intercept	
		Number	Percent			Number	Percent[4]
1. Harbor Freeway	91	77	84.6	42	49	10	20.4
2. Santa Monica Freeway	89	74	83.0	46	43	8	18.6
3. Wilshire/Olympic	70	60	85.7	70	0	0	0
4. Hollywood Freeway	60	50	83.3	38	22	0	0
5. Golden State Freeway	53	34	64.2	28	25	0	0
6. Pasadena Freeway	54	54	100.0	39	15	0	0
7. San Bernadino Freeway	129	75	58.1	53	76	24	31.6
8. Santa Ana Freeway	70	12	17.1	19	51	0	0
9. South Central	45	23	51.1	45	0	0	0
TOTAL	661	459	69.4	380	281	42	14.9

Source: Community Redevelopment Agency and Southern California Rapid Transit District, June 1978.

[1] Number of outbound express and local buses serving the corridor in the PM peak hour.

[2] Number of buses which "interface" with at least one of the following DPM stations: Union Station, Civic Center, 7th and Figueroa, Convention Center.

[3] Including intercept buses.

[4] Intercept buses as a percentage of express buses.

Note: PM Peak Hour is 4:30 - 5:30

TABLE 16

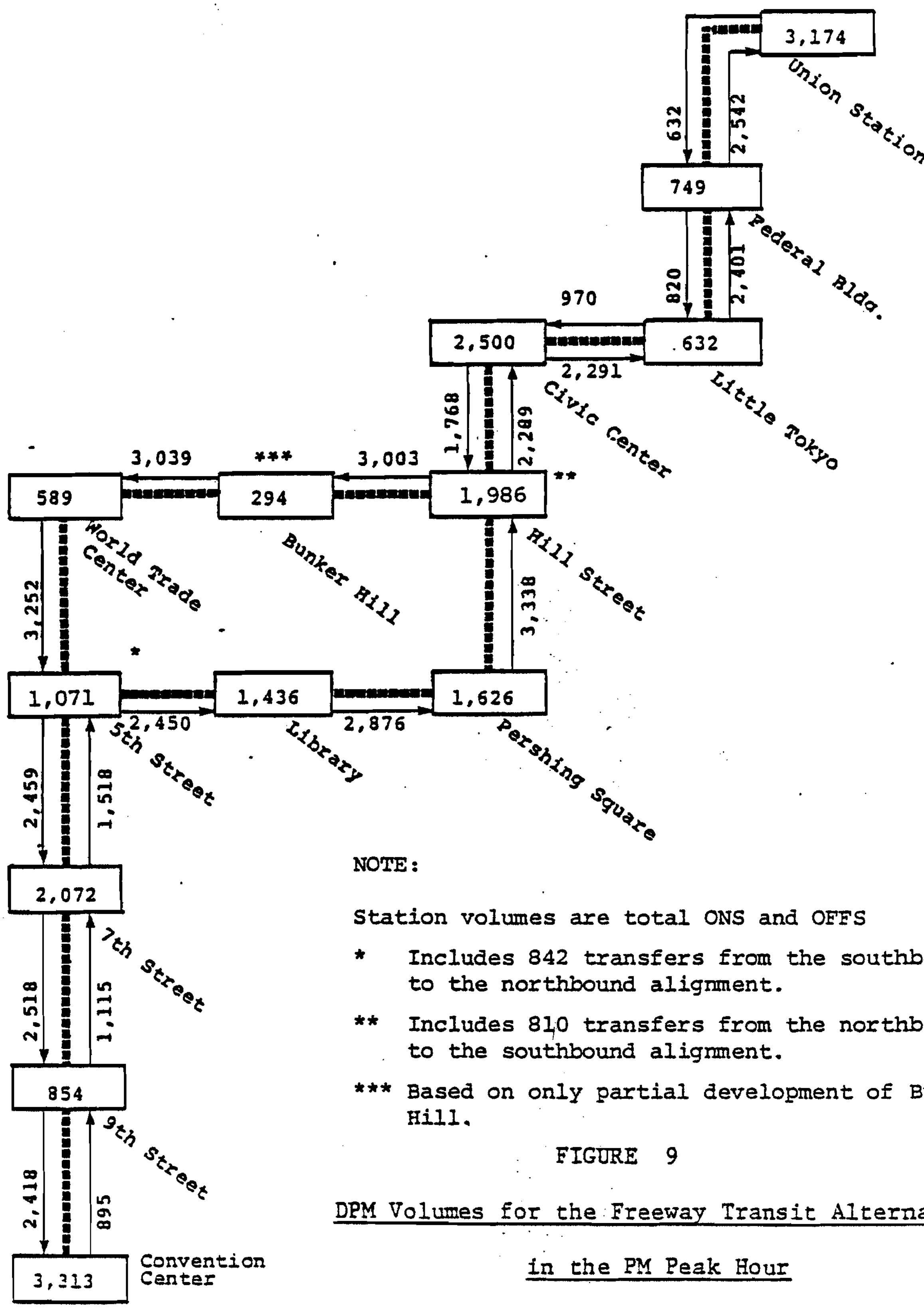
Sensitivity Analysis Results for Regional Transit Alternatives

DPM System	Base Case	Freeway Transit System	Rail System
DPM Patronage			
Total Daily	72,400	73,200	72,500
• Distribution Trips (PM Peak Hour)			
Regional Transit Mode Share	5,062 8.8%	5,238 8.8%	5,234 8.5%
Regional Auto	2,382 3.7%	2,308 3.7%	2,206 3.7%
Total	7,444 6.1%	7,546 6.2%	7,440 6.1%
• Circulation Trips (Noon Hour)			
Workers	2,312 5.4%	2,312 5.4%	2,304 5.4%
Non-workers	260 1.3%	260 1.3%	258 1.3%
Total	2,572 4.1%	2,572 4.1%	2,562 4.1%
• Maximum Volumes (PM Peak Hour)			
Guideway (one-way)	3,509	3,338	3,405
Station (two-way)	3,569	3,313	3,387
Worker Trips (Noon Hour) All Modes	42,898	42,898	42,874

regional auto users, there is a slight increase in total peak period DPM patronage. In spite of this overall increase, the maximum DPM guideway volume decreases, due to shifts in the distribution of DPM users caused mainly by changes in the number of regional transit buses which serve the DPM terminals. Because seven more buses feed into the Convention Center terminal and twelve fewer end at Union Station, the Convention Center DPM station has the highest two-way station volume. Figure 9 provides further detail on the distribution of DPM users on the system in the PM peak period. The shift in emphasis to the southern portion of the alignment is obvious, with all increases in link volumes occurring either on southbound links, or near the Convention Center station.

In the rail system alternative, Table 16 shows that for regional transit users, changes occur in DPM patronage both due to a change in the number of total trips, and due to a change in the DPM mode share. The shift of a number of users' boarding points on regional transit from the DPM terminals to more centrally located rail system stations allows many of them to walk for the entire distribution/access portion of their regional trip. These shifts also serve to reduce DPM flows somewhat in the most heavily-used parts of the system. Both guideway and station maximum volumes decrease.

The entire DPM flow pattern for the rail alternative is shown in Figure 10. The impacts of the rail line appear to be small compared with the impacts of changes in the numbers of buses which interface with the DPM terminals. This DPM flow pattern and that for the freeway transit alternative are quite similar, with the most pronounced differences being due to changes in the number of buses interfacing with the DPM terminals



NOTE:

Station volumes are total ONS and OFFS

* Includes 842 transfers from the southbound to the northbound alignment.

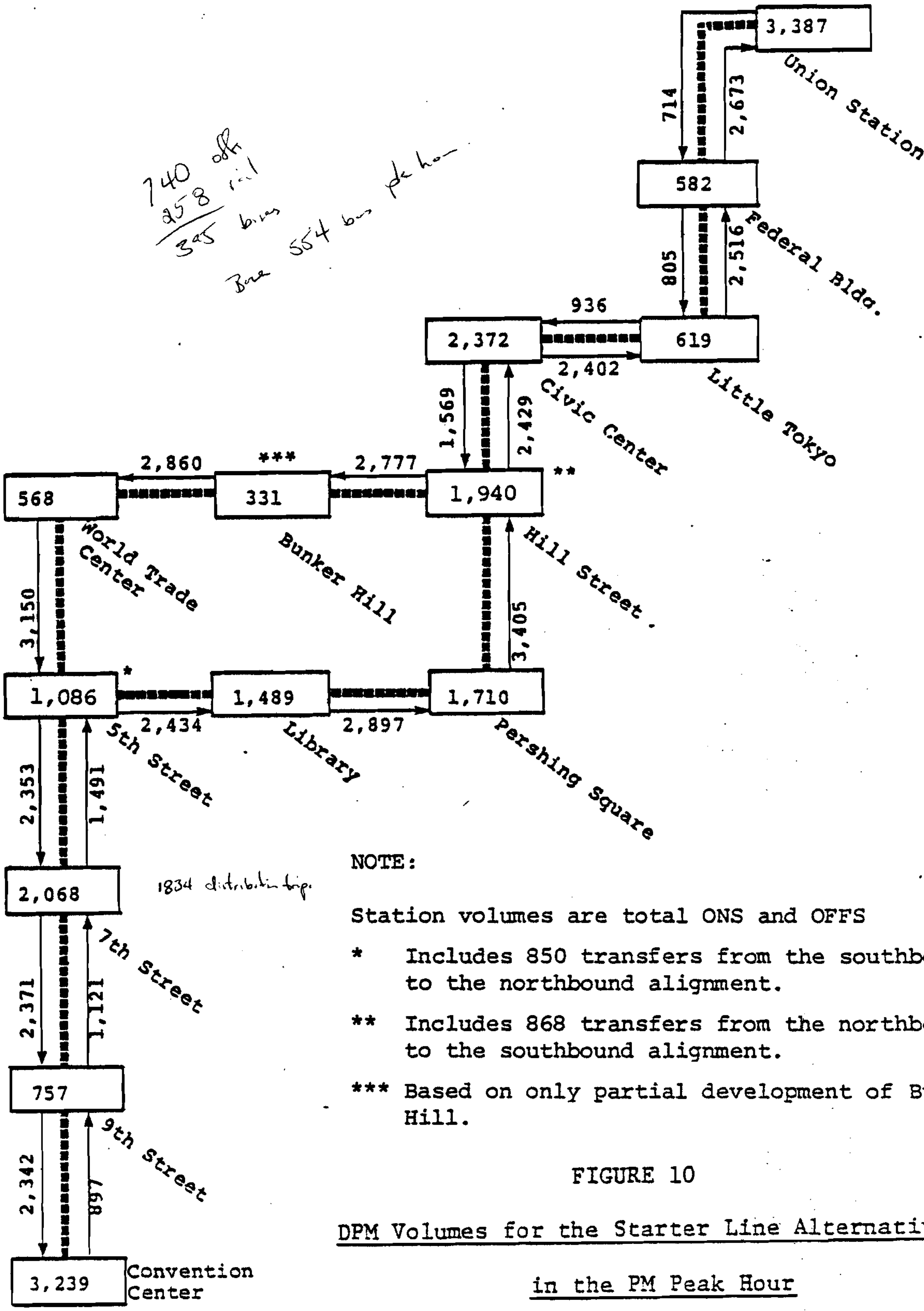
** Includes 810 transfers from the northbound to the southbound alignment.

*** Based on only partial development of Bunker Hill.

FIGURE 9

DPM Volumes for the Freeway Transit Alternative

in the PM Peak Hour



NOTE:

Station volumes are total ONS and OFFS

* Includes 850 transfers from the southbound to the northbound alignment.

** Includes 868 transfers from the northbound to the southbound alignment.

*** Based on only partial development of Bunker Hill.

FIGURE 10

DPM Volumes for the Starter Line Alternative

in the PM Peak Hour

rather than due to the starter line. The most significant decreases in total buses by corridor, including those which interface with the DPM system, occur in those corridors which provide potential interfaces with the Convention Center DPM station. It appears that few starter line users (about 400 in the peak hour) are transferring to the DPM, but that the continuation of all of the intercept buses serving the DPM terminals prevents a loss of DPM patronage.

To summarize the results of the analysis of variations in regional transit policies, the model results indicate that the proposed DPM system will support each of these regional policies nearly equally well. Generally, improved regional transit service to the CBD, and the resulting increases in the mode split for regional transit, will tend to increase DPM usage because regional transit users are more likely to use the DPM than regional auto users are. Beyond this effect, however, a regional rail system which serves a portion of the same corridor as the DPM system will result in a somewhat smaller DPM mode share. The net effect is an insignificant increase in daily DPM patronage for the Starter Line alternative. Finally, changes in the regional transit system have no significant impacts on the use of the DPM system for circulation travel.

2. Alternative DPM Fare Levels

CBD travel predictions were obtained for two levels of DPM fares, to determine the sensitivity of demand to this critical policy variable. In addition to the TSM base case value of 15 cents (in 1978 dollars), a value of 25 cents was used. All other factors were kept constant, including the fares assumed for all non-DPM transit modes. Table 17 displays the resulting travel predictions, using each of the measures also used in the an-

TABLE 17

Sensitivity Analysis Results for DPM Fare Alternatives

	Base Case - 15 cents	25 cents
DPM Patronage		
Total Daily	72,400 Index = 1.00 [1]	69,900 0.97
• Distribution Trips (PM Peak Hour)		
Regional Transit	5,062 1.00	4,949 0.98
Regional Auto	2,382 1.00	2,275 0.96
Total	7,444 1.00	7,224 0.96
• Circulation Trips (Noon Hour)		
Workers	2,312 1.00	2,220 0.96
Non-workers	260 1.00	233 0.90
Total	2,572 1.00	2,453 0.95
• Maximum Volumes (PM Peak Hour)		
Guideway (one-way)	3,509 1.00	3,334 0.95
Station (two-way)	3,569 1.00	3,319 0.93
Worker Trips (Noon Hour) All Modes	42,898 1.00	42,820 1.00

[1] Each index represents the alternative value divided by the base case value.

alysis of sensitivity to the regional transit system.[1]

In general, these results show the relative insensitivity of patronage to a fare change of ten cents. This is not unreasonable, given the relatively low value of either fare level and the large number of short CBD trips not well served by any transit mode. Also reflected is the fact that the DPM system patronage includes a significant number of trips which are long enough to make walking an extremely poor, or unavailable, alternative regardless of what DPM fare is chosen, within the usual range of transit fares.

These changes can also be expressed as arc elasticities of DPM demand with respect to DPM fare.[2] Table 18 shows these elasticities by market segment and in total. The values range from -0.045 for regional transit users to -0.219 for non-workers, with an average daily elasticity of -0.071.

Also shown in Table 17 is total noon worker trips generated. These are predicted to decrease by less than 0.5 percent. This result is consistent with the change in DPM patronage by workers.

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[1] A number of detailed tabulations of the results of the DPM fare sensitivity analysis are included in Appendix E.

[2] An elasticity expresses the percentage change in demand which will occur when a level of service variable (DPM fare in this case) changes by one percent. An <u>arc</u> elasticity provides the most accurate indication of elasticity when changes greater than one percent are observed. In this case, arc elasticity is defined as:

$$E\,(p\,|\,c) = \frac{p_2 - p_1}{p_1 + p_2} \Bigg/ \frac{c_2 - c_1}{c_1 + c_2}$$

where $E\,(p\,|\,c)$ is the arc elasticity of DPM mode share (p) with respect to DPM fare (c).

p_1 and p_2 are the base and changed values of DPM mode share, respectively

c_1 and c_2 are the base and changed values of DPM fare, respectively.

TABLE 18

Elasticity of DPM Demand With Respect to Fare

	Arc Elasticity[1]
Distribution Trips (PM Peak Hour)	
Regional Transit Users	-.045
Auto Users	-.092
TOTAL	-.060
Circulation Trips (Noon Hour)	
Workers	-.081
Non-Workers	-.219
TOTAL	-.095
Daily Travel	
Distribution Trips	-.058
Circulation Trips	-.095
Total Trips	-.071

[1] Arc elasticity is defined as the average percent change in DPM ridership divided by the average percent change in fare.

E. Conclusions

The patronage analysis results summarized in this section of the report aptly illustrate the usefulness of the adjusted CBD travel models. A number of their deficiencies have been corrected by making model adjustments which temper the estimation results obtained earlier with additional information concerning travel behavior, as it has been observed and modelled in a wide range of urban contexts. Although additional data collection, followed by a new model estimation process using the additional data, would have been the ideal way to improve the models, this was not possible. Both time and cost limitations prevented this approach, and the lack of an operating DPM system further limited its potential advantages.

Because these present limitations will be changing in the future, it is useful now to plan for future improvements of models for CBD travel demand. UMTA's nationwide DPM implementation program in general, and Los Angeles' program specifically, will provide a unique opportunity for these improvements. As DPM systems progress to the implementation stage, and their evaluation is begun, both pre- and post-DPM implementation travel surveys should be conducted which will provide a wealth of data useful for estimating improved demand models.

As pre-DPM implementation surveys are carried out, they should be designed to obtain better information on the hourly distribution of CBD travel by each of the market segments identified in Section II. This will require committing a portion of the survey effort to collecting travel data for the all-day and evening periods, rather than only for the noon and PM peak periods.

After these pre-implementation surveys are conducted, a new round of model estimations can be carried out, concentrating on obtaining improved statistical estimates of travel cost coefficients and of the differences in trip rates, trip lengths, and mode shares of CBD workers vs. non-workers.

Only when one or more DPM systems have begun operation can surveys be conducted which will provide more definite answers to some of the questions addressed preliminarily by the adjustments discussed in Section II. Then post-DPM implementation survey data can be used to address the following issues:

- What is DPM's "modal image"? Is it consistent with that of regional rail transit systems, as assumed in the work to date, or is it significantly different?
- To what extent can DPM systems be expected to induce new intra-CBD trips? Will the rate of trip inducement be as low as that inferred from available data for conventional travel modes, or will it be significantly greater?
- How readily will travellers to the CBD accept integrated DPM-auto and DPM-bus transfer facilities?
- How will DPM travel vary by hour of the day? Will it be the same for each market segment, as for existing modes, or will new patterns emerge?

Only when data is available on the actual behavior of CBD travellers when a DPM system is available, will many of these questions be finally resolved. Until then, the refined models presented in this report, tempered by tests of reasonability, will continue to provide the best estimate of expected DPM patronage.

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APPENDIX A

Derivation of DPM Peak Hour to Daily and Annual Conversion Factors

This appendix summarizes the analysis conducted by the CRA staff to obtain factors which could be used to convert the peak hour estimates of DPM patronage provided by the travel demand models to daily totals. Table A-1 shows how hourly values as a fraction of the peak hour volume were obtained for each of three market segments: regional auto users, regional transit users, and circulation trips.

For the distribution trips, these factors were derived from two-way CBD cordon count data collected in 1976 by the Los Angeles City Traffic Department, wherever possible. Hourly fractions for regional auto users in the off-peak periods (9:30 A.M. - 3:30 P.M., and 6:30 P.M. - 12:00 A.M. were estimated because it was recognized that these travellers to the CBD would be more concentrated in the peak periods than the cordon count data (which also includes through-CBD travel) would indicate. Similarly, hourly fractions for regional transit users were estimated for the 9:30 P.M. - 12:00 A.M. period for which no cordon data is available. For circulation trips, the hourly distribution was estimated using the limited information available from the Los Angeles CBD internal travel survey conducted in 1975,[1] and from comparable data for existing transit systems.[2]

The summations of the hourly factors in Table A-1 by market segment provide the factors which can be used to convert peak hour DPM trips to

[1] "Los Angeles Central Business District Internal Travel Survey," prepared for the Community Redevelopment Agency of the City of Los Angeles by Barton-Aschman Associates, October 1975.

[2] Washington Area Metropolitan Transit Authority, May 1978

TABLE A-1

Estimated Hourly DPM Users as a Fraction of the Peak Hour

Time		Regional Auto Users		Regional Transit Users		Circulation Trips
		Cordon Data[1]	Estimated	Cordon Data[1]	Estimated	Estimated
6:00 - 6:30	AM	.116		.128		.019
6:30 - 7:30	AM	.611		.820		.039
7:30 - 8:30	AM	.808		.766		.156
8:30 - 9:30	AM	.645		.338		.584
9:30 - 10:30	AM		.042	.264		.700
10:30 - 11:30	AM		.042	.284		.868
11:30 - 12:30[2]	--		.042	.330		1.000
12:30 - 1:30	PM		.084	.328		.973
1:30 - 2:30	PM		.042	.334		.895
2:30 - 3:30	PM		.042	.405		.700
3:30 - 4:30	PM	.889		.657		.623
4:30 - 5:30[3]	PM	1.000		1.000		.700
5:30 - 6:30	PM	.679		.523		.778
6:30 - 7:30	PM		.084	.253		.817
7:30 - 8:30	PM		.042	.108		.584
8:30 - 9:30	PM		.042	.073		.272
9:30 - 10:30	PM		.024		.066	.136
10:30 - 11:30	PM		.020		.040	.078
11:30 - 12:00	--		.009		.030	.039
SUM (Daily Factor)		5.263		6.747		10.000
Peak hour as a percentage of Daily Factor		19.0		14.8		10.0

[1]Based on two-way CBD Cordon Counts for 1976 collected by the Los Angeles City City Traffic Department

[2]Peak Hour for circulation travel

[3]Peak Hour for distribution travel

daily trips. Both these sums, and their inverses expressed as percentages, are shown in the Table. These factors were used throughout the project to obtain estimates of daily DPM patronage. Figure A-1 shows graphically the hourly distribution of distribution, circulation, and total DPM travel for the TSM base case.

To convert from daily to annual totals, an expansion factor of 293 was applied. This is based on the assumption that Saturday patronage would be 50 percent of average weekday ridership, and Sunday and holiday patronage would be 25 percent of weekday. (252 weekdays + .5 x 52 Saturdays + .25 x 61 Sundays and holidays = 293)

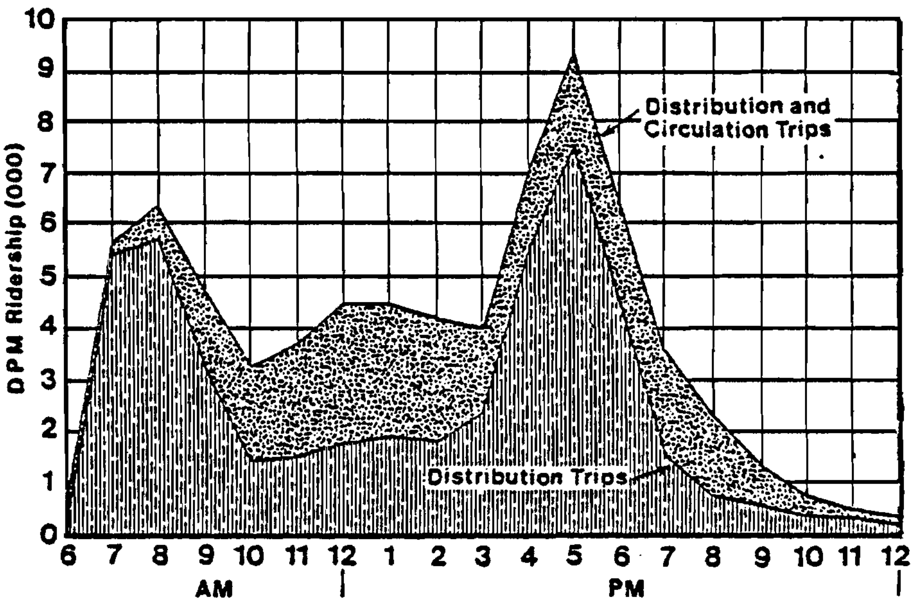


FIGURE A-1

Estimated DPM Ridership by Hour of the Day, 1990

APPENDIX B

Data Requirements for DPM Travel Demand Modelling

Data Item	Dimensions	Units	Model(s)[1]
TRIP PATTERNS			
• Peak period trip table			
- by transit	Entry corridor to CBD destination or regional zone to zone	Trips per hour (in PM peak hour)	1
- by auto	Entry corridor to CBD destination or regional zone to zone	Trips per hour (in PM peak hour)	1,2
LAND USE			
• Employment	By zone[2]	Employees	3,4
• Floor area by - private office - government office - retail - service, hotel, inst. - manfc., whlsle.	By zone	Thousands of square feet	3,4
• Land area	By zone	Tenths of acres	3,4
PARKING			
• Short-term parking costs	Average hourly rate by zone	1975 cents	4
• Long-term parking costs	Average all-day rate by zone	1975 cents	2
• Parking capacity	By zone	Total spaces	2

[1] 1 = Peak hour mode choice
2 = Parking facility choice
3 = Worker noon-hour travel
4 = Non-Worker noon-hour travel

[2] for detailed analyses, zones equal to single CBD blocks are typically defined for data collection and system analysis.

Data Item	Dimensions	Units	Model(s)[1]
LEVEL OF SERVICE			
• Walk	By directional link		4
- time		Tenths of minutes	1,3,4
- distance		Tenths of miles	2,3,4
- grade		Yes (1) or No (0)	1,3,4
• Auto	By directional link		
- time		Tenths of minutes	3,4
- distance		Tenths of miles	2,3,4
• Regional bus, shuttle bus, DPM			
- time	By directional link	Tenths of minutes	1,3,4
- fare	By route	1975 cents	1,3,4
TRANSIT SERVICE			
• Operator	By line		
• Mode	By line	Regional bus, shuttle bus, or DPM	all
• Route followed	By line	Directional links	all
• Stop locations	By line	Closest node	all
• Headway	By line		all
- PM peak	By line	Tenths of minutes	all
- noon hour	By line	Tenths of minutes	all
• CBD zone in which regional service boarding/alighting occurs	By corridor, line, and CBD destination zone	Zone number	1

[1]
1 = Peak hour mode choice
2 = Parking facility choice
3 = Worker noon-hour travel
4 = Non-Worker noon-hour travel

APPENDIX C

1990 CBD Activity System Data by Zone

The data listed on the following pages was developed as part of the preliminary engineering phase of the Los Angeles DPM program. Those responsible for developing it included Wilbur Smith and Associates, Inc., and the CRA DPM program staff.

LOS ANGELES DOWNTOWN PEOPLE MOVER PROGRAM
1990 ZONAL DATA

ZONE	TOTAL EMPL	BUILDING FLOOR SPACE SQ. FT. * 1000 PRIV OFF	GOVT OFF	RETL	SERV	MFG, WHSL	PARK CUST 1975 CENTS	PARK CAP	LAND AREA AC*10
1	0	0	0	0	0	0	0	0	43.8
2	110	0	0	20	10	0	0	0	77.5
3	10	0	0	0	0	0	288	1000	33.3
4	0	0	0	0	0	0	0	700	33.1
5	2385	500	0	65	0	0	0	500	33.0
6	735	285	0	0	0	0	250	442	44.0
7	70	0	0	20	10	0	0	0	57.4
8	20	0	0	0	0	0	0	0	24.7
9	175	0	0	100	0	0	0	0	40.9
10	2080	800	0	20	10	0	250	800	54.0
11	20	0	0	0	10	0	0	0	28.2
12	550	50	0	10	350	0	250	300	34.2
13	600	300	0	15	10	0	374	2500	36.0
14	2360	1300	0	0	10	0	362	2500	41.0
15	5400	1500	0	80	50	0	339	2650	43.0
16	1400	300	0	80	20	0	339	132	56.0
17	240	0	0	10	150	0	339	150	35.0
18	2530	700	0	0	10	0	345	1000	44.0
19	1475	0	0	140	1000	0	402	430	34.0
20	2100	700	0	10	20	0	431	2550	34.0
21	6020	2000	0	0	5	0	403	800	41.7
22	2140	700	0	10	0	0	385	1150	40.9
23	2300	640	0	20	30	40	357	720	41.0
24	910	300	0	0	20	0	300	425	25.0
25	10170	2800	0	90	60	0	455	603	34.0
26	660	160	0	10	130	0	420	50	48.0
27	2750	750	0	0	200	0	420	825	48.0
28	2630	500	0	10	450	0	452	261	39.0
29	50	0	0	0	5	0	420	2000	38.8
30	1105	270	0	0	10	0	300	300	29.1
31	3100	750	0	0	10	0	420	470	20.0
32	5085	1700	0	5	10	0	420	500	19.0
33	715	200	0	5	40	0	420	925	19.0
34	4150	1310	0	25	20	0	436	1200	45.0
35	1540	300	0	10	45	40	441	900	41.0
36	1355	170	0	20	440	0	630	300	28.0
37	1280	300	0	5	10	0	400	400	15.0
38	795	240	0	10	20	0	420	525	16.0
39	795	190	0	10	40	0	445	210	16.0
40	4070	600	0	400	470	0	400	900	46.0
41	2380	350	0	385	10	60	325	1000	39.0
42	3300	600	0	330	330	0	300	2000	39.0
43	710	50	0	250	40	0	305	1326	39.0
44	950	250	0	100	0	0	315	700	39.0
45	1860	570	0	30	35	40	315	700	39.0
46	20	0	0	0	0	0	250	900	46.5

BUILDING FLOOR SPACE
SQ. FT. * 1000

ZONE	TOTAL EMPL	PRIV OFF	GOVT OFF	RETL	SERV	MFG WHSL	PARK COST 1975 CENTS	PARK CAP	LAND AREA AC*10
47	230	25	0	20	5	35	100	500	19.0
48	1290	300	0	5	5	0	283	200	38.0
49	190	50	0	20	0	0	354	250	38.0
50	700	30	0	30	125	40	175	1465	227.3
51	350	35	0	20	40	20	135	1000	59.0
52	1150	355	0	5	50	25	190	821	116.6
53	2225	290	105	35	25	0	165	2120	117.0
54	400	70	0	25	25	65	145	750	185.2
55	1050	315	0	0	115	35	125	1000	127.1
56	1100	380	0	20	60	300	150	2000	248.3
57	6020	860	0	90	205	360	150	3000	238.0
58	550	0	0	0	950	0	150	750	364.2
59	3500	290	515	40	20	30	812	1275	103.0
60	9000	445	520	60	15	520	250	2700	215.1
61	3070	30	460	10	100	170	200	665	129.2
62	2895	185	0	70	220	1600	225	1200	189.1
63	1720	425	0	150	110	210	660	400	91.0
64	5050	1430	150	150	525	0	180	2250	183.0
65	1225	170	0	80	150	55	150	645	79.0
66	1150	0	10	45	50	805	245	1800	323.0
67	1395	105	0	1185	20	210	709	200	65.0
68	4050	1970	0	235	110	95	235	940	131.0
69	880	100	0	20	20	40	185	600	60.0
70	1650	0	65	25	65	700	90	3000	302.8
71	4900	935	0	550	25	0	442	242	64.0
72	1750	300	0	75	75	220	255	1450	117.1
73	2320	5	0	170	5	660	240	500	69.0
74	4700	30	105	210	30	1360	95	2700	354.2
75	1250	200	15	20	5	320	200	1000	65.0
76	1250	100	0	60	25	270	250	700	65.0
77	4200	10	0	55	10	1570	240	1400	67.0
78	2350	50	110	55	20	780	150	1000	242.3
79	1470	680	0	30	45	30	145	600	98.1
80	650	115	0	35	45	45	130	700	96.0
81	1250	0	20	35	0	795	150	1000	117.0
82	6950	10	35	95	120	3440	85	3500	785.3
83	50	0	0	0	10	0	0	0	208.3
84	1350	0	395	0	0	0	0	0	398.2
85	140	20	0	0	20	0	175	70	38.0
86	0	0	0	0	0	0	190	1000	59.7
87	3500	0	1250	0	0	0	210	350	102.0
88	4680	0	970	50	50	0	190	1400	80.0
89	170	0	0	40	70	25	100	395	204.8
90	895	0	225	0	0	0	83	800	124.1
91	2810	0	485	0	100	0	490	1880	221.1
92	6800	0	1285	0	0	0	220	1060	184.0
93	2400	0	300	0	510	0	250	590	71.0
94	7000	0	1735	0	0	0	305	440	141.0
95	3050	0	610	0	50	0	300	1200	45.0
96	1300	0	275	0	0	0	0	0	83.0
97	2735	190	20	160	60	590	246	350	1210.2
98	2300	0	0	0	0	700	0	0	646.1
99	7600	0	0	0	0	2200	0	0	1541.6
100	4400	0	0	0	0	800	0	0	836.5
101	3020	0	600	10	0	0	0	0	0.0
102	0	0	0	0	0	0	0	0	0.0
103	0	0	0	0	0	0	0	0	0.0
104	0	0	0	0	0	0	0	0	0.0
105	0	0	0	0	0	0	0	0	0.0
106	0	0	0	0	0	0	0	0	0.0
107	0	0	0	0	0	0	0	0	0.0

BUILDING FLOOR SPACE
SQ. FT. * 1000

ZONE	TOTAL EMPL	PRIV OFF	GOVT OFF	RETL	SERV	MFG, WHSL	PARK COST 1975 CENTS	PARK CAP	LAND AREA AC*10
108	0	0	0	0	0	0	0	0	0.0
109	0	0	0	0	0	0	0	0	0.0
110	0	0	0	0	0	0	0	0	0.0
111	0	0	0	0	0	0	100	0	0.0
112	0	0	0	0	0	0	100	0	0.0
113	0	0	0	0	0	0	100	0	0.0
114	0	0	0	0	0	0	100	0	0.0
115	0	0	0	0	0	0	100	1750	0.0
116	0	0	0	0	0	0	100	0	0.0
117	0	0	0	0	0	0	100	2000	0.0

APPENDIX D

Additional Tabulations for Regional Transit Sensitivity Analysis Runs

The pages which follow contain a number of additional tabulations prepared by CRA of the results obtained in running the following alternatives used in the regional transit sensitivity analysis:

- The TSM base case
- Freeway transit
- Starter (regional rail) line.

These alternatives are described in detail in Section III.D.1. That section also discusses the results of the sensitivity analyses.

Two-Way CBD Cordon Crossings

1990 - PM Peak Hour

TSM Scenario

Corridor	Auto Person Trips*	Per Cent	Transit Person Trips	Per Cent	Total	Per Cent
1. Harbor Freeway	9,324	14.3	8,416	14.7	17,740	14.5
2. Santa Monica Freeway	6,036	9.3	6,792	11.9	12,828	10.5
3. Wilshire/Olympic	12,356	19.0	8,745	15.3	21,101	17.3
4. Hollywood Freeway	9,056	13.9	6,842	11.9	15,898	13.0
5. Golden State Freeway	4,796	7.4	4,494	7.8	9,290	7.6
6. Pasadena Freeway	4,437	6.8	4,298	7.5	8,735	7.1
7. San Bernardino Freeway	8,195	12.6	7,845	13.7	16,040	13.1
8. Santa Ana Freeway	9,198	14.1	8,045	14.1	17,243	14.1
9. South Central	1,634	2.6	1,787	3.1	3,421	2.8
TOTAL	65,032	100.0	56,264	100.0	122,296	100.0
Mode Split	53.2%		46.8%		100.0%	

*Calculated by multiplying auto driver trips by an average occupancy of 1.35

SOURCE: Cambridge Systematics, Inc. Based on LARTS trip tables for RTD Benchmark #11

Two-Way CBD Cordon Crossings

1990 - Daily

TSM Scenario

Corridor	Auto Person Trips*	Per Cent	Transit Person Trips	Per Cent	Total	Per Cent
1. Harbor Freeway	96,127	14.3	58,038	14.7	154,165	14.5
2. Santa Monica Freeway	62,226	9.3	46,842	11.9	109,068	10.5
3. Wilshire/Olympic	127,385	19.0	60,309	15.3	187,694	17.3
4. Hollywood Freeway	93,359	13.9	47,188	11.9	140,547	13.0
5. Golden State Freeway	49,442	7.4	30,992	7.8	80,434	7.6
6. Pasadena Freeway	45,741	6.8	29,642	7.5	75,383	7.1
7. San Bernardino Freeway	84,484	12.6	54,105	13.7	138,589	13.1
8. Santa Ana Freeway	94,821	14.1	55,483	14.1	150,304	14.1
9. South Central	16,848	2.6	12,325	3.1	29,173	2.8
TOTAL	670,433	100.0	394,924	100.0	1,065,357	100.0
Mode Split	62.9%		37.1%		100.0%	

* Calculated by multiplying auto driver trips by an average occupancy of 1.35

SOURCE: Cambridge Systematics, Inc. Based on LARTS trip tables for RTD Benchmark #11

Two-Way CBD Cordon Crossings
1990 - PM Peak Hour
Freeway Transit Scenario

Corridor	Auto Person Trips*	Per Cent	Transit Person Trips	Per Cent	Total	Per Cent
1. Harbor Freeway	9,015	14.3	8,672	14.6	17,687	14.5
2. Santa Monica Freeway	5,703	9.1	7,116	12.0	12,819	10.5
3. Wilshire/Olympic	12,215	19.5	8,669	14.6	20,884	17.1
4. Hollywood Freeway	8,686	13.9	7,202	12.2	15,888	13.0
5. Golden State Freeway	4,644	7.4	4,579	7.7	9,223	7.6
6. Pasadena Freeway	4,261	6.8	4,460	7.6	8,721	7.2
7. San Bernardino Freeway	7,854	12.5	8,145	13.8	15,999	13.1
8. Santa Ana Freeway	8,687	13.9	8,561	14.5	17,248	14.2
9. South Central	1,601	2.6	1,794	3.0	3,395	2.8
TOTAL	62,666	100.0	59,198	100.0	121,864	100.0
Mode Split	51.4%		48.6%		100.0%	

* Calculated by multiplying auto driver trips by an average occupancy of 1.35.

SOURCE: Cambridge Systematics, Inc. Based on LARTS trip tables, RTDP #30.

Two-Way CBD Cordon Crossings

1990 - Daily

Freeway Transit Scenario

Corridor	Auto Person Trips*	Per Cent	Transit Person Trips	Per Cent	Total	Per Cent
1. Harbor Freeway	92,940	14.3	59,805	14.6	152,745	14.5
2. Santa Monica Freeway	58,794	9.1	49,073	12.0	107,867	10.5
3. Wilshire/Olympic	125,925	19.5	59,785	14.6	185,710	17.1
4. Hollywood Freeway	89,550	13.9	49,671	12.2	139,221	13.0
5. Golden State Freeway	47,875	7.4	31,584	7.7	79,459	7.6
6. Pasadena Freeway	43,925	6.8	30,759	7.6	74,684	7.2
7. San Bernardino Freeway	80,974	12.5	56,173	13.8	137,147	13.1
8. Santa Ana Freeway	89,560	13.9	59,042	14.5	148,602	14.2
9. South Central	16,498	2.6	12,370	3.0	28,868	2.8
Total	646,041	100.0	408,262	100.0	1,054,303	100.0
Mode Split	61.3%		38.7%		100.0%	

* Calculated by multiplying auto driver trips by an average occupancy of 1.35

SOURCE: Cambridge Systematics, Inc. Based on LARTS trip tables, RTDP #30

Two-Way CBD Cordon Crossings

1990 - PM Peak Hour

Starter Line Scenario

Corridor	Auto Person Trips*	Per Cent	Transit Person Trips	Per Cent	Total	Per Cent
1. Harbor Freeway	8,630	14.4	9,003	14.6	17,633	14.5
2. Santa Monica Freeway	5,439	9.1	7,443	12.0	12,882	10.5
3. Wilshire/Olympic	11,693	19.5	9,017	14.6	20,710	17.1
4. Hollywood Freeway	8,235	13.8	7,625	12.3	15,860	13.1
5. Golden State Freeway	4,365	7.3	4,891	7.9	9,256	7.6
6. Pasadena Freeway	4,103	6.9	4,600	7.4	8,703	7.1
7. San Bernardino Freeway	7,525	12.6	8,458	13.7	15,983	13.1
8. Santa Ana Freeway	8,287	13.9	8,939	14.5	17,226	14.2
9. South Central	1,535	2.5	1,861	3.0	3,396	2.8
TOTAL	59,812	100.0	61,837	100.0	121,649	100.0
Mode Split	49.2%		50.8%		100.0%	

* Calculated by multiplying auto driver trips by an average occupancy of 1.35

SOURCE: Cambridge Systematics, Inc. Based on LARTS trip tables, RTDP #31

Two-Way CBD Cordon Crossings
1990 - Daily
Starter Line Scenario

Corridor	Auto Person Trips*	Per Cent	Transit Person Trips	Per Cent	Total	Per Cent
1. Harbor Freeway	88,964	14.4	62,092	14.6	151,056	14.5
2. Santa Monica Freeway	56,074	9.1	51,331	12.0	107,405	10.5
3. Wilshire/Olympic	120,558	19.5	62,185	14.6	182,743	17.1
4. Hollywood Freeway	84,899	13.8	52,589	12.3	137,488	13.1
5. Golden State Freeway	45,000	7.3	33,725	7.9	78,725	7.6
6. Pasadena Freeway	42,294	6.9	31,725	7.4	74,019	7.1
7. San Bernardino Freeway	77,579	12.6	58,334	13.7	135,913	13.1
8. Santa Ana Freeway	85,428	13.9	61,649	14.5	147,077	14.2
9. South Central	15,823	2.5	12,832	3.0	28,655	2.8
TOTAL	616,619	100.0	426,462	100.0	1,043,081	100.0
Mode Split	59.1%		40.9%			

*Calculated by multiplying auto driver trips by an average occupancy of 1.35

SOURCE: Cambridge Systematics, Inc. Based on LARTS trip tables, RTDP #31

INTERNAL MODE CHOICE--P.M. PEAK HOUR

Plan Alternative	Internal CDS Mode Walk*	Mini Bus	DPM	RTD Bus	Total
<u>Regional Transit Users</u>					
TSM	47,023 82.1%	1,985 3.5%	5,062 8.8%	3,194 5.6%	57,264 100.0%
Freeway Transit	48,581 82.1%	2,107 3.6%	5,238 8.8%	3,272 5.5%	59,198 100.0%
Starter Line	50,766 82.1%	2,266 3.7%	5,234 8.5%	3,571 5.8%	61,837 100.0%
<u>Regional Auto Users</u>					
TSM	62,145 95.5%	164 0.3%	2,382 3.7%	341 0.5%	65,032 100.0%
Freeway Transit	59,878 95.5%	153 0.3%	2,308 3.7%	327 0.5%	62,666 100.0%
Starter Line	57,156 95.5%	141 0.3%	2,206 3.7%	309 0.5%	59,812 100.0%
<u>Total P.M. Peak Hour</u>					
TSM	109,168 89.3%	2,149 1.8%	7,444 6.1%	3,535 2.8%	122,296 100.0%
Freeway Transit	108,459 89.0%	2,260 1.9%	7,546 6.2%	3,599 2.9%	121,864 100.0%
Starter Line	107,922 88.7%	2,407 1.9%	7,440 6.2%	3,880 3.2%	121,649 100.0%

* Walk is defined as individuals who (a) depart on bus and walk to bus stop (i.e., self-distribute) or (b) depart in auto and walk to parking lot.

INTERNAL MODE CHOICE--NOON HOUR

Plan Alternative	Internal CDS Mode: Walk	Auto	Mini Bus	DPM	RTD Bus	Total
Workers						
TSM	21,084 49.1%	17,456 40.7%	1,360 3.2%	2,312 5.4%	686 1.6%	42,898 100.0%
Freeway Transit	21,084 49.1%	17,456 40.7%	1,360 3.2%	2,312 5.4%	686 1.6%	42,898 100.0%
Starter Line	21,084 49.2%	17,456 40.7%	1,344 3.1%	2,304 5.4%	686 1.6%	42,874 100.0%
Non-Workers						
TSM	13,059 64.4%	6,582 32.5%	114 0.6%	260 1.3%	251 1.2%	20,266 100.0%
Freeway Transit	13,059 64.4%	6,582 32.5%	114 0.6%	260 1.3%	251 1.2%	20,266 100.0%
Starter Line	13,062 64.4%	6,585 32.5%	113 0.6%	258 1.3%	251 1.2%	20,269 100.0%
Total Noon Hour						
TSM	34,143 54.1%	24,038 38.1%	1,474 2.3%	2,572 4.1%	937 1.4%	63,164 100.0%
Freeway Transit	34,143 54.1%	24,038 38.1%	1,474 2.3%	2,572 4.1%	937 1.4%	63,164 100.0%
Starter Line	34,146 54.1%	24,041 38.1%	1,457 2.3%	2,562 4.1%	937 1.4%	63,152 100.0%

Estimated DPM Ridership
1990

Distribution Trips	TSM	Freeway Transit	Starter Line
PM Peak Hour	7,444	7,546	7,440
Noon Hour	1,820	1,851	1,829
Daily*	46,688	47,486	46,923
Circulation Trips			
PM Peak Hour	1,777	1,777	1,775
Noon Hour	2,572	2,572	2,562
Daily*	25,720	25,720	25,620
Total Trips			
PM Peak Hour	9,221	9,323	9,215
Noon Hour	4,392	4,423	4,391
Daily*	72,408	73,206	72,543

* Defined as 6:00 am to 12:00 midnight

DPM Passenger Loadings
TSM Scenario
P.M. Peak Hour, 1990

STATION	SOUTHBOUND		
	In	On	Off
Union Station	0	699	0
Federal Building	699	224	83
Little Tokyo	840	194	66
Civic Center	968	862	233
Hill Street	1,597	1,230[1]	65
Bunker Hill	2,762	172	127
World Trade Center	2,807	380	156
5th & Figueroa	3,031	65	892[2]
7th & Figueroa	2,204	605	619
9th & Figueroa	2,190	201	313
Convention Center	2,078	0	2,078

STATION	NORTHBOUND		
	In	On	Off
Convention Center	0	855	0
9th & Figueroa	855	301	63
7th & Figueroa	1,093	590	156
5th & Figueroa	1,527	969[3]	10
Library	2,486	925	476
Pershing Square	2,935	1,170	596
Hill Street	3,509 [5]	216	1,229[4]
Civic Center	2,496	675	592
Little Tokyo	2,579	248	119
Federal Building	2,708	286	124
Union Station	2,870	0	2,870

[1] Includes 787 transfers from the Northbound alignment.
[2] Includes 859 transfers to the Northbound alignment.
[3] Includes 859 transfers from the Southbound alignment.
[4] Includes 787 transfers to the Southbound alignment.
[5] Maximum one way link volume.

DPM Passenger Loadings
Freeway Transit Scenario
P.M. Peak Hour, 1990

STATION	SOUTHBOUND		
	In	On	Off
Union Station	0	632	0
Federal Building	632	268	80
Little Tokyo	820	212	62
Civic Center	970	1,021	223
Hill Street	1,768	1,303[1]	68
Bunker Hill	3,003	165	129
World Trade Center	3,039	401	188
5th & Figueroa	3,252	81	874[2]
7th & Figueroa	2,459	693	634
9th & Figueroa	2,518	205	305
Convention Center	2,418	0	2,418

STATION	NORTHBOUND		
	In	On	Off
Convention Center	0	895	0
9th & Figueroa	895	282	62
7th & Figueroa	1,115	574	171
5th & Figueroa	1,518	945[3]	13
Library	2,450	931	505
Pershing Square	2,876	1,044	582
Hill Street	3,338[5]	188	1,237[4]
Civic Center	2,289	629	627
Little Tokyo	2,291	234	124
Federal Building	2,401	271	130
Union Station	2,542	0	2,542

[1] Includes 810 transfers from the Northbound alignment.
[2] Includes 842 transfers to the Northbound alignment.
[3] Includes 842 transfers from the Southbound alignment.
[4] Includes 810 transfers to the Southbound alignment.
[5] Maximum one-way link volume.

DPM Passenger Loadings
Starter Line Scenario
P.M. Peak Hour, 1990

STATION	SOUTHBOUND In	SOUTHBOUND On	SOUTHBOUND Off
Union Station	0	714	0
Federal Building	714	165	74
Little Tokyo	805	195	64
Civic Center	936	872	239
Hill Street	1,569	1,282[1]	74
Bunker Hill	2,777	207	124
World Trade Center	2,860	429	139
5th & Figueroa	3,150	86	883[2]
7th & Figueroa	2,353	661	643
9th & Figueroa	2,371	194	223
Convention Center	2,342	0	2,342

STATION	NORTHBOUND In	NORTHBOUND On	NORTHBOUND Off
Convention Center	0	897	0
9th & Figueroa	897	282	58
7th & Figueroa	1,121	567	197
5th & Figueroa	1,491	955[3]	12
Library	2,434	976	513
Pershing Square	2,897	1,109	601
Hill Street	3,405[5]	238	1,214[4]
Civic Center	2,429	617	644
Little Tokyo	2,402	237	123
Federal Building	2,516	250	93
Union Station	2,673	0	2,673

[1] Includes 866 transfers from the Northbound alignment.
[2] Includes 850 transfers to the Northbound alignment.
[3] Includes 850 transfers from the Southbound alignment.
[4] Includes 868 transfers to the Southbound alignment.
[5] Maximum one-way link volume.

DPM Passenger Loadings
TSM Scenario
Noon Hour, 1990
Circulation Trips Only

STATION	SOUTHBOUND In	SOUTHBOUND On	SOUTHBOUND Off
Union Station	0	0	0
Federal Building	0	126	0
Little Tokyo	126	139	0
Civic Center	265	471	58
Hill Street	678	418[1]	26
Bunker Hill	1,070	89	99
World Trade Center	1,060	159	119
5th & Figueroa	1,100	14	519[2]
7th & Figueroa	595	35	122
9th & Figueroa	508	9	207
Convention Center	310	0	310

STATION	NORTHBOUND In	NORTHBOUND On	NORTHBOUND Off
Convention Center	0	293	0
9th & Figueroa	293	185	10
7th & Figueroa	468	158	21
5th & Figueroa	605	547[3]	4
Library	1,148[5]	172	222
Pershing Square	1,098	420	403
Hill Street	1,115	37	421[4]
Civic Center	731	59	513
Little Tokyo	277	0	152
Federal Building	125	0	125
Union Station	0	0	0

[1] Includes 277 transfers from the Northbound alignment.
[2] Includes 503 transfers to the Northbound alignment.
[3] Includes 503 transfers from the Southbound alignment.
[4] Includes 277 transfers to the Southbound alignment.
[5] Maximum one way link volume.

Daily Passenger Volumes At
DPM Stations, 1990
6:00 A.M. - 12:00 A.M.
TSM Scenario

Convention Center	23,023
9th and Figueroa	6,950
7th and Figueroa	15,493
5th and Figueroa	8,483 [1]
Library	11,005
Pershing Square	13,866
Hill Street	15,301 [2]
Bunker Hill	2,352
World Trade Center	4,199
Civic Center	18,534
Little Tokyo	4,923
Federal Building	5,503
Union Station	28,092

[1] Includes 6,745 transfers from the southbound alignment to the northbound alignment.

[2] Includes 6,179 transfers from the northbound alignment to the southbound alignment

NOTE: Station volumes are total ONS and OFFS. Excluding transfers, total ONS and OFFS equal 144,800, which is twice the number of daily trips, 72,400.

P.M. Peak Hour Passenger Volumes
At DPM Stations, 1990
TSM Scenario

Convention Center	2,933
9th and Figueroa	878
7th and Figueroa	1,970
5th and Figueroa	1,077[1]
Library	1,401
Pershing Square	1,766
Hill Street	1,953[2]
Bunker Hill	299
World Trade Center	536
Civic Center	2,362
Little Tokyo	627
Federal Building	717
Union Station	3,569

[1] Includes 859 transfers from the southbound alignment to the northbound alignment.

[2] Includes 787 transfers from the northbound alignment to the southbound alignment.

Midday Passenger Volumes At
DPM Stations, 1990
Circulation Trips Only
TSM Scenario

	12:00-1:00	11:00-2:00 [5]
Convention Center	603	1,705
9th and Figueroa	411	1,162
7th and Figueroa	336	950
5th and Figueroa	581 [1]	1,643 [3]
Library	394	1,114
Pershing Square	823	2,327
Hill Street	625 [2]	1,767 [4]
Bunker Hill	188	531
World Trade Center	278	786
Civic Center	1,101	3,113
Little Tokyo	291	823
Federal Building	251	710
Union Station	0	0

[1] Includes 503 transfers from the southbound alignment to the northbound alignment.

[2] Includes 277 transfers from the northbound alignment to the southbound alignment.

[3] Includes 1,422 transfers from the southbound alignment to the northbound alignment.

[4] Includes 783 transfers from the northbound alignment to the southbound alignment.

[5] Calcualted by multiplying noon-hour volumes by a factor of 2.827.

Impact of Starter Line On
DPM Station Volumes*
P.M. Peak Hour, 1990

DPM Station	TSM Scenario	Starter Line Scenario	% Change
7th and Figueroa	1,970	2,068	+5.0
Civic Center	2,362	2,372	+0.4
Union Station	3,569	3,387	-5.1

*Volumes are total ONS and OFFS

Estimated Number of Passengers Boarding Outbound Buses
During PM Peak Hour at Intercept Stations
by Mode of Access, 1990

TSM Scenario

Convention Center

Mode of Access	TSM	Freeway Transit	Starter Line
Walk	1,096	1,574	1,516
Minibus	180	238	246
DPM	1,090	1,466	1,415
RTD Bus	189	251	244
TOTAL	2,555	3,529	3,421

Union Station

Mode of Access	TSM	Freeway Transit	Starter Line
Walk	280	213	307
Minibus	155	127	112
DPM	1,793	1,497	1,676
RTD Bus	211	173	200
TOTAL	2,439	2,010	2,295

North/South DPM Ridership, 1990
PM Peak Hour

Plan Alternative	Boardings (Unlinked Trips)		Transfers		Riders (Linked Trips)	Percent
TSM						
Northbound	6,235	-	787	=	5,448	59.1
Southbound	4,632	-	859	=	3,773	40.9
TOTAL	10,867	-	1,646	=	9,221	100.0
Freeway Transit						
Northbound	5,993	-	810	=	5,183	55.6
Southbound	4,981	-	842	=	4,139	44.4
TOTAL	10,974	-	1,652	=	9,322	100.0
Starter Line						
Northbound	6,128	-	868	=	5,260	57.1
Southbound	4,805	-	850	=	3,955	42.9
TOTAL	10,933	-	1,718	=	9,215	100.0

Number of DPM Trips To/From Intercept Stations
P.M. Peak Hour, 1990
TSM Scenario

Convention Center	Off	On	Total	
Regional Transit Users	1,090	262	1,352	×6.747 =
Auto Users	734	216	950	9,122
Others*	254	377	631	
Total	2,078	855	2,933	

Union Station	Off	On	Total	
Regional Transit Users	1,793**	378	2,171	×6.747 =
Auto Users	1,077	321	1,398	14,648
Others*	0	0	0	
Total	2,870	699	3,569	

TOTAL 23,770

*Circulation Trips

**Includes 1,597 DPM riders who transfer to El Monte Busway Buses.

Number of DPM Trips To/From Intercept Stations
P.M. Peak Hour, 1990
Freeway Transit Scenario

Convention Center	Off	On	Total
Regional Transit Users	1,466	337	1,803
Auto Users	708	209	917
Others*	244	349	593
Total	2,418	895	3,313

Union Station	Off	On	Total
Regional Transit Users	1,497**	320	1,817
Auto Users	1,045	312	1,357
Others*	0	0	0
Total	2,542	632	3,174

*Circulation Trips

**Includes 1,300 DPM riders who transfer to El Monte Busway Buses.

Number of DPM Trips To/From Intercept Stations
P.M. Peak Hour, 1990
Starter Line Scenario

Convention Center	Off	On	Total
Regional Transit Users	1,415	326	1,741
Auto Users	677	200	877
Others*	250	371	621
Total	2,342	897	3,239

Union Station	Off	On	Total
Regional Transit Users	1,676**	416	2,092
Auto Users	997	298	1,295
Others*	0	0	0
Total	2,673	714	3,387

*Circulation Trips

**Includes 1,444 DPM riders who transfer to El Monte Busway buses.

APPENDIX E

Additional Tabulations for DPM Fare Sensitivity Analysis Runs

The pages which follow contain a number of additional tabulations prepared by CRA of the results obtained in running the following alternatives used in the DPM fare sensitivity analysis:

- The TSM base case, with a DPM fare of 15 cents in 1978 dollars
- DPM fare of 25 cents.

These alternatives are described in detail in Section III.D. Section II.D.2 also discusses the results of the sensitivity analyses.

INTERNAL MODE CHOICE--P.M. PEAK HOUR

	Internal CDS Mode				
Plan Alternative	Walk*	Mini Bus	DPM	RTD Bus	Total
Regional Transit Users					
15¢ Fare	47,023 82.1%	1,985 3.5%	5,062 8.8%	3,194 5.6%	57,264 100.0%
25¢ Fare	47,076 82.2%	2,005 3.5%	4,949 8.6%	3,234 5.7%	57,264 100.0%
Regional Auto Users					
15¢ Fare	62,145 95.5%	164 0.3%	2,382 3.7%	341 0.5%	65,032 100.0%
25¢ Fare	62,190 95.7%	166 0.3%	2,275 3.5%	339 0.5%	65,032 100.0%
Total P.M. Peak Hour					
15¢ Fare	109,168 89.3%	2,149 1.8%	7,444 6.1%	3,535 2.8%	122,296 100.0%
25¢ Fare	109,266 89.4%	2,171 1.8%	7,224 5.9%	3,573 2.9%	122,296 100.0%

* Walk is defined as individiudals who (a) depart on bus and walk to bus stop (i.e., self-distribute); or (b) depart in auto and walk to parking lot.

INTERNAL MODE CHOICE--NOON HOUR

	Internal CDS Mode					
Plan Alternative	Walk	Auto	Mini Bus	DPM	RTD Bus	Total
Workers						
15¢ Fare	21,084 49.1%	17,456 40.7%	1,360 3.2%	2,312 5.4%	686 1.6%	42,898 100.0%
25¢ Fare	21,094 49.3%	17,460 40.8%	1,360 3.1%	2,220 5.2%	686 1.6%	42,820 100.0%
Non-Workers						
15¢ Fare	13,059 64.4%	6,582 32.5%	114 0.6%	260 1.3%	251 1.2%	20,266 100.0%
25¢ Fare	13,076 64.5%	6,595 32.5%	114 0.6%	233 1.1%	251 1.2%	20,269 100.0%
Total Noon Hour						
15¢ Fare	34,143 54.1%	24,038 38.1%	1,474 2.3%	2,572 4.1%	937 1.4%	63,164 100.0%
25¢ Fare	34,170 54.2%	24,055 38.1%	1,474 2.3%	2,453 3.9%	937 1.5%	63,089 100.0%

ESTIMATED DPM RIDERSHIP, 1990
Fare Sensitivity Analysis

	15¢ Fare	25¢ Fare	% of Change
Internal-Extenral Trips (Distribution)			
Peak Hour (PM)			
Regional transit users	5,062	4,949	-2.2
Auto users	2,382	2,275	-4.5
TOTAL	7,444	7,224	-3.0
Daily			
Regional transit users	34,159	33,396	-2.2
Auto users	12,529	11,967	-4.5
TOTAL	46,688	45,363	-2.8
Internal - Internal Trips (Circulation)			
Peak Hour (PM)	1,777	1,695	-4.6
Noon Hour	2,572	2,453	-4.6
Daily	25,720	24,530	-4.6
Total Daily DPM Trips (Circulation/ Distribution)			
Internal - External	46,688	45,363	-2.8
Internal - Internal	25,720	24,530	-4.6
TOTAL DAILY	72,408	69,893	-3.5

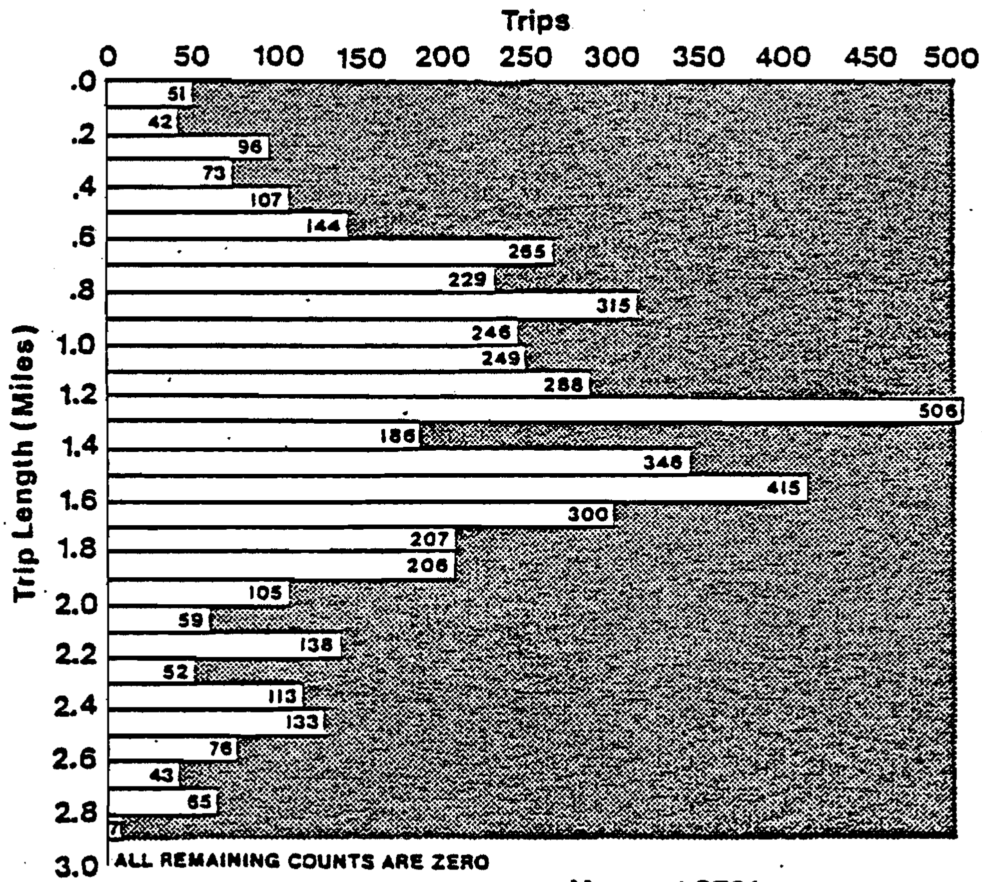
APPENDIX F

Average Trip Lengths

The pages which follow contain a graphical display of the distribution of DPM regional transit user trips by increments of trip length in 0.1 mile units. Also included are tabulations of the averages, standard deviations, and variances of trip lengths by alternative, market segment, and mode.

PEOPLE MOVER TRIPS DISTRIBUTED BY TRIP LENGTH

Regional Transit Users, P.M. Peak Hour, 1990. TSM Scenario



Mean = 1.3791
S.D. = .5979
Var. = .3575

Predicted Average Trip Length (Miles)
Distribution Trips in PM Peak Hour, 1990
TSM Scenario

Regional Transit Users	Mean	Standard Deviation	Variance
Walk	0.4328	.3161	.0999
Minibus	1.1411	.4547	.2068
DPM	1.3791	.5979	.3575
RTD Bus	1.1585	.4412	.1946

Auto Users (Outbound)			
Walk	.2938	.2358	.0556
Minibus	.7101	.2404	.0578
DPM	.8476	.1581	.0250
RTD Bus	.7948	.2527	.0639

Predicted Average Trip Length (Miles)
Circulation Trips in the Noon Hour, 1990
TSM Scenario

Workers	Mean	Standard Deviation	Variance
Walk	0.4137	.3019	.0911
Auto	1.2560	.5076	.2576
Minibus	1.3673	.5045	.2545
DPM	1.4212	.5106	.2607
RTD Bus	0.7835	.2728	.0744
Nonworkers			
Walk	0.3364	.2319	.0537
Auto	1.1294	.4700	.2209
Minibus	1.0588	.3886	.1510
DPM	1.2173	.5112	.2613
RTD Bus	0.6701	.2389	.0571

Predicted Average Trip Length (Miles)
Distribution Trips in PM Peak Hour, 1990
Freeway Transit Scenario

Regional Transit Users	Mean	Standard Deviation	Variance
Walk	0.4900	.3512	.1233
Minibus	1.4627	.5592	.3127
DPM	1.7890	.7224	.5218
RTD Bus	1.4775	.5385	.2900

Auto Users (Outbound)	Mean	Standard Deviation	Variance
Walk	.2940	.2356	.0551
Minibus	.7009	.2359	.0564
DPM	.8459	.1548	.0239
RTD Bus	.8008	.2615	.0684

Predicted Average Trip Length (Miles)
Circulation Trips in the Noon Hour, 1990
Freeway Transit Scenario

Workers	Mean	Standard Deviation	Variance
Walk	0.4137	.3019	.0911
Auto	1.2560	.5076	.2576
Minibus	1.3673	.5045	.2545
DPM	1.4212	.5106	.2607
RTD Bus	0.7835	.2728	.0744

Nonworkers	Mean	Standard Deviation	Variance
Walk	0.3364	.2319	.0537
Auto	1.1294	.4700	.2209
Minibus	1.0588	.3886	.1510
DPM	1.2173	.5112	.2613
RTD Bus	0.6701	.2389	.0571

Predicted Average Trip Length (Miles)
Distribution Trips in the PM Peak Hour, 1990
Starter Line Scenario

Regional Transit Users	Mean	Standard Deviation	Variance
Walk	.5039	.3382	.1144
Minibus	1.3084	.5004	.2505
DPM	1.7787	.7555	.5707
RTD Bus	1.3784	.5238	.2744

Auto Users (Outbound)			
Walk	.2940	.2356	.0555
Minibus	.7091	.2380	.0566
DPM	.8454	.1559	.0243
RTD Bus	.7988	.2521	.0636

Predicted Average Trip Length (Miles)
Circulation Trips in the Noon Hour, 1990
Starter Line Scenario

Workers	Mean	Standard Deviation	Variance
Walk	.4137	.3020	.0912
Auto	1.2557	.5071	.2572
Minibus	1.3487	.4795	.2299
DPM	1.4194	.5086	.2586
RTD Bus	.7853	.2773	.0769
Nonworkers			
Walk	.3365	.2322	.0539
Auto	1.1299	.4692	.2201
Minibus	1.0504	.3690	.1361
DPM	1.2050	.4918	.2419
RTD Bus	.6681	.2323	.0539

Predicted Average Trip Length (Miles)
Distribution Trips in the PM Peak Hour
TSM/25¢ Fare Scenario

Regional Transit Users	Mean	Standard Deviation	Variance
Walk	0.4885	.3529	.1245
Minibus	1.4859	.5613	.3150
DPM	1.8495	.7096	.5036
RTD Bus	1.4918	.5303	.2812
Auto Users (Outbound)			
Walk	.2939	.2358	.0556
Minibus	.7077	.2279	.0519
DPM	.8458	.1552	.0241
RTD Bus	.7970	.2560	.0655

Predicted Average Tip Length (Miles)
Circulation Trips in the Noon Hour, 1990
TSM/25¢ Fare Scenario

Workers	Mean	Standard Deviation	Variance
Walk	0.4139	.3022	.0913
Auto	1.2558	.5076	.2577
Minibus	1.3674	.5045	.2545
DPM	1.4267	.5244	.2750
RTD Bus	0.7850	.2752	.0757

Nonworkers	Mean	Standard Deviation	Variance
Walk	0.3371	.2339	.0547
Auto	1.1311	.4694	.2204
Minibus	1.0526	.3889	.1513
DPM	1.2288	.4709	.2217
RTD Bus	0.6689	.2367	.5601