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Urban Mass
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planning for downtown circulation systems

appendices
volume 3

final report

october 1983

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16. Abstract

This document provides a compendium of state-of-the-art methods and data for planning downtown circulation systems. The report is divided into three volumes.

Volume 1 -- Planning Concepts comprises the first six sections of the report. Its focus is on the concept stage of the downtown circulator planning process. Included are sections on the development of goals and objectives, generation of alternative conceptual designs, familiarization with important planning issues, and crude feasibility studies of alternative systems. An additional section is included on institutional factors related to downtown circulator planning.

Volume 2 -- Analysis Techniques contains the last five sections of the report. Its emphasis is on the analysis and refinement stages of downtown circulator planning. Included are sections on methods for estimating patronage, costs, revenues, and impacts, and a section on methods for performing micro-level analyses.

Volume 3 -- Appendices contains worksheets for estimating circulator patronage, costs, revenues and travel impacts, detailed discussions of estimation and application procedures for the demand models developed, and a case study of the models' application using a Los Angeles downtown people mover example.

17. Key Words
downtown circulation, circulator systems, DPM, feasibility analysis, demand, cost, revenue, impact estimation, manual sketch planning, computerized network analysis, planning process

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NOTICE

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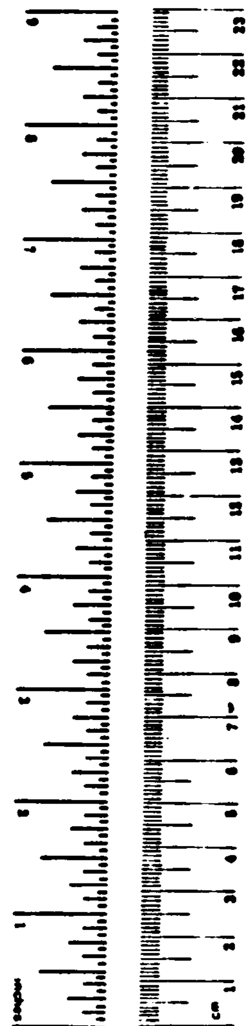
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

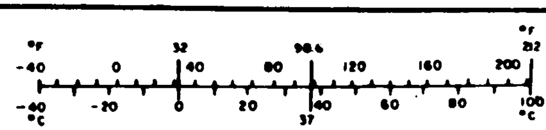
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

In response to widespread interest, yet general lack of knowledge of Downtown People Mover (DPM) systems in the mid to late 70's, the Urban Mass Transportation Administration (UMTA) sponsored the production of a comprehensive compendium of state-of-the-art planning concepts and methods applicable to DPM systems. The compendium, which for expedience was published in draft report form in 1979 under the title, DPM -- Planning for Downtown People Mover Systems, was distributed to numerous local, state and federal agencies, public libraries and private consultants. The draft report received favorable reviews regarding its usefulness and breadth of coverage of downtown circulation planning. Many valuable suggestions were also received with respect to possible improvements to the methods and descriptions in the report.

Based on the responses received and the large expressed demand for a revised version of the report, the report presented herein was produced. It incorporates: fully revised, more easily understood sections and appendices on demand estimation, including a new appendix covering computer-aided demand model application and an updated Los Angeles case study; updated cost estimation techniques and cost tables; and other suggested revisions, updates and corrections to the earlier draft. In recognition of the general applicability of the methods described in the report to downtown circulation planning, the title and portions of the text have been broadened. Thus, although DPM examples remain dominant in the discussions, other potential circulator methods such as shuttle bus, light rail, busways and paratransit can also be considered in the context of the planning concepts and techniques presented.

This three-volume report was prepared by the Urban and Regional Research Division of the Transportation Systems Center under project funding from the Urban Mass Transportation Administration's Office of Planning Methods and Support. Project direction and coordination were the responsibility of Donald Ward and Michael Couture. Thomas Dooley was a major contributor. Other TSC participants were Simon Prensky, Samuel Schiff, and Michael Jacobs.

Major portions of the report were prepared by the firm of Cambridge Systematics, Inc. under the direction of William Loudon. Other major contributors were Earl Ruiter, Wendy P. Stern, Ellyn Eder, and Lajos Heder of Moore-Heder Architects (under subcontract to Cambridge Systematics). Also contributing to the report were Richard Albright and James Wojno.

Peat, Marwick, Mitchell & Co. had major responsibility for preparing the revised sections and appendices on circulator demand estimation. Mark Goldman was project manager and Lawrence Bowman was a principal participant.

A major section of the report was developed by the Regional Plan Association under the direction of Jeffrey Zupan. Robert Cumella was also a major contributor. Also participating was Boris Pushkarev.

Project specification, overall program guidance and valuable suggestions were provided by Granville E. Paules, Acting Director of the Office of Planning Methods and Support, Urban Mass Transportation Administration.

The final report was designed and produced under the direction of Michael Couture of TSC. Major editorial assistance was provided by Theresa McTague. Donna D'Alessandro and Vera Ward also assisted in the preparation of the manuscript.

The Urban Mass Transportation Administration would appreciate hearing of applications of the approaches or information contained in this report. Also, please address any comments and suggestions you may have to:

Mr. Granville E. Paules, Chief
Methods Division
Office of Methods and Support
Urban Mass Transportation Administration (URT-41)
U.S. Department of Transportation
Washington, DC 20590

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(Bound Separately)

VOLUME 2 -- ANALYSIS TECHNIQUES
(Bound Separately)

VOLUME 1 -- PLANNING CONCEPTS
(Bound Separately)

VOLUME 2 -- ANALYSIS TECHNIQUES
(Bound Separately)

A. MODELING THE DEMAND FOR TRAVEL BY DOWNTOWN CIRCULATOR SYSTEMS

A.1 INTRODUCTION

A.1.1 Background

The Activity Center Model (ACM) demand estimation methods discussed in Section 7 are based on travel demand models developed using data collected in the Los Angeles central business district (CBD). This section presents the development of the models in terms of the survey data used, the travel behavior represented, the models' mathematical structure and assumptions, and the estimated coefficients.

The ACM travel demand models were originally developed to represent observed travel decisions made in the Los Angeles downtown area in 1975.[1] At that time, the local transit agency (Southern California Rapid Transit District) was operating minibus service with 20-passenger buses to provide circulation and distribution service in the downtown area.

The ACM models were refined in 1980 based on the results of two major surveys: a workplace employee survey and an onboard transit survey.[2] The minibus service was still in operation although the fare had risen to twenty cents, up from ten cents in 1975.

A.1.2 Objectives

The goal of travel demand analysis for circulator systems is to estimate the expected ridership on a proposed system. Ridership estimates are needed to: (a) evaluate the need for the system; (b) compute the projected farebox revenues; (c) determine the number of vehicles required; and when necessary (d) permit appropriate station sizing.

The ACM demand models were designed to address two specific objectives:

(1) to estimate the probable use of a circulator system for the distribution within the CBD of trips which begin or end outside the CBD (i.e., internal-external trips); and

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[1] Models and Estimates of Los Angeles DPM Demand, prepared for the Los Angeles Community Redevelopment Agency, Cambridge Systematics, Inc., October 1978.

[2] Downtown People Mover Evaluation Program, prepared for the Los Angeles Downtown People Mover Authority, Peat, Marwick, Mitchell & Co., August 1981.

(2) to estimate the probable use of a circulator system for circulation travel within the CBD, such as midday trips by CBD-workers (i.e., internal-internal trips).

The ridership forecasts can be used to estimate the value or benefit of using the circulator system for travel in the CBD rather than some other mode. The following example impact measures are estimated from ridership forecasts:

- congestion and resulting delays;
- air and noise pollution;
- parking availability; and
- the effect on accessibility within the CBD.

A.1.3 Organization of Appendix A

Following this Introduction, Section A.2 provides an overview of the demand estimation process and explains how the ACM model is structured to treat the separate travel markets which the circulator system serves. Section A.3 then describes the development and calibration of the ACM models. Section A.3 first provides a conceptual explanation of model calibration. It then addresses the calibration process and final results for the ACM models applied to each of three travel market segments.

A.2 DEMAND ESTIMATION OVERVIEW

A.2.1 Analysis Structure

A key input to the development of ridership projections for circulator services, and the establishment of a valid basis for before-and-after impact assessment, is the careful identification of travel markets which may be served by the circulator system. Once these markets are identified, data collection methodologies can be chosen to gather information on the travel characteristics of each market. The data collection methodologies will influence the structure of the overall analysis procedure.

Two other design inputs to the analysis process are the assumed zone structure and the selection of forecast study years for which CBD circulation travel estimates must be determined. The travel markets to be analyzed, the zone structure for the development of networks, and the selection of forecast study years are discussed in the following sections.

Travel Markets

The travel markets served by a downtown circulator system are discussed in Section 2. These market segments are defined to recognize the fact that people behave differently when traveling for different reasons. The greater homogeneity of trip and trip maker characteristics within these market segments is intended to improve the ability of the choice models to predict traveler decisions. Market segments were created according to four travel characteristics:

(1) trip type: trips were categorized as circulation trips, trips entirely contained in the CBD, and distribution trips, trips with one end inside and one end outside the CBD.

(2) trip purpose: while many trip purposes are possible, the circulator travel markets are classified as home-to-work trips and other (non-work) trips.

(3) trip maker type: trip makers were categorized as CBD-workers and others (i.e., non CBD-workers). The distinction of working in the CBD study area was considered the most important characteristic in terms of influencing the travel decision process.

(4) regional access mode: the likelihood of a person using the circulator system may be influenced by the mode used to reach the CBD, such as auto, bus, train, or other. This model classifies travelers to the CBD as regional auto or regional transit users.

Each of these four dimensions has been divided into two classifications. Exhibit A-1 illustrates the sixteen market segments created by the combinations of these four dimensions.

Six of the market segments in Exhibit A-1 will not exist and can be eliminated. Home-to-work circulation trips for others (not CBD-workers) are not possible. Home-to-work circulation trips are possible for CBD-workers but these trips will be considered as a special case of home-to-work distribution travel. Finally, home-to-work distribution trips are not possible for others (this disregards the insignificant possibility of a reverse distribution commute by a person living in the CBD and working outside the study area).

Two additional market segments are eliminated because they represent unusual circumstances. Non-work distribution trips by CBD-workers could include midday trips to areas outside the CBD,

EXHIBIT A-1

CIRCULATOR MARKET PRIORITIES

		CBD-Worker		Other (Non CBD-Worker)	
		Regional Access Mode		Regional Access Mode	
		Auto	Transit	Auto	Transit
Distribution Travel	Home-Work	1	1	na	na
	Non-Work	na	na	3	3
Circulation Travel	Home-Work	na	na	na	na
	Non-Work	2	2	3	3

1 - First priority markets.

2 - Second priority markets.

3 - Third priority markets.

na - Not applicable for a circulator system.

or evening trips to the CBD. Neither of these is considered a likely candidate for circulator service.

The remaining eight market segments are gathered into three groups for modeling purposes, indicated in Exhibit A-1 by the numbers 1, 2 or 3:

(1) CBD-worker distribution trips;

(2) CBD-worker circulation trips; and

(3) Other trips (not CBD-workers), both circulation and distribution.

The analysis focuses on CBD-workers as the primary market for a circulator service. They may use it for the distribution portion of their daily home-to-work commute (market 1) and also for circulation travel within the CBD, such as noon hour lunch trips (market 2). Travel by others is less regular and usually occurs throughout the day rather than being concentrated like worker related trips. Since the number of other trips will have few if any implications for system design and capacity, both distribution and circulation travel are grouped together (market 3).

Zone Structure

The zones into which the CBD is geographically divided affect the number of calculations and therefore the cost of the demand estimation. The zone system is also used to code the networks representing the transportation services provided between locations in the CBD.

The sizes of zones and the zone boundaries are established using the following criteria:

- zones take advantage of homogeneous land use activities whenever possible. For example, a garment district would probably be comprised of a number of blocks which have similar employee characteristics;

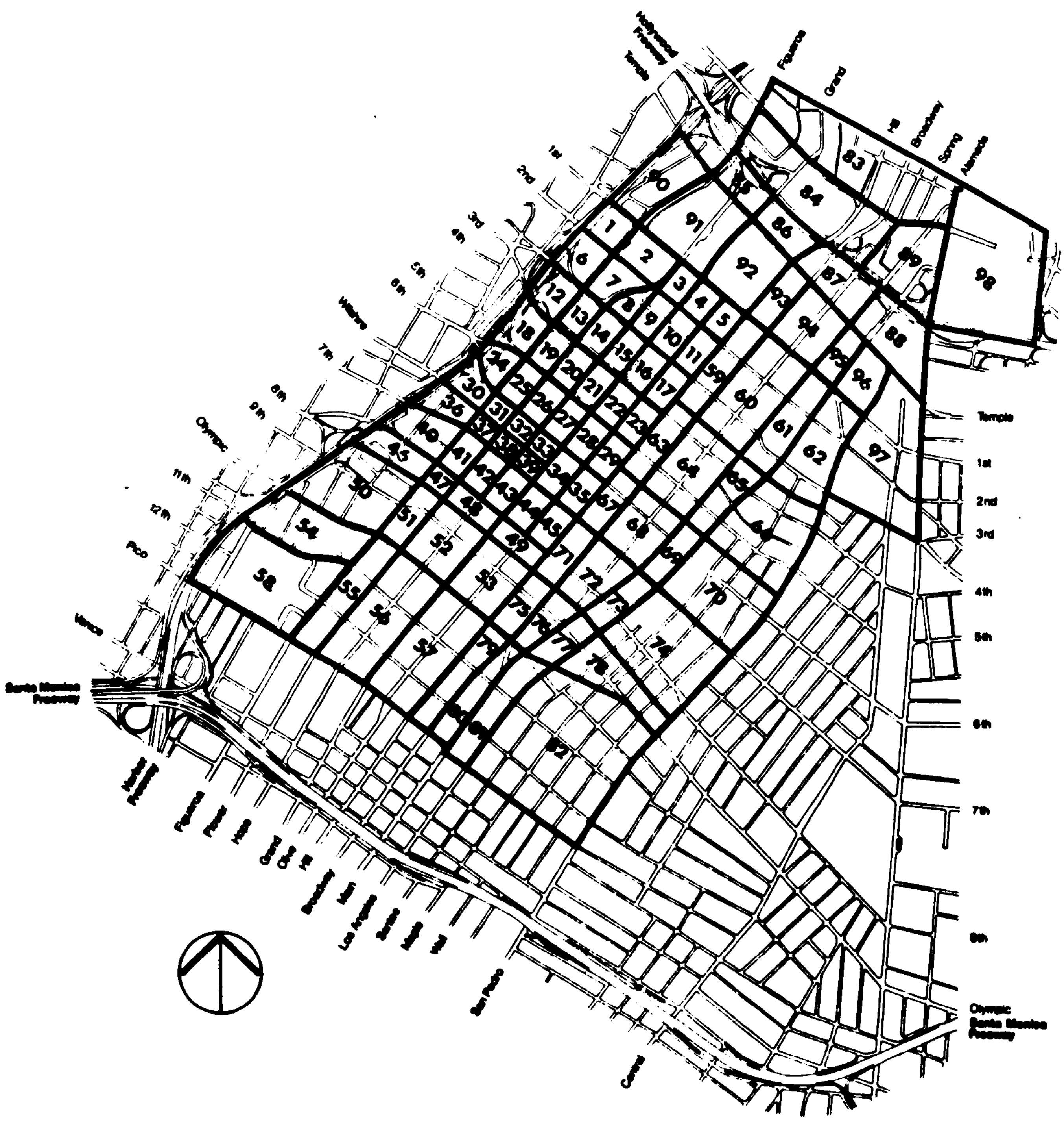
- larger zones (less detail) can be created at farther distances from the circulator system alignment; and

- larger zones can be created for lower employment density areas.

The Los Angeles CBD was divided into 98 zones (see Exhibit A-2). The region outside the Los Angeles CBD was divided into nine regional corridors of approach. The corridor or origin of a distribution trip is important because it determines the path a

EXHIBIT A-2

LOS ANGELES STUDY AREA
BOUNDARIES & ANALYSIS ZONES



regional transit user will follow when traveling to the CBD and therefore determines the bus stop where a regional transit user exits the bus in the CBD.

Forecast Years

Forecast years must be specified in order to estimate the growth which the circulator system must be designed to accommodate. Ridership estimates for the Los Angeles system were developed for the years 1985, 1990, and 2000.

A.2.2 Modeling Structure

The ACM circulator travel model system includes three distinct model procedures to estimate ridership for three travel market segments. The three models address the following trip types:

- CBD-Worker Distribution Trips. This model estimates ridership on the circulator system for the distribution portion of regional trips to the CBD. For regional auto trips the distribution portion is defined as the connection from the parking lot to the traveler's destination. For regional transit trips the distribution portion is defined as the connection from the transit stop where the traveler first exits the transit vehicle in the CBD to the traveler's destination;

- CBD-Worker Circulation Trips. This model estimates ridership on the circulator system for midday circulation travel in the CBD by CBD-workers. A CBD-worker circulation trip is defined as a trip which leaves the building where a person works but remains entirely within the CBD study area. This model uses a two-step process: the first step is a frequency/destination choice and the second step is a mode choice; and

- Other Distribution and Circulation Trips. This model estimates ridership on the circulator system by other than CBD-workers. Two methods are presented: a logit model for trip generation, distribution, and mode choice; and a Fratar trip table factoring approach.

A.3 MODEL DEVELOPMENT AND CALIBRATION

A.3.1 Calibration Overview

The models developed for estimating downtown transit ridership are classified as disaggregate behavioral choice models and have the mathematical form of the logit model. This mathematical form is well suited to modeling choice behavior for a number of reasons:

(1) The logit model directly predicts the share, or fraction, of travelers who choose each alternative. 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 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.

(2) 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 downtown trips. A joint model of these two choices would predict the fractions of trip makers 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 automatically reflecting the competition which may exist between walking to a nearby destination, or using the circulator system to reach a destination far away. This competition between related choices can also be incorporated in single choice models by a process called "chaining."1/

(3) The logit model can be calibrated relatively inexpensively. It is derived from disaggregate data, data on the behavior of individual trip makers. A sufficient number of observations can be obtained with a relatively modest travel survey.

Behavorial choice models involve comparisons of the disutilities or costs of each of the alternatives available to a decision maker. These disutilities are then used in an exponential relationship, the logit equation, to compute the probabilities of the decision maker choosing each of the alternatives.

A truly disaggregate behavioral model requires socioeconomic and travel data on the individual decision makers. In practice,

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1/The process of chaining logit models for joint decisions is discussed in section A.3.1.

the models are frequently used to predict choice behavior for populations for which only average or aggregate data are available. If the models are not used to predict individual choice probabilities, they are not being used in a strictly disaggregate manner and more appropriately represent the behavior of an average person. It is assumed that the choice probabilities of an average decision maker will closely correspond to the aggregate behavior of a large number of decision makers who are modeled individually.

A disutility, U_c, is the cost to a decision maker of choosing alternative C. The disutility of an alternative is assumed to be a linear function of its characteristics. The relative importance or cost of a characteristic (such as travel time) is determined by the estimated parameters or coefficients, b_o, b_1, ... b_n:

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

where X_{ci} is either a characteristic of the decision maker, i, a characteristic of the choice being made, c, or a combined characteristic of both. Examples of these characteristics include:

- characteristics of the decision maker: employment, income, age;
- characteristics of the alternative: for a choice of travel modes these would include the travel time and travel cost; and
- combined characteristics: the travel cost divided by a trip maker's hourly wage.

Once the relevant variables (X's) have been determined, a statistical estimation technique is used to compute their weights or coefficients. The disutilities, U_c, can then be obtained for each alternative by inserting the values of the variables (X's) into the disutility equation.

The utility expressions represent the systematic portion of the behavior underlying individual decision makers' choices. There is also a random element which includes the relevant factors not captured in the utility expression and the differences between individual decision makers. The presence of a random element in the behavioral model is demonstrated by the prediction of probabilities rather than certainties of choices. Alternatives with higher utilities (i.e., lower disutilities) will have higher probabilities of being chosen. This relationship is captured in the mathematical form of the logit model:

$$P_c = \frac{e^{u_c}}{\sum_{\substack{\text{all available} \\ \text{choices, } i}} e^{u_i}}$$

where:

P_c is the probability, or fraction of decision makers expected to make choice c; and

e is the base of natural logarithms, 2.718.

Logit models are calibrated using disaggregate data, that is, data on the choices made by individual decision makers. The first step in model calibration is to specify a logical combination of variables. The variables in the utility expressions should exert a causal influence on the utility to the decision maker of choosing that alternative.

After a logical combination of variables is specified, coefficients are estimated which reflect the relative importance to the decision maker of the variables in the utility expression. These coefficients are estimated by a mathematical process which obtains the "best fit" of the choice model to the observed behavior. The logit models in this report were calibrated using the ULOGIT computer program in the Urban Transportation Planning System (UTPS) software package. The "best fit" is obtained by a process called maximum likelihood estimation (MLE). This computes the model coefficients which, if true, maximize the likelihood that the observed behavior would have occurred. The ULOGIT program is designed to calibrate models with at most ten alternatives. The influence of this constraint on the calibration process will be discussed as part of the individual model explanations in Sections A.3.2 through A.3.4.

Three logit models were developed to estimate ridership on CBD circulator systems. These models were developed with data collected in Los Angeles.1/ The logit models are not independent of one another; two are applied as "chained" models. Chaining refers to the use of two (or more) logit models in sequence

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1/<u>Downtown People Mover Evaluation Program</u>, prepared for the Los Angeles Downtown People Mover Authority by Peat, Marwick, Mitchell & Co., August 1981.

to predict the related decisions in a joint decision process. A chain was created to predict (1) the destination for a midday circulation trip, and (2) the mode choice for traveling to the destination.

The sequential application of two logit models affects the mathematical characteristics of the joint probability. In order to preserve the logit properties in the joint probability a "LOGSUM" variable is added to one of the logit models. The LOGSUM variable added to one of the logit models is the natural logarithm of the denominator of the other logit model in the chain.[1/]

$$\text{LOGSUM} = \ln \left(\sum_{i}^{\text{all choices}} e^{u_i} \right)$$

The data for model calibration include survey data, network characteristic data, and zonal data. These data are discussed in Appendix B.

A.3.2 Distribution of CBD-Worker Regional Trips

The trip tables used in this model are for regional travel to the CBD. The CBD circulator system only serves as an alternative mode to distribute these regional trips from their points of entry in the CBD to their eventual destinations. A two-step process was developed to:

- identify CBD distribution trips from regional trip tables; and
- predict the mode choice for the CBD distribution trip.

A.3.2.1 Create CBD Distribution Trips

CBD distribution trips are defined as trips to the CBD workplace from (a) the transit stop where the CBD-worker first exits the transit vehicle in the CBD for regional transit users or (b) the parking lot in the CBD for regional auto users. The method used in Los Angeles to determine the stop where trip makers must exit their regional mode was a manual coding of potential exit

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[1/] For a more rigorous explanation of the LOGSUM variable, see "Travel Model Development Project: Phase II Final Report Volume II Detailed Model Descriptions," Metropolitan Transportation Commission, San Francisco, California, prepared by Cambridge Systematics, Inc., June 1980.

points determined from inspection of bus route maps. This coding of exit points was done by corridor of approach and the information was used by a program called BUSSTOP to create trip tables for distribution trips by transit users. (See DPM Travel Prediction System Users' Manual, CSI, 1978.)

A technique must also be used to predict the parking location of workers entering the CBD by auto. The distribution trip mode choice model then predicts the mode used to travel between the parking location and the place of work. Parking location choice, however, is a complex phenomenon reflecting tradeoffs between parking cost and proximity to place of employment, which is further complicated by the availability of restricted and/or subsidized parking.

A logit model was developed to predict the choice of parking lot locations for regional auto trips to the CBD. Trip tables were created for the trips from the chosen parking lots to the workplace destinations. These trip tables and the trip tables created for transit users were then used to estimate the mode choice model for CBD distribution trips.

Parking Lot Choice Set

Information on trip patterns and parking lot locations for people who drive to the CBD was obtained from a workplace survey conducted in Los Angeles during May-June 1980 (See Appendix B). Pertinent information included the regional origin of the trip to work, the zone where the car was parked, and the workplace zone. The regional origin establishes the corridor of approach to the CBD and the distance from the corridor boundary at the CBD to the parking zone determines the relative cost of driving to the parking zone. The cost of driving to a zone is included in the utility expression of the parking lot choice model.

Two criteria were used to accept records from the workplace survey to calibrate the parking lot choice model:

(1) the survey trip record must be for a traveler who drives to work; and

(2) the survey trip record must have valid locations for the regional trip origin, the CBD parking zone, and the CBD workplace.

For each record accepted for use in model calibration it was necessary to define the choice set from which the specific parking zone was chosen. Technically, a traveler can park in any of the 98 CBD zones which contain parking spaces. However, the UTPS calibration program, ULOGIT, is restricted to choices among at most 10 alternatives. The choice set for an individual trip record was defined by choosing 10 representative zones from the 98 CBD parking zones.

Data on observed parking lot choices were used to identify the representative set of 10 zones. Two lists were created for each workplace: (a) a high priority list of up to three highly preferred parking zones, and (b) a larger list of all the parking zones used by the employees for a given workplace.

A four step process selected the ten (10) representative parking zones for a given work trip record:

(1) the chosen parking zone was included as one of the alternatives;

(2) up to three zones were chosen from the list of highly preferred parking zones;

(3) a number of parking zones were chosen from a second preferred parking zone list. The number of alternative zones chosen was the lesser of the number of zones listed for the specific workplace zone or the number needed to complete the set of ten zone choices; and

(4) parking zones were chosen at random from the 98 CBD zones if a set of ten alternatives was not yet identified.

Parking Lot Calibration Results

The UTPS computer program ULOGIT was used to calibrate the "best fit" coefficients to the parking lot choice model. The final structure of the modal utility expressions is presented in Exhibit A-3.

The LOGSUM variable expression in Exhibit A-3 is the denominator of the mode choice model for distribution trips for all available modes between the workplace and the parking lot zone. The LOGSUM variable causes the product of the distribution mode choice model and the parking lot choice model to retain the characteristics of the logit distribution. The LOGSUM variable must remain unchanged to perform its mathematical function so its coefficient is fixed equal to 1.0.

EXHIBIT A-3

UTILITY EXPRESSIONS FOR THE PARKING LOT CHOICE MODEL

Mode		Coefficient		Variable	t-statistic
U(Zone i)	=	-5.9063	*	walk distance	26.84
		-0.4508	*	parking cost	6.53
		+1.0	*	LOGSUM	1/

where: walk distance = the distance from the workplace to the parking zone in miles.

park cost = one half the daily parking cost plus 12.8 cents per mile times the distance from the corridor of approach to the parking zone (expressed in 1980 dollars).

LOGSUM = the natural logarithm of the sum of the modal utility expressions for the distribution mode choice model, evaluated between the workplace and a parking zone.

1/This coefficient is fixed at 1.0.

A.3.2.2 Mode Choice Model for Distribution Trips

Choice Set

The modes available in Los Angeles for the CBD distribution trip during the calibration process were walk, regional bus, and minibus. The DPM mode was added after model calibration. Distribution trips were defined from information on individual workplace surveys. The origin of the distribution trip depends on the mode used to travel to the CBD. For people who drive downtown, the distribution trip begins where they park their car, and for people who arrive in the CBD by bus, the distribution trip begins where they first exit the bus in the CBD. The destination of the distribution trip is simply the traveler's workplace.

Two acceptance criteria were used to select workplace survey trip records for the calibration of the distribution trip mode choice model:

(1) the survey trip record must have valid locations for the regional trip origin, the CBD distribution trip origin, and the workplace; and

(2) all three mode alternatives must be available for the distribution trip.

Calibration Results

The UTPS computer program ULOGIT was used to determine the "best fit" coefficients for a number of model structures. The initial structure tested was based on the preliminary model developed for the Los Angeles Community Redevelopment Authority by Cambridge Systematics, Inc. The models were modified by Peat Marwick to reflect the observed behavior reported in an extensive data base collected in May and June of 1980. A modal bias constant was then computed to reflect the unique characteristics of automated DPM circulator systems. The final structure of the modal utility expressions is presented in Exhibit A-4.

The coefficient of the regional bus and minibus fare variable was not freely determined by the calibration process. When left unconstrained in the calibration process, the coefficient of fare took on an unrealistically large value which implied a value of time of nearly zero dollars per hour. This problem also occurred in the preliminary analysis for the Los Angeles DPM project conducted by CSI.1/ The regional bus and minibus

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1/ Models and Estimates of Los Angeles DPM Demand, prepared for the Los Angeles Community Redevelopment Agency, Cambridge Systematics, Inc., October 1978.

EXHIBIT A-4

UTILITY EXPRESSION FOR THE MODE CHOICE MODEL
FOR DISTRIBUTION TRIPS

Mode		Coefficient		Variable	t-statistic
U (walk)	=	-0.5087	*	walk time	4.88[1]
		+5.0414			4.86[5]
U (regional bus)	=	-0.4581	*	vehicle run time	1.86[1]
		-0.5743	*	wait time	5.04[1]
		-2.749	*	fare	[2]
		+3.1928	*	transit access dummy	3.39
		+0.6818			1.12[5]
U (circulator bus)	=	-0.4581	*	vehicle run time	1.86[1]
		-0.5743	*	wait time	5.04[1]
		-2.749	*	rare	[2]
		+3.1928	*	transit access dummy	3.39
U (automated DPM)	=	-0.4581	*	vehicle run time	[3]
		-0.5743	*	wait time	[3]
		-2.749	*	fare	[3]
		+3.1928	*	transit access dummy or station integration	[4]
		+0.995			[5]

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[1] The three time coefficients were determined first. The fare coefficient was then computed based on a $10 per hour value of walk time, and the calibration program was run again to determine the modal bias and access mode dummy coefficients.

[2] The fare coefficient is computed as a $10 per hour value of walk time.

[3] The DPM mode was not included during calibration.

[4] A regional auto user who parks at an integrated DPM is treated similar to a regional transit user. See Section A.3.2.2. Estimate DPM Bias.

[5] Three modal bias constants are used to differentiate between the four modes.

modes have flat fare structures which do not increase with distance. The only variation in cost was the use of a 10 cent transfer fee rather than the 55 cent base fare for the regional bus alternative when the traveler also used the regional bus for the trip to the CBD. Since all trips in the sample face the same cost, the mathematical calibration cannot evaluate the impact of different costs on the decision process and therefore cannot isolate and estimate the magnitude of the cost coefficient in the utility expression.

Transit fare was accounted for in the mode choice model by equating it to a measure of time through an assumed value of walk time. Several values of time were tested and it was decided to use ten dollars per hour ($10/hour) to equate transit fare to walk time in the distribution mode choice model. Ten dollars per hour in 1980 dollars is roughly equivalent to the seven dollars per hour ($7/hour) in 1975 dollars used in the preliminary study by CSI.1/

Several cutoff distances for walking were tested but did not improve the model, so the simpler form without restriction on the walk trip length was chosen. The CBD study area is fairly small and as a result the survey showed that the walk trip length distribution is not appreciably shorter than the trip length distribution for bus trips.

Three time variables are used in the distribution mode choice model: walk time, transit vehicle run time, and transit vehicle wait time. The revised model assigns a separate value to a minute of time spent walking, riding on a bus, or waiting at a busstop.

The survey also showed that people who traveled to the CBD by bus were more likely to use transit for their distribution trip than were people who traveled to the CBD by auto. A bus access dummy variable was created to account for the greater tendency of regional bus users to use transit for their CBD distribution trip. It is believed two factors contribute to the difference in auto and regional bus traveler behavior: (1) people who travel to the CBD by transit are already familiar with the bus system and are more likely to use transit for distribution travel than are auto users; and (2) stratifying CBD-workers as regional auto users or regional bus users may have already separated out the portion of the population who are favorably disposed towards transit.

1/ Models and Estimates of DPM Demand, prepared for the Los Angeles Community Redevelopment Agency, Cambridge Systematics, Inc., October 1978.

Estimate DPM Bias Constant

Model calibration is based on reported traveler decision making given the existing set of alternative transportation services or modes. The calibration process computes coefficients for the relative importance of "abstract" travel characteristics such as travel time and cost. These are called abstract characteristics because they are independent of the mode of travel. It may also estimate bias constants to represent the net effect on the mode choice decision process of the unique and non-quantifiable aspects of a mode.

The abstract level of service characteristics, time and cost, enable the calibrat models to estimate the impact on modal riderships of a change in service for an existing mode. However, a proposed automated DPM system is a new service. It will have unique characteristics which require the estimation of a new modal bias constant. If possible, the development of the bias constant for a new mode in the CBD should be based on the traveler behavior observed for similar services operating elsewhere either within the region or in another urban area. The comparison of the new mode to a service existing in the CBD is important. If such a comparison cannot be found, a bias constant must be based on an objective consideration of the characteristics of the new mode in comparison to the existing services.

For the Los Angeles models two mode specific bias constants are needed to forecast the DPM ridership for distribution travel: a DPM mode bias and a DPM station integration constant.

As a comparable people mover system does not exist in an urban setting, the DPM bias constant was computed from observed behavior on San Francisco's BART system. From models developed for BART operations in downtown San Francisco, it was determined that at indifference, that is, under similar circumstances of time and cost, 73 percent of the people choose to ride BART and only 27 percent choose the competitive bus service. Assuming that the surveyed population in Los Angeles would have the same preference between automated rail and bus service, a DPM bias of +0.995 will provide a 73/27 percent DPM/bus mode split in the calibrated model for equal travel times and costs.

The DPM station integration constant was derived from the calibrated dummy variable for the regional mode of access. The regional mode of access dummy variable reflects the more frequent use of transit in the CBD by persons who ride transit to the CBD and are therefore already familiar with the transit system. The station integration constant represents nonquantifiable influences on the traveler's decision process such as convenience, ease of access, and readily available information on the route and scheduled service. It was assigned the same value as the regional mode of access dummy variable because they are both assumed to overcome the user's reluctance to use an unfamiliar system. The station integration constant is not intended to reflect a shorter walk time or wait time at an integrated parking lot/DPM station. These parameters are accounted for by the time coefficients.

Parking in an integrated parking structure at a DPM station will encourage using the DPM for distribution travel, just as traveling to the CBD by bus rather than auto increases the probability that a traveler will choose transit for his or her CBD distribution travel. The station integration variable is therefore equal to the regional mode of access dummy variable, +3.1928, which encourages the use of the DPM.

A.3.3 Midday Circulation Trips by CBD Workers

The CBD-worker circulation trip model must perform three functions:

- trip generation. The number of midday circulation trips must be calculated from (a) the employment in the study area, (b) the size of the study area, and (c) the land use activity or trip attractions in the study area;
- trip distribution. Circulation trips are generated in their origin zone. Destinations must be identified for these trips in order to have travel patterns which can be loaded onto a network and subjected to a mode choice process; and
- mode choice. Modes can be predicted for use in traveling between each of the previously identified origins and destinations. The choice will depend on network level of service characteristics, such as the travel time and travel cost by each mode.

For CBD-worker circulation trips, these three functions are performed by two chained logit models. The first is a frequency/ destination model and the second is a mode choice model.

A.3.3.1 Frequency/Destination Choice Model

Choice Set

Data for the generation and distribution of midday CBD-worker trips were obtained from a workplace survey midday travel diary collected in Los Angeles in May-June 1980. The travel diary contained information on the destinations, modal characteristics, and the traveler's choice of mode for each one-way trip leg made within the CBD. A leg refers to a one-way segment in the complete trip, starting at the workplace, making one or more stops, and returning to the workplace. The entire round trip is referred to as a tour.

It is generally assumed that individual observations of disaggregate behavioral choice data are independent. Unfortunately, the series of one-way trip legs made by an individual are not independent of one another. For example, for simple two-leg trips the decision process for the trip away from the workplace will probably resemble the decision process for the return trip. Also, the choice of the auto mode for all trip legs is clearly dictated by the choice of mode for the first leg in the tour.

The correlation of mode choice decisions between trip legs in a tour was avoided by using only one stop for the destination of a midday tour. The stop farthest from the workplace was used to represent the chosen destination.

Two criteria were imposed to select records for the calibration of the frequency/destination choice model:

(1) records were accepted for people who did not make a trip outside their workplace during the work day; or

(2) records were accepted for people who did make a trip outside their workplace and whose complete trip or tour did not leave the CBD.

The trip frequency decision was characterized by two alternatives: no trip or one completed round trip. The possibility of more than one tour by an individual was not treated as a unique choice. It was instead accounted for by adjusting upwards the trip generation rate.

The destination choice was represented by the selection of a set of nine alternative destination zones. The nine destination zones plus the null decision (no trip) made up the ten alternatives permitted by ULOGIT. The nine destinations included the chosen destination, if a trip was made, and were chosen from the 98 Los Angeles CBD zones to correspond to the distribution of trip distances from the workplace to the farthest destination observed in the survey results.

<u>Calibration Results</u>

The UTPS computer program ULOGIT was used to calibrate the "best fit" coefficients to a number of frequency/destination choice models. The final forms of the utility expressions are given in Exhibit A-5.

EXHIBIT A-5
UTILITY EXPRESSIONS FOR THE MIDDAY
DESTINATION CHOICE MODEL
(CBD-WORKERS)

Mode		Coefficient		Variable	t-statistic
U (no trip)	=	0.0933	*	origin employment[1/]	2.38
		+ 4.7768[2/]			22.50
U ($zone_i$)	=	0.0095	*	$activity_i/area_i$[3/]	1.40
		+ 1.0	*	LOGSUM (work, $zone_i$)[4/]	

[1/]Employment is in 1000's of workers.

[2/]This coefficient is the modal bias constant.

[3/]This variable is the CSI activity expression for a destination zone divided by the zone area in acres.

[4/]The LOGSUM variable was computed from the calibrated midday mode choice model. Its coefficient is fixed at 1.0.

The model uses the activity variable developed by CSI in the original ACM models to measure the attraction of the destination zone.[1] The activity in a zone is described by the natural logarithm of a linear weighting of the land uses in the zone. The expression for the activity variable follows:

$$\text{activity} = \ln \begin{bmatrix} 0.17 \text{ government office area} \\ +0.17 \text{ private office area} \\ +0.81 \text{ retail floor area} \\ +0.21 \text{ service floor area} \\ +0.042 \text{ manufacturing floor area} \end{bmatrix}$$

The land use floor areas are expressed in thousands of square feet.

The LOGSUM variable is the denominator from the midday mode choice model evaluated between a specific workplace and a specific destination choice. It serves to preserve the logit characteristics of the choice probabilities when the frequency/destination choice model is run in sequence with the midday mode choice model.

A.3.3.2 Midday Mode Choice Model

Choice Set

The information on mode choice behavior for midday circulation trips within the CBD was obtained from the midday travel diary in the workplace survey conducted in Los Angeles in May-June 1980. The concepts of midday tours (round trips) and trip legs (one-way trip segments) were discussed in the preceding section on the frequency/destination choice model. The decision process was again modeled with respect to tours rather than trip legs. However, while the preceding section used the stop on the tour farthest from the workplace location to represent the destination choice, the longest leg in the tour was used to represent the mode choice for the tour.

Three criteria were used to accept midday travel records to calibrate the midday mode choice model:

(1) location codes must be reported for all the stops of a midday tour;

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[1] Models and Estimates of Los Angeles DPM Demand, prepared for the Los Angeles Community Redevelopment Agency, Cambridge Systematics, Inc., October 1978.

(2) all the stops on a tour must be within the CBD study area; and

(3) both the regional bus and minibus must be viable modes for the leg chosen to represent the mode choice for the tour.

The midday trip or tour is constrained to remain in the CBD because the model is being designed to predict travel behavior involving downtown circulator systems. The two transit modes must be available for the trip to assure that the assumed choice set does in fact exist. The DPM mode was added after model calibration. The walk mode is always available and the auto mode is always available if the traveler drove to work. The effect of auto availability is recognized by the creation of two mode choice models, one for regional auto users and one for regional transit users.

Calibration Results

The UTPS computer program ULOGIT was used to calibrate "best fit" coefficients to the midday mode choice models for regional auto users and for regional transit users. A modal bias constant was then computed to include an automated DPM circulator system. The final structures of the utility expressions are depicted in Exhibit A-6.

The midday mode choice model is one of two chained logit models: one for trip generation and distribution, and a second for mode choice. The distribution and mode choice functions were separated to reduce the number of alternatives when calibrating the decision process. ULOGIT limits the calibration process to ten alternatives, and the combination of 98 CBD zones in Los Angeles times four modes cannot reasonably be approximated as ten alternatives.

Estimate DPM Bias Constant

A DPM modal bias constant is needed for the midday mode choice models for both the regional auto and regional transit access modes. The midday model does not have a station integration variable for the DPM mode because auto and the DPM system compete for midday circulation travel. They do not support one another in the midday as they do to accommodate the sequence of trip segments in a traveler's regional access and distribution trips.

It is assumed that a DPM system would be preferred to bus transit to the order of 9 minutes of travel time. This produces DPM bias constants of +1.1133 and +1.5156 for regional auto and

EXHIBIT A-6

UTILITY EXPRESSIONS FOR THE MIDDAY
MODE CHOICE MODEL
(CBD-WORKERS)

REGIONAL AUTO USERS

Mode		Coefficient		Variable[1]	t-statistic
U (walk)	=	-0.1237	*	walk time	4.51
U (regional bus)	=	-0.1237	*	run time	4.51
		-0.1237	*	wait time	4.51
		-8.5401	*	fare	7.43
U (auto)	=	-0.1237	*	auto time[2]	4.51
		-0.3093	*	walk time[3]	
		-0.4679	*	park cost	1.79
		-2.5924	*	purpose[4]	4.92
		+3.0669		[5]	4.51
U (circulator bus)	=	-0.1237	*	run time	4.51
		-0.1237	*	wait time	4.51
		-8.5401	*	fare	7.43
U (automated DPM)	=	-0.1237	*	run time	[6]
		-0.1237	*	wait time	[6]
		-8.5401	*	fare	[6]
		+1.1133		[5]	[7]

EXHIBIT A-6 (Continued)

UTILITY EXPRESSIONS FOR THE MIDDAY
MODE CHOICE MODEL
(CBD-WORKERS)

REGIONAL TRANSIT USERS

Mode		Coefficient		Variable[1]	t-statistic
U (walk)	=	-0.1684	*	walk time	2.65
		+1.2433		8/	3.06
U (regional bus)	=	-0.1684	*	run time	2.65
		-0.1684	*	wait time	2.65
		-3.3332	*	fare	2.84
U (circulator bus)	=	-0.1684	*	run time	2.65
		-0.1684	*	wait time	2.65
		-3.3332	*	fare	2.84
U (automated DPM)	=	-0.1684	*	run time	6/
		-0.1684	*	wait time	6/
		-3.3332	*	fare	6/
		+1.5156		8/	7/

1/The variables are in units of minutes and dollars.

2/This is the travel time from the auto parking lot to the intended destination.

3/This is the walk time from the workplace to the auto parking lot.

4/This dummy variable is 0 for company business trips, and 1 otherwise.

5/Modal bias constants were included only for the auto and DPM modes. The constants to differentiate between the walk, regional bus, and circulator bus modes were not found to be statistically significant.

6/The DPM mode was not included during calibration.

7/The DPM modal bias. See Section A.3.3.2, Estimate DPM Bias.

8/Modal bias constants were included only for the walk and DPM modes. The constant to differentiate between the two bus modes was not statistically significant.

regional transit users respectively. This is considered to be a conservative DPM bias. Nine minutes is roughly 4 1/2 times the travel time equivalent of the DPM bias in the distribution mode choice model. If travel time is 4 1/2 times as important for distribution travel as for circulation travel, it can be argued that the bias constants have roughly equivalent impacts. Dividing the $10 per hour value of time for distribution travel by 4 1/2 gives a $2.22 per hour value of time. This falls between the roughly $1 and $3 per hour values of time for midday travel by regional auto and regional transit users respectively.

The estimated values for the DPM modal bias constant and station integration constants provide the necessary information to use the model system to forecast future travel on circulator systems, including automated DPM circulator systems.

A.3.4 Distribution and Circulation Travel by Other Than CBD-Workers

Two methods are presented to forecast patronage on the circulator system from distribution and circulation travel in the CBD by travelers other than CBD-workers: a Fratar trip table factoring approach and a set of distribution choice and mode choice logit models. The Fratar approach is based on trip tables of travelers other than CBD-workers. These trip tables include (a) regional travel to the CBD and (b) circulation travel within the CBD. The logit model also requires the preparation of regional trip tables to model distribution travel by other than CBD-workers. Circulator trips, though, are generated from land use activities so circulation trip tables are not needed when the logit model approach is used.

A.3.4.1 Distribution Choice and Mode Choice Logit Models

The decisions involved in distributing regional trips to the CBD are identical for CBD-workers and others alike. Therefore the model which was developed for the distribution of CBD work trips is used here as well (See Exhibits A-3 and A-4). The model requires as input a table of regional trips to the CBD by other than CBD-workers.

Other travelers who are in the CBD during the midday also make the same decisions as CBD-workers for midday travel:

- how often to travel (frequency);
- what destination to choose; and
- what mode to choose.

The frequency of CBD-worker midday trips is based on the size of the CBD-worker population. However, it is more difficult to predict the number of others who will be within the CBD study area, so the total number of other noon hour trips from a CBD zone is predicted from data on land use activities in the CBD zone.[1/]

Other noon hour trips from zone i	= 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

The equation generates two-way round trips. The floor areas are measured in 1000s of square feet.

The destination choice decision is treated by simplifying the frequency/destination model developed for CBD-worker midday travel. All that is required is to remove the no-trip alternative from the choice set. The formulation of the logit model assures that, after removing the no-trip alternative, the probabilities across all destinations will still sum to 1.0. The destination choice model is presented in Exhibit A-7.

The midday mode choice decision for other travelers is unchanged from the midday mode choice model developed for CBD-worker circulation trips (see Exhibit A-6).

A.3.4.2 Fratar Trip Table Factoring

The Fratar trip table factoring approach serves as an alternative to the logit models for the trip distribution and mode choice decisions. It provides an empirically based forecast of transit ridership rather than a behaviorally based forecast. For simplicity it forecasts the other than CBD-worker circulator system ridership for both distribution and circulation travel combined. The approach includes four steps:

- develop a CBD transit trip table for the base year;

1/ Models and Estimates of Los Angeles DPM Demand, prepared for the Los Angeles Community Redevelopment Agency, Cambridge Systematics, Inc., October 1978.

EXHIBIT A-7

UTILITY EXPRESSIONS FOR THE MIDDAY
DESTINATION CHOICE MODEL (NON CBD-WORKERS)

Mode		Coefficient		Variable	t-statistic
U ($zone_i$)	=	0.0095	*	$activity_i/area_i$ [1/]	1.40
		+1.0	*	LOGSUM (work, $zone_i$) [2/]	

1/ This variable is the CSI activity expression for a destination zone divided by the zone area in acres.

2/ The LOGSUM variable was computed from the calibrated midday mode choice model. Its coefficient is fixed at 1.0.

- expand the trip table to account for growth in the CBD by the forecast years;

- assign the expanded transit trip table for each forecast year to the best transit path in the transit network for that year; and

- accumulate the ridership on the circulator system by examining the modes used in the assigned best paths.

The base year transit trip table includes origin-destination (O-D) transit travel within the CBD, such as by regional bus or minibus. O-D travel in the CBD may include the distribution portion of regional trips to the CBD as well as circulation trips within the CBD. Data on these trips can be obtained from on-board transit surveys conducted within the study area. CBD-worker trips must be identified and subtracted from the O-D trip volumes in order to avoid double counting of trips.

The base year CBD transit trip table is expanded to reflect the growth in CBD activities which will attract trips by travelers other than CBD-workers.

CBD transit trips are assigned to transit modes by first creating a composite transit network. This contains the "best" path between CBD zones using any or all of the available transit modes: regional bus, minibus, or DPM system. The second step is to assign the trips in the trip table to the transit links or services contained in the best paths.

Ridership on the circulator service is obtained by examining the loadings on the links in the transit network. The forecast circulator ridership is the accumulation of trips which are assigned to links in the transit network which correspond to the proposed circulator service.

B. USERS GUIDE TO COMPUTERIZED NETWORK ANALYSIS USING THE URBAN TRANSPORTATION PLANNING SYSTEM

B.1 INTRODUCTION

The ACM demand estimation methods were presented in Section 7 and further detailed in Appendix A. Appendix B focuses on the use of the computerized network analysis approach, presenting from a user perspective the steps necessary to implement and apply the models within a UTPS framework. Exhibit B-1 describes this process, laying out the major steps and data elements necessary to apply the models. This appendix discusses each of the steps shown in the exhibit, presenting both general issues for consideration by the user and detailed examples and setups for each step. The examples and setups describing the application of the models are taken from their use in the Los Angeles CBD.

This appendix begins with a review of the key characteristics of the ACM process, focusing on the market segments which define many of the processing requirements and general considerations important to beginning the analysis. Section B.2, B.3 and B.4 describe the preparation of the various data inputs, including network, socioeconomic data, and trip tables. Both general consideration and detailed examples are included in these sections. Section B.5 discusses techniques for collecting data useful for transferring the models to your study area. This is followed by a discussion of the specific adjustments which should be made to transfer the models in Section B.6 with Section B.7 providing a step-by-step description of the application of the models.

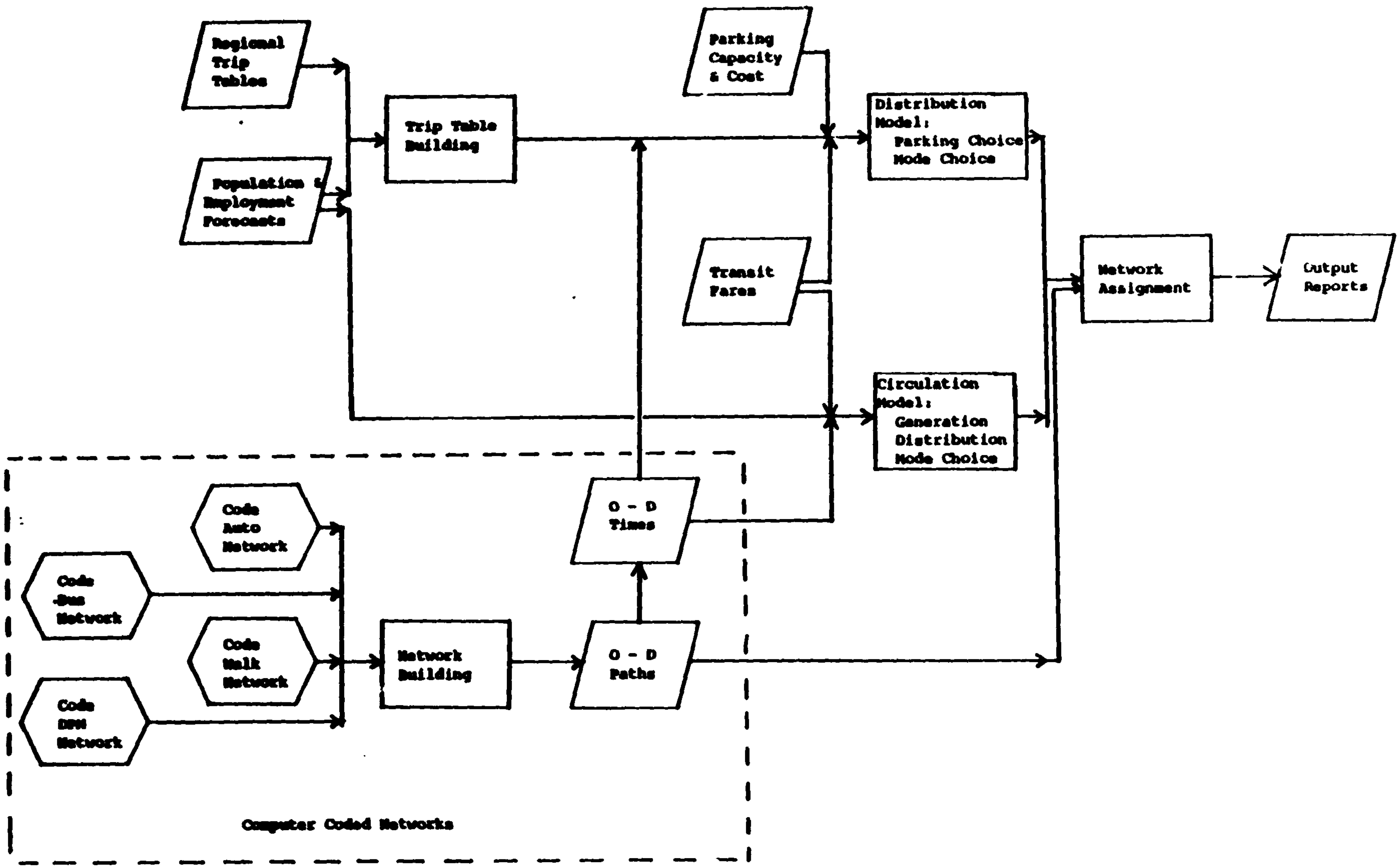
This appendix assumes a working knowledge of the Federal Highway and Urban Mass Transportation Administrations' Urban Transportation Planning System (UTPS) or other computerized planning techniques. Both the terminology and specific examples reflect the use of UTPS to implement much of the model system and data preparation in Los Angeles. Review of the referenced UTPS program documentation is essential to an understanding of this appendix.

B.1.1 Overview of the ACM Process

An activity center circulation system can and will serve a variety of travel markets. In response to the diversity of potential users of the system, the ACM models were structured to address those market segments which are likely to account for a significant proportion of the system ridership and which should serve as the basis for determining the feasibility of the service. Not unexpectedly, these markets are those for which the most information about current travel habits is available and for which we are best able to forecast the data necessary to apply the models for future years.

EXHIBIT B-1

COMPUTERIZED NETWORK ANALYSIS PROCESS



The key stratification for the development and application of the models is the trip maker type. Two classifications are used: study area workers; and nonworkers. Study area workers are considered to be the most likely users of the circulation service as they are at the study area nearly every day and they will have available the most information about the service. Generally, worker trips will comprise a very high proportion of the trips in a study area considering a circulation service. Study area nonworker trips are considered to provide a much smaller potential market for a circulation system.

The trips made by workers and nonworkers can be considered to be of two types: (1) distribution, the study area portion of trips having one end outside the study area; and (2) circulation, trips entirely contained in the study area. Distribution trips are further stratified by the regional mode used to enter or leave the study area, the models structured to address regional transit and regional auto users separately (see Appendix A).

B.1.2 Consistency with Other Regional Planning Efforts

The ACM models have been structured so that much of the data required for their use is generally available from other planning efforts underway in the region. However, because the study area in which the models are to be applied is of limited size, the analysis is often conducted at a more detailed level than regional studies. Whether complete consistency exists for all data requirements will vary considerably between areas, as consistency is dependent on the level of detail for regional analysis and how the data were obtained.

The stratification of trips as worker or nonworker related departs from the traditional trip purpose breakdown used in most areas. Generally, areas use home-based and non-home-based classifications. As will be described in Section B-4, use of appropriate assumptions about the correspondence between trip purposes easily leads to the restructuring of regional trip tables into the format required by the ACM models.

Consistency between ACM planning and other regional planning efforts is more easily maintained if corresponding study years can be used for each of the efforts. When different study years are used, the availability of both socioeconomic and network data is greatly lessened. Generally, the end result is more significant modifications to the regional data base to extract the required ACM data and, quite often, the need to collect additional data through surveys or other means. Any data collected for the ACM modeling effort, however, will generally also be useful for other planning in the region.

B.1.3 Zone Structure

The ACM models require a more detailed zone system than that which is usually used for regional planning. The trips being modeled in an ACM analysis are those which would be considered intrazonal in most regional zone systems. Like regional models, the ACM models can only deal with trips made between zones. As the zone system becomes more detailed, more of the trips within the study area can be accounted for within the modeling process.

At any scale, the study area should be divided into zones which are homogeneous in nature. This is usually not a problem when zones are at the block level, but when a number of blocks are grouped as a zone they should be similar in character, such as office or manufacturing districts. When developing the zone system, consideration should also be given to the available data. For example, if a parking inventory has just been conducted using a certain zone system, one might consider adopting that system as the base so that the parking supply and cost data can be incorporated with very few adjustments. As network data accounts for a significant part of the information required by the ACM models, the regional networks should also be considered when the zone system is defined.

B.1.4 Base and Forecast Years

Data should be available for use with the ACM models for a base year as well as for the forecast years. Base year data is used to adjust and validate the models for the specific characteristics of the study area. Base data should include information for comparing observed ridership on the existing services with model results. This also means that the various model inputs will need to be developed for the base year so that the models can be validated. Similar steps are followed for developing base and forecast year data.

Selection of the forecast years should be coordinated with other planning efforts and with other available data. Preparation of the input data is greatly simplified if the forecast year is consistent with the regional data base. Consideration should also be given to other developments underway in the study area when selecting forecast years. If a major employment complex is under construction or a radical revision to the regional transit system is being planned, the forecast year should be selected so that the effects can be incorporated in the ridership results.

B.2 PREPARATION OF STUDY AREA NETWORKS

B.2.1 Purpose

A network is a method of representing the service provided by a mode of travel. It is constructed of nodes, which indicate street intersections, transit stops or transfer stations, and links, which connect the nodes and show where each mode can travel. For transit modes, the network provides a specification of where the mode operates, that is, which links are combined together to form a route or line; an indication of the frequency with which the route is operated; and a specification of the speed which can be operated on each link. Non-transit modes such as auto or walk require an indication of which links the mode can use and the speed with which the link can be traversed; they are not combined into lines.

Exhibit B-2 shows the coding of DPM and minibus services in Los Angeles. The nodes defining the DPM represent the stations which are elevated above the street network. Each station is connected to the street by walk links representing elevators, escalators, and stairs. The minibus stops are at street intersections which are integrated with the walk network.

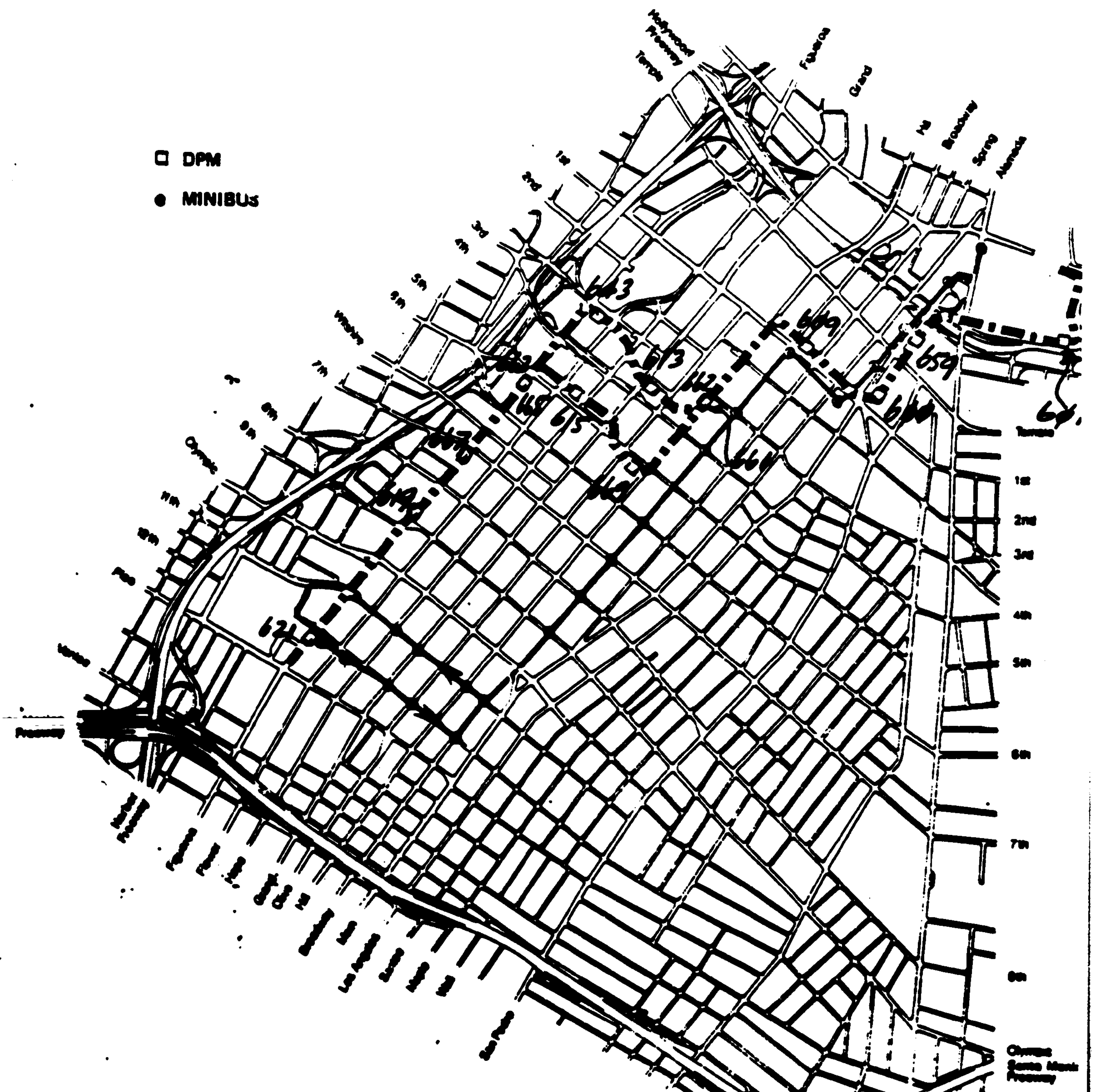
Each mode's level of service is incorporated in the ACM models as the time and cost incurred in making an interchange by using that mode. The models compare the combined time and cost associated with each of the modes available for the interchange to determine what each mode's share or proportion of all travelers making the interchange would be. The coded network is the method by which the modal characteristics used by the models can be systematically determined for each interchange. Key to the development of model inputs is both an accurate and consistent coding of each mode being analyzed.

B.2.2 Coding the Networks

The ACM models have been implemented using UTPS software. The following discussion concerning the coding of networks assumes that the user will be processing the network using UTPS program UNET or INET for transit and UROAD for auto. However, the general considerations for coding the networks presented in this section are applicable no matter what network processing software is used. The reader is referred to the UTPS Network Development Manual for a general discussion of network coding, and to the UTPS program documentation for a complete discussion of the use of each of the UTPS programs referenced in this section.

EXHIBIT B-2

CODING THE LOS ANGELES DPM AND MINIBUS LINES



B.2.2.1 Selecting the Modes

All of the services competing for travelers in the CBD should be included in the network. Those services which are generally perceived as having different or unique characteristics should be included separately, and the remaining services should be combined based on the commonality of their characteristics. For example, in certain areas a minibus service might be perceived as being very different from other bus services due to its unique fare structure, its vehicle, and its well-publicized simple routing. Such in fact was the case in Los Angeles where the models presented in this manual were calibrated. The resulting models, therefore, incorporated the minibus or circulator service as a separate mode. Regional services crossing the CBD are likely to be less well-known to the general population of the study area and are therefore less likely to be selected for an interchange despite offering potentially better service.

The modes generally available in a CBD for distribution service include walking and the CBD portion of regional transit services. A new service such as a people mover would generally be incorporated as a separate mode. If a minibus service is to be analyzed, careful consideration of its characteristics in comparision with those of the other available services should be made before including it as a separate mode. If it is perceived as being unique or different, it should be included as a separate mode.

B.2.2.2 The Multimode Network

Although each mode's service characteristics are required separately by the ACM models, all of the transit modes and the walk mode should be coded as a single network. This is generally termed the "multimode" network. Such a coding strategy permits determining the service characteristics for interchanges which require a transfer between modes, the path building criteria used to determine the primary mode for the interchange. The walk network coded as part of the multimode network should be complete so that it can serve the dual purpose of providing access to the transit modes as well as permitting estimation of the walk time and distance between interchanges.

Care should be taken to code accurately the link times within the CBD study area. As the interchange times and distance are generally very small compared to regional analyses, systematic errors introduced by the use of average speeds or rounded link distances can cause significant bias in the results of the analysis. For example, if the study area has block faces of approximately 800 feet (.151 miles), each block would generally be coded as .2 miles long. Coding these links with an average walk speed of three mph would result in an estimated link time of four minutes, a one minute overestimation for each block. The recommended coding technique in these cases is to accurately determine the distance and to code the resulting link time rather than using an average speed. Link times should be coded to the nearest .1 minute for these detailed CBD networks.

While walk links can be coded with the same time in both directions if there are no significant grades or stairways, the transit links coded for modes operating in mixed traffic should be analyzed for directional imbalance due to congestion. Such a situation is most likely to occur in the peak period, the imbalance increasing as the traveler gets farther from the heart of the study area. Transit company time schedules for lines operating both directions through the downtown are generally a good indicator of the need to code travel times differently for each direction.

Once the network is coded and the link and line cards are entered into the computer, programs UNET or INET can be run to "build" the network. These programs edit the inputs for consistency and output a set of files which can be used to estimate the service characteristics for each interchange. Exhibit B-3 shows link and line cards for the DPM and minibus routes given in Exhibit B-2. Also shown are some of the walk links connecting these services with the remainder of the multimode network. The link cards define the time and speed at which each mode can traverse a link while the line cards define the routing and frequency of each transit service. Exhibit B-4 shows a typical UNET setup. In this example, a catalogued procedure is used to call up the necessary job control language (JCL) with two networks being built, a PM network and a midday network. The same deck of cards was input to each run of UNET, the cards coded to include both PM and midday link times. (See the UNET program documentation for an explanation of the various parameters.)

After the network has been built, UTPS program UPATH and UPSUM are used to trace the shortest paths and determine the time for each interchange. The ACM model require the impact of the run, or in-vehicle time, by mode and the wait, or out-of-vehicle time, to make the interchange. Program UPATH finds the shortest path between each pair of zones and outputs a file which can be used to assign the trips estimated to be using the mode. UPSUM meanwhile "skims" the path file to accumulate the run and wait time for each interchange, outputting a set of matrices in the form required by the mode choice models.

EXHIBIT B-3

EXAMPLE LINK AND LINE CARDS

```
         1    1    2    2    3    3    4    4    5    5    6    6    7
1---5----0----5----0----5----0----5----0----5----0----5----0----5----0--
1   479  476 4       1    7       7    7
1   621  619 5       4     17      17   17
1   619  667 5       2      9       9    9
1   667  665 5       2     11      11   11
1   665  615 5       2     10      10   10
1   615  669 5       2     11      11   11
1   669  661 5       3     13      13   13
1   661  609 5       4     14      14   14
1   609  660 5       2     12      12   12
1   660  659 5       2     09      09   09
1   659  601 5       4     15      15   15
1   601  659 5       4     18      18   18
1   659  660 5       2     09      09   09
1   660  609 5       2     11      11   11
1   609  662 5       4     14      14   14
1   662  613 5       2     10      10   10
1   613  643 5       2     11      11   11
1   643  663 5       3     12      12   12
1   663  667 5       3     11      11   11
1   667  619 5       2     11      11   11
1   619  621 5       4     15      15   15
1   152  150 67      2  8       8    8   2
1   152  158 6       1              23   232
1   498  494 1       2     46      46   462
1   659  313 1       1     13      13   132
1   659  324 1       1     32      32   322
1   662  364 1       1     13      13   132
1   662  380 1       1     29      29   292
1   613  206 1       1     11      11   112
1   613  208 1       1     16      16   162
1   613  376 1       1     19      19   192
1   643  182 1       1     13      13   132
1   643  193 1       1     13      13   132
99999999999
2   4 2111      75 50      353  351  314  315  308  313  329  340  336
2   4 212                  366  382  410  424  438  432  476  474  296
2   4 213                  294  290                                      T
2   4 2211      75 50      461  463  467  473  479  476  452  438  424
2   4 222                  410  382  366  336  340  329  313  308  315
2   4 223                  314  351  353                                 T
2   5 1211      19 45     [601  659  660  609  662  613  643  663  667
2   5 122                 [619  621                                      T
2   5 1311      19 45     [621  619  667  665  615  669  661  609  660
2   5 132                 [659  601                                      T
2  46 111       18 36      488  479  476  452  438  424  410  396  382
2  46 12                   366  336  318  349  310  154  152  150        T
```

People Mover Links

People Mover Network Access Links

People Mover two one-way lines

EXHIBIT B-4

UNET SETUP

```
//PROCLIB DD DSN=PMMPROC,DISP=SHR
//STEP040A EXEC UNET,NET=MMODEPM,YEAR=90
//UNET.SYSIN DD *
        BUILD PM MULTIMODE NETWORK
 &PARAM
      ZONES=116, NODES=750,
      LENAM=0, LENPM=1
 &END
 &OPTION
      BUILD=T, PM=T, AM=F
 &END
 &SELECT
      REPORT=1,2,3,4,5,6
      RMODES=4,-8
 &END
 &DATA
999999999999999999999999999999999999999
     .
   (INSERT LINK AND LINE CARDS HERE)
     .
//STEPØ4ØB EXEC UNET,NET=MMODEMD,YEAR=90
//UNET.SYSIN DD *
      BUILD MIDDAY MULTIMODE NETWORK
 &PARAM
      ZONES=116, NODES=750,
      LENAM=0, LENMID=1
 &END
 &OPTION=T
      BUILD=T, AM=F, MIDDAY=T
 &END
 &SELECT
      REPORT=1,-6
      RMODES=4,-8
 &END
 &DATA
 9999999999999
         .
   (INSERT LINK AND LINE CARDS HERE)
         .
```

As the ACM models require the run and wait time for each individual mode, separate UPATH/UPSUM chains must be used to develop the service characteristics of each mode. Each UPATH run must be set up to "force" the use of a specific "primary" mode. This is done by minimizing the allowable transfers and making the travel time associated with the other modes more costly to the minimum path computation. Exhibit B-5 shows such a UPATH setup.

In this example, mode six, the downtown portion of the regional bus network, has a default weight of 1.0 while modes four and five (minibus and people mover) have their run time weighted by 5.0 by the CTTIME parameter and their wait time weighted by 2.5 by the CWTIME parameter. The number of allowable transfers is also limited to one.

The use of such weights does not prevent other modes from being included in the shortest path or, in fact, from being the entire shortest path. These modes are legitimate access modes to the primary mode, whose characteristics are being determined. If these modes were eliminated from consideration, a path might possibly not be found using only the primary mode. The planner must be able to determine for each interchange whether the primary mode was actually used and, if more than one mode is used, whether the use of the primary mode was significant enough for the mode to be considered available for the interchange.

This identification of the use of the primary mode for an interchange is made by setting up UPSUM to accumulate the run time for the primary mode in a separate table from any of the other modes. In Exhibit B-6 the TRUN parameter is set to accumulate the regional bus run time in Table 1 with Table 2 used to accumulate the run time for the other transit modes. Table 3 is used to accumulate the out-of-vehicle time for all modes. UTPS program UMATRIX can then be used to determine if the primary mode was available for the path. Such a setup is shown by Exhibit B-7. In this example, the criteria used for the availability of the primary mode is a minimum of two minutes run time. Also appropriate would be a primary mode run time greater than the secondary mode run time. (The table value is compared to 19 or 1.9 minutes.) If the primary mode is determined to be unavailable, the run time is set to zero as an indication to the models that the mode should not be considered for the interchange.

Walk mode interchange times and distances can be determined directly from program UPATH, the execution of program UPSUM is not required. As shown by Exhibit B-8, this is done through use of the DIST and IMPED parameters. Table 1 on the output file will be the interchange distance in tenths of a mile while

EXHIBIT B-5

UPATH SETUP

```
//PROCLIB DD DSN=PMMPROC,DISP=SHR
//STEP080A EXEC UPATH,PATH='DSN=LADPM.Y90.REGN.PM.PATH',
//    YEAR=90,NET=MMODEPM,
//    UNITPAT='3330,VOL=SER=LADPM1',
//    NTLINK='DSN=LADPM.Y90.REGN.PM.NTLINK',
//    NTALOC='DSN=LADPM.Y90.REGN.PM.NTALOC',
//    UNITNTL='3330,VOL=SER=LADPM1',
//    DISPNTL='(,CATLG,DELETE)',
//    DISPJ1='(,DELETE)'
//UPATH.SYSIN DD *
       REGIONAL BUS NETWORK PATHS FOR YEAR 1990
 &PARAM
      CTTIME(2)= 0.1, 1.0, 2*5.0, 1.0, 2*5.0,
      CWTIME(4)= 2*2.5, 0.1, 2*2.5,TXFER=1
 &END
 &OPTION
     AM=F, PM=T
 &END
 &SELECT
     REPORT=4,
     I=1,-116
```

EXHIBIT B-6

UPSUM SETUP

```
//PROCLIB   DD  DSN=PMMPROC,DISP=SHR
//STEP080B   EXEC  UPSUM,YEAR=90,MODE='REGN.PM'
//UPSUM.SYSIN   DD  *
      REGIONAL BUS TIME SKIMS FOR ALL ZONES
 &PARAM
      TABOUT=3,
      TRUN(1)=3, 3, 3, 2, 2, 1, 2, 2,
      TWAIT=2*3,
      TXFERS=0,
      TTIME=0,
      NAME1='DPMRUN1', NAME2='DPMRUN2', NAME3='DPMOUT'
 &END
```

EXHIBIT B-7

DETERMINING PRIMARY MODE
AVAILABILITY

```
//PROCLIB  DD DSN=PMMPROC,DISP=SHR
//STEP101A EXEC UMATRIX,CORE=257K,TIME=(,10),
//      J1='DSN=D35B.LADPM.Y90.CIRC.PM.SKIM',
//      J2='DSN=D35B.LADPM.Y90.REGN.PM.SKIM',
//      UNITJ1='3330,VOL=SER=LADPM1',
//      UNITJ2='3330,VOL=SER=LADPM1',
//      J3='DSN=D35B.LADPM.Y90.DPM.PM.SKIM',
//      UNITJ3='3330,VOL=SER=LADPM1',
//      J9='DSN=D35C.LADPM.Y90.STEP101.SKIMTMP2',UNITJ9=PUBLIC,
//      DISPJ9='(,CATLG,DELETE)',SPACEJ9='(TRK,(3,1),RLSE),
//UMATRIX.FT19F001 DD DCB=(RECFM=VBS,LRECL=1604,BLKSIZE=13030)
//UMATRIX.SYSIN DD *
                    COMBINE PM RUN TIME - 1990
 &PARAM
     ZONES=116,  OUTBPT=2,
     COMBIN1='IF T101< =19 OR T101=32767 THEN 0 ELSE T101+T102',
     COMBIN2='T103',
     COMBIN3='IF T201< =19 OR T201=32767 THEN O ELSE T201+T202',
     COMBIN4='T203',
     NAME1='MINIRUN90', NAME2='MINIOUT90',
     NAME3='RBUSRUN90', NAME4='RBUSOUT90',
     COMBIN5='IF T301< =19 OR T301=32767 THEN O ELSE T301+T302',
     COMBIN6='T303',
     NAME5='DPMRUN90', NAME6='DPMOUT90',
     COMBIN7='IF T-111 OR I=114 OR J=111 OR J=114 THEN 1 ELSE 0',
 &END
 &SELECT
     I = 1,-116
     PRINT=14,19,106
 &END
```

EXHIBIT B-8

WALK MODE INTERCHANGE
TIME AND DISTANCE

```
//STEP050A EXEC UPATH,DISPATH='(,DELETE)',
//      YEAR=90,NET=MMODEPM,
//       J1='DSN=D35C.STEP050.TEMP',UNITJ1=PUBLIC
//UPATH,SYSIN DD *
              WALK NETWORK PATHS FOR YEAR 1990
 &PARAM
      NAME1='WALKDISTY90',
      NAME2='WALKTIMEY90',
                                   &END
 &OPTION
      AM=F,  PM=T
      DIST=T,IMPED=T
                                   &END
 &SELECT
        REPORT=4,6,7
        DELETE=4,5,6,7,8
        I=1,-116
                                   &END
//STEP050B EXEC UMATRIX,J1='DSN=D35C.STEP050.TEMP',
//      UNITJ1='3330-1',
//       J9='DSN=D35B.LADPM.Y90.WALK.PM.SKIM',
//       SPACEJ9='(TRK,(3,1),RLSE)',
//       UNITJ9='3330,VOL=SER=LADPM1',
//       DISPJ9='(,CATLG,DELETE)'
//UMATRIX.SYSIN DD *
        RESET WALK NETWORK ZERO DISTANCE INTERCHANGES
 &PARAM
       ZONES=116,
       COMBIN1='IF T102=32767 THEN 32767 ELSE
             IF T101=0 THEN 1 ELSE T101'
       COMBIN2='IF ((I<99 OR I>107) and (J<99 or J>107))
            THEN
            (IF T102=0 AND T901>0 THEN 20 ELSE T102) ELSE 32767'

                                   &END
```

Table 2 will be the interchange time in tenths of a minute. A UMATRIX step is then used to insert an intrazonal time and distance.

B.2.2.3 The Auto Network

The ACM circulation trip model described in Appendix A of this manual includes auto as one of the available modes. This model and the parking choice model require auto mode service characteristics as part of their inputs. If another technique is used to determine parking locations and auto is not really a viable mode for circulation trips because of the availability and cost of parking, the development of automobile time and distance information can be omitted.

When the auto mode is to be included in the analysis, a variety of techniques can be used to develop the required matrices describing the time and distance for each interchange. If a regional auto network exists with the study area coded to the appropriate level of detail this network can be used to develop the data. Networks coded to either FHWA or UMTA UROAD standards will provide the necessary information, time in .1 minute, and distances in .1 mile.

If an appropriate downtown network is not available, a network can be coded using either of the highway formats or one can be coded using UNET access links. Mode 1 could be used for centroid connectors with mode 2 used for the highway links. Each link should be coded to the nearest .1 minute and .1 mile. Different times could be coded for the PM and midday time periods. The planner would then use program UNET to build the auto network and, similar to the walk network, program UPATH to prepare the shortest path time and distance matrices.

B.2.3 Parking Supply and Prices

In addition to the network description of transportation service, the models require data on the availability and cost of parking in each CBD analysis zone. The data must describe the number of spaces available, the cost per hour, and the cost per day for publicly available commercial lots. As shown by the equations in Appendix A, the models use the cost data to determine the relative attraction of each zone as a potential parking zone for the commute trip, while the number of spaces is used to compare the supply with the demand for parking.

B.2.3.1 Estimating the Parking Supply

Parking supply data is required only if the parking choice model is to be used. If so, the model requires an estimate for each zone of the long-term (seven + hours) spaces available to the general public. Curb parking and spaces belonging to retail or commercial establishments should be excluded from the estimate. Spaces restricted by private or government employers should also be excluded, the problems associated with these spaces discussed in Section B.2.3.3.

The best source of parking supply data is a parking inventory. If an inventory does not exist, agencies responsible for licensing of parking facilities or for issuing use permits can be a good source. Crude estimates can be developed from knowledge of the land use and any zoning requirements related to the provision of parking spaces. If reasonably reliable estimates cannot be obtained, it is recommended that the iterative balancing of parking supply with demand not be used.

Estimates of the future year supply of spaces are best made by modifying an inventory based on the expected change in CBD land use. The zoning requirements can be used to estimate the number of spaces required to be included in new developments. Surface lots or parking structures being replaced by future development should be removed from the inventory.

B.2.3.2 Estimating the Parking Price

Two types of parking prices are required by the models: the average daily price for the parking choice model, and the hourly rate for the circulation trip model. In many areas, commuters tend to purchase monthly parking privileges at a discount from the maximum daily rate. Within this model set, the monthly price is a better indicator of the average daily price than the daily maximum and was used for model calibration. If only a small percentage of commuters purchase monthly parking, the minimum of the maximum daily rate and eight hours times the hourly rate should be used.

Some care should be taken to estimate the parking prices as they can change quickly and the available information becomes outdated. If the study area is not large, a windshield survey of posted prices can be made. Pricing information must often be supplied to a licensing agency. While the price itself is important in the determination of mode choice for circulation trips, it is the relationship between the price in each zone which determines the trade-off for parking choice.

B.2.3.3 Special Considerations

One difficulty associated with the application of the ACM models is treating employer-provided or employer subsidized parking. This type of parking affects both the supply of "publicly" available parking as well as its market price, particularly when this parking occurs within a publicly available garage. Probably the best method for dealing with this parking is to remove the associated trips from the trip tables and the parking spaces from the supply estimates. The parking choice model would then apply to only those trips which must truly make a decision regarding parking location. Trips with these parking privileges are not likely to be candidates for a circulator system being designed to move people from low cost parking on the study area periphery as their parking location will be at or extremely close to their place of employment.

Unfortunately, a great deal of data must be available to exclude these trips from the trip table. The trips to each zone that have employer-provided parking are usually not readily identifiable, just as the number of parking spaces in each zone serving these trips is not known. One approach is to eliminate the trips and spaces associated with a zone where it is known that a significant number, i.e., 75 percent or more, of the employees are in this category. This criterion will usually limit the elimination of trips to government complexes or other facilities which comprise an entire zone. Program UMATRIX can be used to eliminate trips to these zones from the parking choice input trip table.

B.2.4 Peaking Factors

The A [illegible] models estimate distribution trip ridership during the PM peak hour. Factors are required to convert this hourly estimate to a daily estimate or to estimates of the ridership during each hour of the day. Often, the regional trip tables input to the process reflect daily ridership which must be factored to represent the PM peak hour prior to the application of the distribution model. Conversely, circulation trips are estimated on a daily basis, factors being required to convert between the daily and peak-hour time periods and to each hour of the day.

B.2.4.1 Distribution Trip Factors

The best source of peaking factors is a survey. Study area cordon count data should be used only if it includes a limited volume of through travel. Given that the focus of the analysis is a small area, an employee workplace survey will provide the necessary information. The number of trips arriving at or departing from work in each half-hour should be tabulated. If the time the study area cordon is crossed is included in the survey, a "trips in motion" concept could be used. If it is not using the time reported for leaving from or arriving at the non-work end of the trip would probably distort the resulting factors due to the potentially long duration of the regional trip relative to the distribution trip. In order to minimize the effect of inaccurate time reporting, "smoothed" frequency distributions should be used. One technique is to compute a moving average for each half-hour based on itself and the halfhour periods before and after it. The resulting frequencies would then be aggregated to represent each hour of the day.

If an appropriate survey is not available, CBD cordon count data can be used. Another alternative would be to base the factors on the distribution of transit service, presuming that transit ridership accounts for a significant proportion of the trips entering the study area. Factors developed in other areas or reported in publications such as Characteristics of Urban Transportation Demand[1] or NCHRP Report 187[2] could also be used. Care should be taken in the reporting of results when such factors are used. Exhibit B-9 shows the frequency distribution developed for Los Angeles.

B.2.4.2 Circulation Trip Factors

Worker circulation trip factors must be similarly developed. A trip diary from an employee workplace survey is a good source of information. A pedestrian survey can provide the necessary data, though it is difficult to establish controls for such a survey. As the ACM circulation trip model estimates daily round trips, separate frequency distributions should be developed for the time leaving the workplace and for the time returning to the workplace. Exhibit B-9 also shows the circulation trip frequency distributions developed for Los Angeles. As might be expected, these distributions are highly concentrated about the noon hour.

B.2.4.3 Nonworker Trip Factors

Nonworker trip factors must be developed appropriate to the process used to estimate circulator system ridership. Two approaches were presented in Appendix A--a nonworker circulation

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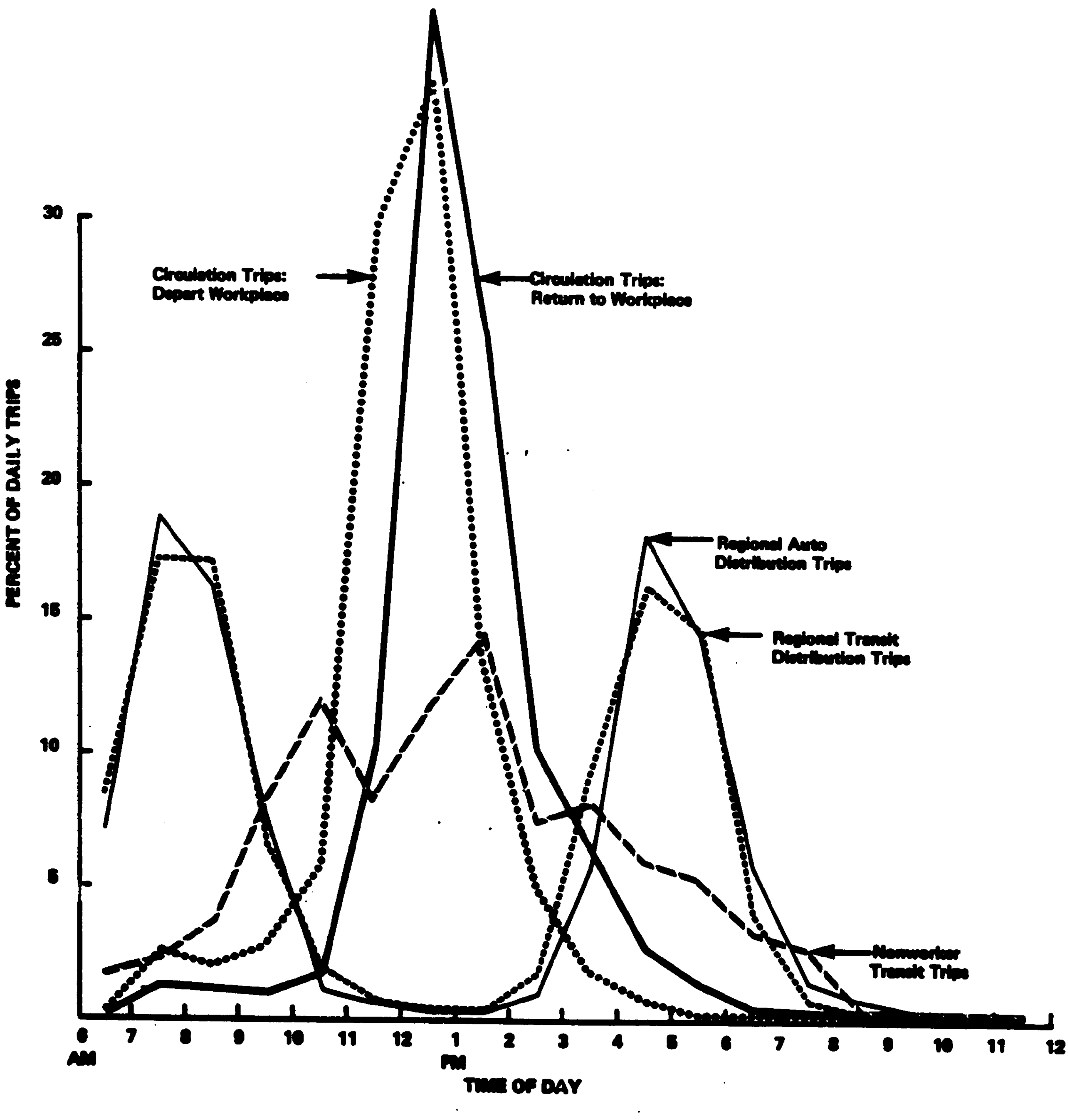
1 Characteristics of Urban Transportation Demand - A Handbook for Transportation Planners, prepared by Wilbur Smith and Associates for the Urban Mass Transportation Administration and Federal Highway Administration, July 1978.

2 Quick Response Urban Travel Estimation Techniques and Transferrable Parameters - Users Guide, NCHRP Report 187, Transportation Research Board, National Research Council, 1978.

EXHIBIT B-9

LOS ANGELES CBD PEAKING FACTORS



trip model and a matrix scaling technique. If the nonworker circulation trip model is used, the factors must reflect only this market segment. A pedestrian survey is probably the best way to develop these factors.

If the nonworker transit trip scaling technique is used, the factors must reflect both the distribution and circulation trips made by persons who do not work in the study area. A transit on-board survey which excludes study area workers from the analysis could be used to estimate these factors. As these trips are likely to be a small portion of the circulator system ridership, the critical factor is determining how many nonworker trips can be expected to occur during the peak-hour and therefore affect system sizing. The factors developed in Los Angeles from an on-board survey are also shown in Exhibit B-9. As this approach combines the nonworker circulation and distribution market segments, the resulting frequencies are evenly spread throughout the day.

B.3 PREPARATION OF THE SOCIOECONOMIC DATA BASE

In addition to the network and parking data described in Section B.2, various other data describing the study area are required for use with the models. This section describes the socioeconomic data requirements and discusses how they are used within the ACM modeling process.

B.3.1 Data Requirements

Two basic types of socioeconomic data are used by the models--land use and employment. The land use data are an estimate of the gross floor space for each of five land use categories: private office, retail, government, hotel/service/institutional, and wholesale/manufacturing. An estimate of the floor space in each category is required for each zone of the study area. The employment data required for use with the models are an estimate of the total employment in each zone of the study area.

In Los Angeles, base year inventories and future year estimates were prepared for both land use and employment. Property tax data maintained by the assessor's office was the basic source of land use information. As will be the case in most areas, the assessor's data classifies the information according to the predominant use of the parcel. For example, an office building containing 100,000 gross square feet of space, of which 10,000 is retail, will be classified as an office building containing 100,000 square feet. Because of this convention, mixed use within a single structure cannot be differentiated. Since the incidence of mixed use is most frequent where office space is the predominant use, the result tends to be an overestimation of the office category and an underestimation of retail and service uses. Some attempt to compensate for the classification problem should be made for large complexes having significant multiple uses. Often the necessary information can be obtained directly from the owner or landlord.

Other sources of data are sometimes available to supplement an assessor's data base. Other local agencies often maintain parallel information, with major commercial brokerage or leasing firms in many areas having sophisticated computerized data bases. Generally, multiple sources of information are required to complete an inventory to account for the missing pieces in each of the individual sources. For example, an assessor's data base will often omit nontaxable properties while a brokerage data base might be limited to first and second class office space.

Projection of the study area future year land use can be a difficult undertaking, particularly since estimates are required by zone within the study area. A wide variety of sources, both governmental and private sector, should be contacted regarding development plans. For short time horizons, those projects under or nearing construction should be explicitly accounted for. The hard part however, is turning a discussion of plans and expectations into numbers for use with a modeling process. One method of dealing with such uncertainty is to develop a range of forecasts, for example, high and low expectations, and use the models with each for determining the feasibility of the proposed circulator service.

Up-to-date employment data at the level of disaggregation required for this type of study is also difficult to obtain. Generally, there is a time lag between the available and required information; there is significant suppression of statistics due to confidentiality and privacy laws; the area systems are not compatible; or the classification structures are not compatible. One method for estimating the employment is to develop employment-square footage ratios using compatible data bases and to apply these ratios to the land use inventory. As the use of averages will result in estimates which are subject to considerable error, careful checks on reasonableness should be made using industry standards and the available data. Forecasts of employment can be made using a similar approach with the zonal land use forecasts.

B.3.2 Uses of the SocioEconomic Data

The land use and employment data have several uses within the ACM process. Most directly, both the employment and land use data are used to estimate the frequency and destination of worker circulation trips. The zonal employment variable helps to determine the likelihood that a circulation trip will be made, while a linear combination of the land use data is used to determine the level of activity, and therefore attractiveness, of each potential destination zone.

As is discussed in Section B.4, the employment data can also be used when revisions to regional trip tables are required as a result of differences in zone systems. The employment data can be used to prepare the factors necessary to reconfigure the trip tables, or to factor nonworker transit trip matrices.

The base year data is useful for making adjustments to the models and for their validation. As is described in later sections, validation of the models requires that the models be applied to a base case. This means that the base year data must be prepared in the format necessary for input to the models. If one wishes to recalibrate rather than adjust the Los Angeles models, base year land use and employment data will be necessary for this process. If one is considering restructuring the models, careful thought should be given to the data requirements prior to data collection as other disaggregations of the information may be necessary.

B.4 PREPARATION OF REGIONAL TRIP TABLES

The ACM distribution trip models require that the regional trip tables be modified to reflect only the movement which occurs within the CBD study area. This is the movement to a person's place of work from a parking lot or from the location where the person alights from the transit vehicle used to enter the study area. Preparation of these internal distribution trip tables requires manipulation of regional trip tables and the use of models or processes to create separate transit and auto internal trip tables; the auto tables including both auto person and vehicle trips.

B.4.1 Adapting Regional Trip Tables

The first step of the trip table processing is to create transit person trip, auto person trip, and auto vehicle trip tables reflecting the trips from each "approach corridor" to each study area zone. These tables should be the trips by workers to/from the study area and should exclude any trips which pass through the study area. Each approach corridor is essentially an enlarged district outside the study area which groups regional analysis zones based on common travel paths to the study area.

The effort involved in adapting existing regional trip tables for input to the ACM process is dependent on the correspondence between: study area and regional analysis zone systems; forecast years; and trip purpose and land use forecasts. The greater the correspondence between these items, the simpler the process required. In fact, if all items agree the process is basically one of aggregation. The effect of each of these items on the required processing is described in the following sections.

B.4.1.1 <u>Correspondence between Zone Systems</u>

In the simplest case, the regional analysis zone system will provide the desired level of detail within the study area and the boundaries of the study area will coincide with regional analysis zone boundaries. The SQUEEZ option of UTPS program USQUEX can be used in this case to reconfigure the regional analysis zones. USQUEX zone/district equivalence cards (&EQUIV) would be coded having a one-to-one correspondence for zones within the study area and combining regional zones outside the study area into larger districts. The resulting USQUEX "district" level trip tables will be the tables required for the circulator system analysis.

At the other extreme is the case where some of the zone systems correspond. Such a case is shown by Exhibit B-10. In this example the analysis is to be conducted at a greater level of detail than that provided by the regional analysis zone systems, the study area zones shown by the solid lines and the regional system shown by the dashed lines. Note that the study area boundary also bisects regional analysis Zone 102. A multi-step process must be used to reconfigure the trip tables in this case: fractions are developed for subdividing regional analysis zones; regional zones outside the study area are compressed using program USQUEX; regional zones within the study area are expanded to study area zone pieces, also through the use of program USQUEX; and USQUEX is used to recombine and renumber the study area zone pieces. Program CSQUEX, which is also available from UMTA, provides a similar capability for modifying trip tables.[1]

Exhibit B-11 shows one technique for developing the fractions for expanding the regional analysis zones within the study area. Each study area zones and its employment is listed. The percent of the study zones' employment that occurs within the

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[1] CSQUEX Program Writeup, Urban Mass Transportation Administration.

EXHIBIT B-10

CORRESPONDENCE BETWEEN ZONE SYSTEMS

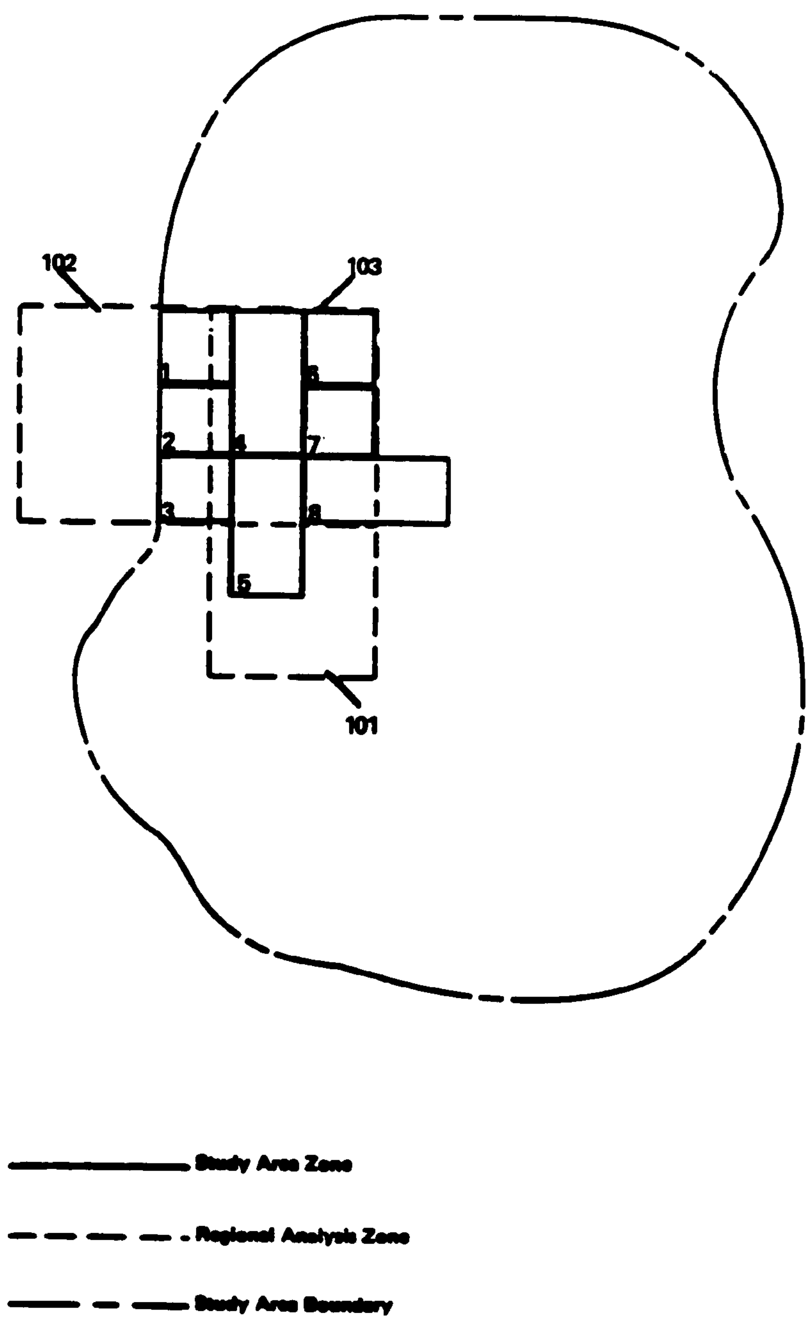

EXHIBIT B-11

PREPARATION OF USQUEX FRACTION CARDS

Regional Analysis Zone: 103

(1) Study Area Zone No.	(2) Intermediate Zone No.	(3) Study Area Zone Employment	(4) Percent of Study Zone Emp. within TAZ	(5) Employment within District	(6) Fraction
1	1	1500	33	500	.055
2	2	1200	33	400	.044
3	3	1500	33	500	.055
4	4	800	100	800	.088
5	59	1000	50	500	.055
6	6	2000	100	2000	.220
7	7	4000	100	4000	.439
8	8	1000	40	400	.044
				9100	1.000

B.26

regional analysis zone being subdivided is also shown. Columns 3 and 4 are multiplied together to determine each study zone's employment within the regional zone. Each study area zone's employment is then divided by the total employment for the regional analysis zone to determine the required fraction.

If more detailed information is available about the location of employment within the study area zone, this could be used to develop the fractions, rather than the proportion of the zone within the district. If employment data are not available, other measures of land use can be used to develop the proportions, though employment data are the best information that can be used.

Note that study area Zone 5 in the exhibit is assigned "intermediate" zone number 59. Zone 5 is comprised of pieces from regional analysis Zones 101 and 103. When USQUEX is being used to fraction districts, the pieces of each district must be assigned unique zone numbers. In this case, the part of Zone 5 that falls in District 101 is assigned intermediate number 5. The piece from Zone 5 that falls in District 103 must be assigned a different number, in this case we are assuming that 59 is the next available zone number. Note that study area Zones 1, 2, 3, and 8 are also comprised of pieces from more than one district.

Exhibit B-12 shows a USQUEX setup from the Los Angeles Downtown People Mover analysis for reconfiguring regional zones into study area zones. In this setup, the portion of regional zones lying outside the study area have already been combined into the approach corridors, Districts 1-9. The first step of the setup fractions the 27 districts into 122 intermediate zones. The fraction cards in this example input, on a separate data set using the "A1" DDNAME, a portion of these cards shown by Exhibit B-13. The second step of the JCL setup combines the 122 intermediate zones into 107 study area zones, the pieces of study area zones originating in different districts added together to form the final study area zones. For example, the final Zone 78 is comprised of intermediate Zones 78, 109, and 120. Following this back to step 1, we can see that study area Zone 78 contains pieces of Districts 12, 13, and 26.

B.4.1.2 Correspondence between Forecast Years and Land Use Estimates

Preparation of the study area trip tables is also made easier when the study forecast year corresponds with a year for which regional trip tables exist. Correspondence between land use and employment estimates made for the circulation study with those prepared as part of the regional planning efforts also

EXHIBIT B-12

USQUEX FOR RECONFIGURING FARE SYSTEMS

```
//PROCLIB  DD  DSN=PMMPROC,DISP=SHR
//STEP014F  EXEC  USQUEX,
//     J1='DSN=D35C.LADPM.Y90.DIST27.TRIPTMP2',UNITJ1='3330-1',
//     A1='DSN=D35C.LADPM.Y90.STEP014.DATA',UNITA1='3330-1',
//     J9='DSN=D35C.LADPM.Y90.CBD122.TRIPTEMP',
//     UNITJ9=PUBLIC,DISPJ9='(,CATLG,DELETE)',
//     SPACEJ9='(TRK,(5,3),RLSE)'
//USQUEX.SYSIN DD *
                    EXPAND TO CBD ZONES
&PARAM
     DISTS=27,
     ZONES=122,
     OUTBPT=4,
     TABLES=101,
     NAME1='WORKTRAN90'
&END
&OPTION
     EXPAND=T, ONE=T
&END
&SELECT
     REPORT = 3,4
     PRING = 14,19,106
&END
&EQUIV  DIST =   1, Z = 99        &END
&EQUIV  DIST =   2, Z =100        &END
&EQUIV  DIST =   3, Z =101        &END
&EQUIV  DIST =   4, Z =102        &END
&EQUIV  DIST =   5, Z =103        &END
&EQUIV  DIST =   6, Z =104        &END
&EQUIV  DIST =   7, Z =105        &END
&EQUIV  DIST =   8, Z =106        &END
&EQUIV  DIST =   9, Z =107        &END
&EQUIV  DIST =  10, Z = 62, 66, 88, 89, 96, 97,        &END
&EQUIV  DIST =  11, Z = 70,108                  &END
&EQUIV  DIST =  12, Z = 74,78                   &END
&EQUIV  DIST =  13, Z = 82,109                  &END
&EQUIV  DIST =  14, Z = 24, 30, 36              &END
&EQUIV  DIST =  15, Z = 83                      &END
&EQUIV  DIST =  16, Z = 90,-92                  &END
&EQUIV  DIST =  17, Z = 84,-87,110              &END
&EQUIV  DIST =  18, Z =  1,-11                  &END
&EQUIV  DIST =  19, Z = 12,-23                  &END
&EQUIV  DIST =  20, Z = 58                      &END
```

EXHIBIT B-12 (Continued)

USQUEX FOR RECONFIGURING FARE SYSTEMS

```
 &EQUIV  DIST =  21, Z = 50, 54         &END
 &EQUIV  DIST =  22, Z = 40, 46,111     &END
 &EQUIV  DIST =  23, Z = 25,-29, 31,-35, 37,-39, 41,-45, 47,-49, 51,-53  &END
 &EQUIV  DIST =  24, Z = 63,-65, 67,-69, 71,-73, 75,-77                 &END
 &EQUIV  DIST =  25, Z = 59,-61, 93,-95,112,113,122                     &END
 &EQUIV  DIST =  26, Z = 55,-57, 79,-81,114,-120,121                    &END
 &EQUIV  DIST =  27, Z = 98             &END
//STEP014G EXEC USQUEX,CORE=253K,TIME=(,20),
//      COND=(4,LT,STEP014F.USQUEX),
//      J1='DSN=D35C.LADPM.Y90.CBD122.TRIPTEMP',UNITJ1='3330-1',
//      J9='DSN=D35C.LADPM.Y90.CBD107.TRIPTAB6',UNITJ9=PUBLIC,
//      SPACEJ9='(TRK,(10,5),RLSE)',DISPJ9='(,CATLG,DELETE)'
//USQUEX.SYSIN DD *
                  RECOMBINE TO STUDY AREA ZONE SYSTEM - 1990
                     LOS ANGELES DOWNTOWN PEOPLE MOVER

 &PARAM
     ZONES=122,
     DISTS=107
     OUTBPT=4
     TABLES=101,
     NAME1=PKTRAN90'
 &END
 &OPTION
     SQUEEZ=T
 &END
 &SELECT
     REPORT=4, PRINT=14,19,106
 &END
 &EQUIV SAME= 1,-49,54,-62,67,-74,79,-81,83,-88,90,-107  &END
 &EQUIV DIST = 50,  Z=50,111      &END
 &EQUIV DIST = 51,  Z=51,114      &END
 &EQUIV DIST = 52,  Z=52,115      &END
 &EQUIV DIST = 53,  Z=53,116      &END
 &EQUIV DIST = 63,  Z=63,112      &END
 &EQUIV DIST = 64,  Z=64,113      &END
 &EQUIV DIST = 65,  Z=65,122      &END
 &EQUIV DIST = 66,  Z=66,108      &END
 &EQUIV DIST = 75,  Z=75,117      &END
 &EQUIV DIST = 76,  Z=76,118      &END
 &EQUIV DIST = 77,  Z=77,119      &END
 &EQUIV DIST = 78,  Z=78,109,120  &END
 &EQUIV DIST = 82,  Z=82,121      &END
 &EQUIV DIST = 89,  Z=89,110      &END
```

EXHIBIT B-13

EXAMPLE USQUEX FRACTION CARDS

01	0.000	0.000	0.000	0.000	0.000	0.000
02	0.000	0.000	0.000	0.000	0.000	0.000
03	0.000	0.000	0.000	0.000	0.000	0.000
04	0.000	0.000	0.000	0.000	0.000	0.000
05	0.000	0.000	0.000	0.000	0.000	0.000
06	0.727	0.727	0.727	0.727	0.727	0.727
07	0.000	0.000	0.000	0.000	0.000	0.000
08	0.052	0.052	0.052	0.052	0.052	0.052
09	0.000	0.000	0.000	0.000	0.000	0.000
10	0.208	0.208	0.208	0.208	0.208	0.208
11	0.013	0.013	0.013	0.013	0.013	0.013

12	0.025	0.025	0.025	0.025	0.025	0.025	
13	0.040	0.040	0.040	0.040	0.040	0.040	
14	0.135	0.135	0.135	0.135	0.135	0.135	
15	0.225	0.225	0.225	0.225	0.225	0.225	
16	0.098	0.098	0.098	0.098	0.098	0.098	District
17	0.000	0.000	0.000	0.000	0.000	0.000	18
18	0.076	0.076	0.076	0.076	0.076	0.076	
19	0.069	0.069	0.069	0.069	0.069	0.069	
20	0.108	0.108	0.108	0.108	0.108	0.108	
21	0.109	0.109	0.109	0.109	0.109	0.109	
22	0.039	0.039	0.039	0.039	0.039	0.039	
23	0.076	0.076	0.076	0.076	0.076	0.076	

24	0.278	0.278	0.278	0.278	0.278	0.278
25	0.194	0.194	0.194	0.194	0.194	0.194
26	0.015	0.015	0.015	0.015	0.015	0.015
27	0.070	0.070	0.070	0.070	0.070	0.070
28	0.054	0.054	0.054	0.054	0.054	0.054
29	0.0	0.0	0.0	0.0	0.0	0.0
30	0.424	0.424	0.424	0.424	0.424	0.424
31	0.044	0.044	0.044	0.044	0.044	0.044
32	0.109	0.109	0.109	0.109	0.109	0.109
33	0.025	0.025	0.025	0.025	0.025	0.025
34	0.092	0.092	0.092	0.092	0.092	0.092
35	0.049	0.049	0.049	0.049	0.049	0.049
36	0.298	0.298	0.298	0.298	0.298	0.298
37	0.022	0.022	0.022	0.022	0.022	0.022
38	0.032	0.032	0.032	0.032	0.032	0.032
39	0.043	0.043	0.043	0.043	0.043	0.043
40	0.733	0.733	0.733	0.733	0.733	0.733
41	0.026	0.026	0.026	0.026	0.026	0.026

simplifies the preparation of regional trip tables. If either the regional trip tables or the land use forecasts do not correspond to the study forecast year, a factoring step must be added to the trip table processing to create the appropriate study area tables.

In general, the smaller the matrix to be processed, the less costly is the processing. For this reason, any factoring of trip tables should be performed once the regional trip tables have been compressed to corridors of approach but before the study area itself is expanded. Multiple factors can be combined into a single step so as to minimize the necessary processing. If possible, a constant base, such as employment, should be used in the development of all factors. Also, unless strong evidence exists which would affect the relationship between the approach corridors and the study area, the factors need be created only for the study area.

For example, suppose a downtown circulation analysis is to be conducted for year 1990 and regional trip tables exist for either 1985 or 1995 but not 1990. The planner should pick the regional trip table which embodies other characteristics most similar to those which will be in place in the circulation study forecast year. Let's assume that the 1995 tables incorporate a radically different regional bus operation from the one existing in 1985. In this case, the trip table to be factored to obtain 1990 should be selected according to the similarity with the 1990 regional bus service. If the revised service is to be in effect in 1989, the 1995 table should be used; if in 1991, the 1995 table should probably still be used.

Once a table has been selected, the factors should be based on some characteristic which is available for both years for comparable zone systems. Generally, the factors should be developed using the zone system of the trip table. As indicated, employment is a good basis for the development of the factors.

Exhibit B-14 shows a setup for factoring a 27-district zone system. Exhibit B-15 shows the fraction cards for performing this factoring. This example also incorporates splitting districts which overlap the study area boundary and combining the portion outside the study area into the appropriate corridor of approach. The main difference between this setup and the one described for fractioning study area zones is that in this setup the fractions for the zones comprising a district are not restricted to totaling 1.0. In the example shown, the fraction cards are input from a separate data set, the actual fractions reflecting differences in study years and in small area employment forecasts.

EXHIBIT B-14

USQUEX FOR FACTORING A DISTRICT ZONE SYSTEM

```
//PROCLIB DD DSN=PMMPROC,DISP=SHR
//STEP012A EXEC USQUEX,TIME=1,CORE=180K,
//        J9='DSN=D35C.LADPM.DIST27.TEMP',
//        J1='DSN=D35C.LADPM.Y95.DIST27.TRIPTAB1',
//        UNITJ1='3330-1',UNITA1='3330-1',UNITJ9=PUBLIC,
//        A1='DSN=D35C.LADPM.Y90.STEP012.DATA'
//USQUEX.SYSIN DD *
          RECONFIGURE DISTRICTS TO STUDY AREA INTERNAL
          AND EXTERNAL ZONES

            DISTRICTS 1 - 9 = CORRIDORS
            DISTRICTS 10 - 27 - LARTS CBD ZONES
 &PARAM
     ZONES=36, DISTS=27,
     TABLES = 101,102,103
     OUTBPT=4
     NAME1 = 'HWPERSON90', NAME2='HWTRANSIT90',
     NAME3 = 'HWAUTODR90'
 &END
 &OPTION
     EXPAND=T
 &END
 &EQUIV  SAME = 1,-10, 16,-19, 23,-26     &END
 &EQUIV  DIST = 14, Z = 14, 28            &END
 &EQUIV  DIST = 15, Z = 15, 29            &END
 &EQUIV  DIST = 20, Z = 20, 30            &END
 &EQUIV  DIST = 21, Z = 21, 31            &END
 &EQUIV  DIST = 22, Z = 22, 32            &END
 &EQUIV  DIST = 27, Z = 27, 33            &END
 &EQUIV  DIST = 11, Z = 11, 34            &END
 &EQUIV  DIST = 12, Z = 12, 35            &END
 &EQUIV  DIST = 13, Z = 13, 36            &END
//STEP012B EXEC USQUEX,TIME=1,CORE=180K,
//       J9='DSN=D35C.LADPM.Y90.DIST27.TRIPTAB3',
//       J1='DSN=D35C.LADPM.DIST27.TEMP',
//       UNITJ9=PUBLIC
//USQUEX.SYSIN DD *
         COMPRESS TO 27 DISTRICTS
 &PARAM
       ZONES=36, DISTS-27,
     TABLES = 101, 102, 103
     OUTBPT=4
     NAME1 = 'HWPERSON90', NAME2='HWTRANSIT90',
     NAME3 = 'HWAUTODR90'
 &END
 &OPTION
       SQUEEZ = T
 &END
```

EXHIBIT B-14

(Continued)

```
&SELECT
      PRINT = 1, -27
      REPORT = 4
&END
&EQUIV  SAME = 1, 2, 5, 6, 9,-27          &END
&EQUIV  DIST = 3, Z = 3, 28, 30,-32       &END
&EQUIV  DIST = 4, Z = 4, 29               &END
&EQUIV  DIST = 7, Z = 7, 33               &END
&EQUIV  DIST = 8, Z = 8, 34,-36           &END
```

B.4.1.3 Correspondence between Trip Purposes

The ACM models presented in this report are applied to trip tables which reflect the trips by workers to and from the study area. This contrasts with many regional planning efforts which usually prepare separate trip tables for from three to six different purposes. If three purposes are used, they generally include: home-based work, home-based other, and non-homebased. Six purpose tables often include: home-based work, home-based other, other to work, other to other, home-based school, and truck/taxi trips.

In general, the trip tables used with this model system should reflect the trips entering and leaving the study area for work each day. The linking of trips between the various trip purposes makes it difficult to obtain a strict correspondence between the traditional trip purposes and these worker trips. The home-based work or home-based work plus other to work tables come closest to the required classification. The trips crossing the study area boundary in these tables should be factored to reflect the number of worker-related trips to the study area each day. The total number of trips to the study area is usually some percentage of total study area employment which accounts for the expected absenteeism. UTPS program UMATRIX can be used to factor the compressed regional trip table on a global basis so that this total number of daily trips to the study area is achieved.

B.4.2 Creating Internal Trip Tables

Internal trip tables reflect the trip to the study area workplace from (a) the regional transit stop where the worker first exits the regional transit service in the study area for regional transit users, or (b) the parking lot in the study area for regional auto uses. It is to these trip tables that the distribution mode choice models are applied to estimate circulation systems ridership. Unfortunately, while tables resulting from this step can greatly affect or bias the resulting ridership estimates, there are no good methods for creating the tables. Suggestions for creating these tables for regional transit and auto users are presented in the following sections, the techniques presented relying heavily on the experience to date in Los Angeles.

B.4.2.1 Regional Transit Users

The method used in Los Angeles to determine the stop where trips must exist from their regional transit vehicle was a manual coding of exit points determined from inspection of bus route maps. This coding of exit points is done separately for

EXHIBIT B-15

EXAMPLE USQUEX FACTORS

01	1.0	1.0
02	1.0	1.0
03	1.0	1.0
04	1.0	1.0
05	1.0	1.0
06	1.0	1.0
07	1.0	1.0
08	1.0	1.0
09	1.0	1.0
10	0.848	0.848
11	0.511	0.511
12	0.394	0.394
13	0.845	0.845
14	0.348	0.348
15	0.113	0.113
16	0.669	0.669
17	0.993	0.993
18	0.389	0.389
19	1.592	1.592
20	0.253	0.253
21	0.200	0.200
22	2.101	2.101
23	1.289	1.289
24	1.804	1.804
25	1.019	1.019
26	0.934	0.934
27	0.117	0.117
28	0.652	0.652
29	0.887	0.887
30	0.747	0.747
31	0.800	0.800
32	0.837	0.837
33	0.883	0.883
34	0.489	0.489
35	0.606	0.606
36	0.155	0.155

each approach corridor. The transit routes in a corridor are first combined into groups, each group of transit lines having a similar routing through the study area. The fraction of the trips in the corridor which would use each group of transit line is then coded.

A card is then coded for each zone in the study area which shows the location of the transit stop used by the trips entering the study area on each group of transit lines. Transit stop location is specified by the zone number in which the stop is located or the number of a specially coded intercept/transfer facility. As indicated, these stop locations are determined by an inspection of transit route maps. The coded information is then used by a special program, known as BUSSTOP,[1] to change the non-study area end of all transit trips crossing the cordon to a study area zone. The output of the process is a UTPS compatible matrix comprised of trips which are completely internal to the study area.

B.4.2.2 Regional Auto Users

A technique must also be used to determine the parking location of workers entering the study area by auto, as the mode used between the parking location and the place of work is what is estimated by the logit distribution choice model. Parking location choice, however, is a complex phenomenon reflecting trade-offs between parking cost and proximity to place of employment. As discussed, any systematic technique is further complicated by the availability of restricted and/or subsidized parking which masks the true market price and supply of parking.

One technique is the parking choice model included with the ACM model set and described in Appendix A. This model estimates the proportion of the trips to each study area destination which would park in each of the study area zones. The choice is based primarily on the cost of parking at each location and the quality of the transportation service between the parking location and the destination. The quality of service is denoted by the LOGSUM variable, the natural logarithm of the sum of the modal utility expressions for the distribution choice model. With such a formulation, an inexpensive but distant lot at the end of a people mover line might be a better choice than an expensive lot within walking distance of the final destination.

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[1] Documentation and source code for program BUSSTOP is included as Attachment 1 to this appendix.

The model can be applied in a single pass to develop a parking pattern without regard to the availability of spaces at any location, or it can be applied iteratively to balance supply and demand. In either case, careful review must be made of the results, particularly when dedicated, low-cost facilities associated with a circulator system are to be analyzed. The model cannot restrict the use of such parking facilities to those

trips which use the circulator, and as a low-cost alternative, the facility will be very desirable for trips whose destinations are nearby the facility. As the model gives all trips an equal opportunity to use each facility, the results may not always appear reasonable.

B.5 PREPARATION OF A TRAVEL CHARACTERISTICS DATA BASE

The need for collecting additional travel characteristics information will depend on the detail and quality of data already available and on the degree to which one will make model adjustments or perform model recalibration. This section discusses some of the considerations and makes some suggestions regarding the conduct of additional survey work.

B.5.1 Purposes of the Survey

The amount and the level of specification of data to be collected depends on its intended use. Increasingly costly and comprehensive data collection efforts are needed if the data are to be used to validate the characteristics of the forecast travel, to develop adjustment factors to correct for discrepancies between the observed and estimated travel patterns, or to recalibrate the set of choice models using data on the behavioral characteristics of travelers in the study area. Generally, though, the most information can be obtained from a workplace survey which includes a daily trip diary. The kinds of information which survey results should provide include:

- trip generation rates for midday travel by employment type;
- CBD travel patterns for midday travel;
- the distribution of walk distances to parking lots;
- the temporal distribution of travel to and from the workplace; and
- behavioral data on individual traveler's mode choice decision process, such as the travel time and cost of all modes available to the traveler.

A workplace survey can be conducted by personal interviews, telephone surveys, or by a questionnaire. The preferred method will depend on the types of information to be collected and or the acceptable level of costs. Due to the quantity and level of detail of the data, questionnaires are frequently used to collect travel characteristic data. Therefore, the following discussion will focus on the issues in conducting a questionnaire survey.

B.5.2 Questionnaire Design

The design of the questionnaire is an extremely important step in conducting a successful workplace survey. The first step is to identify each item of data that will be needed to meet the purposes of the survey. This means that the analysis to be performed on the survey data must be identified and worked through in detail before the data are collected. Too often, tests are proposd after the survey is conducted only to find that the necessary data were not included at all or were not included in the form needed for the analysis.

The questionnaire must be designed to be uncluttered and easily understood. In addition, instructions must be provided to explain how the questions should be filled in. Finally, the wording of the questions should use simple, clear, and unambiguous language.

Before distributing the questionnaire, a pretest should be conducted. This involves distributing a small number of questionnaires to the population to be surveyed and then analyzing the responses to see whether the instructions were followed and whether the questions were properly understood. Any problem areas should be redesigned before the full survey is conducted. The pretest can also serve as an indication of the response rate that can be expected for the survey. The workplace survey designed for Los Angeles is included as an example questionnaire in Attachment 2.

B.5.3 Sample Size and Selection

The distribution of the questionnaires is controlled by a statistical sampling process to ensure that the individuals surveyed are representative of all the individuals in the population of travelers. The size of the sample is computed first and a sample framework is then designed to guide or control the sample selection process. The size of the sample is a function of the specificity of the desired information and the expected response rate. The types of analyses to be conducted on the survey data and the cost trade-offs are used to determine the desired number of survey responses. This number is divided by the expected response rate to determine the number of questionnaires that must be distributed. For example, if 1,000 responses are desired and the expected response rate is .50 percent, one response for every two questionnaires distributed, then 2,000 questionnaires must be distributed (1,000/.50 = 2,000).

The sample framework defines the population being surveyed and draws a respresentative sample from the identified population. The sampling can be designed as a simple random sample, a cluster sample, a stratified sample, or a combination of these techniques. A cluster random sample was used in Los Angeles to sample the population of employees within the boundaries of the CBD study area. First, 25 blocks were randomly sampled from the 210 blocks in the study area. Floors were then sampled from the buildings in each of the 25 sampled blocks. This step required considerable care to insure that all employees maintained equal probabilities of being sampled. Finally, questionnaires were distributed to all the employees in all the businesses on the sampled floors.

B.6 TRANSFERRING THE LOS ANGELES MODEL SYSTEM

The ACM models presented throughout this report implicitly incorporate characteristics of the Los Angeles CBD which may not occur in other study areas. It is reasonable to assume, therefore, that the transfer of the models to another city will require adjustments to the model coefficients to help the models better account for local conditions. Generally, four types of adjustments will need to be considered:

. revising the value of time to reflect local income levels;

. adjusting modal constants to attain the local overall mode split;

. adding a new mode constant; and

. adjusting trip generation constants to achieve the correct frequency of study area circulation trips.

All of these changes are made to the model either by revising the ACM model source code or, as in the case of Los Angeles, updating the coefficients input on a parameter card. Exhibit B-16 shows the Los Angeles distribution model setup, highlighting the various coefficients discussed in this section. The user also has the option of combining market segments to simplify the analysis, though the structure of the models really only permits combining the regional transit and regional auto user markets.

EXHIBIT B-16

DISTRIBUTION MODE CHOICE SETUP AND PARAMETERS

```
//STEP101B EXEC PGM=MSPLIT,REGION=255K,TIME=(,10)
//STEPLIB  DD  DSN=D35C.LADPM.MODEL.LOAD.DISP=SHR
//FT11F001 DD  DSN=D35C.LADPM.Y90.STEP101.SK1MTMP2,DISP=SHR
//FT12F001 DD  DSN=D35B.LADPM.Y90.WALKPM.SKIM,DISP=SHR
//FT13F001 DD  DSN=D35C.LADPM.Y90.CBD116.TRANSIT,DISP=SHR
//FT18F001 DD  DSN=D35C.LADPM.Y90.DISTPM.LOGSUM,UNIT=3330,
//      VOL=SER=D35D01,SPACE=(TRK,(5,1),RLSE),
//      DCB=(RECFM=VBS,LRECL=1604,BLKSIZE=13030),
//      DISP=(,CATLG,DELETE)
//FT19F001 DD  DSN=D35C.LADPM.Y90,DISTPM.TRANSIT,UNIT=3330,
//      VOL=SER=D35D01,SPACE=(TRK,(5.1),RLSE),
//      DCB=(RECFM=VBS,LRECL=1604,BLKSIZE=13030),
//      DISP=(,CATLG,DELETE)
//FT20F001 DD  UNIT=SYSDA,SPACE=(TRK,(1,1)),
//      DCB=(RECFM=FB,LRECL=80,BLKSIZE=1680)
//FT21F001 DD  DUMMY
//FT06F001 DD  SYSOUT=A
//FT05F001 DD  *

 &PARAM
     ZONES=116, MODES=4,
     TRPTAB=301, WLKTAB=202, MNRTAB=101, MNOTAB=102,
     RBRNTB=103, RBOUTB=104, DPMRTB=105, DPMOTB=106, DPMXTB=107,
     WALKCF=-0.050874, C(1)= 5.0414,
     TIMECF=-0.45813, OUTCF=-0.57430, C(2)=0.0, C(3)=0.6818,
     BUSDMY= 3.1928, FARECF=-0.02749, C(4)=0.995,
     MINIFR=20., ABUSFR=55., TBUSFR=6.31, DPMFR=25.
 &END
```

B.6.1 Revising the Value of Time

The relationship between the coefficients of the time and cost variables in any model is the value of time (VOT) implicit to the model. (The VOT implied by a model is often used as a check on the reasonableness of the model coefficients.) For the Los Angeles distribution trip model, the time coefficients were determined by the calibration, with the cost coefficients computed by fixing the value of time to $10 per hour (1980). Remember that this VOT is for the distribution portion of the regional trip, not for the entire trip.

If the models are to be adjusted to reflect a revised VOT, the cost coefficients and the mode constants must be changed. As shown in Section 7, the new cost coefficient is computed as:

$$\phi_c' = \frac{\phi_t}{VOT} * 0.6$$

where:

ϕ_c' = study area specific cost coefficient

ϕ_t = Los Angeles model time coefficient (-.4581)

VOT = study area value of time (dollars per hour).

For example the cost coefficient for an $8 VOT would be

$$-\frac{.4581}{8} \times 0.6 = -.03436$$

with cost measured in cents.

The modal constant must now be adjusted to reflect the change in the cost coefficient. Also, as shown in Section 7, the new mode constant can be computed as:

$$D'_m = D_m + X_{cm} (\phi_c - \phi'_c)$$

where:

D'_m is the study area mode constant for mode m;

D_m is the Los Angeles mode constant for mode m; and

X_{cm} is the value of the cost coefficient for each mode in Los Angeles (minibus - 20¢, DPM - 25¢, regional bus = 50¢ in 1980 cents).

For the example above, the change to the regional bus mode constant would be computed as:

$$.618 + 50 * (-.02749 - (-.03436)) = 1.0253$$

B.6.2 Adjusting the Modal Constants

While the structure of the ACM models and the relationship between coefficients is such that the models should be generally transferable, it is unlikely that they will be able to accurately estimate circulator system ridership in a new setting without adjustments being made to the modal constants. These constants incorporate the characteristics and perceptions which are unique to each local area, affecting both the magnitude of total transit system ridership as well as the balance between the various modes.

The modal constants should be adjusted so that the models are able to accurately replicate a base or existing condition before they are used to estimate the ridership for a new service. Such a validation step also lends confidence to the ability of the models to be used for forecasting. It also, implies having available base case trip tables and networks for developing the inputs to the the ACM models. The planner can make multiple runs with the models while adjusting the coefficients at each step until an acceptable balance between the modes is attained. A good starting point is provided by the following formula based on the average mode split percentages, though a "trial and error" fine tuning is generally required to account for the detailed effects of individual interchanges. In general, a revised modal constant can be computed as:

$$D'_m = D_m + \ln \frac{P'_m (1-P_m)}{P_m (1-P'_m)}$$

where:

D'_m is the study area constant for mode m;

D_m is the Los Angeles constant for mode m;

P_m is the percent of trips estimated to use mode m when using the Los Angeles constant;

P'_m is the observed percent of trips using mode m; and

ln is the natural logarithm.

B.6.3 Adding a New Mode

The calibration of the ACM models in Los Angeles reflects the choices made by travelers for an existing set of alternative transportation services, notably the CBD portion of regional bus service, a downtown minibus service, and the walk and auto modes. The calibration results in a set of coefficients for each mode as well as in a set of mode constants which represent the effect of the unique and nonquantifiable aspects of a mode.

Use of the ACM models to study a proposed new service having characteristics which result in it being considered a unique and new mode requires an extension to the models. Analysis of such a new mode requires that the effect of its service characteristics be estimated separately from the other modes and that a unique modal constant be incorporated for the mode. Such extensions to the models were made in Los Angeles so that a proposed automated downtown people mover service could be studied.

As the travel characteristics of a mode are considered to be abstract, the same coefficients and travel characteristics used for the existing modes are also used for the new mode. However, since the mode constant represents the unique and nonquantifiable characteristics of the mode, estimating the constant is not as simple. In general, the mode constant should be based on behavior observed for a similar service operating elsewhere, preferably in the region. If such a comparision cannot be found, the mode constant must be based on objective consideration of the existing modes.

When a service similar to the new mode is found elsewhere in the region or in another urban area, the development of the mode constant should reflect the observed usage of the new service in that area relative to the usage of a service existing in your study area. A good way to make this comparision is to compare the use of the two modes at "indifference," that is, in the situation where the sum of the impedances for all of the travel characteristics except the mode constants is identical for the two modes. At indifference, it is the characteristics incorporated in the mode constants which determine the choice of mode. The relationship between modes at indifference is most easily determined if a logit model exists for the area. If not, perhaps the local planner can provide data for a sample of interchanges at or near indifference or can make an objective determination of the relationship between the modes.

Assuming that travelers in the study area would have the same preferences between the modes, the ACM logit equations can be solved so that the mode constants provide a similar relationship. If we assume that (a) travelers in Los Angeles would choose an automated people mover 75 percent of the time when compared to circulator bus service for distribution trips, and (b) circulator bus service has a mode constant of 0, we can solve for the DPM mode constant as:

$$.25\ e^{D_d} = .75$$

$$D_d = \ln\ 3.0$$

$$D_d = 1.099$$

B.6.4 Adjusting Trip Generation Constants

The circulation trip generation rates estimated by the ACM models are essentially determined by the value of the "zero frequency constant" of the model. As the model estimates the number of round trips which leave the buildings of employment during a day, the rate at which trips are observed to be made can vary significantly from area to area according to such factors as climate and the size of the buildings in the study area. Adjustments similar to those made for the mode constants of the mode choice models should be made to correct for the number of trips made on a daily basis.

This adjustment should be made by executing the model in its abstracted form and comparing the results to observed information. The value of the constant is decreased to increase the numbers of trips, the opposite of the way the mode constants are handled. An estimate of the change to the value of the constant can be made by computing:

$$D = \ln \frac{P' (1-P)}{P (1-P')}$$

where:

P is the percent of workers not making trips estimated using the Los Angeles formulation;

P' is the observed percent of workers not making circulation trips; and

ln is the natural logarithm.

As the actual model results will vary by zone, the model should be rerun using the new constant, with additional runs made as fine tuning is necessary.

B.7 FORECASTING FUTURE YEAR TRAVEL

The previous sections have discussed the various steps which should be taken to prepare the ACM models for use in one's area and to develop the data and network inputs necessary to apply the models. This section presents the sequence of steps for applying the Los Angeles models to determine the daily ridership of a new service. Exhibit B-17, taken from the Los Angeles User's Guide, details the required processing steps and the flow of data throughout the process. Exhibit B-17(a) shows the overall structure and highlights the major processing blocks. Exhibits B-17(b) through (f) expand on this exhibit detailing the relationship between job steps and the creation and flow of data within and between blocks. As for the other sections, it is assumed that the UTPS software will serve as the basis for the application models, the discussion focusing on the UTPS program which would be used at each step. It is also assumed that all of the network processing has been completed at this time.

B.7.1 Generate Regional Trips to the Study Area

The regional trip table inputs to the process must first be created. As discussed, separate transit person trip, auto person trip, and auto vehicle trip tables are required. The regional trip tables should be manipulated using the sequence of USQUEX expand and compress steps necessary to develop the tables for the forecast year. The trip end summaries created by program UFMTR provide a good method for reviewing the results of these manipulations. Alternatively, program CSQUEX can be used to perform similiar trip table adjustments.

B.7.2 Estimating Regional Transit User Mode Split

Prior to applying the distribution trip mode choice model, an internal study area transit person trip table must be created. In Los Angeles the BUSSTOP program[1] was created to perform this function. This is a specially coded program which accepts UTPS inputs and outputs the internal transit trips in UTPS format. Exhibit B-18, shows a setup for using the BUSSTOP program, including the use of UFMTR to prepare trip end summaries for reviewing the results. (Attachment 1 to this appendix contains a copy of the BUSSTOP program documentation and source code.)

The distribution trip logit equations were calibrated for the PM peak hour and with trips in origin-destination format. The internal transit trip table, which should be in production-attraction format, needs to be peaked and directionalized before the distribution trip mode split is estimated. UTPS program UMATRIX can be used to perform this function as is shown in Exhibit B-19.

EXHIBIT B-17 (a)

STRUCTURE OF THE ACM TRAVEL PREDICTION SYSTEM

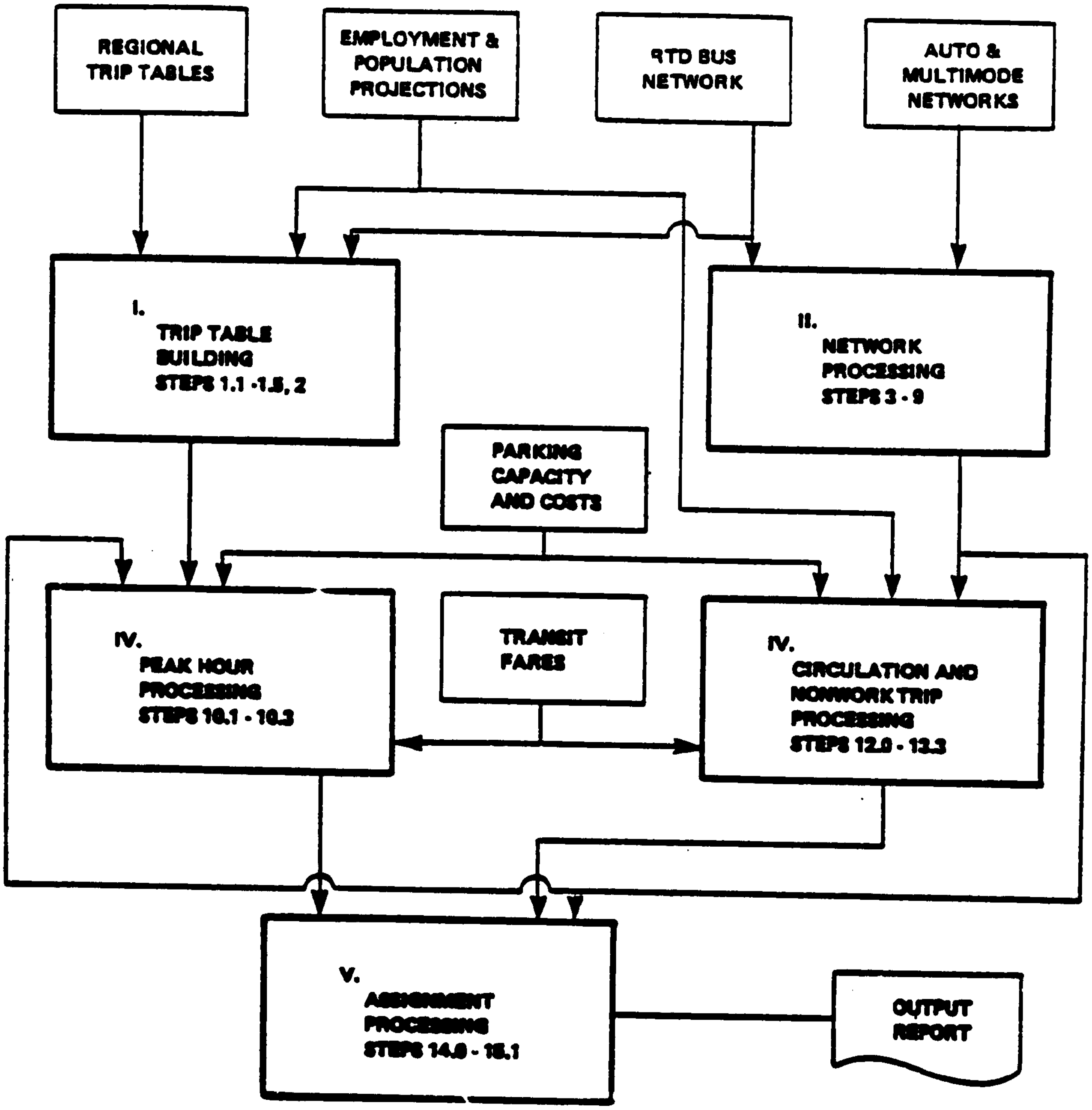

EXHIBIT B-17 (b)

BLOCK I - TRIP TABLE BUILDING

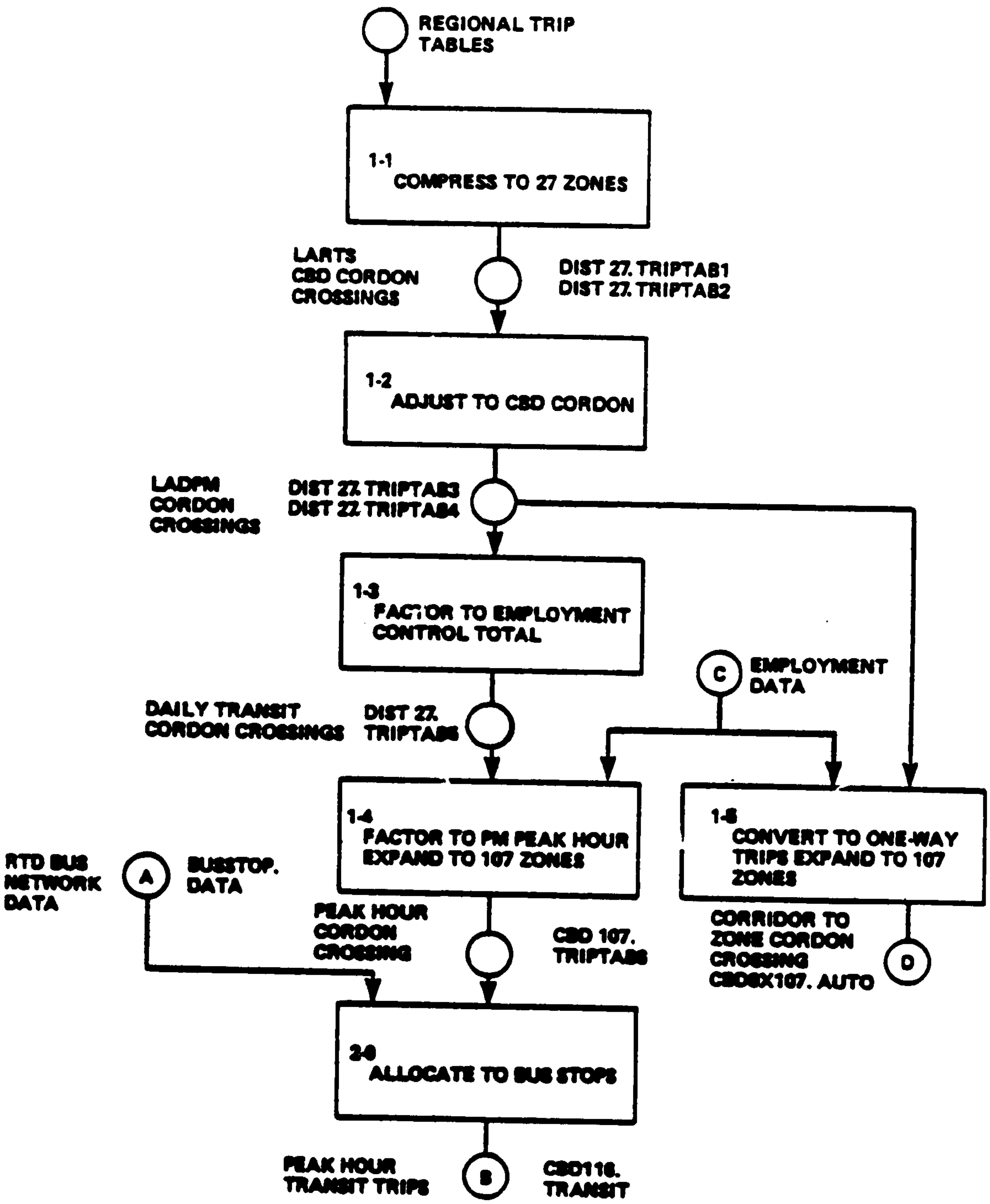

EXHIBIT B-17 (c)

BLOCK II NETWORK PROCESSING

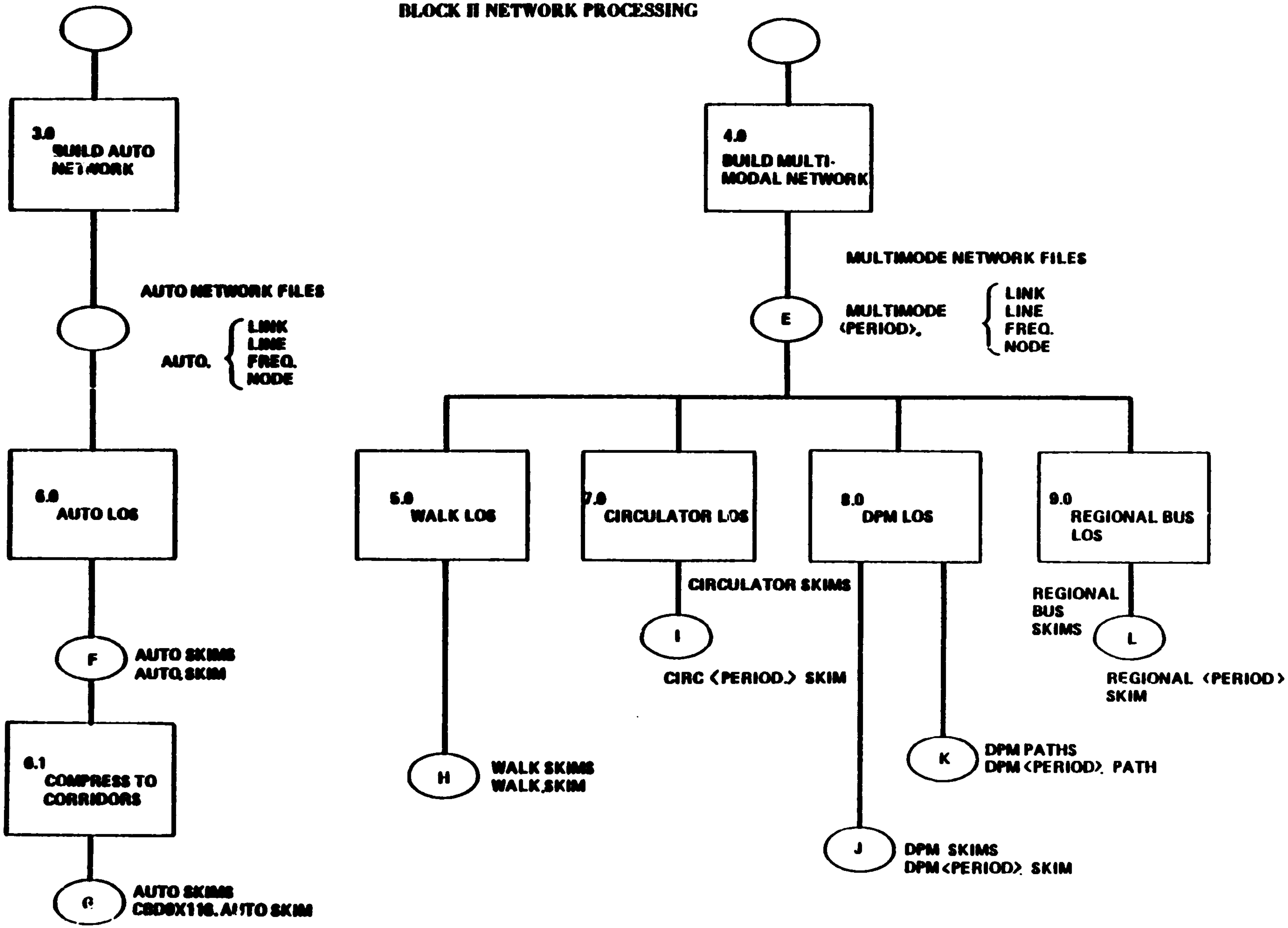

EXHIBIT B-17 (d)

BLOCK III - PEAK HOUR PROCESSING

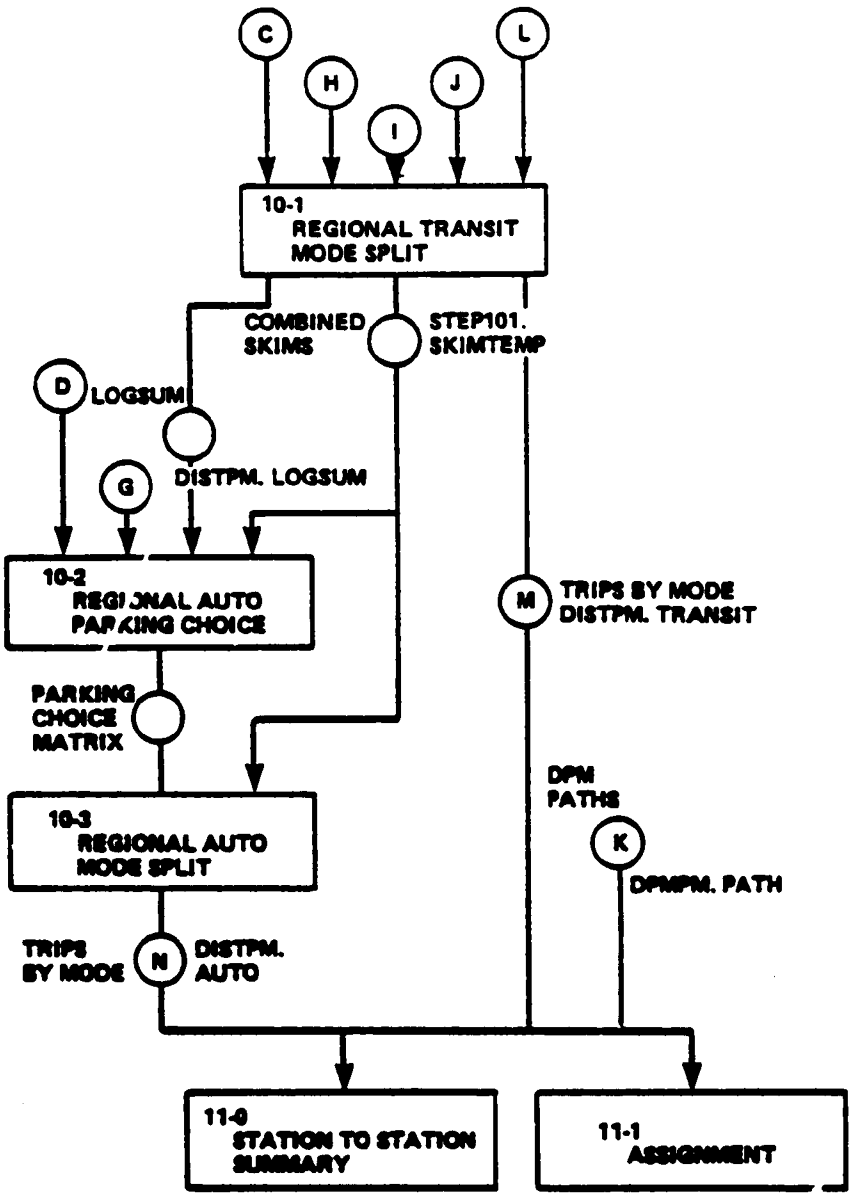

EXHIBIT B-17 (c)

BLOCK IV - CIRCULATION AND NONWORK TRIP PROCESSING

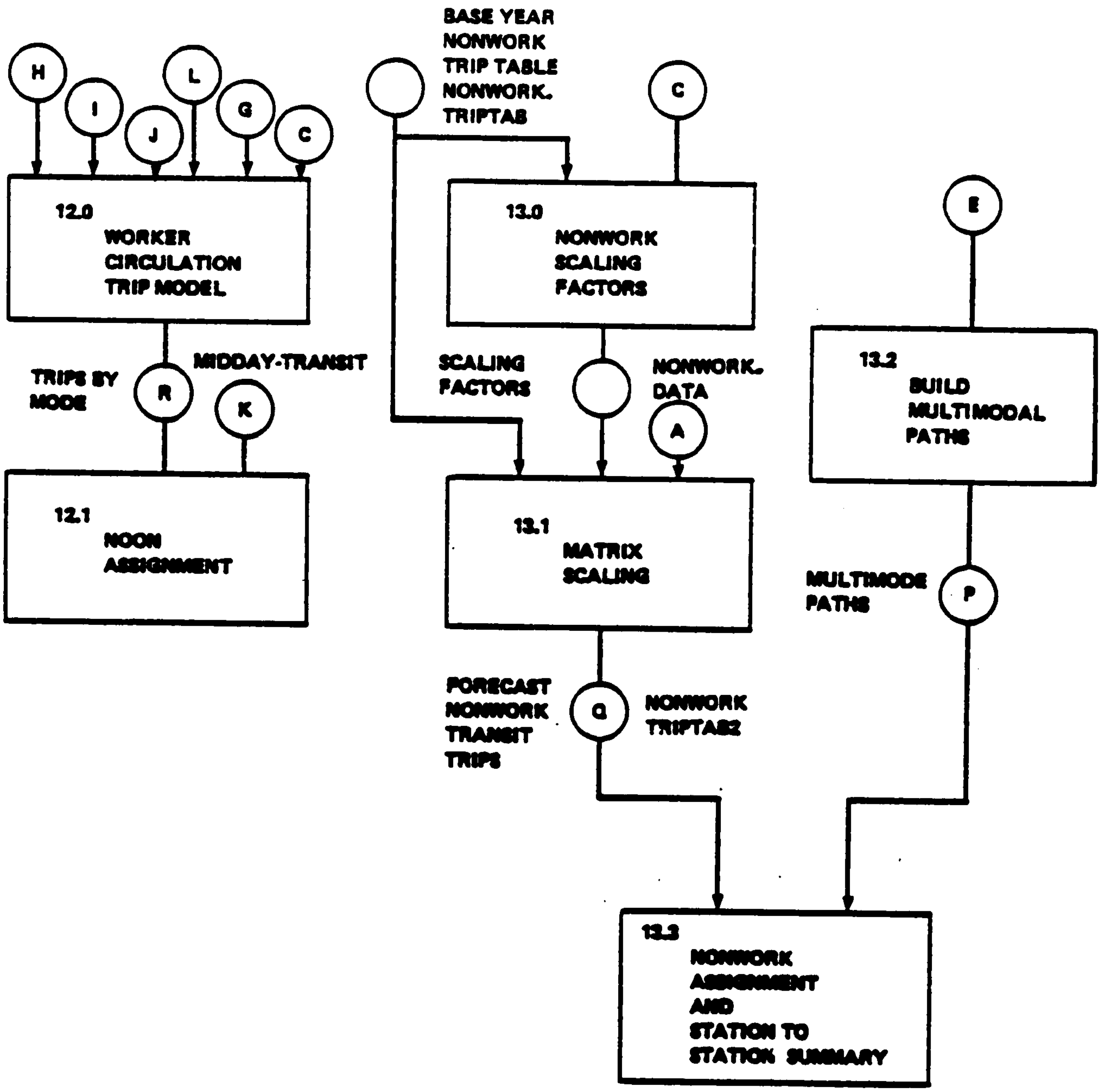

EXHIBIT B-17 (f)

BLOCK V - ASSIGNMENT PROCESSING

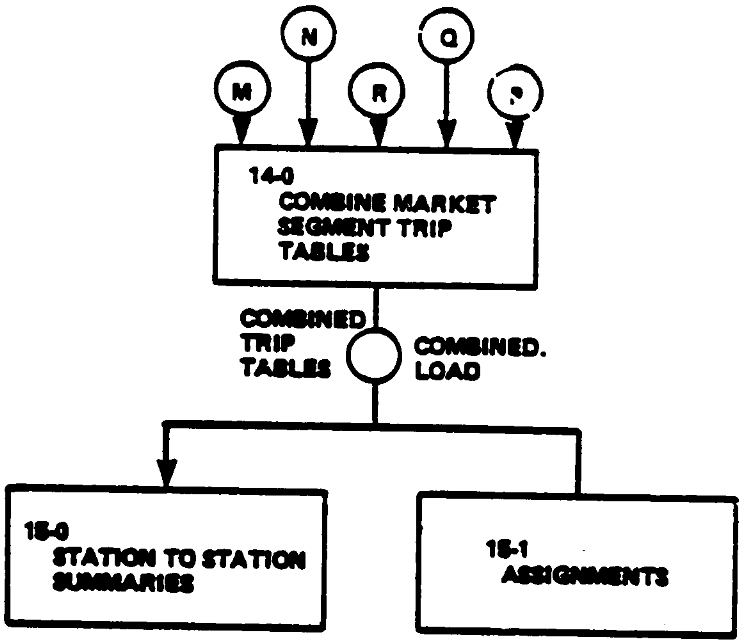

EXHIBIT B-18

BUSSTOP

```
//PROCLIB DD DSN=PMMPROC,DISP=SHR
//STEP020A EXEC PGM=BUSSTOP,REGION=256K
//STEPLIB DD DSN=D35C.LADPM.MODEL.LOAD,DISP=SHR
//FT11F001 DD DSN=D35C.LADPM.Y90.CBD107.TRIPTAB6,DISP=OLD
//FT19F001 DD DSN=D35C.LADPM.Y90.CBD116.TRANSIT,DISP=(,CATLG,DELETE),
//    UNIT=PUBLIC,DCB=(RECFM=VBS,LRECL=1604,BLKSIZE=6447,
//    SPACE=(TRK,(10,3),RLSE)
//FT20F001 DD UNIT=SYSDA,SPACE=(TRK,(1.1)),
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=1680)
//FT21F001 DD DUMMY
//FT06F001 DD SYSOUT=A
//FT05F001 DD DSN=D35C.LADPM.Y90.BUSSTOP.DATA,DISP=SHR
//STEP020B EXEC UFMTR,CORE=253K,TIME=(,10),
//      COND=(0,LT,STEP020A),
//      J1='DSN=D35C.LADPM.Y90.CBD116.TRANSIT'
//UFMTR.SYSIN DD *
           1990 PEAK HOUR INTERNAL TRANSIT TRIP END SUMMARY
 &PARAM
     ZONES=116,
     TABLES = 101,
     TITLE1='PKTRAN90'
 &END
 &SELECT
     REPORT=3
 &END
```

EXHIBIT B-19

PEAKING AND DIRECTIONALIZING INTERNAL TRANSIT TRIP TABLES

```
//PROCLIB  DD DSN=D35B.PMMPROC.CNTL,DISP=SHR
//STEP014A EXEC UMATRIX,CORE=255K,TIME=(,10),
//      J1='DSN=D35C.LADPM.Y90.DIST27.TRIPTAB5',UNITJ1='3330-1',
//      J9='DSN=D35C.LADPM.Y90.DIST27.TRIPTMP1',UNITJ9=PUBLIC,
//      DISPJ9'(,CATLG,DELETE)',SPACEJ9='(TRK,(3,1),RLSE)'
//UMATRIX.SYSIN DD *
                    TRANSPOSE DAILY TRIP TABLES
 &PARAM
     ZONES=27, OUTBPT=4,
     COMBIN1='TR(T101)',  NAME1='HWTRAN90',
 &END
 &SELECT
     I = 1,-27
 &END
//STEP014B EXEC UMATRIX,CORE=225K,TIME=(,10),
//      J1='DSN=D35C.LADPM.Y90.DIST27.TRIPTAB5',UNITJ1='3330-1',
//      J2='DSN=D35C.LADPM.Y90.DIST27.TRIPTMP1',UNITJ2='3330-1',
//      J9='DSN=D35C.LADPM.Y90.DIST27.TRIPTMP2',
//      SPACES2='(CYL,(1,1))',
//      UNITJ9=PUBLIC,DISPJ9='(,CATLG,DELETE)',
//      SPACEJ9='(TRK,(3,1),RLSE)'
//UMATRIX.SYSIN DD *
                         FACTOR DAILY TO PEAK HOUR
                         TRANSIT PERSON TRIPS - 1990
+-------------------------------------------------------------+
+                                                             +
+   ASSUMPTIONS                                               +
+                 IN        OUT       PEAK                    +
+    TRANSIT     8.7%      91.3%     16.7%                    +
+                                                             +
+-------------------------------------------------------------+

&PARAM
    ZONES=27,
    OUTBPT=4,
    COMBIN1='IF  (I< =9 AND J> =10)  THEN 0.01386 * (T101+T201)
         ELSE
             IF I> =10 THEN
                      (IF J< =9 THEN 0.1525 * (T101+T201)
                                ELSE 0.01386 * T101 +
                                     0.1525*T201)
                          ELSE 0'
    NAME1='HWTRAN90'
&END
&SELECT
    I = 1,-27
&END
```

Once the internal trip table and network inputs have been finalized, the distribution trip mode choice can be estimated. The logit equations presented in this report can be coded as a UMODEL subroutine, as UMATRIX 'COMBIN' statements, or as in Los Angeles,[1] a special UTPS-compatible program can be coded. The Los Angeles program, a setup for which is shown in Exhibit B-20, was coded to allow easy access to the coefficients, to permit execution for either three or four modes, and to output a LOGSUM table for input to the parking choice model. Whichever technique is used, a UMODEL subroutine or a special program, the output should include a UTPS matrix for each downtown circulation mode. In Los Angeles, the mode split program was setup to report the total usage of each mode, with UFMTR trip end summaries and trip length distributions used to provide additional detail.

Programs ULOAD and USTOS are used to look at link loadings and station-to-station movements. ULOAD assignments can be performed for all circulation modes in the study area or for just the mode being studied. However, as the paths are created separately for each mode, if all modes are to be assigned, each must be assigned in a separate run. ULOAD does permit the "loaded legs" for each mode to be combined for reporting purposes. Exhibit B-21 and B-22 show ULOAD and USTOS setups for the people mover line previously described.

B.7.3 Estimating Regional Auto User Mode Split

Internal auto person and vehicle trip tables must also be created before the regional auto user distribution trip mode split can be estimated. In Los Angeles, the parking choice model was applied iteratively to develop the tables. The model was implemented through the coding of a UTPS compatible program which uses the parking choice equation to allocate the trips to be assigned during each iteration to the parking spaces remaining available for the iteration.[1] To make this comparision between demand and supply, the model must be applied to the total daily trips in one direction, i.e., either entering or leaving the study area. This requires that the regional production-attraction format trip tables be converted to origin destination format prior to the use of the model. Program UMATRIX is used to perform this conversion as is shown by Exhibit B-23. The tables input to the model should also be compressed to

---

[1] Demand Model Users' Guide, prepared by Peat, Marwick, Mitchell & Co. for the Los Angeles Downtown People Moves Authority, June 1981.

EXHIBIT B-20

DISTRIBUTION MODE CHOICE

```
//STEP101B EXEC PGM=MSPLIT,REGION=255K,TIME=(,10)
//STEPLIB  DD  DSN=D35C.LADPM.MODEL.LOAD,DISP=SHR
//FT11F001 DD  DSN=D35C.LADPM.Y90.STEP101.SKIMTMP2,DISP=SHR
//FT12F001 DD  DSN=D35B.LADPM.Y90.WALK.PM.SKIM,DISP=SHR
//FT13F001 DD  DSN=D35C.LADPM.Y90.CBD116.TRANSIT,DISP=SHR
//FT18F001 DD  DSN=D35C.LADPM.Y90.DISTPM.LOGSUM,UNIT=3330,
//             VOL=SER=D35D01,SPACE=(TRK,(5,1),RLSE),
//             DCB=(RECFM=VBS,LRECL=1604,BLKSIZE=13030),
//             DISP=(,CATLG,DELETE)
//FT19F001 DD  DSN=D35C.LADPM.Y90.DISTPM.TRANSIT,UNIT=3330,
//             VOL=SER=D35D01,SPACE=(TRK,(5,1),RLSE),
//             DCB=(RECFM=VBS,LRECL=1604,BLKSIZE=13030),
//             DISP=(,CATLG,DELETE)
//FT20F001 DD  UNIT=SYSDA,SPACE=(TRK,(1,1)),
//      DCB=(RECFM=FB,LRECL=80,BLKSIZE=1680)
//FT21F001 DD  DUMMY
//FT06F001 DD  SYSOUT=A
//FT05F001 DD  *
                    PEAK PERIOD REGIONAL TRANSIT MODE SPLIT - 1990
                         LOS ANGELES DOWNTOWN PEOPLE MOVER
+-----------------------------------------------------------------------+
+      NOTES                                                            +
+                                                                       +
+      ORDER OF OUTPUT TABLES (FT19F001)                                +
+                                                                       +
+      1 = DPM     (IF AVAILABLE)                                       +
+      2 = WALK                                                         +
+      3 = MINI                                                         +
+      4 = REGIONAL BUS                                                 +
+                                                                       +
+      IF TRANSIT=T THEN FILE FT18F001 CONTAINS SUM OF EXPONENTIALS     +
+                                                                       +
+      WALK TIME ASSUMED INPUT AS 1/10 MINUTE BY SCALING                +
+           OF THE WALKCF COEFFICIENT VALUE                             +
+                                                                       +
+      FARE SPECIFIED AS WEIGHTED AVERAGE OF TRANSFER FARE              +
+           AND BUS PASS FOR MODE SPLIT, REGIONAL BUS FARE FOR THE      +
+           LOGSUM CALCULATION                                          +
+                                                                       +
+-----------------------------------------------------------------------+
&PARAM
    ZONES=116, MODES=4,
    TRPTAB=301, WLKTAB=202, MNRTAB=101, MONOTAB=102,
    RBRNTB=103, RBOUTB=104, DPMRTB=105, DPMOTR=106, DPMXTB=107,
    WALKCF=-0.050874, C(1)= 5.0414,
    TIMECF=-0.45813, OUTCF=-0.57430, C(2)=0.0, C(3)=0.6818,
    BUSDMY= 3.1928, FARECF=-0.02749, C(4)=0.995,
    MINIFR=20., ABUSFR=55., TBUSFR=6.31, DPMFR=25.
&END
```

EXHIBIT B-20

(Continued)

```
&OPTION
    SELECT=14,19,106,114,116,
    TRANST=T
&END
//STEP101C EXEC UFMTR,REGION=257K,TIME=(,10),COND=(0,LT,STEP101B),
//      J1='DSN-D35C.LADPM.Y90.DISTPM.TRANSIT',
//      J2='DSN=D35B.LADPM.Y90.WALKPM.SKIM'
//UFMTR.SYSIN DD *
              TRIP END SUMMARY FOR PEAK PERIOD TRANSIT
                 LOS ANGELES DOWNTOWN PEOPLE MOVER
&PARAM
    ZONES=116,
    TABLES=101,102,103,104
&END
&SELECT
    REPORT=3
&END
&PLOT
    PAIR=201,101, FREQ=T
&END
&PLOT
    PAIR=201,102, FREQ=T
&END
&PLOT
    PAIR=201,103, FREQ=T
&END
&PLOT
    PAIR=201,104, FREQ=T
&END
```

EXHIBIT B-21

ULOAD SETUP

```
//PROCLIB   DD DSN=PMMPROC,DISP=SHR
//STEP111A EXEC ULOAD,YEAR=90,ALT='DPM.PM',
//    LEGS='DSN=&&LFGS',UNITLEG=SYSDA,
//    LIB='SYS2.URD.PROGLIB',
//    J1='DSN=D35C.LADPM.Y90.DISTPM.TRANSIT'
//ULOAD.SYSIN DD *
           1990 PM TRANSIT DISTRIBUTION TRIPS
 &PARAM
     TABLE=101, LENPM=1
 &END
 & OPTION
     PM=T, WALK=T, RIDE=T,FSPLIT=T
 &END
 &SELECT
     REPORT=1,2,3,4,5
     RLINE5=1,-255
 &END
//STEP111B EXEC ULOAD,YEAR=90,ALT='DPM.PM',
//    LEGS='DSN=&&LEGS',UNITLEG=SYSDA,
//    J1='DSN=D35C.LADPM.Y90.DISTPM.AUTO'
//ULOAD,SYSIN DD *
           1990 PM AUTO DISTRIBUTION TRIPS
 &PARAM
     TABLE=101, LENPM=1
 &END
 &OPTION
    PM=T, WALK=T, RIDE=T,FSPLIT=T
 &END
 &SELECT
     REPORT=1,2,3,4,5
     RLINE5=1,-255
 &END
```

EXHIBIT B-22

USTOS SETUP

```
//PROCLIB   DD DSN=PMMPROC,DISP=SHR
//STEP110A EXEC USTOS,YEAR=90,ALT='DPM.PM',
//     J1='DSN=D35C.LADPM.Y90.DISTPM.TRANSIT'
//USTOS.SYSIN DD *
               STATION TO STATION SUMMARY
          1990 PM TRANSIT DISTRIBUTION TRIPS
 &PARAM
      ZONES=116, RIDE=5,
      ARRIVE=1,2,3,4,6,7,8,
      DEPART=1,2,3,4,6,7,8,
      TABLE=101,
      STOP=601,659,660,609,662,613,643,663,667,619,
           621,665,615,669,661
      NAME='TRANPM90'
 &END
 &SELECT
      REPORT=1,2
 &END
//STEP110B EXEC USTOS,YEAR=90,ALT='DPM.PM',
//    J1='DSN=D35C.LADPM.Y90.DISTPM.AUTO'
//USTOS.SYSIN DD *
               STATION TO STATION SUMMARY
          1990 PM AUTO DISTRIBUTION TRIPS
 &PARAM
      ZONES=116, RIDE=5,
      ARRIVE=1,2,3,4,6,7,8,
      DEPART=1,2,3,4,6,7,8,
      TABLE=101,
      STOP=601,659,660,609,662,613,643,663,667,619,
           621,665,615,669,661
      NAME='AUTOPM90'
 &END
 &SELECT
      REPORT=1,2
 &END
```

EXHIBIT B-23

PEAKING AND DIRECTIONALIZING REGIONAL
AUTO TRIP TABLES

```
//PROCLIB   DD DSN=PMMPROC,DISP=SHR
//STEP015A EXEC UMATRIX,
//      J1='DSN=D35C.LADPM.Y90.DIST27.TRIPTAB3',UNITJ1='3330-1',
//      J2='DSN=D35C.LADPM.Y90.DIST27.TRIPTAB4',UNITJ2='3330-1',
//      DISPJ9='(,CATLG,DELETE)',
        J9='DSN=D35C.LADPM.Y90.DIST27.TRIPTEMP',UNITJ9=PUBLIC
//UMATRIX.SYSIN DD *
//              FACTOR TO DAILY AUTO TRIPS ENTERING THE CBD
 &PARAM
     ZONES=27, OUTBPT=4,
     COMBIN1='IF (I<=9 AND J<=9) THEN (T101-T102)
        ELSE 1.149 * (T101-T102)',
     COMBIN2='IF (I<=9 AND J<=9) THEN (T103+T201+T203)
        ELSE 1.149 * (T103+T201+T203)',
     NAME1='AUTOPER90', NAME2='AUTOVEH90'
 &END
 &SELECT
     I=1,-27
 &END
```

approach corridors, that is, the table should have one row for each approach corridor which shows the trips from the corridor to each study area zone. As is shown by Exhibit B-24, program USQUEX is also used to compress a table in one dimension.

Once the above processing is completed, the distribution mode split model is applied for the regional auto trips as it was for the regional transit user trips. This includes factoring the tables using UMATRIX to represent the PM peak hours. The planner might want to carefully review the fare specified for each mode, as full fare will be paid by trips arriving in the study area by auto while a transfer fare was probably paid by the trips arriving on transit. Programs UFMTR, ULOAD, and USTOS can be used to look at the results as was described above.

B.7.4 Estimating Worker Circulation Trips

The ACM worker circulation trip model shown in Appendix A estimates the number of daily round trips made using each mode between each pair of zones. The model does not require the input of any trip tables, but rather estimates the number of trips which will be made based on the level of employment and activity in a zone. In Los Angeles a special program was coded to implement the model,[1] though it could have been implemented as a UMODEL user-coded subroutine.

As the model is limited to only estimating the circulation trips made entirely within the study area, the output matrices generally reflect a different number of zones than the coded networks which also include approach corridors and any special transfer zones. Before the circulation trip matrices are assigned to the network they must be expanded so that the number of zones correspond. Program UMCON, as shown by Exhibit B-25, is used to perform this function.

As the outputs of the circulation model are daily round trips, they must be factored and directionalized prior to assignment for a specific time period. The factors should be applied in two parts to determine when trips leave their place of work and when they return. The return factor is applied to

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1 Demand Model User's Guide, prepared by Peat, Marwick, Mitchell & Co. for the Los Angeles Downtown People Mover Authority, June 1981.

EXHIBIT B-24

COMPRESSING A TABLE IN ONE DIMENSION

```
//PROCLIB DD DSN=PMMPROC,DISP=SHR
//STEP015F EXEC USQUEX,CORE=255K,TIME=(,10),
//    J1='DSN=D35C.LADPM.Y90.CBD107.AUTO',UNITJ1='3330-1',
//    J9='DSN=D35C.LADPM.Y90.CBD9X107.AUTO',UNITJ9=PUBLIC,
//    DISPJ9='(,CATLG,DELETE)',SPACEJ9='(TRK,(3,1),RLSE)'
//USQUEX.SYSIN DD *
              COMPRESS TRIPS FROM 107 ZONES TO 9 CORRIDORS
                   LOS ANGELES DOWNTOWN PEOPLE MOVER
 &PARAM
    ZONES=107, DISTS=10,
    TABLES= 101, 102,
    OUTBPT=4,
    NAME1='AUTOPER90', NAME2='AUTOVEH90'
 &END
 &OPTION
    SQUEEZ=T, ROW=T
 &END
 &SELECT
    REPORT=4, PRINT=1,-10
 &END
 &EQUIV    DIST=1, Z= 99    &END
 &EQUIV    DIST=2, Z=100    &END
 &EQUIV    DIST=3, Z=101    &END
 &EQUIV    DIST=4, Z=102    &END
 &EQUIV    DIST=5, Z=103    &END
 &EQUIV    DIST=6, Z=104    &END
 &EQUIV    DIST=7, Z=105    &END
 &EQUIV    DIST=8, Z=106    &END
 &EQUIV    DIST=9, Z=107    &END
 &EQUIV    DIST=10,Z=1,-98  &END
```

EXHIBIT B-25

FACTORING AND EXPANDING CIRCULATION TRIP MATRICES

```
//PROCLIB  DD DSN=PMMPROC,DISP=SHR
//STEP121A EXEC UMATRIX,CORE=321K,
//    J1='DSN=D35C.LADPM.Y90.MIDDAY.TRANSIT',UNITJ1='3330-1',
//    J9='DSN=&&LOAD',UNITJ9=SYSDA,
//    DISPJ9='(,PASS)',SPACEJ9='(TRK,(3,1),RLSE)'
//UMATRIX.FT19F001 DD DCB=(RECFM=VBS,LRECL=1604,RLKSIZE=13030)
//UMATRIX.SYSIN DD *
                1990 CIRCULATION TRANSIT TRIPS
 &PARAM
    OUTBPT=2,NAME1='MID90LOAD',ZONES=98,
    COMBIN1='.3512*T101 + .3704*TR(T101)'
 &END
 &SELECT
     PRINT=6,25,98
 &END
//STEP121B EXEC PGM=UMCON,REGION=256K,TIME=(,10)
//STEPLIB DD DSN=SYS1.UTPS.V79.PROGLIB,DISP=SHR
//FT06F001 DD SYSOUT=A
//FT90F001 DD UNIT=SYSDA,SPACE=(TRK,(1,1)),
//    DCB=(RECFM=FB,LRECL=80,BLKSIZE=1680)
//FT21F001 DD DUMMY
//FT11F001 DD DSN=&&LOAD,DISP=(OLD,PASS)
//J1 DD DUMMY
//FT19F001 DD DSN=D35C.LADPM.Y90.MIDDAY.LOAD,UNIT=PUBLIC,
//   DISP=(,CATLG,DELETE),SPACE=(TRK,(3,1),RLSE),
//   DCB=(RECFM=VBS,LRECL=1604,BLKSIZE=13030)
//FT05F001 DD *
            1990 CIRCULATION TRANSIT TRIPS
                 EXPAND TO 116 ZONES
 &PARAM
    OUTPUT=3,INPUT=3,ZONES=98,COUT=116,ROUT=98
    TABLES=101,NAME1='TRANMD90'
 &END
 &SELECT
    I=1,-98
 &END
```

the transpose of the model outputs. Exhibit B-24 also shows a UMATRIX setup which factors and directionalizes the model outputs as a single step. Programs UFMTR, USTOS, and ULOAD can be used as discussed above to review the results.

B.7.5 Estimating Nonworker Trips

Either of two approaches can be taken for estimating nonworker trip usage of the study area circulation systems: the nonworker circulation trip model can be used, or a Fratar factoring technique can be used to "grow" a current nonworker transit ridership matrix. The first approach has the limitation that it does not estimate nonworker distribution trips when used with the worker models. Ridership estimated through the second approach is dependent on shortest path network algorithms for determining mode choice.

The factoring approach was used in Los Angeles. A base year nonworker transit ridership matrix was created from on-board survey data. The matrix included regional trips crossing the study area boundary as well as nonworker trips made entirely within the study area. Factors were then created to grow this matrix to the forecast year, the factors based on the growth in study area employment and the forecast change in regional transit ridership. The factors were used to create forecast year production and attraction (row and column) totals for each year, these and the base year matrix input to program UMCON for scaling. The output matrix determines the total number of nonworker transit trips in the forecast year.

The nonworker trips crossing the study area corridor must now be converted to internal distribution trips. Program BUSSTOP was used for this purpose. A run of UPATH is made which gives each mode an equal opportunity to be used for an interchange. The ULOAD assignment of the internal trip matrix to these shortest paths determines the daily nonworker ridership of each circulation mode.

B.7.6 Preparing Total Ridership Estimates

At this point separate ridership estimates have been prepared for each market: the worker distribution trips estimated for the PM peak hour and the worker circulation and nonwork trips estimated on a daily basis. Reporting of the total

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1 Demand Model User's Guide, prepared by Peat, Marwick, Mitchell & Co. for the Los Angeles Downtown People Movers Authority, June 1981.

ridership on a daily basis or for any time period during the day requires that the time period segments be combined, each of the modes to be reported combined separately.

As a first step, the nonworker trips for the mode must be extracted from the total nonworker matrix. This is done by using USTOS to establish which mode is used for each interchange. Program UMATRIX is then used to look at the USTOS outputs and extract the trips for those interchanges which are classified as using the mode in question. Exhibit B-26 shows a setup for performing this step, the example extracting Mode 5 riders from the nonworker matrix.

The outputs for each of the market segments can now be factored and directionalized according to the time period being reported and then added together for input to programs USTOS and ULOAD. Exhibit B-27 shows one technique for reporting the ULOAD results.

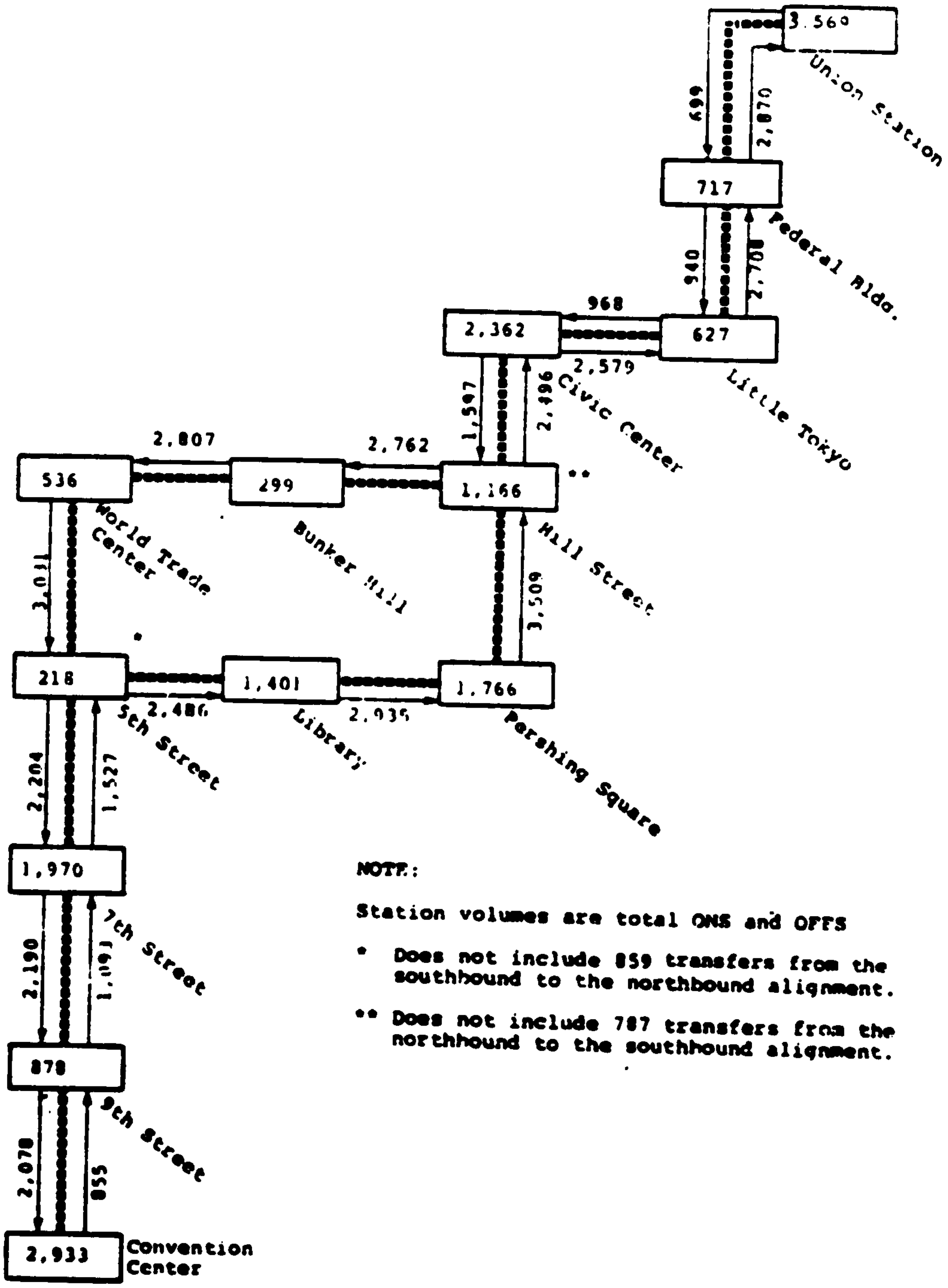
EXHIBIT B-26

. EXTRACTING NONWORKER RIDERSHIP

```
//PROCLIB   DD DSN=PMMPROC,DISP=SHR
//STEP140A EXEC USTOS,NFT=MMODEPM,YEAR=90,
//    J1='DSN=D35C.LADPM.Y90.NONWORK.TRIPTAB2',UNITJ1='3330',
//    J8='DSN=D35C.LADPM.Y90.NONWORK.USTOS',UNITJ8=PUBLIC
//USTOS.SYSIN DD *
              STATION TO STATION SUMMARY
           1990 DAILY NON-WORK TRANSIT TRIPS
 &PARAM
      ZONES=116,
      ARRIVE=1,2,3,4,6,7,8,
      DEPART=1,2,3,4,6,7,8,
      RIDE=5,
      TABLE=101,
      STOP=601,659,660,609,662,613,643,663,667,619,
           621,665,615,669,661
      NAME='NONWORK85'
 &END
 &SELECT
      REPORT=1
 &END
//STEP140B EXEC UMATRIX,CORE=321K,
//      LIB='SYS1.UTPS.V77.PROGLIB',
//      J1='DSN=D35C.LADPM.Y90.NONWORK.TRIPTAB2',UNITJ1=3330,
//      J2='DSN=D35C.LADPM.Y90.NONWORK.USTOS',UNITJ2='3330-1',
//      J9='DSN=D35C.LADPM.Y90.NONWORK.LOAD',UNITJ9=PUBLIC,
//      DISPJ9='(,CATLG,DELETE)',SPACEJ9='(TRK,(3,1),RLSE)'
//UMATRIX.FT19F001 DD DCB=(RECFM=VBS,LRECL=1604,BLKSIZE=13030)
//UMATRIX.SYSIN DD *
           CREATE COMBINED MARKET SEGMENT LOAD TABLES
 &PARAM
     OUTBPT=2,NAME1='NONWKLOAD90',ZONES=116
     COMBIN1='IF T204=5 THEN T101 ELSE 0'
 &END
```

EXHIBIT B-27

REPORTING ULOAD RESULTS



ATTACHMENT 1

PROGRAM BUSSTOP

PURPOSE

Program BUSSTOP is used to convert transit trips crossing the CBD cordon to internal study area trips for input to the distribution mode choice step. BUSSTOP changes the non-CBD end of the trip from a corridor of approach to a CBD zone based on the program inputs. The inputs reflect the location where the passengers on specific transit lines and having a specific CBD origin/destination would alight/board the transit vehicle used to cross the CBD cordon.

FILE DEFINITIONS

Input

FT11FØØ1 thru	-	Peak hour transit trips on the file given by the TABLE keyword value
FT18FØØ1	-	Program control and input data cards

Output

FT19FØØ1	-	Peak hour transit distribution trips

KEYWORD VALUES

&PARAM

ZONIN	-	I*4	-	Size of the input table (default = 107)
ZONOUT	-	I*4	-	Size of the putput table (default = 116)
TABLE	-	I*4	-	UTPS table number of the input table (default = 101)
TITLE	-	A(12)	-	Title of the output table

```
//D35CBUSS JOB (D35C,LADPM,0JA),CLASS=P
//FORTRAN EXEC FORTGCL,
//  PARM.FORT='GOSTMT,MAP,XREF,OPT(0),NOLIST,NODECK',
//  REGION.FORT=192K,PARM.LKED='LIST,XREF,MAP',
//  REGION.LKED=128K,TIME=1
//FORT.SYSIN DD *
C
C     PROGRAM TO CREATE BUS-STOP TRIP RECORDS
C
C
C         WRITTEN BY EARL RUITER, CAMBRIDGE SYSTEMATICS,
C         BORROWING PARTS OF AN EARLIER PROGRAM
C         BY LARRY SEIDERS, COMSIS CORP.
C
C         MAY 2, 1978
C
C
C        MODIFIED BY MARK GOLDMAN, PEAT,MARWICK,MITCHELL&CO.
C
C        JAN 13, 1981
C
C     INPUT FORMATS
C     -------------
C
C     &PARAM CARD
C
C        USED TO SUPPLY NAMELIST VALUES TO PROGRAM BUSSTOP
C
C        ZONIN = SIZE OF THE INPUT TABLES (DEFAULT = 107)
C        ZONOUT = SIZE OF THE OUTPUT TABLES (DEFAULT = 116)
C        TABLE = UTPS TABLE NUMBER OF THE INPUT TABLE
C                (REPLACES THE *TABLE CARD)
C        TITLE = TITLE OF THE OUTPUT TABLE (12 CHARACTERS)
C        DEBUG = DEBUG TRACE FLAG (DEFAULT = 0)
C
C      &DATA CARD
C
C        MUST APPEAR BEFORE THE FIRST DATA CARD
C
C     CARD COLUMNS FOR ALL CARDS WHICH FOLLOW:
C
C     0         1         2         3         4         5         6
C     123456789012345678901234567890123456789012345678901234567890
C
```

```
C      * CARD 1:
C      ---------
C      *COMMENT        <ANY MESSAGE>
C
C      THE MESSAGE CONTAINED ON THE FIRST COMMENT CARD WILL APPEAR
C      AT THE TOP OF SELECTED PAGES OF PROGRAM OUTPUT.
C
C      * CARD 2:
C      ---------
C      *TABLE      FTTT
C
C                F = UTPS MATRIX FILE NUMBER
C              TTT = UTPS MATRIX TABLE NUMBER
C              FTTT DEFAULT IS 1001
C
C      * CARD 3:
C      ---------
C      *CORLINE
C
C      FOLLOWED BY DATA CARDS:
C
C       CLLL PCTX  LLL PCTX  ETC THRU END OF CARD
C                C = INCOMING CORRIDOR (1-9)
C              LLL = LINE NUMBER IN THAT CORRIDOR (INTEGER)
C             PCTX = PERCENT OF TRIPS FROM CORRIDOR PCTX=1000=100.0 PCT
C
C             LAST CARD = 99 IN CC 1-2
C
C      * CARD 4:
C      ---------
C      *INTCEPT
C
C      FOLLOWED BY DATA CARDS:
C
C       CLLL  ZZZ  LLL  ZZZ  ETC THRU END OF CARD
C                C = INCOMING CORRIDOR (1-9)
C              LLL = LINE NUMBER IN THAT CORRIDOR (INTEGER)
C              ZZZ = INTERCEPT ZONE TO WHICH ALL TRIPS ON THE LINE WILL
C                    BE ASSIGNED
C
C              LAST CARD = 99 IN CC 1-2
C
C      ALL BUS LINES CODED ON *INTCEPT CARDS SHOULD BE NUMBERED
C      CONSEQUTIVELY STARTING WITH LINE NUMBER 1 IN EACH CORRIDOR
```

```
C
C     * CARD 5:
C     ---------
C     *ZONLINE CLL
C
C              C = CORRIDOR NUMBER (1-9)
C             LL = FIRST BUS LINE NUMBER ON SUBSEQUENT DATA CARDS
C
C     FOLLOWED BY DATA CARDS:
C
C      ZZZ SSS SSS SSS SSS   ETC TO END OF CARD
C            ZZZ = CBD ORIGIN/DESTINATION ZONE
C            SSS = BUS STOP ZONE FOR LINES LL, LL+1, LL+2, ETC.
C                  TO/FROM ZZZ
C
C            LAST CARD = 999 IN CC 2-4
C
C     THE FIRST LINE NUMBER SHOULD BE GREATER THAN THE LARGEST
C     LINE NUMBER USED IN *INTCEPT DATA FOR EACH CORRIDOR
C
C     * CARD 6:
C     ---------
C     *END
C
C     END OF DATA INPUT, PROCESSING CAN BEGIN
C
C     CURRENT PROGRAM SIZE LIMITATIONS:
C            TOTAL ZONES         116
C            LINES PER CORRIDOR  16
C            CORRIDORS            9
C
C     ZONE NUMBERING ASSUMPTIONS:
C            INTERNAL CBD ZONES   1- 98
C            CORRIDORS 1-9       99-107
C            TRANSFER ZONES     108-116
C
      IMPLICIT INTEGER(A-Z)
C
      COMMON/TITLE/FOUT,NDATE(2),NTIME(2),NPAGE,PHEAD(18),
     1             PNAME(2),LINES,LINPPG,CPUTIM(21),UCKDSP,
     2             OPNAME,OCDAT
C
      REAL*8    CPUTIM
C
```

```
C
      REAL*8     CARD8(10)
      INTEGER*2 ZONLIN(16,9,117)/16848*0/
      INTEGER*2 CORLIN(16,9)/144*0/,DATA(2,8)
      DATA      MAXZON,MAXLIN/116,16/
      DATA      MAXCOR,CNT/9,0/
      REAL*8    STARCD,LABEL(6)/'*COMMENT','*TABLE   ','*CORLINE',
     X          '*INTCEPT','*ZONLINE','*END    '/
      REAL*8    HEAD(8)/8*'        '/
      LOGICAL*1   CONT(6)/6*.FALSE./,LSW(6)/6*.FALSE./
      REAL*4      R/.5/,XTRIP,RTRIP(116,116)/13456*0.0/
      INTEGER*2   INTS(3),ZLDAT(19)
      INTEGER*4   NAME(2)/'BUSS','TOP '/, CDAT(2)/'13JA','N81 '/
      INTEGER*4   TRACE/0/,TRIPS(117)/117*0/,NTABS/1/,ZONES,TABLE/1001/
      INTEGER*4   ZONIN/107/,ZONOUT/116/,DEBUG/0/,TITLE(3,1)
C
      NAMELIST/PARAM/  ZONIN,ZONOUT,DEBUG,TABLE,TITLE
C
C     INITIALIZE UTPS COMMON
C
      INFILE=5
      OUTFIL=20
      FOUT=6
      NPAGE=-1
      LINES=1
      LINPPG=55
      CALL SIGNON(INFILE,OUTFIL,NAME,CDAT,CONT)
C
C     READ PARAM CARD
C
      IF(CONT(1)) READ(OUTFIL,PARAM)
C
C     READ NEXT ID CARD
C
5     READ(5,9501) STARCD,INTS,(CARD8(I),I=1,8)
9501  FORMAT(A8,2I2,I4,8A8)
      IF(STARCD.EQ.LABEL(1)) GO TO 10
      IF(STARCD.EQ.LABEL(2)) GO TO 20
      IF(STARCD.EQ.LABEL(3)) GO TO 30
      IF(STARCD.EQ.LABEL(4)) GO TO 40
      IF(STARCD.EQ.LABEL(5)) GO TO 50
      IF(STARCD.EQ.LABEL(6)) GO TO 60
6     WRITE(6,9502) STARCD,INTS,(CARD8(I),I=1,8)
9502  FORMAT('0ERROR IN LABEL CARD.  CARD WAS IGNORED'/
```

```
     X 5X,A8,2I2,I4,8A8/)
      GO TO 5
C
C     *COMMENT CARD
C
10    IF(LSW(1)) GO TO 12
      WRITE(6,9503)
9503  FORMAT('1')
      LSW(1)=.TRUE.
      DO 11 I=1,8
      HEAD(I)=CARD8(I)
11    CONTINUE
12    WRITE(6,9504)(CARD8(I),I=1,8)
9504  FORMAT(10X,8A8//)
      GO TO 5
C
C     *TABLE CARD
C
20    IF(LSW(2)) GO TO 6
      LSW(2)=.TRUE.
      DEBUG=INTS(1)
      TABLE=INTS(3)
      WRITE(6,9505)STARCD,INTS,(CARD8(I),I=1,8)
9505  FORMAT(' ',A8,2I2,I4,8A8/)
      GO TO 5
C
C     *CORLINE CARD
C
30    IF(LSW(3)) GO TO 6
      LSW(3)=.TRUE.
      WRITE(6,9505) STARCD,INTS,(CARD8(I),I=1,8)
34    READ(5,8000) C,DATA
8000  FORMAT(I2,I3,20I5)
      WRITE(6,8500) C,DATA
8500  FORMAT(' ',I2,I3,20I5)
      IF(C.GT.9) GO TO 5
      DO 35 I=1,8
      K=DATA(1,I)
      IF(K.LE.0 .OR. K .GT. MAXLIN) GO TO 35
      CORLIN(K,C)=DATA(2,I)
35    CONTINUE
      GO TO 34
C
C     *INTCEPT CARD
```

```
C
40    IF(LSW(4)) GO TO 6
      LSW(4)=.TRUE.
      WRITE (6,9512)
9512  FORMAT('0')
      WRITE(6,9505)STARCD,INTS,(CARD8(I),I=1,8)
41    READ(5,8000) C,DATA
      WRITE(6,8500) C,DATA
      IF(C.GT.9) GO TO 5
      DO 45 I=1,8
      K=DATA(1,I)
      IF(K.LE.0 .OR. K .GT. MAXLIN) GO TO 45
      INTCP=DATA(2,I)
      DO 44 IZ=1,MAXZON
      ZONLIN(K,C,IZ)=INTCP
44    CONTINUE
45    CONTINUE
      GO TO 41
C
C     *ZONLINE CARD
C
C
50    WRITE(6,9506)HEAD
9506  FORMAT('1',9X,8A8//)
      WRITE(6,9505)STARCD,INTS,(CARD8(I),I=1,8)
      IF(INTS(1).GT.MAXCOR) GO TO 6
      C=INTS(1)
      IF(INTS(2).GT.MAXLIN) GO TO 6
      L1=INTS(2)-1
51    READ(5,8002)ZONE,ZLDAT
8002  FORMAT(20I4)
      WRITE(6,8502)ZONE,ZLDAT
8502  FORMAT(' ',20I4)
      IF(ZONE.GT.MAXZON) GO TO 5
      IF(ZONE .LE. 0) GO TO 51
      L=L1
      LIM=MAXLIN-L1
      DO 55 I=1,LIM
      L=L+1
      IF(ZLDAT(I).EQ.0) GO TO 55
      ZONLIN(L,C,ZONE)=ZLDAT(I)
55    CONTINUE
      GO TO 51
C
```

```
C      *END CARD
C
60     WRITE(6,9512)
       WRITE(6,9505)STARCD,INTS,(CARDA(I),I=1,8)
       IF(LSW(3)) GO TO 110
       WRITE(6,9507)
9507   FORMAT('0ERROR -- NO *CORLINE INPUT -- RUN ABRUPTLY ABORTED ')
       RETURN
110    WRITE(6,9506)HEAD
       IF(DEBUG .EQ. 0) GO TO 120
C
C      WRITE ARRAYS
C
       WRITE(6,9601)CORLIN
9601   FORMAT('0CORLIN'/(16I5/))
       WRITE(6,9602)((ZONLIN(I,J,1),I=1,16),J=1,9)
9602   FORMAT('0ZONLIN, ZONE 1'/(16I5/))
C
120    CALL UJREAD(1,TABLE,ZONES,NTABS,&910)
       IF(ZONES.NE.ZONIN) GO TO 910
C      CBD ZONE TO CORRIDOR
C
       DO 600 IZ=1,ZONIN
       CALL UJIN(TABLE,ZONIN,EM,4,ORG,TRIPS,1,0,IZ,TRACE,KERR,
      X &911,&911,&911)
       IF(ORG.NE.IZ) GO TO 911
       IF(IZ.GT.98) GO TO 220
C
C      ORIGIN IS IN THE CBD
C
C          FIRST RECODE THE TRIPS TO THE CORRIDORS
C
       DO 200 C=1,MAXCOR
       JZ=C+98
       IF(TRIPS(JZ).LE.0) GO TO 200
       XTRIP=.001*TRIPS(JZ)
       DO 190 L=1,MAXLIN
       IF(CORLIN(L,C).LE.0) GO TO 200
       JD=ZONLIN(L,C,IZ)
       IF(JD.GT.0) GO TO 150
       WRITE(6,9509) C,IZ,L
9509   FORMAT('0ERROR -- NO BUS STOP SPECIFIED. CORRIDOR = ',I3,
      X ' ZONE = ',I4,' LINE = ',I4)
       GO TO 190
```

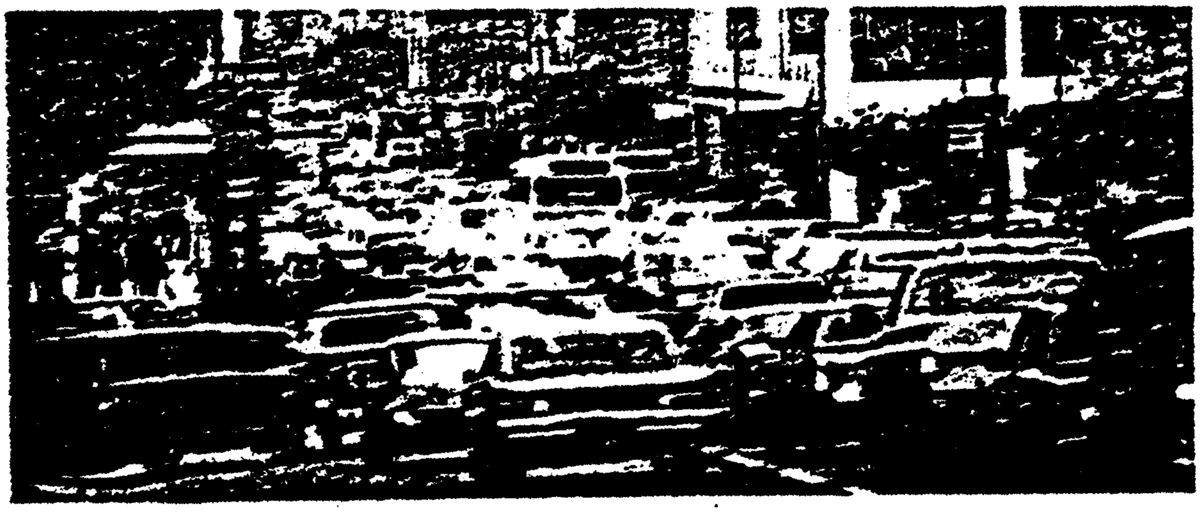
```
150   RTRIP(JD,IZ)=RTRIP(JD,IZ)+XTRIP*CORLIN(L,C)
8004  FORMAT(2I4,I12)
190   CONTINUE
200   CONTINUE
C
C     STORE THE TRIPS INTERNAL TO THE CBD
C
      DO 210 JZ=1,98
         RTRIP(JZ,IZ)=RTRIP(JZ,IZ)+TRIPS(JZ)
  210 CONTINUE
      GO TO 600
C
C     CORRIDOR TO CBD ZONE
C
  220 C=IZ-98
      DO 500 JZ=1,98
C
C     RECODE ORIGIN AND FACTOR
C
      IF(TRIPS(JZ).LE.0) GO TO 500
      XTRIP=.001*TRIPS(JZ)
      DO 400 L=1,MAXLIN
      IF(CORLIN(L,C).LE.0) GO TO 500
      ID=ZONLIN(L,C,JZ)
      IF(ID.GT.0) GO TO 350
      WRITE(6,9509) C,JZ,L
      GO TO 400
350   RTRIP(JZ,ID)=RTRIP(JZ,ID)+XTRIP*CORLIN(L,C)
400   CONTINUE
500   CONTINUE
600   CONTINUE
C
C      NOW LETS ROUND AND WRITE OUT THE MARTRIX
C
      NTAB=1
      OUTTAB=901
      CALL UJWRT(OUTTAB,ZONOUT,NTAB,TITLE,&912)
      TTRIP=0
C
      DO 800 IZ=1,ZONOUT
         CALL ROUND(RTRIP(1,IZ),TRIPS,ZONOUT,TOTAL)
         TTRIP=TTRIP+TOTAL
         CALL UJOUT(OUTTAB,ZONOUT,4,4,IZ,TRIPS,-1,0,0,0,0,
     +                DUMMY,KERR,&913)
```

```
 800 CONTINUE
     WRITE(6,9510) TTRIP
9510 FORMAT('OPROGRAM COMPLETED'/
    X 5X,'TOTAL TRIPS =     ',I10)
     RETURN
910  WRITE(6,9511) TABLE,ZONES,NTABS
9511 FORMAT('0ERROR IN UJREAD. TABLE = ',I4,
    X ' ZONES = ',I4,' NTABS = ',I4)
     RETURN
911  WRITE(6,9508) TABLE,ORG,IZ,KERR
9508 FORMAT('0ERROR IN UJIO.  TABLE = ',I4/17X,'ZONE READ = ',
    X I4/17X,'ZONE REQUESTED = ',I4/17X,'KERR = ',I8)
     RETURN
 912 WRITE(6,9519)
9519 FORMAT('0UJWRT ERROR')
     RETURN
 913 WRITE(6,9513) KERR
9513 FORMAT('0UJOUT ERROR, KERR=',I4)
     RETURN
     END
//LKED.SYSLMOD  DD DSN=D35C.LADPM.MODEL.LOAD,DISP=SHR,
//      UNIT=3330,VOL=SER=D35D01
//LKED.ULIB  DD  DSN=SYS2.URD.SUBRLIB,DISP=SHR
//LKED.SYSIN  DD  *
  ENTRY MAIN
  REPLACE  IHCECOMH,IHCCOMH2,IHCFCVTH,IHCEFNTH,IHCEFIOS,IHCFIOS2
  REPLACE  IHCUOPT,IHCERRM,IHCUATBL,IHCETRCH
  INCLUDE ULIB(UJIN)
  REPLACE  IHCFCOMH,IHCCOMH2,IHCFCVTH,IHCEFNTH,IHCEFIOS,IHCFIOS2
  REPLACE  IHCUOPT,IHCERRM,IHCUATBL,IHCETRCH
  INCLUDE ULIB(UJREAD)
  REPLACE  IHCECOMH,IHCCOMH2,IHCFCVTH,IHCEFNTH,IHCEFIOS,IHCFIOS2
  REPLACE  IHCUOPT,IHCERRM,IHCUATBL,IHCETRCH
  INCLUDE ULIB(DCBCSECT)
  REPLACE  IHCECOMH,IHCCOMH2,IHCFCVTH,IHCEFNTH,IHCEFIOS,IHCFIOS2
  REPLACE  IHCUOPT,IHCERRM,IHCUATBL,IHCETRCH
  INCLUDE ULIB(UPRNT,UJWRT,UJOUT)
  REPLACE  IHCFCOMH,IHCCOMH2,IHCFCVTH,IHCEFNTH,IHCEFIOS,IHCFIOS2
  REPLACE  IHCUOPT,IHCERRM,IHCUATBL,IHCETRCH
  INCLUDE ULIB(UHEAD,SIGNON,ROUND,ELTIME,UCHECK,DATE)
  NAME  BUSSTOP(R)
```

ATTACHMENT 2

Preceding page blank

Downtown Employee Travel Survey



Sponsored by:
The
City of
Los Angeles

The City of Los Angeles is seeking your help in improving transportation in downtown Los Angeles.

The City is conducting a survey of people who work in downtown. The purpose of this survey is to obtain information about your travel to and from work and about the trips you make during the day outside of the building. Your answers will enable the City to plan better transportation for people like yourself who work in downtown Los Angeles.

Please fill out this questionnaire on the day you receive it. The easiest way is to answer the questions about each trip you make right after you finish making the particular trip. That way, you won't forget about any of the trips you make, and it will take you less time to fill out the questionnaire. Please mark the answer boxes this way ☒. All answers will be kept confidential.

QUESTION 9 on Pages 6 and 7 is especially important. Please be sure to fill it out completely and properly.

Please complete the questionnaire and return it tomorrow to the person who gave it to you.

Thank you for your help. If you have any questions about the survey, please contact Sharon Robinson at The Planning Group, Inc., (213) 661-1185.

YOUR TRIP TO WORK TODAY

PLEASE DO NOT WRITE IN THIS SPACE →

1. Where did you begin your trip to work today?

____
(Building name, or address, or nearest intersection)

_______________ (City)   _______________ (ZIP code)

2. Is this your place of residence?

☐ Yes   ☐ No

3. At what time did you get to your place of work today?

__________ A.M.   __________ P.M.

4. How did you get to work today? (Please mark only one box, then follow arrow to next question)

☐ Drove a Car, Truck, Van or Motorcycle all or most of the way → Please skip to QUESTION 5 on Page 2

☐ Rode as a PASSENGER in a CAR, Truck, or Van all or most of the way → Please skip to QUESTION 6 on Page 3

☐ Rode in a BUS all or most of the way → Please skip to QUESTION 7 on Page 4

☐ Rode in a TRAIN all or most of the way → Please skip to QUESTION 8 on Page 5

☐ Rode in a TAXI all or most of the way → Please skip to QUESTION 9 on Page 6

☐ Rode a BICYCLE or MOPED all or most of the way → Please skip to QUESTION 9 on Page 6

☐ WALKED all or most of the way → Please skip to QUESTION 9 on Page 6

1 2 7 1 12 16 1 18 2 2

5. Please answer the following questions only if you DROVE a CAR, TRUCK, VAN, or MOTORCYCLE all or most of the way to work today.

A. Counting yourself, how many people were in the car, truck, van or motorcycle in which you rode to work today?

______________ people

23 24

B. Where did you park the car, truck, van or motorcycle? (Please give the exact address if you can. If not, please give the name of the building or place and the street it is on, or give the names of the nearest intersecting streets.)

____

25 29

C. Did you or will you have to pay to park there?

☐ Yes ☐ No → If "No", please skip to QUESTION 5F below.

30

D. How much did you have to pay to park there? (If other people rode with you and helped to pay for the parking, do NOT include what these people paid. Only include what you yourself paid.)

$________ → Please check whether you paid this by the day, by the week, by the month, or by the year.

31 33

☐ By the day ☐ By the month

☐ By the week ☐ By the year

E. Does your employer reimburse you for all or part of what you said you paid to park in QUESTION 5D?

34

☐ Yes → If "Yes", how much of what you said you paid in QUESTION 5D is reimbursed by your employer?

☐ No

$__________

35 37

F. How did you get from your parking place to your place of work?

38

☐ Walked

☐ Took a downtown Minibus

☐ Took a regular bus

☐ Took a taxi

☐ Other means (Please specify) → ____________

B.13

PLEASE SKIP TO QUESTION) ON PAGE

6. Please answer the following questions only if you RODE AS A PASSENGER in a CAR, TRUCK, or VAN all or most of the way to work today.

A. Counting yourself, how many people were in the car, truck, or van in which you rode to work today?

_______________ people. | 39 40

B. Where was this car, truck, or van parked? (Please give the exact address if you can. If not, please give the name of the building or place and the street it is on, or give the names of the nearest intersecting streets.)

_______________________________________ | 41 45

C. Did you or will you have to pay all or at least part of the cost of parking there?

☐ Yes ☐ No → If "No", please skip to QUESTION 6F below. | 46

D. How much did you have to pay to park there? (If other people in the car, truck, or van also helped to pay for the parking, do not include what these people paid. Only include what you yourself paid.)

$__________ → Please check whether you paid this by the day, by the week, or by the year. | 47 49

☐ By the day ☐ By the month

☐ By the week ☐ By the year

E. Does your employer reimburse you for all or part of what you said you paid to park in QUESTION 6D? | 50

☐ Yes → If "Yes", how much of what you said you paid in QUESTION 6D is reimbursed by your employer?

☐ No

$__________ | 51 53

F. Were you dropped off at your place of work before the car, truck, or van was parked? | 54

☐ Yes → Please skip to QUESTION 9 on Page 6

☐ No → If "No", how did you get from the parking place to your place of work?

☐ Walked

☐ Took a downtown Minibus

☐ Took a regular bus

☐ Took a taxi

☐ Other means (Please specify) → __________

B-84

PLEASE SKIP TO QUESTION 9 ON PAGE 6

7. Please answer the following questions only if you rode in a BUS all or most of the way to work today.

A. What bus company operates the bus you used to reach downtown today? today?

- [ ] - SCRTD → Please answer QUESTIONS 7B and 7C
- [ ] - Santa Monica Municipal Bus Lines
- [ ] - Gardena Municipal Bus Lines
- [ ] - Torrance Transit
- [ ] - Trailways
- [ ] - Greyhound
- [ ] - Other (Please specify) ______________

} Please skip to QUESTION 7D below.

[ ] 55

B. What bus line did you use? (Please specify line number) ______________
e.g., #83

[ ][ ][ ] 56 58

C. Did you use a SCRTD Monthly Pass on the trip?

[ ] Yes [ ] No

[ ] 59

D. Where did you FIRST get on a bus on your way to work today? (Please give the names of the nearest intersecting streets if you can. If not, please give the street name and the name of the nearest building or place.)

____

[ ][ ][ ][ ][ ] 60 64

E. When you got to downtown Los Angeles, did you transfer to another bus?

[ ] Yes [ ] No → If "No", please skip to QUESTION 7H below.

[ ] 65

F. Did you transfer to a downtown Minibus?

[ ] Yes [ ] No

[ ] 66

G. Where in downtown Los Angeles did you make the transfer? (Please give the names of the nearest intersecting streets if you can. If not, please give the street name and the name of the nearest building or place.)

____

[ ][ ][ ][ ][ ] 67 71

H. Where did you LAST get off a bus on your way to work today? (Please give the names of the nearest intersecting streets if you can. If not, please give the street name and the name of the nearest building or place.)

____

[ ][ ][ ][ ][ ] 72 76

PLEASE SKIP TO QUESTIO[illegible] ON PAGE 6

8. Please answer the following questions only if you rode in a TRAIN all or most of the way to work today.

2

A. How did you get FROM the train station to your place of work today?

- ☐ Took a downtown Minibus
- ☐ Took a regular bus
- ☐ Took a taxi → Please skip to QUESTION 9 on Page 6
- ☐ Walked → Please skip to QUESTION 9 on Page 6
- ☐ Other means (Please specify) → ______________________

Please skip to QUESTION 9 on Page 6

B. Where did you get on the bus? (Please give the names of the nearest intersecting streets if you can. If not, please give the street name and the name of the nearest building or place.)

____

8

C. Where did you LAST get off a bus on your way from the train station to your place of work today? (Please give the names of the nearest intersecting streets if you can. If not, please give the street name and the name of the nearest building or place.)

____

13

PLEASE CONTINUE WITH QUESTION 9 ON PAGE 6

TRIPS YOU MADE DURING YOUR WORKING HOURS

9. Please check this box ☐ if you did not leave the building where you work at any time during your regular working hours today. Then skip to QUESTION 10 on Page

IF YOU DID LEAVE THE BUILDING WHERE YOU WORK AT ANY TIME DURING YOUR REGULAR WORKING HOURS TODAY, PLEASE READ THE INSTRUCTIONS ON THIS PAGE AND FILL IN THE TABLE ON THE NEXT PAGE.

The purpose of this part of the survey is to obtain information about the trips you make during your working hours to places OUTSIDE of the BUILDING WHERE YOU WORK. In the chart on Page 7, we ask you to write down the location of each place you visited today between the time you arrived at your place of work and the time you will leave work for the day. Then we ask you to answer a few questions about your trip to each of these places. Each line is for a different place you visited. The first line is for the first place you visited, the second line for the second place you visited, and so on.

EXAMPLE: Suppose during your lunch time, you left the building where you work and walked to a drug store, then took the Minibus to a restaurant, and then rode the Minibus back to the building where you work. You would have made 3 trips. The first trip would have been your walking trip from the building where you work to the drug store. The second trip would have been your Minibus trip from the drug store to the restaurant. The third trip would have been your Minibus trip from the restaurant back to the building where you work.

On the first line, you would write in the name of the drug store and the street it is on and then answer the questions shown across the top. On the second line, you would write in the name of the restaurant and the street it is on and then answer the same question. On the third line, you would write in the name of the building or address where you work and answer the questions again. The example above is filled in on the chart.

PLEASE REMEMBER:

For each time you left the building where you work, you should fill in a line for each place you visited. DON'T FORGET TO ALSO FILL IN A LINE FOR EACH OF YOUR RETURN TRIPS TO THE BUILDING WHERE YOU WORK.

Trip No.	Where did you go? (Please give an exact address if you can. If not, please give the name of the building or place and the street it is on.)	What was your main purpose for going there? Return to work	Company business	School	Shopping	Personal business	Meal	Recreation or Entertainment	Other	How did you get there? Drove a car, truck, or van	Rode as a passenger in a car, truck or van	Minibus	Other bus	Taxi	Bicycle, moped	Walked	At what time did you leave to go there? Please give the time and circle A.M. or P.M.)	At what time did you get there? Please give the time and circle A.M. or P.M.)	(Answer this question ONLY if you DROVE a car, truck, or van to the Place) How much did you pay for parking there?	(Answer these questions only if you took the MINIBUS or OTHER BUS) Where did you get ON the bus? (Please give the names of the nearest intersecting streets)	Where did you get OFF the bus? (Please give the names of the nearest intersecting streets)
EXAMPLE	Ronell 515 So. Flower				X											X	12:05 A.M. (P.M.)	12:10 A.M. (P.M.)	$		
	300 Spring						X					X					1:00 A.M. (P.M.)	1:15 A.M. (P.M.)	$	6th & Flower	1st & Spring
	3rd & Flower	X										X					1:45 A.M. (P.M.)	2:00 A.M. (P.M.)	$	1st & Spring	3rd & Flower
1.																	A.M. P.M.	A.M. P.M.	$		
2.																	A.M. P.M.	A.M. P.M.	$		
3.																	A.M. P.M.	A.M. P.M.	$		
4.																	A.M. P.M.	A.M. P.M.	$		
5.																	A.M. P.M.	A.M. P.M.	$		
6.																	A.M. P.M.	A.M. P.M.	$		
7.																	A.M. P.M.	A.M. P.M.	$		
8.																	A.M. P.M.	A.M. P.M.	$		
9.																	A.M. P.M.	A.M. P.M.	$		
10.																	A.M. P.M.	A.M. P.M.	$		
11.																	A.M. P.M.	A.M. P.M.	$		
12.																	A.M. P.M.	A.M. P.M.	$		
13.																	A.M. P.M.	A.M. P.M.	$		
14.																	A.M. P.M.	A.M. P.M.	$		

PLEASE CONTINUE WITH QUESTION 10 ON PAGE 8

YOUR TRIP FROM WORK TODAY

4

10. At what time did you leave your place of work for the day?

_________ A.M. _________ P.M.

2 6

7 10

11. Where did you end your trip from work today?

____
(Building name, or address, or nearest intersection)

11 15

_________________________ (City) _____________ (ZIP Code)

12. Is this your place of residence?

☐ Yes ☐ No

16

13. How did you get to the location in QUESTION 11 from your place of work? (Please check only one box)

17

☐ DROVE a CAR, TRUCK, VAN, or MOTORCYCLE all or most of the way → Please skip to QUESTION 14 on Page 9

☐ RODE as a PASSENGER in a CAR, TRUCK, or VAN all or most of the way → Please skip to QUESTION 15 on Page 10.

☐ RODE in a BUS all or most of the way → Please skip to QUESTION 16 on Page 11.

☐ RODE in a TRAIN all or ost of the way → Please skip to QUESTION 17 on Page 12.

☐ RODE in a TAXI all or most of the way → Please skip to QUESTION 18 on Page 13.

☐ RODE a BICYCLE or MOPED all or most of the way → Please skip to QUESTION 18 on Page 13.

☐ WALKED all or most of the way → Please skip to QUESTION 18 on Page 13.

14. Please answer the following questions only if you DROVE a CAR, TRUCK, VAN or MOTORCYCLE all or most of the way to your destination after leaving your place of work for the day.

A. How did you get from your place of work to where the car, truck, van, or motorcycle was parked?

☐ Walked

☐ Took the downtown Minibus

☐ Took a regular bus

☐ Took a taxi

☐ Other means (Please specify) → ____________

☐ 18

B. Counting yourself, how many people were in the car, truck, van, or motorcycle in which you rode from work today?

____________ people

☐☐ 19 20

(PLEASE SKIP TO QUESTION 18 ON PAGE 13 .)

15. Please answer the following questions only if you RODE AS A PASSENGER in a CAR, TRUCK, or VAN all or most of the way to your destination after leaving your place of work for the day.

A. Were you picked up at your place of work?

☐ Yes

☐ No → If "No", how did you get from your place of work to the car, truck, or van?

☐ Walked

☐ Took the downtown Minibus

☐ Took a regular bus

☐ Took a taxi

☐ Other means (Please specify)

____

21

B. Counting yourself, how many people were in the car, truck, or van?

______________ people.

22 23

(PLEASE SKIP TO QUESTION 18 ON PAGE 13).

16. Please answer the following questions only if you rode in a BUS all or most of the way to your destination after leaving your place of work for the day.

A. What company operates the bus you used for all or most of the trip to the location in QUESTION 11?

☐ SCRTD
☐ Santa Monica Municipal Bus Lines
☐ Gardena Municipal Bus Lines
☐ Torrance Transit
☐ Trailways
☐ Greyhound
☐ Other (Please Specify) ________

☐ 24

B. What bus line did you use? (Please indicate line number) ________ e.g., #83

☐☐☐ 25 27

C. Where did you FIRST get on a bus after leaving your place of work? (Please give the names of the nearest intersecting streets if you can. If not, please give the street name and the name of the nearest building or place.)

____

☐☐☐☐☐ 28 32

D. Was this a downtown Minibus?

☐ Yes ☐ No

☐ 33

E. Did you transfer from this bus to another bus?

☐ Yes ☐ No → If "No", please skip to QUESTION 16G.

☐ 34

F. Where did you transfer from your FIRST bus to your SECOND bus? (Please give the names of the nearest intersecting streets if you can. If not, please give the street name and the name of the nearest building or place.)

____

☐☐☐☐☐ 35 39

G. Where did you LAST get off a bus on your way from work today? (Please give the names of the nearest intersecting streets if you can. If not, please give the street name and the name of the nearest building or place.)

____

☐☐☐☐☐ 40 44

(PLEASE SKIP TO QUESTION 18 ON PAGE 13.)

17. Please answer the following questions only if you rode in a TRAIN all or most of the way to your destination after leaving your place of work for the day.

A. How did you get to the train station from your place of work? — 45

- [ ] Walked → Please skip to QUESTION 18
- [ ] Took the downtown Minibus
- [ ] Took a regular bus
- [ ] Took a taxi → Please skip to QUESTION 18
- [ ] Other means ____________ (Please specify) → Please skip to QUESTION 18

B. Where did you get on the bus? (Please give the names of the nearest intersecting streets if you can. If not, please give the street name <u>and</u> the name of the nearest building or place.)

______________________________________ — 46 – 50

C. Where did you <u>LAST</u> get off a bus on your way to the train station from your place of work today? (Please give the names of the nearest intersecting streets if you can. If not, please give the street name <u>and</u> the name of the nearest building or place.)

______________________________________ — 51 – 55

(PLEASE CONTINUE WITH THE QUESTIONS ON PAGE 13)

C. THE LOS ANGELES DOWNTOWN PEOPLE MOVER PROJECT: A CASE STUDY

C.1 INTRODUCTION

This case study demonstrates the use of the Activity Center Models (ACM) to forecast demand for CBD travel. The ACM models are applied at the three levels of aggregation discussed in Section 7 and Appendix A: detailed network analysis, aggregate network analysis, and manual sketch planning. The data used for these sample applications came from the Los Angeles CBD where the ACM models were refined and calibrated.

The case study application of the ACM model is presented here for several reasons:

- the case study provides a numerical example to supplement the discussions in Section 7 and Appendix A;
- the case study illustrates the use of the forms discussed in Section 7 which were designed to help carry out the manual calculations; and
- the case study presents tests of the sensitivity of the forecast ACM ridership to changes in various input parameters by preparing forecasts for several alternative services.

The next section, Section C.2, presents the assumed 1990 demographic forecasts and the characteristics of the base CBD transit network proposed for the year 1990. Section C.3 applies the detailed network analysis procedures to forecast CBD circulation travel in the Los Angeles CBD. Sections C.4 and C.5 apply the aggregate network analysis and manual sketch planning procedures respectively. Section C.6 summarizes the results and discusses the criteria for selecting the appropriate level of network aggregation.

C.2 LOS ANGELES STUDY AREA CHARACTERISTICS

The sample application of the set of ACM models is based on data collected for the Los Angeles CBD, which were used to refine and calibrate the ACM models.[1] The data were projected to assumed 1990 conditions to forecast travel on the proposed CBD circulation systems.

---

[1] The data were obtained from two studies: Cambridge Systematics, Inc., 1977, and Peat Marwick, 1981.

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C.2.1 Proposed Base Circulator System - 1990

The central element of the proposed 1990 CBD circulator system is an automated downtown people mover (DPM) system. This is a modern technology system consisting of small (about 30 passenger) driverless vehicles running along an elevated fixed guideway. It provides circulation service between some of the major business activity centers in the CBD, it connects the CBD to the Convention Center and Union Station, and it provides interfaces with regional auto and regional bus trips at both the Convention Center and Union Station.

The proposed alignment of the DPM system is shown in Exhibit C-1. The guideway is 2.[illegible] miles long with a one-way loop in the Bunker Hill area. It has thirteen stations, nine of which handle traffic in both directions and four of which are located on the loop of single direction guideway. All but one of the stations are elevated. The remaining station is underground in the Bunker Hill development. The DPM system will be operated throughout the day and evening with headways of 1.5 minutes. The average speed, including station stops, is 13 mph, and the projected 1990 fare is 20 cents in 1980 dollars.

In addition to the new DPM system, a number of changes are assumed to exist in the 1990 regional transit system:

- the number of local buses leaving the CBD during the PM peak hour is increased by 12 percent, from 421 to 473 buses;

- the number of express buses leaving the CBD during the PM peak hour is increased by 32 percent, from 207 to 273 buses;

- express bus service is added to the Convention Center and Union Station, the two terminals of the DPM service. The number of departures per PM peak hour is 11 from the Convention Center and 32 from Union Station;

- some regional bus routes are revised in the CBD to facilitate transfers at DPM stations, including the Convention Center and Union Station; and

- the existing shuttle bus is rerouted from the West to the East side of the CBD study area. Exhibits C-2 and C-1 show the existing 1980 and the proposed 1990 shuttle bus alignments respectively.

EXHIBIT C-1

DPM AND 1990 MINIBUS ALIGNMENTS

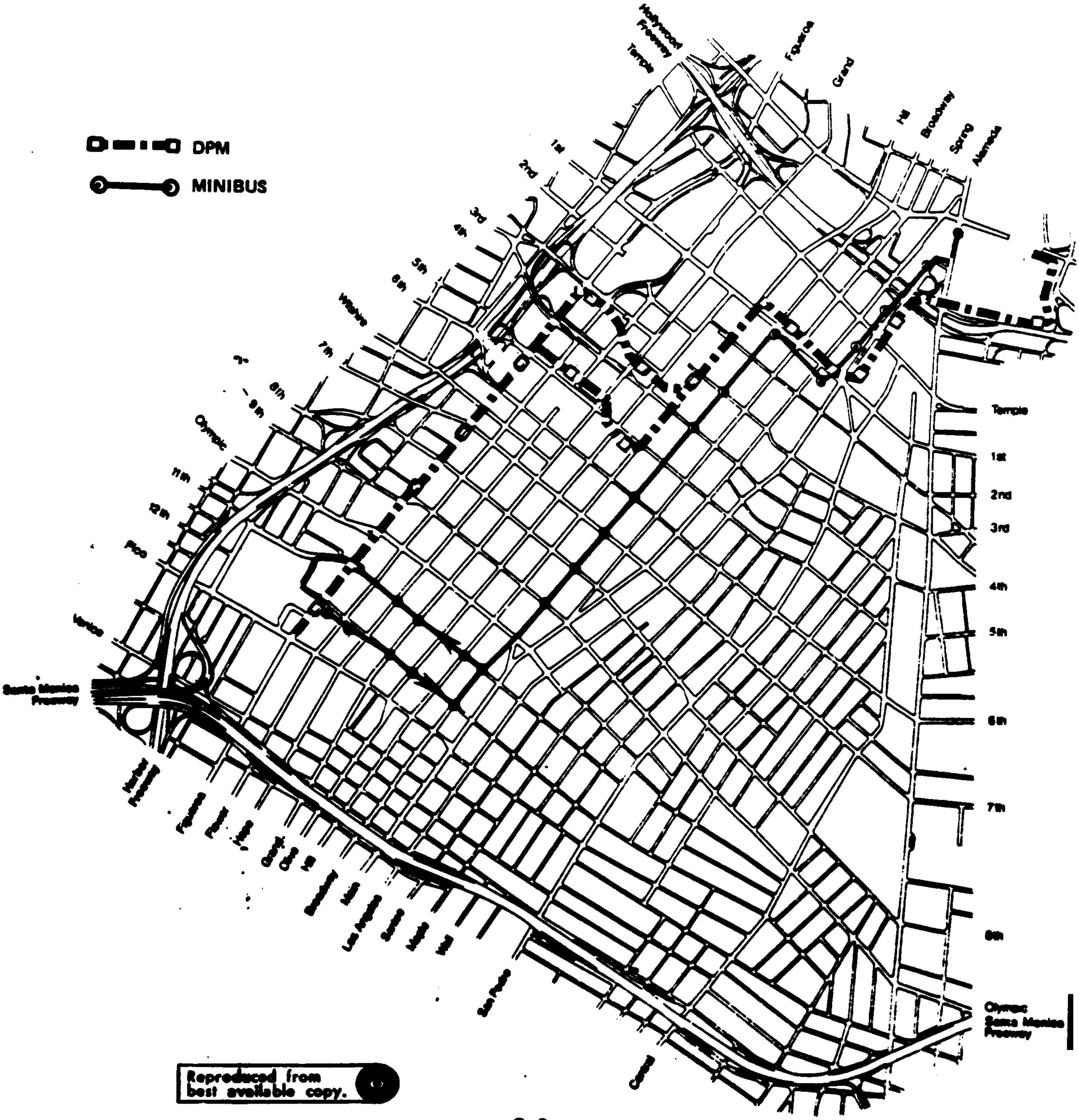
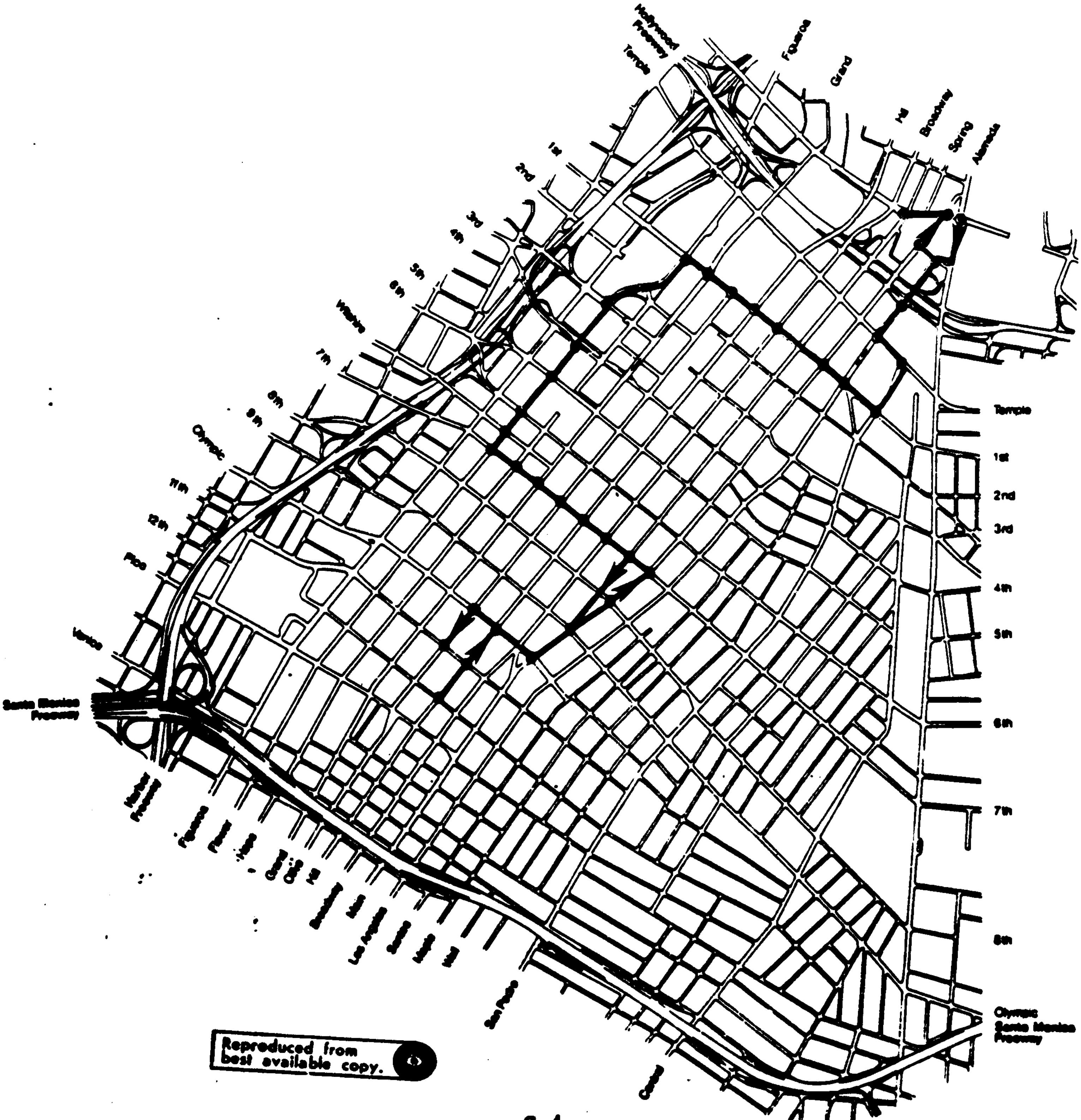


EXHIBIT C-2

MINIBUS ALIGNMENT 1980



C.2.2 CBD Demographics and Travel Forecasts - 1990

The 1990 demographic data were developed from data collected in the Los Angeles CBD in 1980. The data and their sources are listed in Exhibit C-3. These data were accumulated for a 98 zone CBD study area which was used for the detailed network analysis. The data were then aggregated to form the larger zones for the other less detailed methods.

The land-use data were projected to the year 1990 based on extensive interviews with local developers. These interviews discussed existing plans for development in the CBD as well as the developer's opinions on probable areas of future growth.

The 1990 land-use data were then used to estimate 1990 CBD employment. The employment estimates were based on the 1980 ratio of employers per square foot of land use times the 1990 land-use estimates.

The number of parking spaces in CBD zones in 1990 were developed by adjusting the 1980 parking capacities to accommodate growth in the square footage of CBD land uses. A minimum of one parking space per 1000 square feet of new land use was assumed. The additional spaces were sometimes allocated to adjacent zones if they appeared better situated to accommodate construction of new parking facilities.

Workplace surveys provided 1980 trip production rates for midday travel by CBD-workers. For the year 1990, these trip production rates were simply multiplied by the expanded number of employees in each zone.

In addition to the zonal demographic data, data on regional trips to the CBD were needed to determine the volume of CBD distribution trips. The Los Angeles Regional Transportation Study (LARTS) provided trip tables for regional travel to the CBD by auto and by transit for the years 1979 and 1995. Year 1990 trip tables were created by interpolating between the year 1979 and 1995 LARTS trip tables.

For travelers to and within the CBD who do not work in the CBD, circulation trips were modeled in conjunction with CBD distribution trips. The combined number of trips was determined from LARTS trip tables of regional travel to the CBD by auto and transit, and from an on-board transit survey conducted in Los Angeles in 1980, which provided origin-destination data for transit circulation trips in the CBD. The 1990 trip rates were obtained by interpolating between LARTS trip tables for the years 1979 and 1995.

EXHIBIT C-3

DEMOGRAPHIC DATA AND DATA SOURCES

DATA	DATA SOURCE
Zone employment	Employment inventory
Zone land use	Land-use inventory
Zone parking capacities	Parking inventory
Zone areas	CBD map
Zone midday trip productions: CBD-workers	Workplace survey and LARTS regional trip tables
Zone midday trip productions: Non-workers	On-board transit survey and LARTS regional trip tables

C.3 DETAILED NETWORK ANALYSIS FORECASTS

The detailed network analysis approach generally provides a sufficient level of zone detail to determine on-off station loadings and, therefore, link volumes. Analysis is needed at this level of detail if the effects of different route alignments and station locations are to be tested.

This section presents the detailed network analysis forecasts in three subsections. The first subsection discusses the individual steps in the procedure as outlined in Section 7. The second subsection presents the results of the year 1990 patronage forecasts and the third section discusses some sensitivity testing for different design characteristics for the proposed circulator system.

C.3.1 Forecasting Procedure

The detailed network analysis forecasting procedure is presented in Section 7 as four major steps, two of which involve the execution of computer programs.

(1) Choose the analysis parameters

First, the zone system is defined. This guides both the data collection and the definition of travel networks for the CBD circulator travel. For the detailed network analysis method, the study area was divided into 98 zones (see Exhibit C-4). Smaller zones were created in areas of high employment concentrations and along the proposed alignment of the DPM system.

Second, travel markets are identified for which patronage forecasts are to be produced. The ACM model system is designed to most easily forecast travel for the following four markets:

(1) distribution travel by CBD-workers who travel to the CBD by auto;

(2) distribution travel by CBD-workers who travel to the CBD by transit;

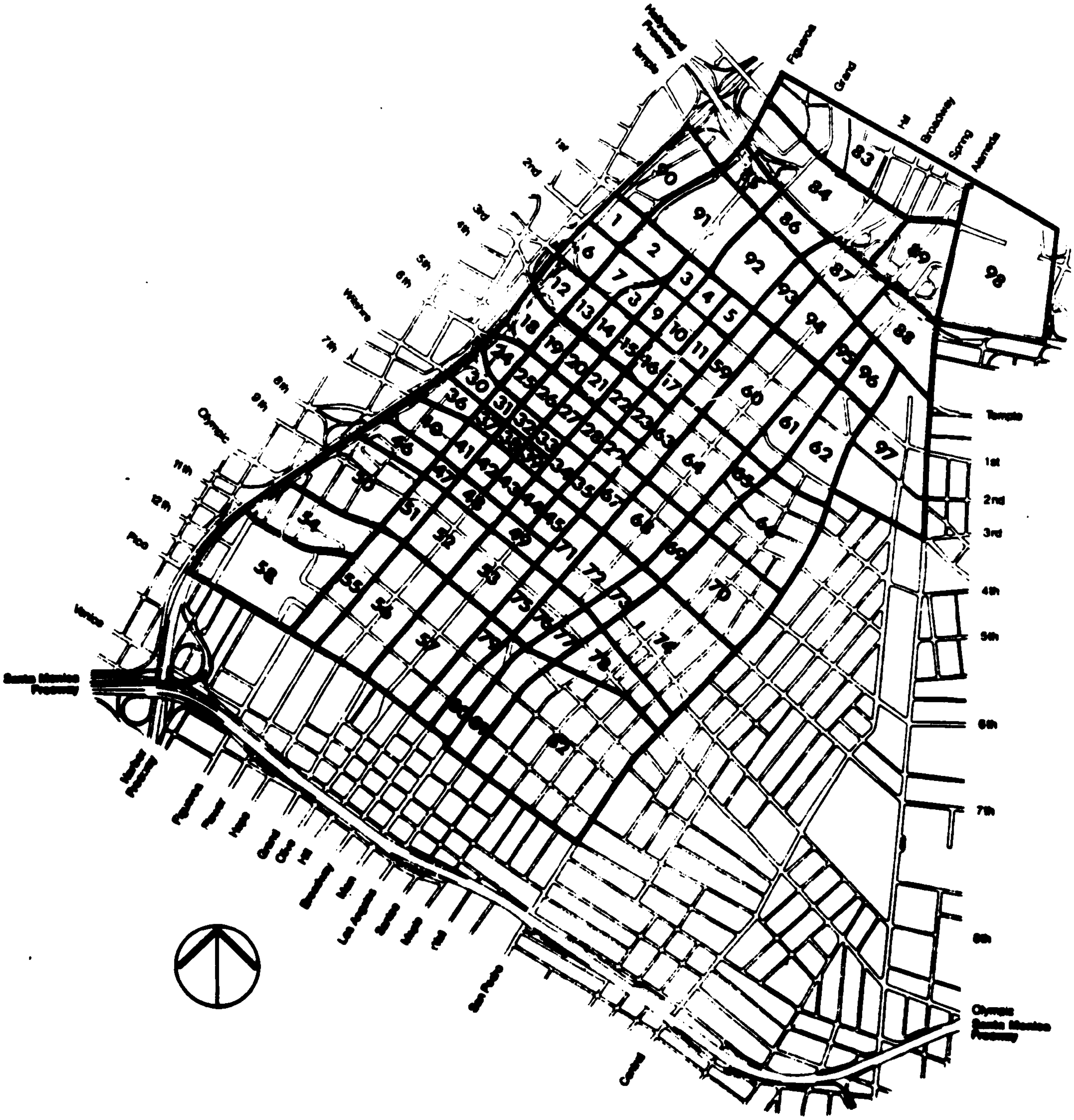
(3) circulation travel by CBD-workers; and

(4) distribution and circulation travel by others.

Third, alternative circulator systems are designed for which patronage forecasts can be estimated. The base alternative for this case study was described in Section C.2. The case study also models several alternatives with different level of service characteristics than the base case, such as frequency of service and cost, to test the sensitivity of the patronage forecasts to the levels of service provided.

EXHIBIT C-4

THE LOS ANGELES STUDY AREA ZONE SYSTEM
FOR DETAILED NETWORK ANALYSIS



(2) Collect data for the base system and each alternative - 1990

These data include the projected 1990 demographic characteristics of the zones in the study area, the regional trip tables of travel to the CBD which are used to drive much of the trip generation process, and the zonal attributes of the travel to access each mode within a zone (e.g., the walk and wait times to access bus service).

Form I is used to collect zone demographic data specific to the network analysis methods, including:

- o number of employees;
- o land uses;
- o zone area;
- o parking capacity;
- o hourly parking cost; and
- o total non-worker circulation trip productions.

Exhibit C-5 illustrates the data collected on Form I for a few of the 98 zones in the detailed network analysis method.

Form II is used to collect data on the level of service to access a mode of travel from each of the study zones. These data include the access walk distance, and the peak and off-peak wait times for each of the available modes. The data on Form II are also used in the sketch planning process. Exhibit C-6 illustrates the data collected on Form II for a few of the 98 zones in the detailed network analysis method.

The data in Form II are specific to one circulator transit system. If several alternatives are to be tested, the walk distances and wait times may differ for each system and the service characteristic data will have to be collected on separate Form II for each system.

In addition to the demographic level of service data collected on Forms I and II, estimates of regional travel to the CBD by mode are needed. Ideally, separate trip tables should be obtained for each of the four travel markets the ACM models are designed to accommodate. These markets were discussed in step (1).

As is often the case, the zone system designed to analyze travel to CBD for the case study is more detailed than the zone system for which regional trips are available. Therefore, the trip table matrices were expanded and compressed through the use of the UTPS computer program USQUEX to create trip tables consistent with the 98 zone system used in this example. The first step in creating compatible zone systems is to split any trip table zones which overlap two or more of the study area zones. The

EXHIBIT C-5

EXAMPLE DEMOGRAPHIC DATA COLLECTED ON FORM I

FORM I: ZONE DATA INPUTS TO NETWORK ANALYSIS PROCESS

DATA USED TO CALCULATE INPUTS ← INPUT DATA →

Zone	Land Use Data (1000's ft²): Pvt Off	Gov't Off	Retail	Hotel	Manuf	Zone Area (acres)	Parking Capacity (no. spaces)	Hourly Pk. Cost (1980 cents)	No. Employees	Employee Density (emp/acre)	Non-Worker Circ. Trip Productions 1/ (trips)	Circulation Trip Attraction Density 1/
1	0	0	0	0	0	43.8	18	84	0	0	0	0
2	0	0	0	0	0	77.5	401	2/	0	0	0	0
3	0	0	0	0	0	33.3	600	2/	0	0	0	0
4	0	0	0	0	0	33.1	1461	2/	0	0	0	0
5	500	0	65	0	0	33.0	861	200	1685	51.1	185.9	137.7
6	270	0	0	0	0	44.0	0	2/	840	19.1	62.1	45.9
7	0	0	0	0	0	57.4	464	2/	0	0	0	0
8	0	0	0	40	0	24.7	9	2/	60	2.4	11.2	8.4
9	0	0	0	0	0	40.9	12	2/	0	0	0	0

1/ See Appendix A to compute the variables.
2/ The parking spaces are not available for public use.

EXHIBIT C-6

EXAMPLE MODE CHARACTERISTICS COLLECTED ON FORM II

FORM II: ZONE MODE ACCESS CHARACTERISTICS

Check: [X] Base system

[ ] Option ______________

Origin Zone	Access Walk Distance (feet)				Peak Period Wait Time (minutes)				Off-Peak Wait Time (minutes)			
	Circulator	Regional Bus	Shuttle Bus	Other	Circulator	Regional Bus	Shuttle Bus	Other	Circulator	Regional Bus	Shuttle Bus	Other
1	1183	1267	2872		.75	3.0	2.0		1.5	10.0	3.5	
2	1605	422	2112		.75	3.0	2.0		1.5	10.0	3.5	
3	2281	253	1436		.75	3.0	2.0		1.5	10.0	3.5	
4	2028	676	1014		.75	3.0	2.0		1.5	10.0	3.5	
5	1183	253	676		.75	3.0	2.0		1.5	10.0	3.5	
6	760	1014	2872		.75	3.0	2.0		1.5	10.0	3.5	
7	845	253	1859		.75	3.0	2.0		1.5	10.0	3.5	
8	591	253	1436		.75	3.0	2.0		1.5	10.0	3.5	

second step is then to aggregate or combine all trip table zones which are entirely contained in one of the study area zones. Program USQUEX accomplishes these tasks by first expanding and then compressing the numbers of rows and columns in the trip table matrices (for more information on USQUEX see Appendix B.

Once the trip table matrices are compatible with the study area zones, CBD distribution trips are extracted from the regional trip tables. A CBD distribution trip is created from each regional trip to the CBD. For regional auto users, the distribution portion of the regional trip is defined as the trip from the parking lot in the CBD to the traveler's final destination. For regional transit users, the distribution trip is defined as the trip from the bus stop where the traveler first exits the bus in the CBD to the final destination.

(3) Compute the network level of service characteristics

This step involves a computerized procedure for the detailed network analysis method. The process is computerized due to the sheer volume of origin-destination (O-D) pairs in the network. For example, the 98 zones in the case study have (98*97)=9506 O-D combinations. In addition, each of the 9506 O-D pairs may have 3 or 4 possible modes of travel each of which has at least 2 level of service characteristics.

Appendix B contains a detailed description of the computerized procedure for developing the network level of service characteristics. The following is a brief summary of the procedure, the step numbers match those used in Appendix B:

Step 3: Build the auto network.

Step 4: Build the multimodal networks for the PM peak hour and the midday. For this case study, the multimodal network includes walking, shuttle bus, regional bus, the Wilshire rail starter line, and the DPM modes.

Step 5: Develop walk mode level of service data.

Step 6: Develop auto mode level of service data, including the distances from the regional corridors to the CBD zones.

Step 7: Develop shuttle bus mode level of service data.

Step 8: Develop regional bus mode level of service data.

Step 9: Develop DPM mode level of service data.

The network level of service data for the Los Angeles CBD case study were developed using two UTPS programs: UPATH and UPSUM. UPATH determines the minimum time path connecting each zone pair, and UPSUM accumulates the characteristics of each link in the preferred path to produce a single travel time, distance, and cost for travel between a given zone pair.

(4) Execute the computerized mode split models

This step is described in detail in Appendix B from which step numbers 10 through 15 were taken. The computerized models are used to perform the following tasks:

Step 10: Determine the number of PM peak hour distribution trips by mode.

Step 11: Load the DPM distribution trips to the DPM system.

Step 12: Determine the number of CBD-worker circulation trips by mode and load the DPM trips to the DPM system.

Step 13: Determine the number of other circulation trips by mode and load the DPM trips to the DPM system.

Step 14: Create combined market segment load tables for the PM peak hour, noon hour, and all day.

Step 15: Prepare DPM system station-to-station loadings for the PM peak hour, noon hour, and all day.

C.3.2 Base Case Patronage Forecasts - 1990

The full set of computerized ACM travel models described in Appendix A were used along with the Los Angeles case study data to estimate the 1990 patronage by (a) mode, (b) market segment, and (c) origin-destination zone pair. These patronage estimates are summarized by mode and market segment in Exhibit C-7.

The ACM models estimate the number of distribution trips for the peak hour and the number of circulation trips for the whole day. The peak hour volume of distribution trips is then factored up to represent the all day volume. The all day volume of circulation trips is factored by the time-of-day to estimate the noon-hour volume. These time-of-day factors are derived from data on the distribution by time-of-day of trips made for CBD distribution and circulation purposes. According to the trip distribution factors developed for Los Angeles,[1] the peak hour distribution trips include 19 percent of the daily regional auto

[1] Cambridge Systematics, Inc., 1977.

EXHIBIT C-7

BASE CASE PM PEAK HOUR AND NOON HOUR PATRONAGE FORECASTS: DETAILED NETWORK ANALYSIS

DISTRIBUTION TRIPS
PM PEAK HOUR

Market Segment [1/]	MODE					
	DPM	Shuttle Bus	Regional Bus	Walk	Auto	Total
Regional Auto User	2382	164	341	62,145	-	65,032
Regional Transit User	5062	1985	3194	47,023	-	57,264
TOTAL	7444	2149	3535	109,168	-	122,296

CIRCULATION TRIPS
NOON HOUR

Market Segment [1/]	MODE					
	DPM	Shuttle Bus	Regional Bus	Walk	Auto	Total
CBD-Workers	2312	1360	686	21,084	17,456	42,898
Others	260	114	251	13,059	6,582	20,166
TOTAL	2572	1474	937	34,143	24,038	63,164

[1/]Distribution travel market segments stratify trips by the regional mode used to travel to the CBD; auto or transit. The same models are used for regional travel to the CBD by both CBD-workers and other travelers.

Circulation travel market segments stratify trips by the type of individual rather than the regional mode of travel used to arrive in the CBD. Therefore, circulation trips are segmented by CBD-workers and others.

distribution trips and 15 percent of the regional transit distribution trips. The noon hour circulation trips include 25 percent of the daily CBD-worker circulation trips and 10 percent of the other circulation trips. The trips in Exhibit C-7 were developed using these factors and a total daily DPM patronage forecast of 73,200 trips.

Exhibit C-8 shows the PM peak hour DPM link and station volumes. The PM peak hour has the heaviest one-hour volume of DPM riders. The maximum one-way link volume is estimated at 3509 passengers per hour, occuring on the northbound link between the Pershing Square and Hill Street stations. The maximum two-way station volume is estimated at 3569 passengers per hour at Union Station. The maximum one-way one-hour volume is a critical factor since it determines the required capacity of the DPM system. The capacity can be adjusted by changing the size or the number of vehicles in service.

C.3.3 Patronage Forecast Sensitivies

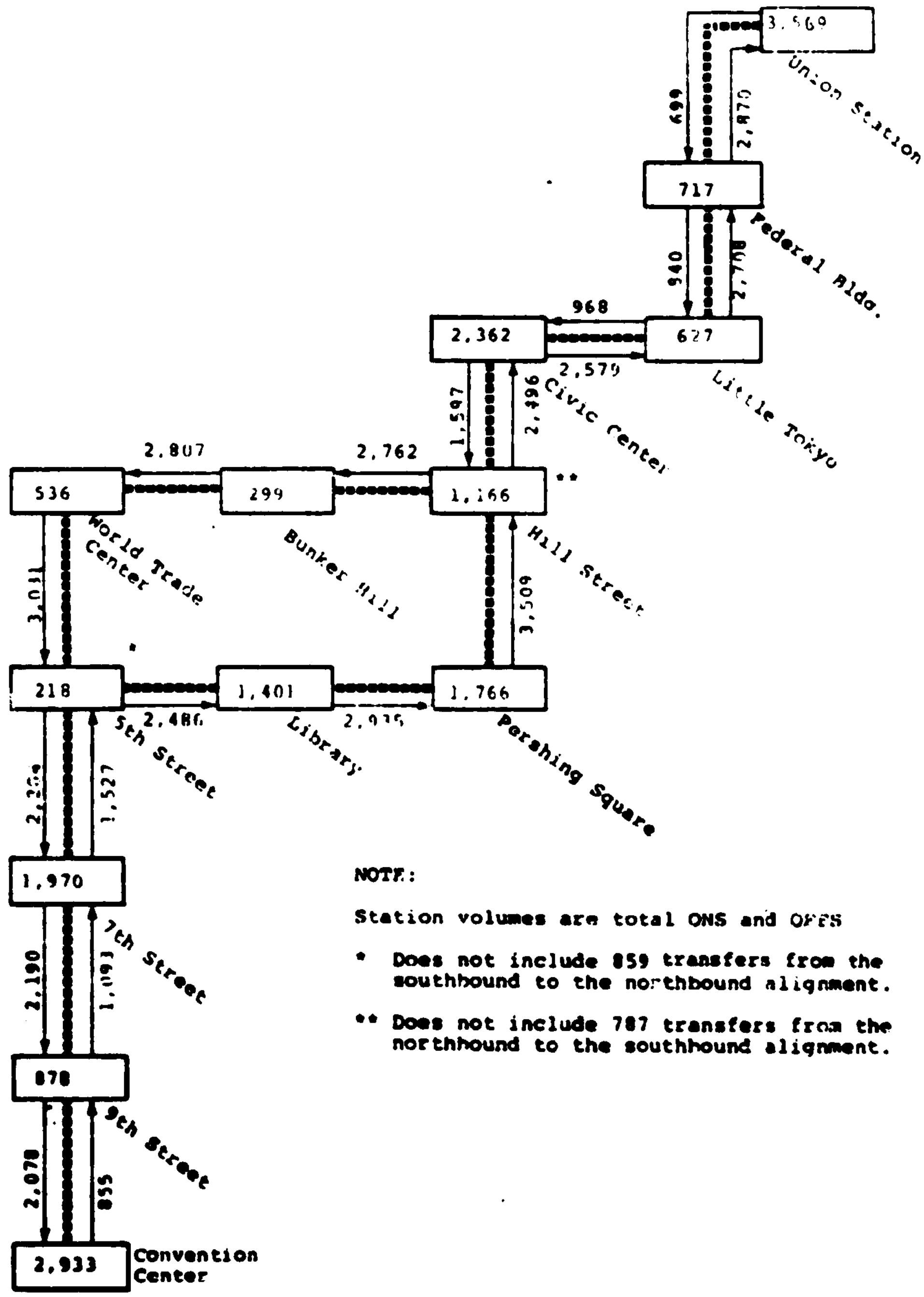
Sensitivity testing involves analyzing the impact on patronage forecasts of changes in either the operating characteristics of the proposed circulator system or the assumed future conditions under which the system is being designed to operate. Sensitivity tests with respect to operating characteristics are used to identify operating characteristics which have a strong impact on the number of travelers who choose each mode. This information can then be used to improve the overall system design for a fixed level of costs and revenues, by trading improvements in important service characteristics with reductions in service of less critical characteristics. Sensitivity tests with respect to assumed future conditions are used to identify the assumptions which strongly impact the patronage forecasts. The planner can then concentrate his or her efforts on developing accurate estimates of the critical future conditions. The sensitivity tests can also be used to develop alternate forecasts for various future scenarios when the critical future characteristics are uncertain.

The sensitivity of travel to the DPM fare was used to compare the sensitivity of the ACM models at different levels of aggregation, ranging from detailed network analysis to sketch planning. Other sensitivity tests were also conducted to demonstrate the use of the procedures presented in Section 7 to evaluate alternate circulator system designs and policies. The sensitivity tests conducted using the detailed network analysis method are presented in Appendix B.

Patronage forecasts for the CBD travel modes were developed for two levels of the DPM fare: a base fare of 20 cents in 1980 dollars and an alternate fare of 33 cents in 1980 dollars. All other factors were held constant, including the fares and costs for the non-DPM modes.

EXHIBIT C-8

BASE CASE PM PEAK HOUR STATION AND LINK VOLUMES:
DETAILED NETWORK ANALYSIS



NOTE:

Station volumes are total ONS and OFFS

* Does not include 859 transfers from the southbound to the northbound alignment.

** Does not include 787 transfers from the northbound to the southbound alignment.

Exhibit C-9 presents the patronage sensitivities by mode to a shift in DPM fare from 20 cents to 33 cents in 1980 dollars. These results show a low sensitivity of DPM patronage to the DPM fare. The 66.7 percent fare increase caused daily ridership on the DPM to decrease by only 3 percent. The largest decrease of any single market segment was a 10 percent decrease in DPM ridership for noon-hour circulation travel by persons who do not work in the CBD. This insensitivity of DPM ridership to DPM fare is not unreasonable given the relatively low values of both the base and alternate fare levels and the fact that a significant number of the DPM riders are making trips which are long enough to make walking an unattractive alternative.

C.4 AGGREGATE NETWORK ANALYSIS FORECASTS

The aggregate network analysis procedure employs the same methodology to forecast demand for CBD travel as does the detailed network analysis procedure. It merely represents the CBD by a more aggregate zone structure. This means the aggregate network analysis method is based on zone demographic data, such as total employment and land uses. It forecasts patronage on the travel modes in the CBD based on these demographic data. This differs from the method used in the manual sketch planning procedure which requires a measurement of the existing CBD travel by mode. This difference will be clarified in the following section, Section C.5.

The aggregate method serves a different purpose than the detailed network analysis method presented in Section C.3. It does not provide information on individual station loadings, nor does it permit testing of localized refinements to the circulator system, such as changes to the route alignment or the station locations. As a result of its lesser detail, the aggregate method can be executed with considerably less computer preparation. Computer coded representations of the CBD travel network, including regional bus, circulator bus, automated DPM, walk, and auto modes, are not needed.

The preparation of aggregate network analysis forecasts is described in three subsections. The first subsection discusses the individual steps in the procedure as outlined in Section 7. The second subsection presents the results of the year 1980 patronage forecasts, and the third subsection discusses some sensitivity testing for changes to the proposed DPM system. The sensitivity tests also illustrate the manual computations performed to produce forecasts for alternative CBD circulator systems.

EXHIBIT C-9

SENSITIVITY OF DPM PATRONAGE TO DPM FARE:
DETAILED NETWORK ANALYSIS

	DPM PATRONAGE 25 CENTS	DPM PATRONAGE 33 CENTS	PERCENT OF INCREASE OR DECREASE
DISTRIBUTION TRIPS PM PEAK HOUR			
Regional Auto User	2382	2275	-4.5%
Regional Transit User	5062	4949	-2.2%
TOTAL	7444	7224	-3.0%
CIRCULATION TRIPS NOON HOUR			
CBD-Workers	2312	2220	-4.0%
Others	260	233	-10.4%
TOTAL	2572	2453	-4.6%
TOTAL DAILY DPM PATRONAGE	72,400	69,900	-3.5%
MAXIMUM HOURLY VOLUME			
Guideway (one direction)	3509	3334	-5.0%
Station (two directions)	3569	3319	-7.0%

C.4.1 Forecasting Procedure

The aggregate network analysis forecasting procedure is presented in Section 7 as four major steps, the last of which is a computerized process. The only difference from the detailed network analysis procedure is that Step 3, the preparation of network level of service characteristics, is a manual process rather than a computerized process.

(1) Choose the analysis parameters

This step is identical to the first step in the detailed network analysis procedure (see Section C.3.1). First, the zone system is defined. Exhibit C-10 illustrates how the study area was divided into 6 large zones rather than the 98 zones used for the detailed network analysis procedure. It is readily apparent that this coarse zone structure will not be sensitive to small changes in the alignment of a circulator service or the placement of individual stations.

The second analysis parameter to be defined is the market segmentation for the patronage forecasts. The aggregate network analysis procedure creates three market segments from the four market segments used in the detailed network analysis procedure:

(1) distribution travel by regional auto and transit users;

(2) circulation travel by CBD-workers; and

(3) circulation travel by others.

The third analysis parameter involves the design of the alternative circulator systems to be evaluated. The base alternative is still the scenario described in Section C.2 for the Los Angeles CBD in the year 1990. The only change is in the zone system described previously and in the use of different alternatives in the sensitivity testing of the ACM model. The sensitivity tests were chosen to illustrate how the worksheet forms are used to aid in the manual preparation of data for input to the computerized ACM model system.

(2) Collect data for the base system and each alternative - 1990

This step is identical to the second step of the detailed network analysis procedure (see Section C.3.1) except the data are aggregated to fewer zones. The data to be accumulated include: projected 1990 demographic characteristics of the study zones, regional trip tables of travel to the CBD, and the service characteristics to access each mode starting in each study zone (e.g. the walk and wait times to access the regional bus service).

EXHIBIT C-10

THE LOS ANGELES STUDY AREA ZONE SYSTEM FOR AGGREGATE NETWORK ANALYSIS

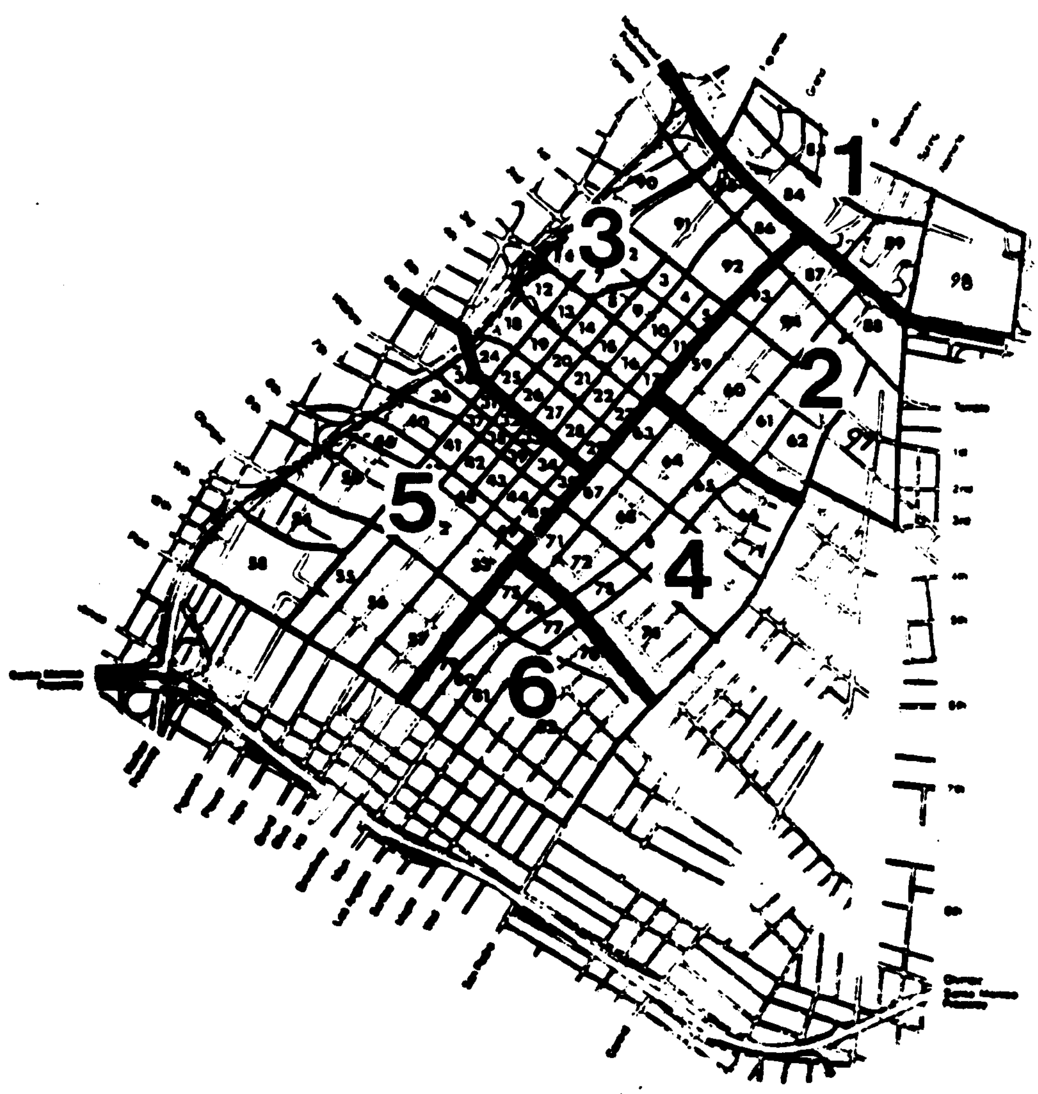


Exhibit C-11 illustrates the demographic data summarized on Form I for the six zone system. These data were first collected for the 98 zone system and then combined to describe the six zones.

Exhibit C-12 illustrates the data compiled on Form II for the level of service characteristics to access a given mode of travel starting from an origin in a given zone. These data are not obtained by aggregating the data collected for the 98 zone example in Exhibit C-6. The service characteristics to access a mode of travel from a large zone is the average of the access service characteristics for each of the smaller zones contained within it.

The data collected on Form II are specific to one circulator system, in this case the base proposed system. Different operating assumptions, such as average headways, will result in changes to the service characteristics summarized on this form. This issue will be dealt with in Section C.3 on sensitivity testing.

Interzonal data are collected on Form IIIa on the levels of services provided by each mode of travel. These data include travel distances or times, and travel costs for all modes. The data also include a station integration variable, INTEG, for the circulator mode.

The station integration variable (INTEG) measures how well the CBD circulation system accommodates transfers to and from the regional travel modes. It is defined as the fraction of distribution trips for an interchange which enter the CBD using transit or parking facility integrated with the circulation system. For interchanges having an integrated parking facility, the variable would have a value of 1.0 as all trips would either enter the downtown using transit or park in the specified facility, while for interchanges not having a parking facility the variable would be computed as the number of trips making the interchange who access the downtown by transit divided by the total number of distribution trips making the interchange. When using the manual sketch planning approach and assuming that the circulation system has little or no impact on regional transit ridership, the change in the station integration variable should be set to zero.

Exhibit C-13 illustrates the collection of interzonal distances for the DPM mode, and Exhibit C-14 illustrates the values of the station integration variable computed for the circulator bus mode.

EXHIBIT C-11
DEMOGRAPHIC DATA COLLECTED ON FORM I FOR THE AGGREGATE ZONE SYSTEM

FORM I: ZONE DATA INPUTS TO NETWORK ANALYSIS PROCESS

DATA USED TO CALCULATE INPUTS ← **INPUT DATA** →

Zone	LAND USE DATA (1000's ft²)					Zone Area (acres)	Parking Capacity (no. spaces)	Hourly Pk. Cost (1980 cents)	No. Employees	Employee Density (emp/acre)	Non-Worker Circ. Trip Productions1/ (trips)	Circulation Trip Attraction Density1/
	Pvt Off	Gov't Off	Retail	Hotel	Manuf							
1	10	1135	210	40	95	1186	3165	104	4,420	3.7	509	377
2	2,260	4565	800	1015	1100	1533	8184	175	43,130	28.1	2790	2066
3	20,020	1800	795	4375	0	1810	39,789	250	60,705	33.5	7110	5272
4	7,555	275	6640	2730	4960	1839	14,283	210	40,690	22.1	10,091	7491
5	20,375	980	2465	4745	2710	2314	32,256	200	48,465	20.9	9084	6737
6	3,225	35	420	485	4830	1536	10,397	160	23,770	15.5	1624	1199

1/ See Appendix A to compute the variables.

EXHIBIT C-12

1990 ACCESS LEVEL OF SERVICE DATA COLLECTED ON FORM II FOR THE AGGREGATE 6 ZONE SYSTEM

FORM II: ZONE MODE ACCESS CHARACTERISTICS

Check: [✓] Base system

[ ] Option ____________

Origin Zone	Access Walk Distance (feet)				Peak Period Wait Time (minutes)				Off-Peak Wait Time (minutes)			
	Circulator	Regional Bus	Shuttle Bus	Other	Circulator	Regional Bus	Shuttle Bus	Other	Circulator	Regional Bus	Shuttle Bus	Other
1	4118	1056	2376		.75	3.0	2.0		1.5	10.0	3.5	
2	1056	1690	1901		.75	3.0	2.0		1.5	10.0	3.5	
3	1003	1531	1690		.75	3.0	2.0		1.5	10.0	3.5	
4	4488	1320	2693		.75	3.0	2.0		1.5	10.0	3.5	
5	1214	2218	1690		.75	3.0	2.0		1.5	10.0	3.5	
6	4805	792	2798		.75	3.0	2.0		1.5	10.0	3.5	

EXHIBIT C-13
1990 INTERZONAL DPM DISTANCES COLLECTED ON FORM III FOR THE AGGREGATE 6 ZONE SYSTEM

FORM IIIa: ZONE PAIR DATA FOR ALL INTERCHANGES STUDY

Mode: DPM

Check: [X] Base system
[ ] Option ____________

Check: [X] In-vehicle travel distance (in miles)
[ ] Fare (in cents)
[ ] Station Integration

In-vehicle travel time (in minutes)
[ ] Peak period
[ ] Off-peak period

Origin Zone	Destination Zone 1	2	3	4	5	6	7	8	9	10
1	9999	.5	1.7	2.5	2.6	2.9				
2	.5	.5	1.2	2.0	2.1	2.4				
3	1.7	1.2	.6	.8	.9	1.2				
4	1.5	1.0	.8	9999	1.7	1.9				
5	2.6	2.1	.9	1.1	5	9999				
6	2.9	2.4	1.2	1.4	9999	9999				
7										
8										
9										
10										

EXHIBIT C-14
INTERZONAL STATION INTEGRATION VALUES FOR DISTRIBUTION TRIPS COLLECTED ON FORM III FOR THE AGGREGATE 6 ZONE SYSTEM

FORM IIIa: ZONE PAIR DATA FOR ALL INTERCHANGES STUDY

Mode: Circulator bus

Check: [X] Base system
[ ] Option ____________

Check: [ ] In-vehicle travel distance (in miles)
[ ] Fare (in cents)
[X] Station Integration

In-vehicle travel time (in minutes)
[ ] Peak period
[ ] Off-peak period

Origin Zone	Destination Zone									
	1	2	3	4	5	6	7	8	9	10
1	.40	.40	.40	.40	.40	.40				
2	.60	.60	.60	.60	.60	.60				
3	.70	.70	.70	.70	.70	.70				
4	.45	.45	.45	.45	.45	.45				
5	.65	.65	.65	.65	.65	.65				
6	.40	.40	.40	.40	.40	.40				
7										
8										
9										
10										

The final source of data needed are trip tables for regional travel to the CBD. Ideally these should include:

- CBD-worker auto trips;
- Other auto trips;
- CBD-worker transit trips; and
- Other transit trips.

The trip tables will frequently be based on a different zone structure than the one developed for the aggregate network analysis forecasting procedure. The UTPS computer program USQUEX is then used to split (expand) and combine (compress) the trip table zones until they are compatible with the study area zones. This procedure is explained as part of the detailed network analysis procedure in Section C.3.1. Further reference to program USQUEX can be found in Appendix B.

The final step involves extracting the CBD distribution portion of regional trips to the CBD. The extraction of CBD distribution trips which the circulator system can serve is explained as part of the detailed network analysis procedure in Section C.3.1.

(3) Compute the network level of service characteristics

This procedural step is performed via manual calculations for the aggregate network analysis method. It is the principal departure from the detailed network analysis procedure which uses a computerized process.

The time required to access a mode of travel from a given zone was collected on Form II and the interzonal distances by mode were collected on Form IIIa. The walk distance is from zone centroid to zone centroid and must follow the street system. Straight line distances are not to be used. The DPM and bus distances include only the on-vehicle portion of the trip since the access and egress distances are included in the information collected on Form II. The auto in-vehicle distance is assumed to be the same as the walk distance. However, the auto travel time calculation includes access and egress times. The walk time to and from the auto was computed for an average distance to the car of .1 miles (528 feet). These data are included in the access characteristics on Form II.

Form IV is then used to manually calculate the travel times for all origin-destination pairs and all modes. The calculation requires three data inputs: the access times from Form II, the interzonal distances from Form IIIa, and the travel speeds by mode to convert distances to times. The following speeds were assumed for the example calculations:

o walk	3	mph	264	fps
o DPM	13	mph	1144	fps
o bus transit	6.6	mph	581	fps
o auto	10	mph	880	fps

Exhibit C-15 provides a sample travel time calculation for each of the travel modes using Form IV for an assumed trip from zone 2 to zone 5.

The final step in determining the level of service characteristics is to summarize on a single form the total interzonal time and cost data for all modes between a single origin-destination pair. This is accomplished on Form V, see Exhibit C-16. In addition to the travel time by mode from Form IV, Form V includes the following information:

- transit fares for the DPM, circulator bus, and regional bus modes; and
- the station integration variables for distribution travel.

The DPM and circulator bus fares were assumed to be 20 cents in 1980 dollars and the regional bus fare was assumed to be 55 cents in 1980 dollars.

(4) Execute the computerized mode split models

This step is identical to the fourth step in the detailed network analysis procedure presented in Section C.3.1. A detailed description is also provided in Appendix B.

C.4.2 Base Case Patronage Forecasts - 1990

The full set of computerized ACM travel demand models described in Appendix A were used to estimate 1990 patronage for the six zone Los Angeles case study. The 1990 patronage was forecast by mode, market segment, and origin-destination pair. It was then summarized by modes and market segment and presented in Exhibit C-17.

The ACM models estimate the total number of distribution trips and circulation trips. These volumes are then multiplied by time-of-day factors to determine the travel in the PM peak hour and the noon hour, as they were in Section C.3.2 for the detailed network analysis case study. The travel volumes in

EXHIBIT C-15

TRAVEL TIMES CALCULATED ON FORM IV FOR THE AGGREGATE 6 ZONE SYSTEM

FORM IV: TRAVEL TIME CALCULATIONS

Mode: All Modes

Check: [X] **Base System**

[ ] **Option** ____________

Check: [X] **Peak**

[ ] **Off-Peak**

Mode	Origin	Destination	Origin Walk 1/	Wait	On-Vehicle	Dest. Walk 1/	Total Time
DPM	2	5	D 1056 S ÷ 264 T 4 + .5	+ .75	11.088 ÷ 1.144 + 9.7	1214 ÷ 264 + 4.6 + .3 =	19.85
Shuttle Bus	2	5	D 1901 S ÷ 264 T 7.2	+ 2.0	6019 ÷ 581 + 10.4	1690 ÷ 204 + 6.4 =	26.00
Regional Bus	2	5	D 1690 S ÷ 264 T 6.4	+ 3.0	6019 ÷ 581 + 10.4	2218 ÷ 264 + 8.4 =	28.20
Auto	2	5	D 600 S ÷ 264 T 2.3	+ 0	7920 ÷ 880 + 9.0	600 ÷ 264 + 2.3 =	13.60
			D S ÷ T	+	÷ +	÷ + =	
			D S ÷ T	+	÷ +	÷ + =	

D = distance (feet) S = speed (feet/minute) T = Time (minutes)

1/ DPM walk times include 0.5 minutes to climb up stairs and 0.3 minutes to climb down stairs.

EXHIBIT C-16
ZONE PAIR LEVEL OF SERVICE INPUTS TO THE AGGREGATE NETWORK ANALYSIS PROCESS

FORM V: ZONE PAIR INPUTS TO NETWORK ANALYSIS PROCESS

Check: [X] Base System　　　Check: [X] Peak period

[ ] Option ____________　　　[ ] Off-peak period

Origin Zone	Destination Zone	Walk		Auto		Regional Bus		Shuttle Bus		DPM		All Transit
		Time (minutes)	Distance (miles)	Time (minutes)	Cost (cents)	Time (minutes)	Cost (cents)	Time (minutes)	Cost (cents)	Time (minutes)	Cost (cents)	Station Integration
1	1	10	.5	4.6	7	15.6	55	25.0	20	9999	25	.40
1	2	16	.8	6.5	11	22.9	55	17.0	20	19.6	25	.40
1	3	22	1.1	8.3	15	24.8	55	20.0	20	27.9	25	.40
1	4	34	1.7	11.7	22	33.4	55	25.0	20	35.2	25	.40
1	5	42	2.1	14.0	27	32.3	55	35.0	20	28.5	25	.40
1	6	46	2.3	15.4	30	9999	55	28.0	20	9999	25	.40
2	1	16	.8	6.5	11	22.9	55	20.0	20	19.6	25	.60
2	2	8	.4	4.0	5	17.0	55	15.0	20	17.8	25	.60
2	3	20	1.0	7.6	13	23.0	55	20.0	20	16.9	25	.60
2	4	18	.9	6.3	11	28.9	55	17.0	20	24.6	25	.60
2	5	30	1.5	13.6	19	28.2	55	26.0	20	19.9	25	.60

EXHIBIT C-16 (Continued)

FORM V: ZONE PAIR INPUTS TO NETWORK ANALYSIS PROCESS

Check: [X] Base System   Check: [X] Peak period

[ ] Option ____________   [ ] Off-peak period

Origin Zone	Destination Zone	Walk		Auto		Regional Bus		Shuttle Bus		DPM		All Transit
		Time (minutes)	Distance (miles)	Time (minutes)	Cost (cents)	Times (minutes)	Cost (cents)	Time (minutes)	Cost (cents)	Time (minutes)	Cost (cents)	Station Integration
2	6	30	1.5	11.6	20	30.4	55	21.0	20	40.1	25	.60
3	1	22	1.1	8.3	15	24.8	55	20.0	20	27.9	25	.70
3	2	20	1.0	7.6	13	23.0	55	20.0	20	16.9	25	.70
3	3	10	.5	5.3	6	19.4	55	9999	20	20.3	25	.70
3	4	24	1.2	8.8	16	28.0	55	20.0	20	32.8	25	.70
3	5	18	.9	7.0	12	26.9	55	30.0	20	17.7	25	.70
3	6	36	1.8	12.4	24	9999	55	23.0	20	40.2	25	.70
4	1	34	1.7	11.7	22	33.4	55	25.0	20	35.2	25	.45
4	2	18	.9	6.7	11	28.9	55	17.0	20	24.8	25	.45
4	3	24	1.2	8.8	16	28.0	55	20.0	20	32.8	25	.45
4	4	12	.6	5.3	8	27.6	55	20.0	20	9999	25	.45

EXHIBIT C-16 (Continued)

FORM V: ZONE PAIR INPUTS TO NETWORK ANALYSIS PROCESS

Check: [X] Base System Check: [X] Peak period

[ ] Option ______________ [ ] Off-peak period

Origin Zone	Destination Zone	Walk		Auto		Regional Bus		Shuttle Bus		DPM		All Transit
		Time (minutes)	Distance (miles)	Time (minutes)	Cost (cents)	Times (minutes)	Cost (cents)	Time (minutes)	Cost (cents)	Time (minutes)	Cost (cents)	Station Integration
4	5	26	1.3	9.0	16	26.9	55	25.0	20	33.5	25	.45
4	6	12	.6	5.4	8	29.4	55	20.0	20	9999	25	.45
5	1	41	2.1	14.0	27	32.3	55	30.0	20	28.5	25	.65
5	2	30	1.5	9.4	19	28.3	55	23.0	20	17.5	25	.65
5	3	18	.9	7.0	12	26.9	55	25.0	20	17.7	25	.65
5	4	26	1.3	9.0	16	26.9	55	20.0	20	33.5	25	.65
5	5	10	.5	4.3	6	18.6	55	25.0	20	19.3	25	.65
5	6	20	1.0	7.6	13	26.3	55	20.0	20	9999	25	.65
6	1	46	2.3	15.4	30	9999	55	28.0	20	50.[illegible]	25	.40
6	2	30	1.5	10.6	20	30.4	55	21.0	20	40.1	25	.40
6	3	36	1.8	12.4	24	9999	55	23.0	20	40.2	25	.40

EXHIBIT C-16 (Continued)

FORM V: ZONE PAIR INPUTS TO NETWORK ANALYSIS PROCESS

Check: [X] Base System [ ] Option ____________

Check: [X] Peak period [ ] Off-peak period

Origin Zone	Destination Zone	Walk		Auto		Regional Bus		Shuttle Bus		DPM		All Transit
		Time (minutes)	Distance (miles)	Time (minutes)	Cost (cents)	Times (minutes)	Cost (cents)	Time (minutes)	Cost (cents)	Time (minutes)	Cost (cents)	Station Integration
6	4	12	.6	5.4	8	29.4	55	20.0	20	32.7	25	.40
6	5	20	1.0	7.6	13	26.3	55	25.0	20	9999	25	.40
6	6	10	.5	4.6	7	21.3	55	20.0	20	9999	25	.40

EXHIBIT C-17
BASE CASE PM PEAK HOUR AND NOON HOUR PATRONAGE FORECASTS: AGGREGATE NETWORK ANALYSIS

Market Segment	MODE					
	DPM	Shuttle	Regional	Walk	Auto	Total
PM PEAK HOUR Distribution Trips	7066	6520	7102	101,599	-	122,287
NOON HOUR Circulation Trips						
o CBD-workers	3710	2082	2520	18,836	19,998	47,146
o Others	356	179	347	9,806	9,598	20,286
TOTAL	4066	2261	2867	28,642	29,596	67,432

Exhibit C-17 were computed using the time-of-day factors developed in Los Angeles and a daily total of 84,964 DPM trips.[1]

Several differences are evident when the patronage forecasts for the detailed and aggregate network analysis models are compared:

- the walk mode share in each of the market segments is lower in the aggregate network analysis forecast than in the detailed network analysis forecast; and
- the regional bus and shuttle bus modes have the largest percentage differences between the patronage forecasts from the aggregate and detailed network analysis procedures. The patronage forecasts by transit are higher using the aggregate procedure.

These differences can be explained as a result of the aggregation process. Model availability is an important determinant of mode choice in the detailed network analysis model. Travelers are frequently forced to walk when a particular origin-destination trip is not served by the existing transit network. As detailed zones are aggregated into a small number of large study zones it becomes less probable that the transit network will not provide some form of service between any given pair of zones. The result appears to be higher transit use and fewer walking trips in the aggregate network analysis forecast.

Exhibit C-18 contains a direct comparison of the forecast DPM patronage by market segment between the aggregate and the detailed network analysis models. There is close correspondence between the forecasts for the PM peak hour but the aggregate forecasts are more than 50 percent higher than the detailed network forecasts for the noon hour. The daily total DPM ridership is 17 percent higher for the aggregate model.

The comparison of the detailed and aggregate network analysis forecasts in Exhibit C-17 and C-18 point out the value of model calibration whenever (a) aggregate data are used, such as the average time to walk to a bus stop from a study zone, and (b) base case data exist against which to calibrate the model results. The base case in the Los Angeles case study is a prediction for the year 1990 so data do not exist for use in calibrating the 1990 base case forecasts, and the conclusions cannot be made as to whether the detailed or the aggregate network analysis forecast is more accurate. Emphasis will therefore be placed on changes from the base case forecasts when comparing the results of the three modeling procedures.

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[1] Cambridge Systematics, Inc., 1977.

EXHIBIT C-18
COMPARISON OF DPM PATRONAGE FORECASTS BY THE DETAILED AND AGGREGATE NETWORK ANALYSIS MODELS

	LEVEL OF NETWORK ANALYSIS		
	Detailed 98 zones	Aggregate 6 zones	Ratio (Agg/Detail
PM Peak Hour DPM Patronage	7,444	7,066	.95
Noon Hour DPM Patronage			
CBD-Workers	2,312	3,710	1.60
Others	260	356	1.37
Total	2,572	4,066	1.58
Total Daily DPM Patronage	72,400	84,904	1.17

C.4.3 Patronage Forecast Sensitivities

Sensitivity tests can be conducted to analyze the impacts on patronage forecasts of changes in either the operating characteristics of the proposed circulator service, or the assumed future conditions under which the system is designed to operate. The uses of such sensitivity tests was discussed in Section C.3.3.

The sensitivity of patronage forecasts to changes in the DPM fare was computed for the detailed and aggregate network analysis methods, and the relative sensitivities were compared. Exhibit C-19 presents the patronage sensitivities by mode to a shift in the DPM fare from 20 cents to 33 cents in 1980 dollars. For ease of comparison, this exhibit repeats the sensitivities presented in Exhibit C-9 for the detailed network analysis model. The sensitivity of DPM patronage to DPM fare is extremely close for the network analysis model executed on both 98 zones and on 6 zones, differing by 1 percent or less in each of the travel markets. Both models utilize the same equations and coefficients so the sensitivities should be quite similar. Any differences are attributable to the discrete nature of travel patterns in the CBD and imperfections which arise when averaging the dissimilar travel patterns of zone systems at different levels of aggregation.

Several other sensitivity tests were conducted to demonstrate the use of Forms I through IV to prepare the alternative inputs to the computerized ACM models. These sensitivity tests involved changes to three DPM system characteristics:

- vehicle speed - base 13 mph, test 6.5 mph;
- vehicle headways - based 1.5 min., test 3.0 min.;
- station spacings - base .25 miles; test .50 miles.

One run of the computerized ACM model system was made for each of these variables. Each run with its single changed variable was then compared to the base case model run to test the sensitivities of DPM patronage to changes in the DPM service.

The results of these three sensitivity tests are summarized in Exhibit C-20. Non-worker circulation trips are the market segment most sensitive to changes in the DPM level of service. The CBD-worker models for circulation and distribution travel are roughly equal in sensitivity to the DPM level of service, and are both less sensitive than the non-worker circulation trip model.

EXHIBIT C-19
SENSITIVITY OF DPM PATRONAGE TO DPM FARES:
DETAILED AND AGGREGATE NETWORK ANALYSES

AGGREGATE NETWORK ANALYSIS

	FARE POLICY			DETAILED NETWORK ANALYSIS
	25 Cents	33 Cents	Increase or Decrease	Increase or Decrease
DISTRIBUTION TRIPS PM PEAK HOUR				
TOTAL	7,066	6,742	-.05	-.04
CIRCULATION TRIPS NOON HOUR				
CBD-Workers	3,710	3,572	-.04	-.04
Others	356	317	-.11	-.10
TOTAL	4,066	3,889	-.04	-.05
DAILY DPM PATRONAGE				
TOTAL	84,964	81,162	-.04	-.03

EXHIBIT C-20
EXAMPLE SENSITIVITY TESTS FOR DPM PATRONAGE:
AGGREGATE NETWORK ANALYSIS

DPM Patronage	Base Case	Reduced DPM Speed	Increased DPM Headway	Increased DPM Station Spacing
Total Daily	84,964 Index* = 1.00	66,263 .78	80,732 .95	74,930 .88
PM Peak				
Total	7,066 1.00	5,565 .79	6,702 .95	6,177 .87
Noon Hour				
Workers	3,710 1.00	2,962 .80	3,558 .96	3,370 .91
Nonworker	356 1.00	175 .49	313 .88	250 .70
Total	4,066 1.00	3,137 .77	3,871 .95	3,620 .89

$$*\text{Index} = \frac{\text{alternative value}}{\text{base case value}}$$

The inputs to the ACM models for the sensitivity runs were prepared by modifying the base case data collected on Forms I through IV. A change in the DPM speed affects only the in-vehicle time, which is computed on Form IV (see Exhibit C-21). A change in the DPM headway affects only the wait time component of DPM service and it is a constant adjustment applied to every origin-destination pair. This wait time adjustment can be entered directly on Form V (see Exhibit C-22). A change in DPM station spacing affects the access/egress distances. These distances are unique to each zone and are entered on Form II; an example of which is included in Exhibit C-23. These data are then used to revise the data in Forms IV and V.

C.5 MANUAL SKETCH PLANNING FORECASTS

The sketch planning method differs from the network analysis models in more than the level of zone aggregation. Sketch planning is an incremental process which computes revised mode shares as a function of changes in the modal levels of service. Network analysis computes total ridership by mode from the mode levels of service and from the demographic characteristics of each zone, such as land use and total employment. The data inputs to the base case for sketch planning must therefore include initial measurements of the mode shares for travel between and within each of the CBD zones.1/ The base case mode shares for the 1990 Los Angeles CBD case study were obtained by aggregating the 1990 base forecasts produced by the detailed network analysis model.

The sketch planning method also serves a different purpose than the network analysis methods. It is meant to produce quick rough estimates of the impact on patronage of changes to the transportation system. It is not intended for use in estimated origin-destination travel patterns as are the network analysis models. The sketch planning method requires no network preparation and no computer processing. The required calculations can be further reduced by analyzing travel on only a sample of the origin-destination interchanges and using the results to represent all travel in the study area.

This section discusses the preparation of CBD travel forecasts by the manual sketch planning methods. The first subsection discusses the six major steps in the procedure as

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1/ Since the sketch planning model computes revised mode shares, it is most appropriately used to forecast changes in ridership due to changes in an existing CBD circulation system. It is applied here to a proposal system to permit comparisons with the results of the network analysis forecasts.

EXHIBIT C-21
REVISE TRAVEL TIME DATA TO TEST A NEW DPM SPEED

FORM IV: TRAVEL TIME CALCULATIONS

Mode: DPM

Check: [ ] **Base System**
[X] **Option** Change DPM Speed from 13 mph to 6.5 mph.

Check: [X] **Peak**
[ ] **Off-Peak**

Origin	Destination	Origin Walk	Wait	On-Vehicle	Dest. Walk	Total Time
2	5	D 1056 S ÷ 264 T 4.0 + 0.5	+ .75	11,088 ÷ ~~1144~~ 572 + ~~9.7~~ 19.4	1216 ÷ 264 + 4.6 + 0.3 =	29.55 ~~19.85~~
		D S ÷ T	+	÷ +	÷ + =	
		D S ÷ T	+	÷ +	÷ + =	
		D S ÷ T	+	÷ +	÷ + =	
		D S ÷ T	+	÷ +	÷ + =	
		D S ÷ T	+	÷ +	÷ + =	

D = distance (feet) S = speed (feet/minute) T = Time (minutes)

EXHIBIT C-22

REVISE WAIT TIME DATA TO TEST A DIFFERENT DPM FREQUENCY OF SERVICE

FORM V: ZONE PAIR INPUTS TO NETWORK ANALYSIS PROCESS

Check: [ ] Base System

[x] Option Change DPM Frequency of Service From Every 1.5 minutes to every 3 minutes

Origin Zone	Destination Zone	Walk		Auto		Regional Bus		Shuttle Bus		DPM	
		Time (minutes)	Distance (miles)	Time (minutes)	Cost (cents)	Times (minutes)	Cost (cents)	Time (minutes)	Cost (cents)	Time (minutes)	Cost (cents)
2	5	30	1.5	10.4	19	28.3	55	28.0	20	~~17.5~~ 19.25 1/	25

1/ All DPM times are increased by 0.75 minutes.

EXHIBIT C-23

REVISE ACCESS LEVEL OF SERVICE DATA TO TEST A DIFFERENT DPM STATION SPACING

FORM II: ZONE MODE ACCESS CHARACTERISTICS

Check: [ ] Base system

[X] Option Change DPM Station Spacing

Origin Zone	Access Walk Distance (feet)				Peak Period Wait Time (minutes)				Off-Peak Wait Time (minutes)			
	Circulator	Regional Bus	Shuttle Bus	Other	Circulator	Regional Bus	Shuttle Bus	Other	Circulator	Regional Bus	Shuttle Bus	Other
2	1556 ~~1056~~	1690	1901		.75	3.0	2.0		1.5	10.0	3.5	

presented in Section 7. The second subsection discusses the sensitivity of the forecasts to the proposed alternatives and compares the results to the network analysis forecasts.

C.5.1 Forecasting Procedure

The manual sketch planning forecasting process is presented in Section 7 as six major steps. Forms II, III, IV, VI, and VII, have been designed as worksheets to guide the analyst through the manual calculations.

(1) Choose the analysis parameters

This step is identical to the first step in the network analysis procedures (see Section C.3.1). First, the zone system must be defined. The sketch planning example uses the same 6 zone study area developed for the aggregate network analysis process and presented in Exhibit C-10. Second, the travel markets must be defined. The manual sketch planning examples uses the same three travel markets as the aggregate network analysis example:

- o total PM peak hour distribution travel;
- o CBD-worker noon hour circulation travel; and
- o other noon hour circulation travel.

Third, the alternative CBD circulator services must be defined. The base case for this example is obtained by aggregating the 1990 base forecast developed with the detailed network analysis model. This alternative was described in Section C.2. The manual sketch planning process is then used to develop revised forecasts for two proposed changes to the DPM system: an increase in the DPM fare from 20 to 33 cents in 1980 dollars, and a reduction in the DPM average speed from 13 to 6.5 miles per hour.

(2) Select a sample of zone interchanges

This case study has 6 zones and 36 zone interchanges. All 36 interchanges could be analyzed with the manual process but a sample of 12 was selected to illustrate the sampling process and the expansion process to come later. Two destinations were selected for each of the 6 origin zones. The selected interchanges are illustrated in Exhibit C-24.

(3) Collect data for the base system and each alternative - 1990

The manual sketch planning process requires data on the base case trip volume and mode shares whereas the network analysis model needs demographic data on land uses and CBD employment.

EXHIBIT C-24
TWELVE SAMPLE INTERCHANGES FOR
THE SKETCH PLANNING PROCESS

ORIGIN \ DESTINATION	1	2	3	4	5	6
1	X			X		
2			X			X
3		X			X	
4	X					
5			X			X
6		X			X	

However, both approaches use the same level of service data to describe the CBD circulator system: walk time, wait time, in-vehicle time and cost.

Data on trip volumes and mode shares were obtained for the selected zone pair interchanges by aggregating the base case forecast produced by the detailed network analysis model. These data were then entered on Form VI. The level of service data are the same as were needed for the 6 zone aggregate network analysis model; the access level of service data were collected on and presented in Exhibit C-12 and the interzonal distances were collected on Form IIIa and presented in Exhibit C-13. A modified form, Form IIb, is provided to collect interzonal distance and cost data when only a sample of interchanges are to be analyzed. Exhibit C-25 presents the data from Exhibit C-13 on Form IIb for the twelve sampled interchanges only.

The level of service data compiled on Forms II and III must be prepared for the base system and for each revised service to be analyzed. The sketch planning model operates on the changes in service which result from changes in the operation of the CBD circulator system.

(4) Compute the level of service characteristics

Travel times are calculated on Form III using the data collected on Forms I and II for the sampled interchanges. This step is identical to step 3 of the aggregate network analysis model as discussed in Section C.4.1.

It is not necessary to summarize the level of service data for input to a computer program. Instead, these data are transferred directly to Form VI to compute revised patronage forecasts.

(5) Compute the revised patronage forecasts

Form VI is used to compute revised patronage forecasts for individual interchanges. An example is provided in Exhibit C-26 of the use of Form VI to compute revised PM peak hour distribution travel between zones 2 and 5 for a change in the DPM mode speed. The data needed in Form VI are specified in its column headings. Columns (3), (4), and (5) contain the changes in level of service characteristics obtained by taking the differences between the values in Forms III and IV for the option being evaluated and the base conditions. Columns (8) and (9) contain the total trip productions and the market shares for each interchange. These data were obtained for this case study from the 1990 detailed network analysis forecasts. The coefficients entered in column (7) are obtained from Exhibit C-27 and depend on the travel market.

EXHIBIT C-25

INTERZONAL DISTANCES COLLECTED ON FORM IIIb FOR 12 SAMPLE INTERCHANGES

FORM IIIb: ZONE PAIR DATA FOR SAMPLE INTERCHANGE STUDY

Check: [X] Base System (Current or Proposed)

[ ] Option ____________

Origin Zone	Destination Zone	In-vehicle Distance (in miles)				Fare (in cents)			
		Circulator	Regional Bus	Shuttle Bus	Other	Circulator	Regional Bus	Shuttle Bus	Other
1	1	9999				25	55	20	
1	4	2.5				25	55	20	
2	3	1.2				25	55	20	
2	6	2.4				25	55	20	
3	2	1.2				25	55	20	
3	5	.9				25	55	20	
4	1	1.5				25	55	20	
4	4	9999				25	55	20	
5	3	.9				25	55	20	

EXHIBIT C-25 (Cont.)

FORM IIIb: ZONE PAIR DATA FOR SAMPLE INTERCHANGE STUDY

Check: [X] Base System (Current or Proposed)

[ ] Option ____________

Origin Zone	Destination Zone	In-vehicle Distance (in miles)				Fare (in cents)			
		Circulator	Regional Bus	Shuttle Bus	Other	Circulator	Regional Bus	Shuttle Bus	Other
5	6	9999				25	55	20	
6	2	2.4				25	55	20	
6	5	9999				25	55	20	

EXHIBIT C-26

EXAMPLE CALCULATION OF REVISED DISTRIBUTION TRAVEL USING FORM VI

FORM VI: CHANGES IN TRAVEL FROM BASE SYSTEM

MARKET SEGMENT CBD-Worker OPTION Change DPM Speed From 13 mph to 6.5 mph
Distribution Trips

(1) Origin Zone	(2) Dest. Zone	Mode C or O.T.	(3) ΔTime	(4) ΔCost	(5) ΔImage	(6) ΔU = [-.026] • ΔTime + [-.040] • ΔCost + [1.297] • ΔImage	(7) Exp (ΔU)	(8) Base Market Share	(9) y=(7)(8)	(10) Σy	(11) Revised Market Share $y_C/\Sigma y$	(11) Revised Market Share $y_{OT}/\Sigma y$	(12) Total Trip Productions	(13) Revised Trips (11) • (12) C	(13) Revised Trips (11) • (12) O.T.
2	5	C	9.7	-	-	- 1.344	.261	.600	.156	.556	.281		2500	701	
		O.T.	-	-	-	0.0	1	.400	.400			.719			1799
		C													
		O.T.													
		C													
		O.T.													
		C													
		O.T.													
		C													
		O.T.													
		C													
		O.T.													
													TOTAL		

EXHIBIT C-27
COEFFICIENTS FOR THE UTILITY EXPRESSIONS
OF THE TRAVEL MARKETS

Market Segment

Variable	CBD Workers	Others	All Circulation Trip-makers
Travel Time[1]	-.1386	-.0878	-.1183
Travel Cost[1]	-.0681	-.0109	-.0452
Modal Image[2]	+1.247	+1.121	+1.197

[1]From the models described in Appendix A.

[2]Based on analyses carried out for Los Angeles (Ref: CSI, 1978)

(6) Expand the revised patronage forecasts

The impact of the service changes on patronages was only computed for 1/3 of the interchanges, 12 out of 36. The 12 interchanges were chosen at random so the patronage in the total network is obtained by multiplying the results for the 12 sampled interchanges by a factor of 3.

C.5.2 Patronage Forecast Sensitivities

The sketch planning method does not produce a base case patronage forecast. It produces revised forecasts which are comparable to the sensitivity tests run for the network analysis models. The changes in level of service characteristics are determined by comparing the values in Forms II, III, and IV for the base and alternative systems. The use of these forms was illustrated in Exhibits C-13, C-21, and C-23. The change in a variable is then entered in Form VI as illustrated by Exhibit C-26.

Revised patronage forecasts were prepared for a change in DPM fare from 25 cents to 33 cents in 1980 dollars, and for a change in DPM speed from 13 mph to 6.5 mph. The results of these forecasts are summarized in Exhibit C-28. The impact of the increased fare was compared to the forecasts produced by the detailed and aggregate network analysis models under the same conditions. The changes were computed as percentage changes from each of the respective base cases, and are summarized in Exhibit C-29. The results are extremely close for all markets and all 3 methods. The fare change is an action which will impact equally on all trips everywhere in the CBD study area; therefore, the close correspondence in the results is not surprising. Greater differences in the forecasts can be expected when the action being measured has more localized or focused impacts such as changing the service on a few bus routes.

C.6 SUMMARY AND CONCLUSIONS

The Los Angeles case study demonstrates the use of the ACM models at varying levels of detail and provides indications of the sensitivity of DPM demand to variations in a number of design variables.

A final purpose of the case study is to provide information on the relative costs and accuracy of the alternative procedures. It is hard to make generalizations about analysis costs, because situations can be quite different with respect to data availability, labor costs per hour, and unit computer costs.

EXHIBIT C-28

REVISED DPM PATRONAGE FORECASTS
USING MANUAL SKETCH PLANNING

	BASE CASE[1]	REDUCED[2] SPEED	PERCENT OF BASE CASE	INCREASED[3] FARE	PERCENT OF BASE CASE
PM PEAK HOUR	7,444	6,223	84%	7,233	97%
NOON HOUR					
CBD-Workers	2,312	1,767	76%	2,230	96%
Others	260	127	49%	230	88%
Total	2,572	1,894	74%	2,460	96%
ALL DAY	72,400	57,958	80%	69,951	97%

1/The base case values are from the detailed network analysis forecast for the Los Angeles CBD in the year 1990 (see Exhibit C-18).

2/This alternative assumes a reduction in the average DPM speed from 13 mph to 6.5 mph.

3/This alternative assumes a DPM fare increase from 25 cents to 33 cents in 1980 dollars.

EXHIBIT C-29
COMPARISON OF THE IMPACT OF A 10 CENT DPM FARE INCREASE
AS FORECAST BY EACH OF THE THREE METHODS

	Detailed Network Analysis	Computerized Sketch Planning	Manual Sketch Planning
Percent Change in DPM Patronage			
Total Daily	-3.5%	-4.5%	-3.4%
PM Peak Hour - Total	-3.0%	-4.6%	-2.8%
Noon Hour			
Workers	-4.0%	-3.7%	-3.5%
Non-Workers	-10.4%	-11.0%	-11.5%
Total	-4.6%	-4.4%	-4.4%

But it is possible to report on the costs of actual analysis such as the Los Angeles case study fairly accurately. These costs are reported in hours of analyst time and dollars of computer costs at a typical commercial service bureau, to keep the indicators of cost as general as possible. Also, costs have been divided into those for two general types of activities: problem set-up and alternative analysis. Problem set-up consists of all the activities required before the first alternative can be analyzed, including:

- data collection from secondary sources such as planning agencies, chambers of commerce, and traffic departments;
- data processing to aggregate and/or disaggregate data to the chosen zone system, and to adapt to the required formats;
- network coding and/or reconnaissance and checking; and
- computer program implementation and checking, where required.

The costs for the three forecasting procedures have been classified as set-up or analysis tasks, and as person-hours or computer dollars. Exhibit C-30 shows these resource costs. The unique nature of the case study, and its probable impacts on the costs, must be kept in mind. The alternatives analyses dealt with fairly simple scenarios requiring fairly little problem definition, which serves to reduce the person-hours per alternative from what they otherwise might be. Also, the costs reflect the use of 98 zones for detailed network analysis, and six zones for the aggregate network analysis and manual sketch planning procedures.

A comparison of manual sketch planning and network analysis results demonstrates both an important advantage, and an important disadvantage, of the manual procedure. Because it is an incremental procedure, and because its starting point was an aggregation of the detailed base case results, it agrees very well with the results produced by the detailed network analysis procedure. The disadvantage, of course, is that the manual method cannot be used unless a base case is available, either from observed data, or from other analyses.

With respect to applicability, it is important to note that many scenarios and changes can only be analyzed using detailed analysis. Examples are one-block shifts in DPM alignments, and predictions of parking facility choice. For changes in such factors as CBD employment, DPM station spacing, speed,

EXHIBIT C-30
COST DATA FOR THE LOS ANGELES CASE STUDY

Analysis Procedure	Task	Person-Hours	Computer Dollars
Detailed Network Analysis	Set-up[1]	480	2,000
	Analysis[2]	20	500
Aggregate Network Analysis	Set-up[1]	240	300
	Analysis[2]	12	150
Manual Sketch Planning	Set-up[1]	80	0
	Analysis[2]	8	0

[1]Total cost.

[2]Cost per alternative.

headways, and fare; and regional trip tables; both manual sketch planning and network analysis at an aggregate level are very useful. Since their costs are quite similar, the choice of a method will be based mainly on the availability of base year data. If sufficient data are available, the manual method can be used; otherwise, the computerized method is required. If more specific information is required, the detailed network analysis method must be used.

APPENDIX D

DOWNTOWN CIRCULATOR PLANNING WORKSHEETS

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APPENDIX D-1

Worksheets for Manual Sketch Planning and Aggregate Network Analysis

FORM I: ZONE DATA INPUTS TO NETWORK ANALYSIS PROCESS

DATA USED TO CALCULATE INPUTS ← INPUT DATA →

Zone	LAND USE DATA (1000's ft^2)					Zone Area (acres)	Parking Capacity (no. spaces)	Hourly Pk. Cost (1980 cents)	No. Employees	Employee Density (emp/acre)	Non-Worker Circ. Trip Productions1/ (trips)	Circulation Trip Attraction Density2/
	Pvt Off	Gov't Off	Retail	Hotel	Manuf							

1/ See Appendix A, Section A.3.4.1 to compute the value of this variable.

2/ See Appendix A, Section A.3.3.1 to compute the value of this variable.

FORM II: ZONE MODE ACCESS CHARACTERISTICS

Check: |__| Base system

|__| Option ______________

Origin Zone	Access Walk Distance (feet)				Peak Period Wait Time (minutes)				Off-Peak Wait Time (minutes)			
	Circulator	Regional Bus	Shuttle Bus	Other	Circulator	Regional Bus	Shuttle Bus	Other	Circulator	Regional Bus	Shuttle Bus	Other

FORM IIIa: ZONE PAIR DATA FOR ALL INTERCHANGES STUDY

Mode: ________________

Check: [ ] Base system

[ ] Option ____________

Check: [ ] In-vehicle travel distance (in miles)

[ ] Fare (in cents)

[ ] Station Integration

In-vehicle travel time (in minutes)

[ ] Peak period

[ ] Off-peak period

Origin Zone	Destination Zone									
	1	2	3	4	5	6	7	8	9	10
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

FORM IIIb: ZONE PAIR DATA FOR SAMPLE INTERCHANGE STUDY

Check: ☐ Base System (Current or Proposed)

☐ Option ____________

Origin Zone	Destination Zone	Variable ____________				Variable ____________			
		Circulator	Regional Bus	Shuttle Bus	Other	Circulator	Regional Bus	Shuttle Bus	Other

FORM IV: TRAVEL TIME CALCULATIONS

Mode: ______________ Check: |_| Base System

|_| Option ___________

Check: |_| Peak

|_| Off-Peak

Origin	Destination	Origin Walk	Wait	On-Vehicle	Dest. Walk	Total Time
		D ____ S ÷ ____ T ____	____ + ____	____ ÷ ____ + ____	____ ÷ ____ + ____	=
		D ____ S ÷ ____ T ____	____ + ____	____ ÷ ____ + ____	____ ÷ ____ + ____	=
		D ____ S ÷ ____ T ____	____ + ____	____ ÷ ____ + ____	____ ÷ ____ + ____	=
		D ____ S ÷ ____ T ____	____ + ____	____ ÷ ____ + ____	____ ÷ ____ + ____	=
		D ____ S ÷ ____ T ____	____ + ____	____ ÷ ____ + ____	____ ÷ ____ + ____	=
		D ____ S ÷ ____ T ____	____ + ____	____ ÷ ____ + ____	____ ÷ ____ + ____	=

D = distance (feet) S = speed (feet/minute) T = time (minutes)

FORM V: ZONE-PAIR INPUTS TO NETWORK ANALYSIS PROCESS

Check: [ ] **Base System** **Check:** [ ] **Peak period**

[ ] **Option** ____________________ [ ] **Off-peak period**

Origin Zone	Destination Zone	Walk		Auto		Regional Bus		Circulator Bus		Other		Transit Modes
		Time (minutes)	Distance (miles)	Time (minutes)	Cost (cents)	Times (minutes)	Cost (cents)	Time (minutes)	Cost (cents)	Time (minutes)	Cost (cents)	Station Integration

FORM VI: CHANGES IN TRAVEL FROM BASE SYSTEM

MARKET SEGMENT ____________ OPTION ____________

(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)		(12)	(13)	
Origin Zone	Dest. Zone	Mode C or O.T.	ΔTime	ΔCost	ΔInteg	ΔU = [ ] • ΔTime + [ ] • ΔCost + [ ] • ΔInteg	Exp (ΔU)	Base Market Share	y=(7)(8)	$\sum y$	Revised Market Share $\frac{y_C}{\sum y}$	$\frac{y_{O.T.}}{\sum y}$	Total Trip Productions	Revised Trips (11) • (12) C	O.T.
		C													
		O.T.													
		C													
		O.T.													
		C													
		O.T.													
		C													
		O.T.													
		C													
		O.T.													
		C													
		O.T.													
													TOTAL		

C - circulator system
O.T. - other transit

FORM VII: REVISED TRAVEL SUMMARY USING
MANUAL SKETCH PLANNING

DISTRIBUTION TRIPS

Mode	Revised trips, all origins		Total		Total mode share
Circulator	______	÷	______	=	______
Regional Transit	______	÷	______	=	______
Other	______	-	______	=	______
TOTAL	______				

CBD-WORKER CIRCULATION TRIPS

Mode	Revised trips, all origins		Total		Total mode share
Circulator	______	÷	______	=	______
Regional Transit	______	+	______	=	______
Other	______	÷	______	=	______
TOTAL	______				

OTHER CIRCULATION TRIPS

Mode	Revised trips, all origins		Total		Total mode share
Circulator	______	+	______	=	______
Regional Transit	______	+	______	=	______
Other	______	÷	______	=	______
TOTAL	______				

TOTAL INTRA-CBD TRIPS

Mode	Revised trips, all origins		Total		Total mode share
Circulator	______	÷	______	=	______
Regional Transit	______	+	______	=	______
Other	______	+	______	=	______
TOTAL	______				

APPENDIX D-2

Worksheets for Manual Cost Estimation

A. SUMMARY OF SYSTEM CHARACTERISTICS

ELM	=	**Lane-Miles of Elevated Guideway**	=	☐	ELM
ALM	=	**Lane-Miles of At Grade Guideway**	=	☐	ALM
BLM	=	**Lane-Miles of Below Grade Guideway**	=	☐	BLM
EXM	=	**Extra Lane-Miles of Guideway**	=	☐	EXM
ELSTA	=	**Number of elevated station platforms**	=	☐	ELSTA
AGSTA	=	**Number of at grade station platforms**	=	☐	AGSTA
BGSTA	=	**Number of below grade station platforms**	=	☐	BGSTA
NSTA	=	**Total number of stations**	=	☐	NSTA
SSTA	=	**Number of Station Platform Sides**	=	☐	SSTA
RTGD	=	**Round-Trip Guideway Distance (miles)**	=	☐	RTGD
STIME	=	**Round-Trip Schedule Time (minutes)**	=	☐	STIME
HDWY	=	**Peak Period Headway (minutes/train)**	=	☐	HDWY
VCAP	=	**Vehicle Capacity (passengers/vehicle)**	=	☐	VCAP
PVOL	=	**One-Way Peak Per. Volume at Maximum Load Point (passengers/hour)**	=	☐	PVOL
NDIS	=	**Number of Days in Service (days/year)**	=	☐	NDIS
LPP	=	**Length of Peak Period (minutes)**	=	☐	LPP

A. SUMMARY OF SYSTEM CHARACTERISTICS (continued)

Assumed Demand Variation

	Time Period (I)		Total Hours(I) H(I)	Fraction of Peak Period Demand FR(I)	Equivalent Peak Hours EPH(I)=H(I)*FR(I)
	From	To			
AM					
midmorning					
noon					
midafternoon					
PM					
night					

DEPH = Daily equivalent peak hours = $\sum$EPH(I) = [ ] DEPH

B. ESTIMATION OF GUIDEWAY, VEHICLE AND TRAIN REQUIREMENTS

Total One-Way Lane-Miles

TLM = ELM ________ +ALM ________ +BLM ________ +EXM ________ = [ ] TLM

Vehicles Per Train at Maximum Load Point

VPT = [1 + PVOL ______ x HDWY ______ /(LPP ______ x VCAP ______)] = [ ] VPT

Note: [y] means the integer part of y, i.e., [4.7] = 4

Vehicles Required Past Maximum Load Point

VPH = 60 x VPT __________ /HDWY __________ = [ ] VPH

Vehicles Required for Revenue Service

RVEH = VPH __________ x STIME __________ /60 = [ ] RVEH

Total Vehicles Required

TVEH = (1 + spare vehicles per revenue vehicle __________) x RVEH ______ = [ ] TVEH

Average Speed in Revenue Service

ASRS = 60 x RTGD __________ /STIME __________ = [ ] ASRS

Annual Vehicle - Miles of Service

AVMS = RVEH ________ xDEPF _______ x ASRS _______ x NDIS _______ = [ ] AVMS

C. ESTIMATION OF CAPITAL COSTS
(all costs in millions of 1980 dollars)

1) Guideway Costs

GDWY$ = ELM ____________ x cost/lane-mile, elevated ________________

+ ALM ____________ x cost/lane-mile, at grade ________________

+ BLM ____________ x cost/lane-mile, below grade ________________

+ EXM ____________ x cost/lane-mile, extra ________________ = [ ] GDWY$

2) Station Costs

STA$ = ELSTA ____________ x cost/station platform, elevated ________________

+ AGSTA ____________ x cost/station platform, at grade ________________

+ BGSTA ____________ x cost/station platform, below grade ________________ = [ ] STA$

3) Vehicle Costs

VEH$ = [Fixed cost/veh. ____________ + cost/sq. ft. ________________

X (fixed sq. ft./veh. ____________ + VCAP ________________

X sq. ft./passenger ____________)] x TVEH ________________

OR = [ ] VEH$

VEH$ = cost/veh. ________________ x TVEH ________________

4) Control Costs

CNTL$ = FIXED ____________ + TLM ________ x cost/lane-mile ________________

+ SSTA ____________ x cost/station side ________________ = [ ] CNTL$

+ TVEH ____________ x cost/vehicle ________________

C. ESTIMATION OF CAPITAL COSTS (continued)
(all costs in millions of 1980 dollars)

5) Power Supply Costs

PWR$ = TLM ______ x cost/lane-mile ______
+ NSTA ______ x cost/station ______ = [ ] PWR$

6) Maintenance Support Costs

MAINT$ = FIXED ______ + TLM ______ x cost/lane-mile ______
+ TVEH ______ x cost/vehicle ______ = [ ] MAINT$

7) Direct Costs

DCOST$ = GDWY$ ______ + STA$ ______ + VEH$ ______
+ CNTL$ ______ + PWR$ ______ + MAINT$ ______ = [ ] DCOST$

8) Engineering and Project Management Cost

EPM$ = DCOST$ ______ x Eng. & Proj. Mgt. rate ______ = [ ] EPM$

9) Contingency Cost

CONT$ = [DCOST$ ______ + EPM$ ______] x contingency rate ______ = [ ] CONT$

10) Right-of-way Costs

ROW$ ______ = [ ] ROW$

11) Total Capital Costs

TCAP$ = DCOST$ ______ + EPM$ ______
+ CONT$ ______ + ROW$ ______ = [ ] TCAP$

D. ESTIMATION OF ANNUAL COSTS
(all costs in millions of 1980 dollars)

1) Annual Operating Costs

AOP$ = AVMS ____________ x cost/vehicle-mile ____________

+ TVEH ____________ x cost/vehicle ____________

+ NSTA ____________ x cost/station ____________

+ TLM ____________ x cost/lane-mile ____________

+ FIXED ____________ = [ ] AOP$

2) Annual Capital Costs

ACAP$ = ROW$ ____________ x CRF (ROW) ____________ ______ + (VEH$ ____________

+ CNTL$ ____________ + PWR$ ____________ + MAINT$ ____________)

x CRF (Vehicles) ____________ + (GDWY$ ____________ + STA$ ____________)

x CRF (Structures) ____________ = [ ] ACAP$

3) Total Annual Costs

ATOT$ + AOP$ ____________ + ACAP$ ____________ = [ ] ATOT$

SUMMARY OF VARIABLES

Variable Name	Definition	Computed or Input on Form
ACAP$	Annual Capital Costs	D
AGSTA	Number of At Grade Station Platforms	A
ALM	Lane-Miles of At Grade Guideway	A
AOP$	Annual Operating Costs	D
ASRS	Average Speed in Revenue Service	B
ATOT$	Annual Total Costs	D
AVMS	Annual Vehicle-Miles of Service	B
BGSTA	Number of Below Grade Station Platforms	A
BLM	Lane-Miles of Below Grade Guideway	A
CNTL$	Control Costs	C
CONT$	Contingency Costs	C
CRF	Capital Recovery Factor	D
DCOST$	Direct Costs	C
DEPH	Daily Equivalent Peak Hours	A
ELM	Lane-Miles of Elevated Guideway	A
ELSTA	Number of Elevated Station Platforms	A
EPH(I)	Equivalent Peak Hours in Period I	A
EPM$	Engineering and Project Management Costs	C
EXM	Extra Lane-Miles of Guideway	A
FR(I)	Fraction of Peak Period Demand in Period I	A
GDWY$	Guideway Costs	C
H(I)	Hours of Operation in Period I	A
HDWY	Peak Period Headway	A
LPP	Length of Peak Period	A
MAINT$	Maintenance Support Costs	C
NDIS	Number of Days in Service	A
NSTA	Total Number of Stations	A
PVOL	One-Way Peak Per. Volume at Maximum Load Point	A
PWR$	Power Supply Costs	C
ROW$	Right-of-Way Costs	C
RTGD	Round-Trip Guideway Distance	A
RVEH	Vehicles Required for Revenue Service	B
SSTA	Number of Station Platform Sides	A
STA$	Station Costs	C
STIME	Round-Trip Schedule Time	A
TCAP$	Total Capital Costs	C
TLM	Total One-Way Lane-Miles	B
TVEH	Total Vehicles Required	B
VCAP	Vehicle Capacity	A
VEH$	Vehicle Costs	C
VPH	Vehicles Required Past Maximum Load Point	B
VPT	Vehicles Per Train at Maximum Load Point	B

Assumptions for Default Capital Cost Parameters

1. Elevated Guideway

   a. bottom supported, 50 passenger vehicles
   b. 6-meter columns, drilled caissons
   c. 30% curved, urban construction

2. At Grade Guideway

   a. urban construction

3. Below Grade Guideway

   a. urban construction
   b. cut/cover

4. Extra Guideway

   a. same unit cost as for at grade guideway

5. Elevated Stations

   a. platform dimensions: 4 meters wide x 32 meters long
   b. 2 car trains = 14 meters long
   c. 2 doors/car
   d. 1 elevator, 1/2 escalator up
   e. free standing station, 7.3 meters high
   f. 2 ticket machines, cameras, phones, etc.
   g. side platform

6. At Grade Stations

   a. platform dimensions: 6 meters wide x 32 meters long
   b. 2 car trains = 14 meters long
   c. 2 doors/car
   d. free standing station
   e. 2 ticket machines, cameras, phones, etc.
   f. center platform

7. Vehicles

   a. cost relationships developed using data from Table 8-4.
   b. cost per vehicle is a linear function of the size (i.e., floor area) of each vehicle, and the size is a linear function of the passenger capacity.

8. Control/Communications

   a. fixed control cost equals cost for central command/ control computer and central communications.
   b. central computer with full ATO, ATP, ATS (Automatic Train Operation, Protection, Supervision).

9. Power

   a. one power substation per station

10. Maintenance

   a. fixed cost represents costs for maintenance/administrative and storage buildings at unit cost of \$570./meter^2.

Assumptions for Default Operating Cost Parameters

1. 2 persons in central control
2. 5¢/KWH for energy
3. Chicago heating/cooling requirements
4. 1880 available man-hours/person/year
5. 2.3 meters/guideway width to heat
6. 5.0 KWH/vehicle-mile vehicle energy requirement
7. hourly wage including fringes and overhead = \$13.48/man-hour
8. system operates 16 hours per day, 365 days per year

References Used in Deriving Default Cost Parameters

1. U.S. DOT/Transportation Systems Center, Assessment of Operational Automated Guideway Systems - AIRTRANS (Phase II), Chapter 5, March 1979.

2. N.D. Lea and Associates, Inc., Summary of Capital and Operations and Maintenance Cost Experience of Automated Guideway Transit Systems, UMTA-IT-06-0157-78-2, June, 1978.

3. N.D. Lea and Associates, Inc., Supplement I, Summary ot Capital and Operations and Maintenance Cost Experience of Automated Guideway Transit Systems Costs and Trends for 1976-1978, UMTA-IT-06-0188-79-1, March 1979.

4. City of St.Paul and Metropolitan Transit Commission, Preliminary Engineering and Related Studies for St. Paul Downtown People Mover, Final Report, MTC-TD-79-1, February, 1979.

5. Community Redevelopment Agency of the City of Los Angeles, California, "Preliminary Cost Estimates for Los Angeles Downtown People Mover," December, 1978.

6. Custom Engineering, Analysis and Correlation of Morgantown Phase II System Costs for Applicability to DPM System Costs, August, 1978.

7. U.S. DOT/Transportation Systems Center, Supplement II, Summary of Capital and Operations and Maintenance Cost Experience of AGT Systems, Costs and Trends 1976 - 1979, UMTA-MA-06-0069-80-1, March 1980.

8. U.S. DOT/Transportation Systems Center, Supplement III, Summary of Capital and Operations and Maintenance Cost Experience of AGT Systems, Costs and Trends 1976 - 1980, UMTA-MA-06-0069-81-2, July 1981.

9. Bhatt, K., "Draft Guidelines for the Estimation of Transit Cost," Urban Institute Report 1266-100, November 1980.

APPENDIX D-3

Revenue Calculation Worksheets

REVENUE CALCULATION WORKSHEETS

I. REVENUE COMPONENTS AND CALCULATION VARIABLES

REVENUE COMPONENT	CALCULATION VARIABLES	VARIABLE NAME
Fares	• Projected number of daily trips (from demand models) by:	
	population group	$TRIPS_P$ =
	origin/destination	$TRIPS_{O/D}$ =
	• Fare level (base)	$FARE_R$ =
	• Adjustment factor to reflect trips made using discounted fares (1)	ADJ =
	or	
	Calculation of trips with discounted fares using rider profile (from demand models) and applying fare discounts	$TRIPS_{DISC}$ =
		$FARE_{DISC}$ =
	• Equivalent revenue days per year	EDAYS =
Parking		
a. Parking facilities at DPM intercept points	• Parking charge:	
	- hourly for short term use	$PRICE(DPM)_H$ =
	- daily for long term use	$PRICE(DPM)_D$ =
	• Number of daily parking users (from parking lot choice models):	
	- short term	$USERS(DPM)_S$ =
	- long term	$USERS(DPM)_L$ =
	• Average number of hours/short term user	HOURS(DPM) =
b. Municipal parking facilities not directly served by DPM	• Parking charge:	
	- hourly for short term use	$PRICE(M)_H$ =
	- daily for long term use	$PRICE(M)_D$ =
	• Number of daily parking users (from parking lot choice models):	
	- short term	$USERS(M)_S$ =
	- long term	$USERS(M)_L$ =
	• Average number of hours/short term user	HOURS(M) =
	• % parking revenues earmarked for the DPM or applied to the DPM from local general revenues	$\%DPM_{PKG}$ =

REVENUE CALCULATION WORKSHEETS

I. REVENUE COMPONENTS AND CALCULATION VARIABLES, continued

REVENUE COMPONENT	CALCULATION VARIABLES	VARIABLE NAME	
Advertising	• Projected advertising revenues per year	ADREV =	
Local general revenues which may be applied towards DPM(2)			
a. Sales Tax	• Sales tax rate	$RATE_S$ =	
	• Amount of annual sales in downtown	SALES =	
	• % Sales tax applied towards DPM	$\%DPM_S$ =	
b. Payroll Tax	• Number of employees in downtown	EMP =	
	• Average annual income of downtown employees	INCOME =	
	• Payroll tax rate	$RATE_E$ =	
	• % payroll tax applied towards DPM	$\%DPM_P$ =	
c. Property Tax	• Assessed value of property in downtown	VALUE =	
	• Property tax rate	$RATE_P$ =	
	• % property tax applied towards DPM	$\%DPM_{PT}$ =	
Value Capture/ Joint Development(3)			
a. Parking substitution	• Number of peripheral spaces substituted for on-site spaces	SUBST =	
	• Yearly assessment to developer per substituted space	$PRICE_{SUBST}$ =	
b. Private development in conjunction with DPM stations(4)	• Present value of property/business	$VALUE_T$ =	
	• Expected new value of property/business from the DPM	$VALUE_{T+1}$ =	
	• Improvement costs incurred	$COST_{DEV}$ =	
	• Yearly assessment to developer per dollar of increased value	$PRICE_{DEV}$ =	

c. Real property development techniques
d. Taxation techniques

} Refer to discussion in Section 9 on Value Capture(5).

REVENUE CALCULATION WORKSHEETS

II. CALCULATION OF INDIVIDUAL REVENUE COMPONENTS

1. Fare Revenue

$TRIPS_P$ or $TRIPS_{O/D}$ x $FARE_R$ x (1-ADJ) x EDAYS = [Fare Revenues/Year]

or $TRIPS_P$ or $[TRIPS_{O/D} \times FARE_R - TRIPS_{DISC} \times FARE_{DISC}]$ x EDAYS = [Fare Revenues/Year]

2. Parking Revenue

$[PRICE(DPM)_H \times HOURS(DPM) \times USERS(DPM)_S + PRICE(DPM)_D \times USERS(DPM)_L]$ EDAYS = [DPM Parking Revenues/Year]

+

$[PRICE(M)_H \times HOURS(M) \times USERS(M)_S + PRICE(M)_D \times USERS(M)_L \times \%DPM_{PKC}]$ EDAYS = [Municipal Parking Revenues for DPM/Year]

Total Parking Revenues = [ ]

3. Local Tax Revenue

SALES x $RATE_S$ x $\%DPM_S$ = [Sales Tax Revenues/Year]

+

EMP x INCOME x $RATE_E$ x $\%DPM_P$ = [Payroll Tax Revenue/Year]

+

VALUE x $RATE_P$ x $\%DPM_{PT}$ = [Property Tax Revenue/Year]

+

= [Revenues from other local taxes to be applied to DPM/Year]

Total Local Tax Revenues = [ ]

4. Value Capture/Joint Development Revenue

$(VALUE_{T+1} - VALUE_T - COST) \div VALUE_T$ = % Increased Value

SUBST x $PRICE_{SUBST}$ = [Parking Substitution Revenue/Year]

+

% Increased Value x $VALUE_T$ x $PRICE_{DEV}$ = [Private Sector Contribution for DPM Station related developments/Year]

+

= [Revenues from Value Capture Taxation Techniques/Year]

+

= [Revenues from Value Capture Real Property Development Techniques/Year]

Total Value Capture Revenues = [ ]

II. CALCULATION OF INDIVIDUAL REVENUE COMPONENTS, Continued

5. Advertising Revenues

= [Advertising Revenues/Year]

III. CALCULATION OF REVENUE FROM INDIVIDUAL COMPONENTS

FARE REVENUES	[ ]
	+
PARKING REVENUES	[ ]
	+
LOCAL REVENUES	[ ]
	+
VALUE CAPTURE/ JOINT DEVELOPMENT REVENUES	[ ]
	+
ADVERTISING REVENUES	[ ]

TOTAL ANNUAL DPM REVENUES = [ ]

NOTES

(1) For instance, Los Angeles adjusted total fare revenues by assuming that gross fares would be reduced by 20 percent after fare discounts so that for a basic $.10 fare, net fare revenues would be $.08.

(2) This differs from value capture in that it does not distinguish between pre-DPM and post-DPM revenues and attempt to "capture" the difference in revenues specifically for the DPM system.

(3) The programs cited here are representative examples and not all inclusive.

(4) Realizable profits will vary by DPM station location.

(5) Revenues utilizing these techniques are difficult to determine prior to DPM implementation. If these value capture techniques are used, revenue estimates should be left open and it should not be intended that these revenues will be available for system construction.

APPENDIX D-4

Worksheets for Travel Impact Estimation

WORKSHEET 10-1

ESTIMATION OF CHANGES IN NON-WORK TRIPS TO THE CBD

Trip Purpose ______________________

Market Segment ______________________

I. CHANGE IN TRAVEL TIMES - Trips to the CBD

Auto Trips

LN (Travel time using DPM (minutes))	=	[ ]
LN (Existing travel time (minutes))	=	[ ]
DIFFERENCE : ΔLN(AUTO TIME)	=	[ ]

Transit Trips

LN (Travel time using DPM (minutes))	=	[ ]
LN (Existing travel time (minutes))	=	[ ]
DIFFERENCE: ΔLN(TRANSIT TIME)	=	[ ]

II. CHANGE IN UTILITIES - Trips to the CBD

Auto Trips

ΔUTILITY =		C(AUTO TIME)[1] [ ]	x	ΔLN(AUTO TIME) [ ]	=	[ ]
	+	C(AUTO COST)[1] [ ]	x	ΔAUTO COST(cents) [ ]	=	[ ]
				TOTAL CHANGE	=	[ ]

Transit Trips

ΔUTILITY =		C(TRANSIT TIME)[1] [ ]	x	ΔLN(TRANSIT TIME) [ ]	=	[ ]
	+	C(TRANSIT COST)[1] [ ]	x	ΔTRANSIT COST(cents) [ ]	=	[ ]
				TOTAL CHANGE	=	[ ]

III. BASE TRIPS AFFECTED BY TIME AND COST CHANGES

	Existing Trips		Fraction using DPM		Base Trips Affected
To CBD By Auto	[ ]	x	[ ]	=	[ ]
	+				+
To CBD By Transit	[ ]	x	[ ]	=	[ ]
TOTALS	[ ]				[ ]

[1]From Table 10-1

(Cont'd)

Worksheet 10-1

IV. REVISED CBD TRIPS

	Base Trips				Revised Trips
To CBD By Auto	[ ]	x EXP	ΔUTILITY [ ]	=	[ ]
					+
To CBD By Transit	[ ]	x EXP	ΔUTILITY [ ]	=	[ ]
			TOTAL	=	[ ]

V. ABSOLUTE AND PERCENTAGE CHANGES

	Revised Trips		Base Trips		ΔCBD Trips		Existing Trips		Percent Change
To CBD By Auto	[ ]	-	[ ]	=	[ ]	*100/	[ ]	=	%
To CBD By Transit	[ ]	-	[ ]	=	[ ]	*100/	[ ]	=	%
TOTAL	[ ]	-	[ ]	=	[ ]	*100/	[ ]	=	%

WORKSHEET 10-2

ESTIMATION OF CHANGES IN NON-WORK MODE SHARES FOR CBD TRIPS

Trip Purpose ______________________________

Market Segment ____________________________

I. EXISTING MODE SHARES

	Existing Trips[1]				Existing Mode Shares
To CBD By Auto	[ ]	*100/	[ ]	=	[ ] %
	+		↑		
To CBD By Transit	[ ]	*100/	[ ]	=	[ ] %
TOTAL	[ ]	→	↑		

II. NEW MODE SHARES

	Existing Trips[1]		CBD Trips[2]		New Trips				New Mode Shares
To CBD By Auto	[ ]	+	[ ]	=	[ ]	*100/	[ ]	=	[ ] %
					+		↑		
To CBD By Transit	[ ]	+	[ ]	=	[ ]	*100/	[ ]	=	[ ] %
			TOTAL		[ ]	→	↑		

1 From Worksheet 10-1, Section III

2 From Worksheet 10-1, Section V

WORKSHEET 10-3

ESTIMATION OF CHANGES IN WORK-TRIP MODE SHARES FOR CBD TRIPS

Market Segment ____________

I. CHANGE IN UTILITY FOR EACH MODE

Drive Alone

ΔUTILITY	=			-.03	x	$\Delta IVTT_{da}$: [ ]	=	[ ]
	+	-.32	÷	Trip Length: [ ]	x	$\Delta OVTT_{da}$: [ ]	=	[ ]
				-.0064	x	$\Delta OPTC_{da}$: [ ]	=	[ ]

TOTAL CHANGE = [ ]

Shared Ride

ΔUTILITY	=			-.03	x	$\Delta IVTT_{sr}$: [ ]			=	[ ]
	+	-.32	÷	Trip Length: [ ]	x	$\Delta OVTT_{sr}$: [ ]			=	[ ]
				-.0064	x	$\Delta SOPTC_{sr}$: [ ]	÷	Average Occupancy: [ ]	=	[ ]
				-.0064	x	$\Delta IOPTC_{sr}$: [ ]			=	[ ]

TOTAL CHANGE = [ ]

Transit

ΔUTILITY	=			-.03	x	$\Delta IVTT_{t}$: [ ]	=	[ ]
	+	-.32	÷	Trip Length: [ ]	x	$\Delta OVTT_{t}$: [ ]	=	[ ]
	+			-.0064	x	$\Delta OPTC_{t}$: [ ]	=	[ ]

TOTAL CHANGE = [ ]

(Cont'd)

WORKSHEET 10-3

II. BASE MODE SHARES - AFFECTED TRIPS ONLY

		Existing Trips		Fraction Using DPM		Base Trips Affected				Base Modal Share
To CBD, Drive Alone	=	[ ]	X	[ ]	=	[ ]	/	[ ]	=	[ ]
						+				
To CBD, Shared Ride	=	[ ]			=	[ ]	/	[ ]	=	[ ]
						+				
To CBD, Transit	=	[ ]	X	[ ]	=	[ ]	/	[ ]	=	[ ]
				AFFECTED TRIP TOTAL	=	[ ]				

III. REVISED MODE SHARES

		Base Modal Share		ΔUtility				Total		Revised Share
Drive Alone	=	[ ]	X EXP	[ ]	=	[ ]	/	[ ]	=	[ ]
						+				
Shared Ride	=	[ ]	X EXP	[ ]	=	[ ]	/	[ ]	=	[ ]
						+				
Transit	=	[ ]	X EXP	[ ]	=	[ ]	/	[ ]	=	[ ]
				TOTAL	=	[ ]				

IV. NEW CBD TRIPS

		Existing Trips		Base Trips Affected		Revised Shares				New Trips
To CBD, Drive Alone	=	[ ]	-	[ ]	+	[ ]	X	[ ]	=	[ ]
				+						
To CBD, Shared Ride	=	[ ]	-	[ ]	+	[ ]	X	[ ]	=	[ ]
				+						
To CBD, Transit	=	[ ]	-	[ ]	+	[ ]	X	[ ]	=	[ ]
	TOTAL	=		[ ]						

WORKSHEET 10-4

ESTIMATION OF CHANGES IN FREQUENCY OF INTRA-CBD TRIPS

I. BASE TRIPS

Existing Worker Trips (from Form VII) ______

Existing Non-Worker Trips (from Form VII) ______

TOTAL ______

II. NEW TRIPS

Speed Elasticity ______ x Change in Average Speed ______ / Base Speed ______ = ______

\+

\+ Fare Elasticity ______ x Change in Fare ______ / Base Fare ______ = ______

TOTAL GROWTH FACTOR = ______

Total Growth Factor ______ x Total Base Trips ______ = Change in Trips ______

WORKSHEET 10-5

TOTAL CBD TRAVEL SUMMARY

I. TOTAL DISTRIBUTION TRAVEL

Existing Trips (from Form VII) ______

New Non-Work Trips to CBD (from Worksheet 10-1) ______

TOTAL ______

II. DISTRIBUTION TRIPS BY MODE

Total		Mode Shares (from Form VII)		Trips by Mode
		Circulator/DPM ______	=	______
______	x	Regional Transit ______	=	______
		Other ______	=	______

III. TOTAL CIRCULATION TRAVEL

Existing Worker Trips (from Form VII) ______

Existing Non-Worker Trips (From Form VII) ______

New Intra-CBD Trips (from Worksheet 10-4) ______

______

IV. CIRCULATION TRIPS BY MODE

Total		Mode Shares (from Form VII)		Trips by Mode
		Circulator/DPM ______	=	______
______	x	Regional Transit ______	=	______
		Other ______	=	______

(Cont'd)

WORKSHEET 10-5

V. TOTAL CBD TRIPS BY MODE

	Distribution Trips		Circulation Trips		Total Trips
Circulator/DPM		+		=	
Regional Transit		+		=	
Other		+		=	
TOTALS		+		=	

VI. AVERAGE TRIP LENGTHS

	Distribution Trips	Circulation Trips	Total Trips
Circulator/DPM			
Regional Transit			
Other			
All Modes			