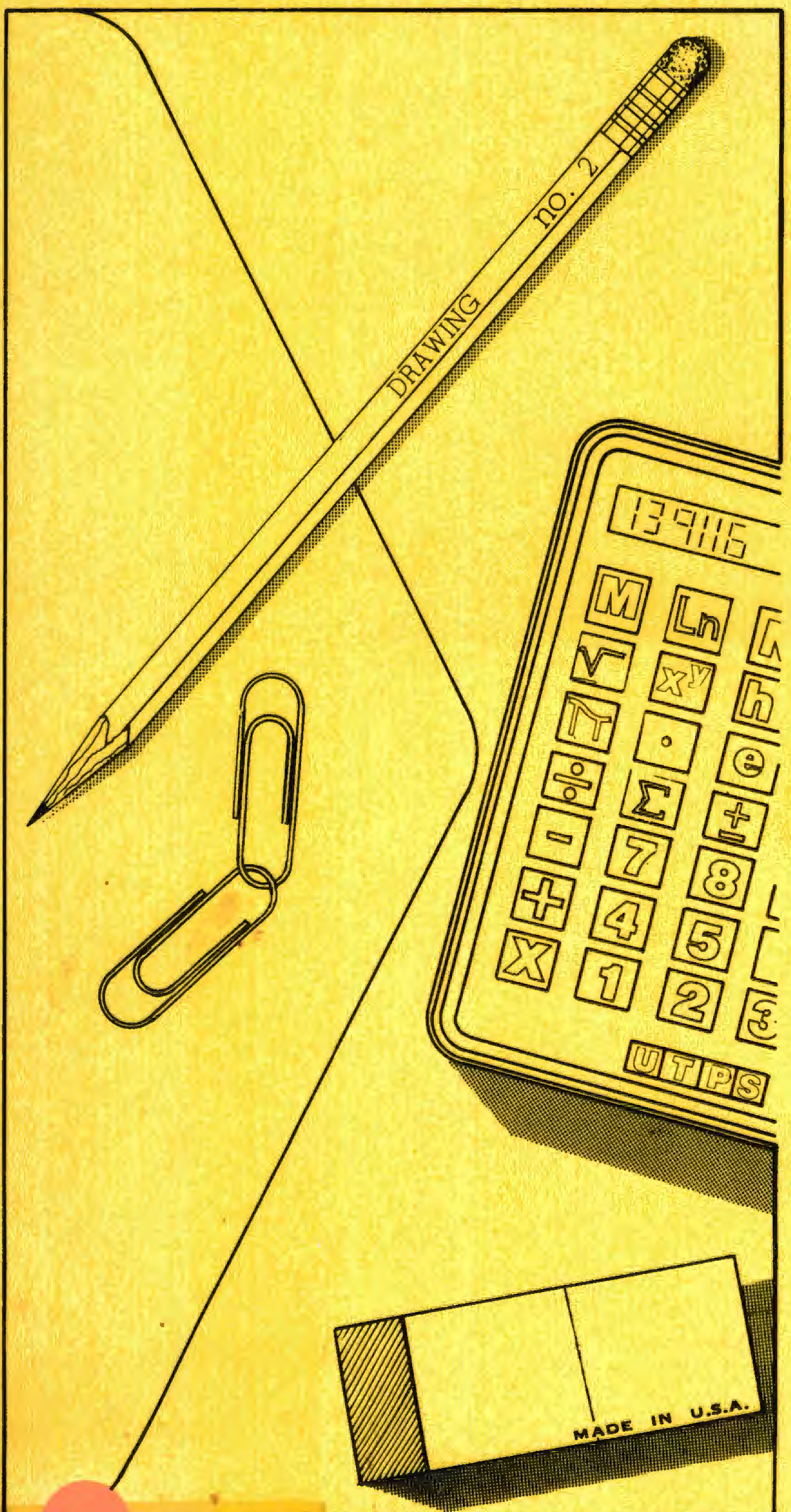

simplified aids for transportation analysis

fringe parking site requirements

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16. Abstract

The analytical aid described in this report provides a method to (1) identify candidate sites for change-of-mode fringe parking facilities, (2) estimate specific parking facility requirements at these candidate sites, and (3) estimate highway access requirements for the sites.

Because the intent of this report is to provide a simplified analysis aid, modifications, embellishments, and improvements to the suggested procedures and models are encouraged should local data or previous analyses suggest a more appropriate method.

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SIMPLIFIED AIDS FOR TRANSPORTATION ANALYSIS

Estimating Fringe Parking Site Requirements

Prepared by

Peat, Marwick, Mitchell & Co.
1025 Conn. Ave., N.W. Washington D.C. 20036
Based on Original Work Submitted by
Charles Dougherty

JANUARY 1979

Prepared for

U.S. Department of Transportation
Urban Mass Transportation Administration
Office of Planning Methods and Support

FOREWORD

Today's transportation planner confronts ever-changing issues within a variety of work environments. To assist him, UMTA's Planning Methods and Support Program researches, develops and distributes planning aids, including novel planning studies, and new design and forecasting techniques.

This is one of a series of six reports describing simplified aids to improve transportation decisions without resorting to computers or extensive data collection. The series, titled Simplified Aids for Transportation Analysis, presently includes the following titles:

1. Annotated Bibliography (UMTA-IT-06-9020-79-1)

2. Forecasting Auto Availability and Travel (UMTA-IT-06-9020-79-2)

3. Estimating Ridership and Cost (UMTA-IT-06-9020-79-3)

4. Transit Route Evaluation (UMTA-IT-06-9020-79-4)

5. Estimating Parking Accumulation (UMTA-IT-06-9020-79-5)

6. Fringe Parking Site Requirements (UMTA-IT-06-9020-79-6)

All are the work of recognized experts. They clearly present usable planning concepts, and add to the growing set of manual and computerized techniques comprising the UMTA/FHWA Urban Transportation Planning System (UTPS).

More important than the production and dissemination of new tools is the experience and opinion of their user. Local issues change. Better methods evolve. Or, realistically errors may appear in the final product. We depend on you, the transportation planner, to alert us to any of the above. We need your comments and your ideas. Please let us hear them, so we can continually improve our products.

You may obtain copies of any of the above reports from the National Technical Information Service (NTIS), Springfield, VA, 22161. On your request, please include the reference number in parenthesis.

Robert B. Dial, Director
Office of Planning Methods
and Support (UPM-20)
Department of Transportation
Washington, DC 20590

ABSTRACT

In January 1976, the U.S. Department of Transportation issued a Technical Notice (DOT-1-76) requesting transportation planners, engineers, and transit operators to submit useful but not widely known manual techniques that could be developed and distributed as simplified aids for transportation analysis. Over 70 analytical aids were submitted in response to this request.

Based on an evaluation process conducted to determine the most useful, easily applied, and generally applicable techniques, several of these analytical aids have been selected and documented in sufficient detail to permit their immediate use. In addition to these techniques, three additional analytical aids were developed as part of the Short Range Transportation Planning project, and an annotated bibliography of each analytical aid reviewed was prepared. These individual analytical aids and the annotated bibliography have been prepared as separate technical reports and have been brought together in this manual of simplified aids for transportation analysis.

The analytical aid described in this report provides a method to (1) identify candidate sites for change-of-mode fringe parking facilities, (2) estimate specific parking facility requirements at these candidate sites, and (3) estimate highway access requirements for the sites.

Because the intent of this report is to provide a simplified analysis aid, modifications, embellishments, and improvements to the suggested procedures and models are encouraged should local data or previous analyses suggest a more appropriate method.

SOURCE

Charles Dougherty
Delaware Valley Regional Planning Commission
1819 John F. Kennedy Boulevard
Philadelphia, Pennsylvania 19103

REFERENCE

Charles Dougherty, Lawrence S. Golfin, and Rasin K. Mufti. Projection of Future Demand for Fringe Parking Facilities

in the Pennsylvania Portion of the Delaware Valley Region. Philadelphia: Delaware Valley Regional Planning Commission, August 1974.

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I. INTRODUCTION

This report describes one of a collection of useful but not widely known techniques employed by local transportation planners, engineers, or transit operators. The technique presented in this report provides a method to (1) identify candidate sites for change-of-mode fringe parking facilities, (2) estimate specific parking facility requirements at these candidate sites, and (3) estimate highway access requirements for these sites. Sufficient information is provided to permit the immediate use of this analytical aid. This information is presented in five sections:

- I. Introduction. This section describes the analytical aid and its applicability as a simplified aid for transportation analysis, identifies the data and information required to use the aid, and illustrates the analysis output.

- II. Identifying Candidate Change-of-Mode Fringe Parking Sites. This section presents suggested criteria for use in identifying candidate change-of-mode sites, describes a qualitative analysis method, and defines the input data required to perform preliminary screening of the sites and to select those sites which warrant further analysis.

- III. Estimating Fringe Parking Space Requirements. This section describes a five-step quantitative procedure for use in determining parking space requirements at each candidate change-of-mode site

- IV. Estimating Highway Access Requirements and Preparing an Evaluation Profile. This section provides a method for estimating highway access requirements for candidate sites and presents a format for preparing an evaluation profile of the sites.

- V. Shortcomings and Limitations. This section describes the shortcomings and limitations of the procedures described in Section III. Shortcomings are described to permit the user to judge the extent to which these procedures are suitable for local application.

The technique reported here is oriented to the practical planner who requires a specific analytical technique but who has limited data and time to perform an in-depth analysis. The soundness of the method described in ths report, however, must be considered independently by the potential user for each specific application. The section on shortcomings and limitations is provided to assist the potential user in making this assessment. Modifications, embellishments, and improvements of this technique are encouraged should local data or past analyses suggest a more appropriate procedure.

DESCRIPTION AND APPLICABILITY

Over the past ten years, increasing emphasis has been placed on the provision of fast, efficient line-haul transportation to serve home to work travel demands between an urban area's suburban and outlying areas and its central business district (CBD). Line-haul transit modes which serve this purpose include commuter railroad, rapid transit (both heavy rail and light rail systems), and express bus. Modes of access to and from such line-haul systems include the automobile,[1] feeder bus systems, walking, or bicycling.

To encourage transit use, facilities must be provided at change-of-mode locations to accommodate existing demand plus projected peak-period demand associated with each of these access modes; these facilities should include parking space, highway access facilities, loading and unloading areas for both automobiles and feeder buses, pedestrian access facilities, and bicycle storage accommodations. This analytical aid provides a method for assessing the need for two of the most important change-of-mode facility requirements: (1) new or additional parking facility requirements and (2) highway access requirements.

The analytical aid provides a procedure which is conducted in four steps. First, a qualitative analysis is performed to select and screen candidates for change-of-mode sites. Second, projected parking space requirements for each candidate site are estimated. Third, projected highway access requirements are estimated for each candidate site. Finally, the results of the above analysis are compiled and a comparative evaluation profile for each of the candidate sites is prepared. This procedure is applicable in any urban area where new or additional change-of-mode fringe parking facilities are under consideration.

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[1]Park and ride for auto drivers and passengers, or kiss and ride.

In particular, there are three situations in which this analytical aid can be useful;[1] they include:

- planning for a proposed new line-haul service;
- evaluating the need and planning for additional stations or stops for an existing line-haul service; and
- determining change-of-mode facility requirements for existing stations or stops.

INPUT DATA

Table 1 summarizes the input data required to implement the procedure described in this report. Detailed specifications for this input data are included in the sections describing the procedure itself. The data includes detailed information describing each existing or proposed change-of-mode site and output from the distribution and modal split steps of the traditional transportation planning process. The local planning agency should have the required transportation modeling output available, although modifications to update this output may be required.

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[1]A computerized alternative to the manual technique described in this report is provided by the Interactive Graphic Transit Design System (IGTDS). IGTDS is a self-contained computer package designed for sketch planning of fixed-route, fixed-schedule transit systems that focus on one central area, generally the CBD.

The IGTDS system enables the transit analyst to describe and evaluate, quickly and efficiently, a large number of transit system alternatives, including various configurations of candidate sites for fringe parking facilities. The user specifies a configuration of routes, bus stops, vehicle types, route frequencies, fares, and parking lot locations for park-and-ride facilities. The IGTDS system determines modal split between automobile, transit accessed by walking, and transit accessed by automobile; it then performs network assignment. The system provides modal split output, determines transit system costs and revenue (including parking lot cost and revenue), and describes system utilization and accessibility characteristics for each mode. This output enables the analyst to evaluate alternatives in relation to established planning objectives. The transit system configuration can then be modified in an attempt to improve system performance.

(continued on next page)

TABLE 1

INPUT DATA

DATA CATEGORY	DATA ITEM	SOURCE
SITE INVENTORY	Geographic location	Planning agency
	Highway access description	Traffic department
	Traffic engineering data	Traffic department
	Transit access	Transit agency
	Site description	Planning agency; reconnaissance
	Community impact assessment	Planning agency
	Line-haul service	Transit agency schedule
	Market influence area	Survey; planning agency
TRANSPORTATION PLANNING NETWORK	Zone structure	Planning agency
	Highway interzonal travel times	Planning agency
	Highway interzonal distances	Planning agency
	Highway zonal terminal times	Planning agency
	Transit interzonal line-haul times	Planning agency
	Transit line-haul wait times	Planning agency, transit agency schedule
	Transit access times (to be calculated for each site)	Planning agency
	Highway interzonal costs	Planning agency
	CBD zonal parking costs	Planning agency
	Transit line-haul costs	Planning agency, current fare structure
TRIP DISTRIBUTION OUTPUT	Work trip table	Planning agency
MODAL SPLIT MODEL (Line-Haul)	Calibrated work trip modal split model	Planning agency; DVRPC utilitarian or UMTA default model can be used
MODAL SPLIT MODEL (Access)	Calibrated line-haul access modal split model	Line-haul, on-board, or station survey; DVRPC access modal split model can be used

OUTPUT DATA

The output which results from application of this analytical aid includes the following:

- delineation of market influence areas for each candidate change-of-mode site, defined by the set of transportation planning zones which comprise each area (designated the "origin shed" area);
- delineation of market influence areas for the destination end of the line-haul service, generally the CBD and the zones which constitute this area (designated the "destination shed" area);
- an estimate of the forecast daily work trip interchanges between each origin shed area and the destination shed area;[2]
- an estimate of daily work trips made via automobile and the transit line-haul mode for each trip interchange;
- an estimate of daily work trips for each access mode to each candidate change-of-mode site;
- an estimate of parking facility requirements for each candidate site;
- an estimate of highway access requirements for each site; and
- an evaluation profile for each site.

(Footnote[1] continued from previous page)

IGTDS is distributed by the Urban Mass Transportation Administration (UMTA) for use on a PDP-10 computer. IGTDS is available on magnetic tape from UMTA and is also maintained and available at several computer service bureaus throughout the United States. The analyst who would like to use IGTDS at a service bureau requires a CRT terminal, which may be leased or purchased. For further information, contact the following UMTA office:

Dr. Robert B. Dial, Director
Office of Planning Methods and Support, UTP-10
Urban Mass Transportation Administration
U.S. Department of Transportation
400 Seventh Street, S.W.
Washington, D.C. 20590

[2]For this analytical aid, a trip interchange is defined in the aggregate between the origin shed area and the destination shed area.

II. IDENTIFYING CANDIDATE CHANGE-OF-MODE FRINGE PARKING SITES

The identification of potential sites for change-of-mode fringe parking facilities begins with a review of planning objectives related to the regional line-haul transit system. If this analysis is to be conducted as part of the long-range transportation planning process, objectives will already have been established to govern the planning and design of the regional line-haul transit system. If, however, this analysis is undertaken to alleviate problems on an existing line-haul system or to improve such a system, specific objectives must be formulated as the initial step in the analysis.

Once these objectives have been established, potential change-of-mode sites should be identified based on a qualitative assessment of the degree to which these sites contribute to the achievement of established objectives. To illustrate this process, Table 2 describes a set of sample objectives and, for each of these objectives, provides a generalized description of one or more sites which might be considered for evaluation as potential locations for change-of-mode facilities.

When conducting the qualitative assessment of these sites, several agencies or groups should be consulted for advice on site selection. These include the following:

- regional planning agency;
- city or county planning and traffic engineering departments;
- county boards;
- local transit planning, marketing, and operations departments;
- neighborhood organizations; and
- state department of transportation.

To further assist in this qualitative assessment, a profile of each potential site should be prepared by collecting the selected data and information suggested in Table 1. This data and information should be summarized as shown in Figure 1, which illustrates a suggested

TABLE 2

SITE SELECTION GUIDELINES

SAMPLE OBJECTIVE[1]	SITES TO BE CONSIDERED IN ANALYSIS
Reduce overloading at existing fringe parking facilities	Existing fringe parking facilities where demand exceeds supply; or
	Potential sites along same line-haul line near overcrowded facilities
Increase transit modal split share of work trips (e.g., to reduce CBD congestion)	
– by improving existing transit service	Existing fringe parking facilities (transit level of service improvements can increase demand at site)
	Potential sites along same line-haul line with service improvements
– by improving access to existing fringe parking facilities	Existing fringe parking facilities where improving access is feasible and warranted
– by imposing a CBD parking tax	Existing fringe parking facilities where increased demand is expected to occur
	Potential sites along existing line-haul lines
Provide new high frequency peak-period transit service to suburban outlying areas	Potential sites along proposed line-haul corridors where highway access is feasible and warranted
Improve accessibility to new residential developments	Potential sites along proposed line-haul corridors in the vicinity of new developments
Minimize residential dislocation and loss of tax base	Potential sites along existing or proposed line-haul corridors with vacant or public land available
	Existing sites with adjacent vacant or public land available

[1] Objectives should relate to the level of transportation service to be provided as well as to community impacts such as noise pollution, air pollution, and safety.

A. SITE IDENTIFICATION AND GEOGRAPHIC LOCATION

1. Site Name: ______________________________
   Circle One: Existing/Proposed

2. Line-Haul Service: ______________________________
   Circle One: Existing/Proposed

3. Mode:
   Commuter Rail ______________________________
   Rapid Transit (heavy rail) ______________________________
   Rapid Transit (light rail) ______________________________
   Express Bus ______________________________

4. Transit Line: ______________________________

5. County: ______________________________

6. Township or City: ______________________________

7. Distance From CBD (Rail or Transit): ______________________________

8. Distance From CBD (Highway): ______________________________

9. Adjacent Sites Impacted: ______________________________

B. SITE DESCRIPTION

1. Existing Parking Spaces: ______________________________

2. Current Daily Ridership From Site: ______________________________

3. Current Parking Lot Utilization (% of spaces used): ______________________________

4. Parking Charge Per Day ______________________________

5. Estimated Number of Daily Site Patrons Parking on Adjacent Streets: ______________________________

6. Availability of Land for Expansion ______________________________

7. Present Use of Land Proposed for:

   New Fringe Parking Lot ______________________________

   Fringe Parking Lot Expansion ______________________________

8. Preliminary Cost Estimate for Land Acquisition ______________________________

C. COMMUNITY IMPACT ASSESSMENT

1. Land Use in Vicinity of Site ______________________________

2. Compatibility with Existing or Proposed Land Uses ______________________________

3. Potential or Known Accident Locations in Vicinity of Site: ______________________________

4. Local Street Traffic Impacts: ______________________________

FIGURE 1: PRELIMINARY INVENTORY OF A FRINGE PARKING SITE

D. LINE HAUL SERVICE DESCRIPTION

	Existing	Proposed
1. Service Frequency		
Peak Hour	________	________
Off Peak	________	________
2. Equipment		
Age	________	________
Capacity (by vehicle; by train)	________	________
3. CBD Station(s) Location and Distribution	________	________
	________	________
	________	________
	________	________
	________	________
4. Service Modifications (possible; proposed)	________	________
	________	________
	________	________
	________	________
	________	________

E. HIGHWAY ACCESS DESCRIPTION

1. Inventory of Site Access by Highway

	Name	Functional Class	No. of Lanes
a.	________	________	________
b.	________	________	________
c.	________	________	________
d.	________	________	________

	Funding Status	Maint. Respon.	Planned Improvements
a.	________	________	________
b.	________	________	________
c.	________	________	________
d.	________	________	________

2. Existing Traffic Conditions

	Peak-Hour Volume	ADT
a.	________	________
b.	________	________
c.	________	________
d.	________	________

FIGURE 1 (Continued)

3. Projected Traffic Conditions in Year ____________________

	V/C	ADT
a.	________	________
b.	________	________
c.	________	________
d.	________	________

4. Adequacy of Highway Access to Site; Problem Areas ____________________

5. Pedestrian Access Description ____________________

6. Intersections Near Site

	Intersecting Streets		Traffic Control Characteristics
a.	________ and ________		________
b.	________ and ________		________
c.	________ and ________		________
d.	________ and ________		________

F. TRAVEL TIME CHARACTERISTICS

1. Line Haul Service Time (Peak) ____________________

2. Site Access Time:
   Estimated Average, All Patrons ____________________
   Estimated Average, Auto Access ____________________
   Estimated Average, Pedestrian Access ____________________
   Estimated Average, Transit Access ____________________

3. Estimated Average CBD Distribution Time ____________________

4. Estimated Total Travel Time,
   (F1 + F2 + F3) ____________________

5. Estimated Total Travel Time, Auto ____________________

FIGURE 1 (Continued)

G. TRAVEL COST CHARACTERISTICS

1. Line-Haul Fare to CBD (One Way Average Commuter Fare) ____________________

2. Other Line-Haul Travel Costs; Identify Parking, Site Access, CBD Access ____________________

3. Total Line-Haul Travel Costs (G1 + G2) ____________________

4. Total Cost of Highway Trip (Parking and Operating Costs) ____________________

FIGURE 1 (Continued)

site inventory format. The format should be modified as appropriate to suit the requirements of each local application.

In many cases, not all the information shown in Figure 1 is required or readily available. Most of the travel time and cost information, for example, may not be available until after the second phase of the analysis is completed, although preliminary estimates can be made for an initial site evaluation, and an initial screening of a large number of sites can be performed using this information. If, for example, preliminary estimates of travel times show that transit service from a particular site to the CBD is far higher than driving time, or if community impacts are very detrimental, then the site can be dropped from further consideration.

III. ESTIMATING FRINGE PARKING SPACE REQUIREMENTS

This section describes a five-step quantitative procedure for use in determining parking space requirements at candidate fringe parking sites. Projected parking space requirements for each candidate site are estimated following the method outlined below:

- Delineate origin and destination market influence areas for each site and identify the transportation zones which make up each influence area.
- Estimate total daily person trip interchanges between origin and destination market influence areas.
- Estimate the proportion of each trip interchange that will use the line-haul mode (commuter railroad, rapid transit, or express bus).
- Estimate the proportion of daily line-haul riders that will use the change-of-mode fringe parking facility.
- Calculate the new or additional parking facilities required at each site.

Instructions to perform each step in this process and an example of the application of each step are presented below.

STEP 1: DELINEATE MARKET INFLUENCE AND SHED AREAS

The first step in the process for determining projected parking space requirements involves delineating the origin and destination market influence areas for each site and determining the transportation zones which constitute each of these areas. The origin market influence area is defined as that area from which a particular site attracts fringe parking users. The corresponding set of transportation planning zones which make up this influence area is defined as the origin shed area.

Similarly, the service destination is associated with a destination market influence area and a corresponding destination shed area. The destination market influence area is defined as that area to which line-haul transit patrons travel, and the corresponding destination shed area is the set of transportation planning zones which define the destination market influence area.

Step 1A: Delineate the Origin Market Influence and Shed Areas

The following procedure is recommended for delineating the origin market influence and origin shed areas for each candidate fringe parking site. Figure 2 illustrates the results of this process.

Origin Market Influence Area

On a base map overlay, sketch a core market influence area surrounding each candidate fringe parking site. For an existing site, it is recommended that this area include 67 percent of the residences of the site's patrons as estimated or determined by surveys. For practical purposes, the core market influence area should not include all site patrons. Widely dispersed travel patterns and significant site overlays will occur, making it difficult to estimate the travel demand for each area. If the existing demand is normally distributed about the mean travel distance from the site, 67 percent represents those patrons within one standard deviation of the mean travel distance.

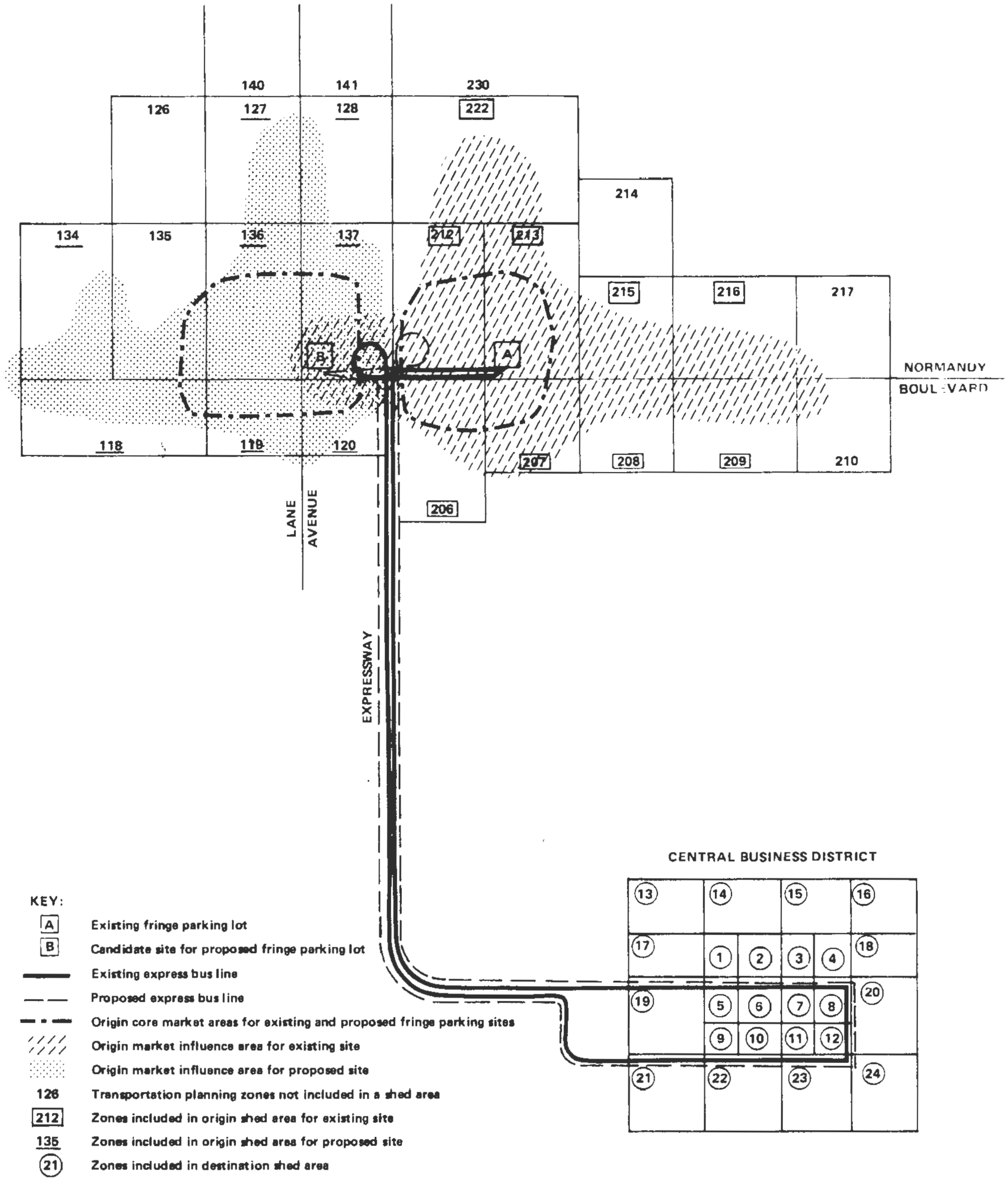
It is often not feasible to conduct surveys to assist in delineating origin and destination market influence areas. Most frequently, therefore, the boundaries of these areas are determined based on judgments and assumptions which introduce a level of uncertainty to the subsequent analysis. The analyst may thus wish to consider the development of maximum and minimum market influence areas for the analysis of fringe parking sites.

One suggested method for estimating a core market influence area is described below:

- Estimate a tolerable maximum driving time to the fringe parking site that is appropriate for the particular suburban area; 8 to 10 minutes is normally appropriate for this maximum.

- Estimate an average automobile travel speed for auto access to the fringe parking site appropriate for the type of development and local highway level of service; 5 to 30 m.p.h. is typically the most appropriate range for average travel speed.

- Multiply the travel time estimated in the first step, converted to hours, by the travel speed estimated in the second step.



NOTES:

1. Boundaries for CBD, existing destination market area, and existing destination shed area are identical and do not change with the initiation of proposed new service.

2. Transportation planning zones falling within the origin shed area for existing fringe parking site include 120, 137, 206, 207, 208, 209, 212, 213, 215, 216, and 222. After proposed service is instituted, zones 120 and 137 will become part of the projected new origin shed area.

3. Zones falling within the origin shed area for proposed site include 118, 119, 120 127, 128, 134, 135, 136, and 137. Note that zones 120 and 137 were formerly part of existing origin shed area.

4. Zones in the destination shed area include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, and 24.

FIGURE 2: DELINEATION OF MARKET INFLUENCE AND SHED AREAS

- Divide the result by an "airline to over-the-road" conversion factor to obtain an estimated maximum travel distance for the core market area; 1.1 to 1.3 is the most likely range for this factor.

- Plot the perimeter of the estimated core market area on a base map based on the radius estimated in the fourth step.

The shape and size of the core area should be influenced by practical knowledge of local travel patterns, the type and orientation of access roads, and existing (or proposed) competing fringe parking sites. For proposed new fringe parking sites, the core area should either be estimated based on comparison with an existing site having similar characteristics, or be approximated based on the judgment of the analyst.

Each site's core market influence area must next be expanded to an estimated origin market influence area (see Figure 2). To determine the origin influence area, the perimeter of the core area is expanded along highway access routes to the site. The magnitude of this expansion should be governed by judgment regarding the following factors:

- the acceptable distance for a change-of-mode trip;

- the acceptable degree of back travel (i.e., travel to the site in a direction opposite to the traveler's destination); and

- the travel time advantage offered by the line-haul service over other travel alternatives.

Origin Shed Area

The origin shed area is defined by the set of transportation planning zones which correspond as closely as possible to the origin market influence area. As shown in Figure 2, a zone should be included in the origin shed area only if the majority of its residences or population is within the perimeter of the origin market influence area. If two candidate sites are competing for a given zone, the zone should be allocated to the shed area for the site closest to the CBD.

Step 1B: Delineate Destination Market Influence and Shed Areas

The destination market influence area is typically the entire CBD, and the destination shed area is the corresponding set of transportation planning zones which make up the CBD. This is the case for the hypothetical example in Figure 2. This can vary, however, depending on the distribution characteristics of the line-haul mode or its CBD station location. If the line-haul route has only one CBD station, its destination market influence area may not correspond to the entire CBD. In such cases, the boundaries of the destination market influence and shed areas must be determined based on analytical judgment and assumptions influenced by practical knowledge of local travel patterns, the type and orientation of the destination's distribution network, and existing (or proposed) destination attractions such as employment centers.

STEP 2: ESTIMATE TOTAL DAILY TRIP INTERCHANGE VOLUMES

The second step in the process for determining fringe parking facility requirements is the estimation of daily person trip interchange volumes between the origin and destination market influence areas for each candidate fringe parking site. In this step, trip interchange volumes are tabulated using existing trip tables. The trip table used in this analysis should reflect conditions appropriate for the design year (the year for which the size of the fringe parking facility is to be determined) and should consider those trip purposes most likely to be associated with the use of fringe parking facilities.

Design year trip tables can be obtained by using the results of the region's long-range comprehensive planning process (which typically include trip tables forecast for the design years of 1985 and 1995 or 1990 and 2000) or by revising an existing trip table based on recent trends, revised plans, or better estimates of likely future conditions. These trip tables generally provide estimates of daily trips for at least three trip purposes: work, shop, and one or more combinations of school, social/recreational, medical/dental, personal business, and other.

Because the vast majority of fringe parking patrons are making work trips, a work trip table is generally sufficient. In certain cases, however, line-haul services may also attract CBD shopping trips.[1] Based on local experience, the analyst should judge whether any portion or all of a shopping trip table should also be included in the analysis.

Once a trip table (or set of tables) is selected for analysis and revised if necessary, the trip interchange volumes between the origin and destination shed areas are estimated for each candidate fringe parking site.

The procedure for estimating the trip interchange volume is described in Table 3. The example used in this table is based on data prepared to describe the candidate site shown in Figure 2. As shown in Table 3, the existing trip interchange volume is computed for the candidate site by summing all trip interchanges which originate in an origin shed area zone and end in a destination shed area zone. This total represents daily one way directional (generally inbound) trips. The total is then adjusted by a growth factor to obtain an estimated trip interchange volume for the candidate site in the design year (1985 in this example).

STEP 3: ESTIMATE MODAL SPLIT

The third step in the procedure involves estimating the proportion of the total trip interchange volume from a candidate site that can be expected to use the line-haul transit mode. To determine this proportion, it is recommended that a locally calibrated trip interchange modal split model be used. If a locally calibrated model is not available, however, a default modal split model suitable for estimation of fringe parking needs is provided below. [This model has been used by the Delaware Valley Regional Planning Commission (DVRPC) in fringe parking analysis.]

---

[1]For example, the propensity to make CBD shopping trips via express bus or commuter rail increases if transit service is provided throughout the day as well as during the peak periods. However, a CBD shopper is likely to use the fringe parking facility only if (1) the parking is low cost or free, (2) it is readily available when desired, (3) parking facilities in the CBD are costly and scarce and (4) shopping opportunities are limited in the local area.

TABLE 3

TRIP INTERCHANGE ESTIMATION EXAMPLE

CANDIDATE SITE
Normandy Blvd. and Lane Ave.

ORIGIN SHED AREA
Zones 118, 119, 120, 127, 128, 134, 135, 136, and 137

DESTINATION SHED AREA
CBD; zones 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, and 24

TRIP TABLE
Existing 24-hour work trip table

FORECASTING ASSUMPTIONS
Origin market influence area population expected to grow by 20 percent between model calibration period and design year 1985. Destination market influence area employment expected to grow by 10 percent in same period. Component growth factor defined as follows:

$$f_c = \sqrt{f_o f_d}$$

where:

f_c = component growth factor
f_o = origin proportionate growth (10% growth = .10)
f_d = destination proportionate growth

For a 20 percent origin growth, $f_o = .2$
For a 10 percent destination growth, $f_d = .1$

$$f_c = \sqrt{(.2)(.1)} = .14$$

TRIP INTERCHANGE VALUE

$$T_{od} = \left(\sum_{i \in o} \sum_{j \in d} t_{ij} \right) \left(1 + f_c \right)$$

where:

T_{od} = trip interchange volume between origin and destination shed areas
$i \in o$ = all zones in the origin shed area
$j \in d$ = all zones in the destination shed area
t_{ij} = trip interchange volume between zones i and j
f_c = component growth factor (= 0 if growth factor not considered; i.e., forecast trip table used)

PARTIAL TRIP TABLE

ORIGIN ZONES	EXISTING 24-HOUR WORK PERSON TRIPS BY DESTINATION ZONE																										TOTAL $\left(\sum_{j \in d} t_{ij}\right)$
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	...	i	
⋮																											
118	2	6	1	3	2	5	9	11	14	10	9	8	16	2	8	12	8	—	2	6	8	2	12	6		118	162
119	5	7	10	12	8	50	2	13	6	8	2	2	20	32	3	8	12	2	18	6	2	—	10	19		119	257
120	2	3	8	6	16	19	6	8	18	10	6	12	16	18	1	6	10	—	9	1	6	2	8	17		120	208
⋮																										⋮	
127	1	12	22	8	10	16	—	20	16	12	18	8	6	7	6	27	15	6	1	2	10	—	2	12		127	239
128	4	6	6	3	8	16	6	16	2	20	6	16	19	11	9	6	18	2	10	8	9	—	6	15		128	222
⋮																										⋮	
134	1	12	18	5	6	9	—	13	19	16	5	6	8	10	2	15	6	—	—	8	15	1	3	7		134	185
135	7	8	10	9	2	26	—	2	12	3	19	12	8	2	6	9	2	—	1	6	12	1	10	18		135	185
136	—	—	6	9	7	10	6	8	2	1	36	11	12	5	1	10	12	6	6	1	6	—	1	12		136	168
137	2	2	5	8	10	5	2	12	—	9	20	7	6	22	8	6	10	1	2	1	10	—	6	18		137	172
⋮																										⋮	
j	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24			
TOTAL $\left(\sum_{i \in o} t_{ij}\right)$	24	56	86	63	69	158	31	103	89	89	121	82	111	109	44	99	93	17	49	39	78	6	58	124			1,798

TRIP INTERCHANGE PROJECTION

Trip interchange value (from existing origin shed area to destination shed area) = 1,798

Growth factor (f_c) = .14

Trip interchange value (from projected origin shed area to destination shed area) = (1,798)(1 + .14) = 2,045 daily person trips

The Default Modal Split Model

The default modal split model used by DVRPC is a "utilitarian" mode choice model.[1] It is based on the hypothesis that a traveler's mode choice is determined by comparison of the service attributes of two or more competing modes. Modal attributes are defined in terms of a composite time and cost impedance value, called "disutility." For a trip between two points served by two modes, each traveler measures the perceived disutility of making the trip via each mode and selects that mode which provides service with the least perceived disutility. The utilitarian mode choice model provides a curve which expresses the percent of travelers who would select one of the two modes as a function of the difference between the disutilities of these two modes.

Several calibrations of the utilitarian mode choice model have indicated that, for a given trip, travelers generally perceive the disutility or impedance of a mode in terms of (a) running time or line-haul time, (b) excess time including access time, wait time, egress time, and other terminal time, and (c) direct costs associated with the trip. The impedance for a given trip interchange via mode x, therefore, is calculated as follows:

$$D_{ijx} = (K_1)(R_{ijx}) + (K_2)(E_{ijx}) + \frac{(C_{ijx})}{(K_3)\left(\frac{I_i}{1,200}\right)} \qquad (1)$$

where:

D_{ijx} = impedance or disutility for trip interchange ij via mode x .

R_{ijx} = running time for trip interchange ij via mode x (in minutes).

E_{ijx} = excess time for trip interchange ij for mode x; includes access time for zone i, any wait time, egress time for zone j, and any other terminal times associated with zones i or j (in minutes).

C_{ijx} = direct cost for trip interchange ij via mode x; generally includes parking cost, tolls, transit fare, and auto operating cost (in cents).

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[1]Richard H. Pratt. "A Utilitarian Theory of Travel Mode Choice," Highway Research Record 322 (1970), pp. 40-53.

I_i = median family income for origin zone i (in dollars per year).[1]

K_1 K_2 K_3 = calibration constants (relative weights for the components of the overall disutility measure). These constants, as estimated in initial calibrations of the utilitarian mode choice model, are as follows:[2]

$$K_1 = 1.0$$

$$K_2 = 2.5$$

$$K_3 = 0.25$$

These coefficients are recommended for use with the modal split curves provided in this analytical aid.

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[1]The factor of 1200 converts annual income in dollars per year to units of cents per minute; assuming 250 working days per year and eight hours per day:

$$\left(\frac{\text{dollars}}{\text{year}}\right) \times \frac{1 \text{ year}}{250 \text{ days}} \times \frac{1 \text{ day}}{8 \text{ hours}} \times \frac{1 \text{ hour}}{60 \text{ minutes}} \times \frac{100 \text{ cents}}{1 \text{ dollar}} = \text{cents per mile}$$

[2]Gordon A. Shunk and Richard J. Bouchard. "An Application of Marginal Utility to Travel Mode Choice," Highway Research Record 322, (1970), pp. 30-39; and Gordon W. Schultz and Richard H. Pratt, "Estimating Multimode Transit Use in a Corridor Analysis", Highway Research Record 369 (1971), pp. 39-46.

The modal split between two competing modes is then determined as a function of the difference in disutility between these modes. For the DVRPC default model, modal split was estimated according to the following equation:

$$\begin{aligned} P_{ijx} &= C_{ijx} + f(D_{ijx} - D_{ijy} + 200^{1}) \\ &= C_{ijx} + f(U_{ij}) \end{aligned} \qquad (2)$$

where: P_{ijx} = percent of trips between i and j via mode x

D_{ijx} = disutility of mode x between i and j

D_{ijy} = disutility of mode y between i and j

C_{ijx} = percent of trips between i and j that are captive to mode x

U_{ij} = utile rate, a measure of the difference in disutility between two modes for trip interchange ij.

Calibration of this model for DVRPC resulted in a series of diversion curves for several trip classifications defined by origin and destination area types, trip purpose, and type of transit mode.[2] The DVRPC diversion curves are shown in Figure 3. These curves are applicable for home based work trips between a suburban, rural, or open rural area at the home end and an urban or CBD area at the work end.[3] The

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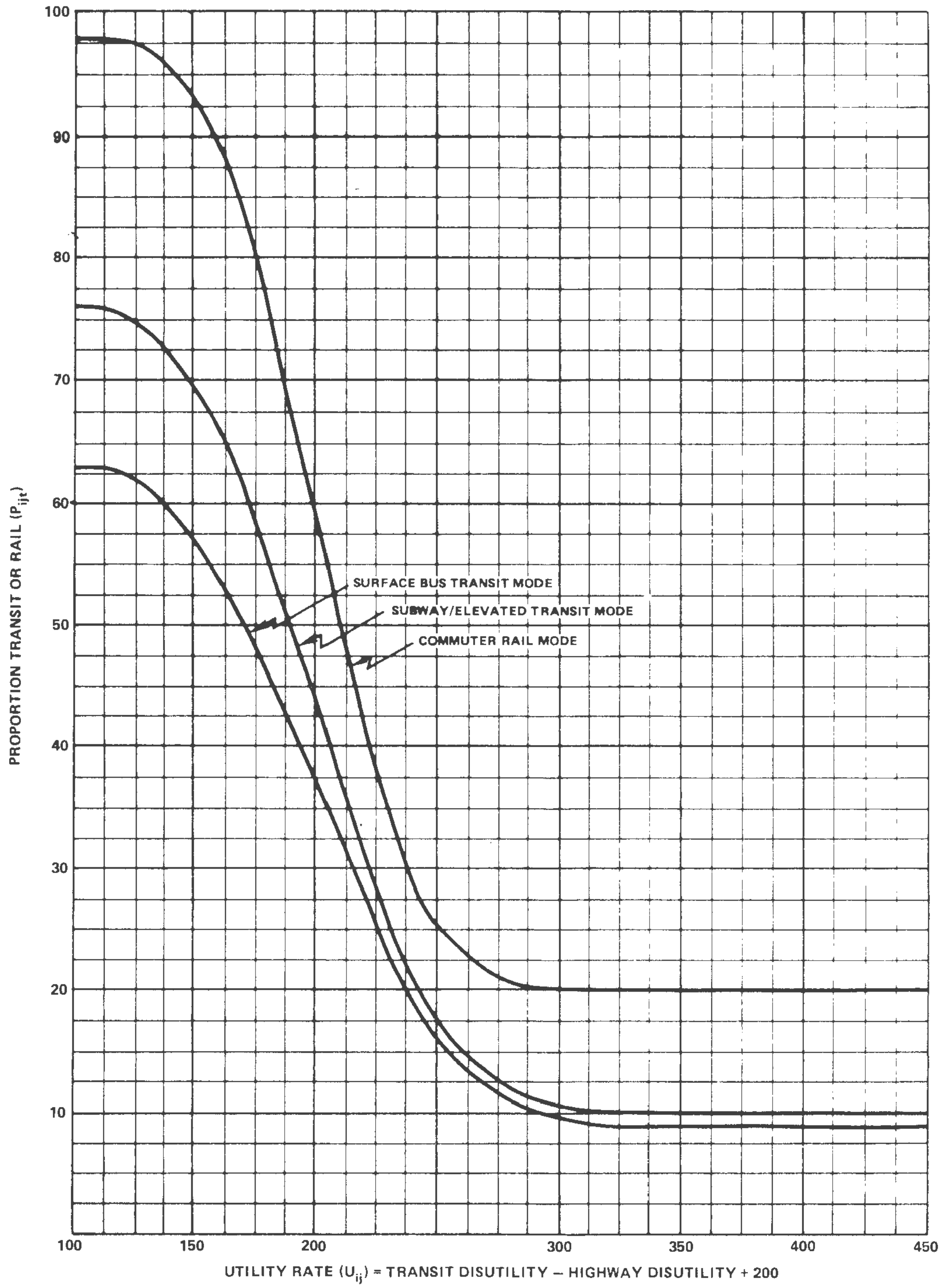
[1]+200 is required to ensure that each U_{ij} is a positive number for calibration in the model.

[2](R.H. Pratt and Associates). Calibration of the Pratt Modal and Sub-Modal Split Models. Philadelphia: Delaware Valley Regional Planning Commisson, August 1972.

[3]Four sets of curves were calibrated for the following area combinations for DVRPC:

- Set 1: urban/CBD to urban/CBD
- Set 2: urban/CBD to suburban/rural/open rural
- Set 3: suburban/rural/open rural to urban/CBD
- Set 4: suburban/rural/open rural to suburban/rural/open rural

Curves for sets 1, 2, and 4, have little general application in fringe parking analysis and are therefore not included in Figure 3.



Note: Valid for home based work trips between suburban, rural, and open rural areas to CBD and urban areas; DVRPC captivity rates assumed.

Source: Gordon Schultz, (R.H. Pratt Associates). Calibration of the Pratt Model and Sub-modal Split Models. Philadelphia: Delaware Valley Regional Planning Commission, August 1972, Figure 5.

FIGURE 3

PRATT-DVRPC MODAL SPLIT DIVERSION CURVES

curves permit estimation of the modal split between transit and automobile for each of three transit modes: commuter rail, subway/elevated (rapid transit), and surface bus.

The shapes of the curves shown in Figure 3 are characteristic of utilitarian modal split diversion curves. The "S" shape reflects the increasing propensity to use transit as the disutility of the automobile mode increases in relation to the disutility of the transit mode. The magnitude of the shift toward one mode or the other is greater where the net impedance difference between the two modes is the least. The curve is steepest at the point where the disutilities for the two modes are equal and travelers are indifferent about which mode they use.

As shown in Figure 3, each curve approaches a limit at both upper and lower extremes. The limits represent "captivity levels" for each mode. The limit at the upper end of the curve represents "auto captives," those tripmakers who either cannot or will not take transit under any circumstances. A certain percent of tripmakers require the use of their automobiles at work, require the automobile for transporting work related goods, or for other reasons are "captive" to the automobile mode for their work trip. No matter how high the disutility of the auto trip is in relation to transit, these tripmakers will not be diverted to the use of transit.

Similarly, the lower limit of the curve represents "transit captives," those tripmakers who cannot or will not use an automobile for the work trip. In some instances, these travelers do not own an automobile or cannot drive. For these and other reasons, a certain percent of tripmakers are captive to the transit mode for their work trip. No matter how high the disutility of the transit trip is in relation to the disutility of the automobile trip, these tripmakers cannot be diverted from the use of transit.

The auto and transit captivities shown in these curves have been determined based on the calibration of the utilitarian mode split model using DVRPC data. Individual captivity rates were determined as a function of area types for the home and work trip ends and the type of transit mode used for the trip interchange. The following captivity rates were determined for the trip interchange with suburban, rural, and open rural areas on the home (origin) end and urban and CBD areas on the work (destination) end:[1]

Transit Mode	Transit Captivity	Auto Captivity
Commuter rail	.20	.02
Subway/ elevated	.10	.23
Surface bus	.09	.37

If specific local captivity rates are not available, these rates may be assumed appropriate, and modal split can be estimated directly from the curves shown in Figure 3. These captivity rates, however, are suggested only to provide an indication of typical values; local captivity rates can vary significantly and should therefore be estimated and used if at all possible.

Estimating Modal Split Using Local Captivity Rates

If local captivity rates can be estimated, the utilitarian mode choice model is used to calculate the percent of travelers using each mode for those travelers who have a choice between modes. For a given trip interchange, auto and transit captives are estimated first, and then modal split is determined for the remaining tripmakers who have a "free choice" between modal alternatives.

Once these rates have been estimated (for both auto and transit), they are subtracted from 100 percent to obtain the percentage of free choice tripmakers for a given trip interchange.[2] The free choice modal split

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[1] Schultz. Pratt Models.

[2] Transit and auto captivity rates can be estimated based on specific knowledge and experience of the local area. These rates are generally related to measures of origin zone income as well as measures of origin and destination zone transit accessibilities. For example, the percent of regional employment within a 45-minute transit travel time from an origin zone provides one measure of origin zone transit accessibility.

for that interchange is then calculated using the free choice diversion model shown in Figure 4. The curves shown were developed using DVRPC data, but they are suitable for use in other areas if the following two conditions are met:

- Free choice modal split estimates are to be calculated for home based work trips between suburban, rural, or open rural areas on the home (origin) end and urban or CBD areas on the work (destination) end.

- Equation 3, shown below, is used to calculate utile rates:

$$U_{ij\ (\text{utile rate})} = D_{ijx} - D_{ijy} + 200 \qquad (3)$$

  with impedance values computed in equation 1 based on coefficients as follows:

  $K_1 = 1.0$

  $K_2 = 2.5$

  $K_3 = .25$

Using local captivity rates, and the free choice model, transit modal split for each trip interchange is determined in the following steps:

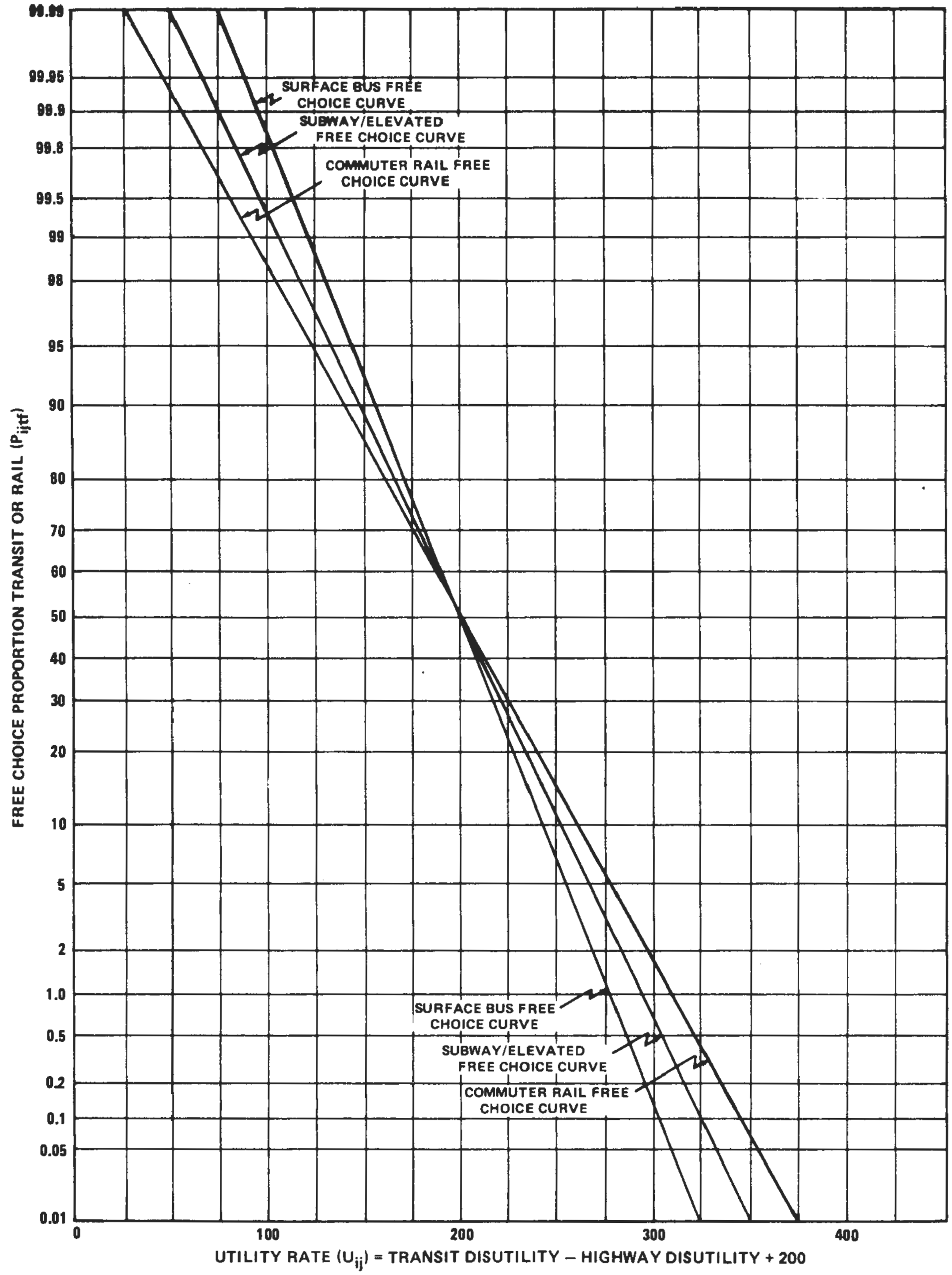
1. Estimate auto and transit captivity rates.

2. Multiply the auto and transit captivity rates from step 1 by the trip interchange volume to obtain the captive auto and transit trips, respectively.

3. Subtract the auto and transit captive trip estimates determined in step 2 from the trip interchange volume to determine total combined free choice auto and transit trips.

4. Compute the utile rate for a given trip interchange: use equation 3 and coefficients in equation 1 as follows: $K_1 = 1.0$, $K_2 = 2.5$, $K_3 = .25$.

5. Estimate the free choice transit percent from the free choice model. Multiply the free choice transit percent by the number of free choice trips from step 3.



Note: Valid for home based work trips between suburban, rural, and open rural areas to CBD and urban areas.

Source: Gordon Schultz (R.H. Pratt Associates). Calibration of the Pratt Modal and Sub-modal Split Models. Philadelphia: Delaware Valley Regional Planning Commission, August 1972, Figure 4.

FIGURE 4:

PRATT-DVRPC MODAL SPLIT FREE CHOICE CURVES

6. Add the free choice transit trips from step 5 and the captive transit trips from step 2 to obtain the estimate of total transit trips for the interchange.

Procedure for Applying Modal Split Models

To use the utilitarian mode split model for fringe parking analysis, the impedance measures (computed using equation 1) are determined as functions of the time and cost variables specified in Table 4. This table presents descriptions of the level of detail at which each of these variables must be measured for use in the utilitarian model. The four levels of detail relevant to the analysis of fringe parking requirements include trip interchange data (at an aggregate level of detail from origin shed to destination shed), origin shed area data, candidate site data, and destination shed area data. Each variable, which is typically measured by zone in the origin or destination shed areas, must be aggregated to the shed area level by computing a weighted average for the variable over all zones in the shed area.

Using the data described in Table 4, the modal split estimation procedure (both with and without specific local captivity rates) is described in Table 5, and an example is provided of the use of the modal split estimation procedure (without specific local captivity rates).

STEP 4: ESTIMATE PARKING FACILITY REQUIREMENTS

The fourth step in the procedure for determining space requirements at candidate fringe parking sites involves estimating the proportion of daily transit line-haul patrons that will use the fringe parking facility (i.e., that will require a fringe parking space). This estimate is based on a relation between parking facility use and two factors: the distance that line-haul patrons travel to the fringe parking facility, and their access mode to that facility.

DVRPC developed a function based on this relation using historical survey data for several commuter rail stations in the Philadelphia area. For each station, the mean radius of the core market area was calculated and compared with the observed percentage of site patrons who drove to the station and parked. The resulting relation, shown in

TABLE 4

MODAL SPLIT INPUT VARIABLES

VARIABLE (EQUATION 1)	VARIABLE COMPONENT	MEASUREMENT LEVEL	SOURCE/CALCULATION
Transit run time (R_{ijt})	V_1 = transit line-haul travel time (min.)	Trip interchange for candidate site to selected CBD centroid	Published timetables or proposed service
Transit excess time (E_{ijt})	V_2 = transit wait time (min.)	Candidate site	Published timetable or proposed service; ½ headway, 7.5 min. maximum
	V_3 = transit origin access time (min.)	Origin shed area	Transportation planning network; weighted average, zone to site travel times for all zones in origin shed area
	V_4 = transit destination egress time (min.)	Destination shed area	Transportation planning network; weighted average, line-haul station(s) to zone travel times for all zones in destination shed area
Transit cost (C_{ijt})	V_5 = transit one-way fare (cents)	Trip interchange for candidate site to selected CBD centroid	Published fares or proposed fares
Transit cost (C_{ijt}) Highway cost (C_{ijh})	V_6 = median family income (dollars per year)(used to convert monetary units to units of time; I_i in equation 1)	Origin shed area	Socioeconomic planning data; weighted average, incomes for all zones in origin shed area
Transit cost (C_{ijt}) (use ½ site parking cost value as variable component)	V_7 = transit site parking cost, if any (cents)	Candidate site	Existing or proposed daily parking charge (if any)
Highway run time (R_{ijh})	V_8 = highway travel time (min.)	Trip interchange for candidate site to selected CBD centroid	Transportation planning network; skim tree for design year network
	V_9 = highway intra-origin shed run time (min.)	Origin shed area	Transportation planning network; skim trees for design year network; weighted average, zone to site travel times for all zones in origin shed area
	V_{10} = highway intra-destination shed run time (min.)	Destination shed area	Transportation planning network; skim trees for design year network; weighted average, selected CBD centroid to zone for all zones in destination shed area
Highway excess time (E_{ijh})	V_{11} = highway origin terminal time (min.) [travel time from origin (house) to auto (garage)]	Origin shed area	Transportation planning data, zonal terminal times; weighted average, terminal times for all zones in origin shed area
	V_{12} = highway destination terminal time (min.) (travel time from CBD parking to final destination)	Destination shed area	Transportation planning data, zonal terminal times; weighted average, terminal times for all zones in destination shed area
Highway cost (C_{ijh}) (variable component = mileage X cents/mile of variable auto operating cost; 7 cents per mile is recommended)	V_{13} = highway mileage, one-way (miles) (used to obtain variable automobile operating cost, measured in cents)	Trip interchange for candidate site to selected CBD centroid	Transportation planning network; skim tree mileage, site to selected CBD centroid (or measured airline distance times a circuity factor)
Highway cost (C_{ijh}) (use ½ CBD parking cost value as variable component)	V_{14} = CBD parking cost (cents)	Destination shed area	Existing or proposed daily parking charge; weighted average, parking charges for all zones in destination shed area
–	V_{15} = trip interchange (daily one-way person trips)	Trip interchange for candidate site to selected CBD centroid	Trip distribution output
Auto captivity rate	V_{16} = auto captivity rate (optional)	Trip interchange for candidate site to selected CBD centroid	Transportation planning data; subtracted from 15 to estimate free choice trip interchange volume
Transit captivity rate	V_{17} = transit captivity rate (optional)	Trip interchange for candidate site to selected CBD centroid	Transportation planning data; subtracted from 15 to estimate free choice trip interchange volume

TABLE 5

MODAL SPLIT ESTIMATION PROCEDURE

STEP	VARIABLE	EXAMPLE
I. ASSEMBLE INPUT DATA		
A. Candidate site and description of proposed service		Express bus service from candidate site at Normandy Blvd. and Lane Ave. in a suburban area to central business district (the modal split estimation procedure is illustrated for the example shown in Figure 2 and the data provided in Table 3).
B. Trip interchange data (site to CBD interchange):		
. Estimated trip interchange volume	V_{15}	2,045 (from Table 3)
. Transit line-haul travel time	V_1	25 min.
. Transit fare	V_5	$0.75
. Highway travel time, site to CBD	V_8	20 min.
. Highway mileage, site to CBD	V_{13}	Airline distance = 8.3 miles Circuity factor = 1.25 Estimated highway mileage = (8.3)(1.25) = 10.4 (Assume only CBD-bound passengers would be attracted to proposed express bus service)[1]
. Auto captivity rate (optional)	V_{16}	
. Transit captivity rate (optional)	V_{17}	

[1]An adjustment should be made to the line-haul demand estimate to account for non-CBD bound riders if the existing or proposed service is designed to serve non-CBD passengers. For existing service, an adjustment factor can be estimated from an on-board origin/destination survey. The factor is simply the reciprocal of the proportion of CBD-bound riders. For example, if 90 percent of inbound express bus service riders are bound for the CBD, the adjustment factor = 1/0.90 = 1.11. For a proposed service, this factor must be estimated based on competing non-CBD employment opportunities served by the proposed service or a connection to the proposed service. The candidate site-to-CBD line-haul demand estimate is multiplied by the adjustment factor to obtain a total estimate of line-haul demand from the candidate site.

TABLE 5 (Continued)

STEP	VARIABLE	EXAMPLE
C. Origin shed area data:		
. transportation planning zones		
. zonal population		
. transit access time	V_3	
. median family income	V_6	
. highway intra-origin shed time	V_9	
. highway origin terminal time	V_{11}	

Zone	Population	Highway Access Time to Site	Median Family Income	Highway Intra-Origin Shed Time	Highway Origin Terminal Time
118	1,386	16	$13,225	5	3
119	1,260	8	12,960	2	3
120	995	6	10,240	1	3
127	1,622	12	16,100	3	3
128	1,122	10	14,560	2	3
134	822	16	13,300	5	3
135	961	10	13,650	2	3
136	722	6	11,390	2	3
137	814	5	10,420	1	3
Total Pop.:	9,704				

STEP	VARIABLE	EXAMPLE
D. Candidate site data:		
. Transit wait time (½ headway or 7.5 minutes, whichever is less)	V_2	Headway = 20 min. ½ headway = 10 min. Use 7.5 min.

TABLE 5 (Continued)

STEP	VARIABLE	EXAMPLE
. Site parking cost	V_7	$0.0
E. Destination shed area data:		
. transportation planning zones		
. employment		
. transit egress time	V_4	
. highway intra-destination run time	V_{10}	
. highway terminal time	V_{12}	
. CBD parking cost	V_{14}	

Zone	Employment	Transit Egress Time	Highway Intra-Destination Run Time	Highway Terminal Time	CBD Parking Cost
1	310	5	2	5	190
2	2,200	5	2	5	210
3	1,800	5	3	5	210
4	360	5	3	5	200
5	520	4	2	5	190
6	1,620	4	2	5	210
7	350	4	3	5	200
8	820	4	3	5	190
9	610	2	2	5	190
10	980	2	2	5	225
11	1,450	2	3	5	210
12	1,110	2	3	5	170
13	810	9	6	6	80
14	970	8	5	6	90
15	520	8	5	6	110
16	1,320	8	6	6	75
17	1,810	8	5	6	115
18	360	6	5	6	125
19	620	3	5	6	150
20	280	5	5	6	140
21	1,270	2	5	6	95
22	180	3	5	6	125
23	630	3	6	6	130
24	1,720	4	6	6	100
TOTAL	22,620				

TABLE 5 (Continued)

STEP	VARIABLE	EXAMPLE
II. CALCULATE AGGREGATE DATA		
A. Origin shed area data, using variables V_3, V_6, V_9, and V_{11} $$V_m = \frac{\sum_{k=1}^{n} P_k V_{mk}}{\sum_{k=1}^{n} P_k}$$ where: V_m = aggregate value for variable m for origin shed area n = number of zones in origin shed area $\sum$ = summation over all zones in origin shed area P_k = population in zone k V_{mk} = value for variable m in zone k		1. For V_3, transit access time to site: $$V_3 = \frac{(1{,}386(16) + (1{,}260)(8) + (995)(6) + (1{,}622)(12) + (1{,}122)(10) + (822)(16) + (961)(10) + (722)(6) + (814)(5)}{9{,}704}$$ $= 100{,}074/9{,}704$ $= 10.3$ min. 2. For V_6, median family income: $$V_6 = \frac{(1{,}386)(13{,}225) + (1{,}260)(12{,}960) + \ldots + (814)(10{,}420)}{9{,}704}$$ $= 128{,}054{,}480/9{,}704$ $= \$13{,}196$ 3. For V_9, highway intra-origin shed time: $V_9 = 25{,}845/9{,}704$ $= 2.7$ min. 4. For V_{11}, highway origin terminal time: $V_{11} = 3$ min.

TABLE 5 (Continued)

STEP	VARIABLE	EXAMPLE
B. Destination shed area data, using variables V_4, V_{10}, V_{12}, and V_{14} $$V_m = \frac{\sum_{k=1}^{n} E_k V_{mk}}{\sum_{k=1}^{n} E_k}$$ where: V_m = aggregate value for variable m for destination shed area n = number of zones in destination shed area $\sum$ = summation over all zones in destination area E_k = employment in zone k V_{mk} = value for variable m in zone k		1. For V_4, transit egress time: V_4 = 106,410/22,620 = 4.7 min. 2. For V_{10}, highway intra-destination run time: V_{10} = 87,080/22,620 = 3.8 min. 3. For V_{12}, highway terminal time: V_{12} = 123,590/22,620 = 5.5 min. 4. For V_{14}, CBD parking cost: V_{14} = 3,556,000/22,620 = 157 ¢

TABLE 5 (Continued)

STEP	VARIABLE	EXAMPLE
III. CALCULATE UTILITY RATE $U_{ij} = \left(K_1 R_{ijt} + K_2 E_{ijt} + \frac{C_{ijt}}{K_3 I_i/1,200}\right) - \left(K_1 R_{ijh} + K_2 E_{ijh} + \frac{C_{ijh}}{K_3 I_i/1,200}\right) + 200$ where: U_{ij} = utility rate calculation for candidate site; CBD trip interchange ij K_1 = 1.0 (Pratt-DVRPC model) K_2 = 2.5 (Pratt-DVRPC model) K_3 = 0.25 (Pratt-DVRPC model) R_{ijt} = transit run time = V_1 E_{ijt} = transit excess time = $V_2 + V_3 + V_4$ C_{ijt} = transit cost = $V_5 + ½V_7$ I_i = median family income = V_6 R_{ijh} = highway run time = $V_8 + V_9 + V_{10}$ E_{ijh} = highway excess time = $V_{11} + V_{12}$ C_{ijh} = highway cost = $(7.0 \text{ X } V_{13}) + ½V_{14}$		K_1 = 1.0 K_2 = 2.5 K_3 = 0.25 R_{ijt} = V_1 = 25 min. E_{ijt} = $V_2 + V_3 + V_4$ = 7.5 + 10.3 + 4.7 = 22.5 min. C_{ijt} = $V_5 + ½V_7$ = 75 + ½(0) = 75 ¢ I_i = V_6 = $13,196 R_{ijh} = $V_8 + V_9 + V_{10}$ = 20.0 + 2.7 + 3.8 = 26.5 min. E_{ijh} = $V_{11} + V_{12}$ = 3.0 + 5.5 = 8.5 min. C_{ijh} = $(7.0 \text{ X } V_{13}) + ½V_{14}$ = (7.0 X 10.4) + ½(157) = 151.3 ¢ $U_{ij} = \left[(1.0)(25) + (2.5)(22.5) + \frac{(75.0)(1,200)}{(0.25)(13,196)}\right] - \left[(1.0)(26.5) + (2.5)(8.5) + \frac{(151.3)(1,200)}{(0.25)(13,196)}\right] + 200$ = 108.53 – 102.78 + 200 = 205.75

TABLE 5 (Continued)

STEP	VARIABLE	EXAMPLE
IV. CALCULATE MODAL SPLIT Use method A <u>or</u> method B		
A. User-specified auto and transit captivities for a given trip interchange:		Method A is not used in this example because optional captivity rate entries were not specified in Step I.
1. Enter appropriate free choice modal split curve (from Figure 4) with utility rate value (U_{ij}) to obtain estimated free choice proportion using transit (P_{ijtf})		
2. Specify auto and transit captivity rates for the trip interchange (V_{16} and V_{17}, expressed as proportions)		
3. Multiply auto captivity rate by trip interchange volume to obtain captive auto trips for the trip interchange (T_{ija}) $T_{ija} = V_{15} \times V_{16}$		
4. Multiply transit captivity rate by trip interchange volume to obtain captive transit trips for the trip interchange (T_{ijtc}) $T_{ijtc} = V_{15} \times V_{17}$		
5. Subtract captive auto and transit trips from trip interchange volume to obtain free choice trip interchange volume (T_{ijf}) $T_{ijf} = V_{15} - T_{ijt} - T_{ija}$		
6. Multiply free choice proportion of transit (P_{ijtf}) by free choice trip interchange volume (T_{ijf}) to obtain free choice transit trips (T_{ijtf}) $T_{ijtf} = P_{ijtf} \times T_{ijf}$		

TABLE 5 (Continued)

STEP	VARIABLE	EXAMPLE
7. Add free choice transit trips (T_{ijtf}) to captive transit trips (T_{ijtc}) to obtain total estimated transit trip interchange (T_{ijt}) $T_{ijt} = T_{ijtf} + T_{ijtc}$		
B. Default auto and transit captivity rates		Use method B in this case:
1. Enter appropriate modal split curve (from Figure 3) with utility rate value (U_{ij}) to obtain estimated proportion of total trips using transit (P_{ijt})		1. Consider surface (express) bus mode in Figure 3. Enter surface bus curve with U_{ij} = 205.75 P_{ijt} = 34%
2. Multiply proportion of transit (P_{ijt}) by trip interchange volume (V_{15}) to obtain estimated transit trips for candidate site (T_{ijt}) $T_{ijt} = V_{15} \times f_s(U_{ij}) = V_{15} \times P_{ijt}$ where: T_{ijt} = estimated transit trips for candidate site to CBD trip interchange ij f_s = diversion curve for interchange stratifications (e.g., work trip: suburban area to CBD)(from Figure 3 or 4) V_{ij} = utility rate value for candidate site to CBD trip interchange ij P_{Ijt} = estimated percent transit		2. T_{ijt} = (.34)(2,045) = 695

Figure 5, is suitable for general use in estimating park-and-ride demand for fringe parking facilities.[1]

The input data required to use this relation is a measure of the mean access distance to the candidate fringe parking site. This measure is calculated as the weighted average of zonal centroid highway distances from the site (weighted by the population for each zone in the origin shed area). Using this computed value, park-and-ride patrons, as a percentage of all facility users, is determined directly from Figure 5.[2]

The number of parking spaces required to satisfy estimated park-and-ride demand is then determined as the number of estimated total park-and-ride patrons divided by an average auto occupancy factor for park-and-ride trips. The auto occupancy factor of 1.16 used by DVRPC for park-and-ride line-haul access trips is suitable for general use, although it can be replaced at the discretion of the analyst.

The step by step procedure for estimating the demand for parking spaces at candidate fringe parking sites is illustrated in Table 6. The example provided to illustrate this procedure uses data from Table 3 and Table 5 resulting from the analysis of the candidate site shown in Figure 2.

STEP 5: CALCULATE ADDITIONAL PARKING SPACE NEEDS

The final step in the estimation procedure involves tabulating and comparing estimated parking space demand with the actual supply of fringe parking spaces to obtain the net additional parking supply required at each candidate site.

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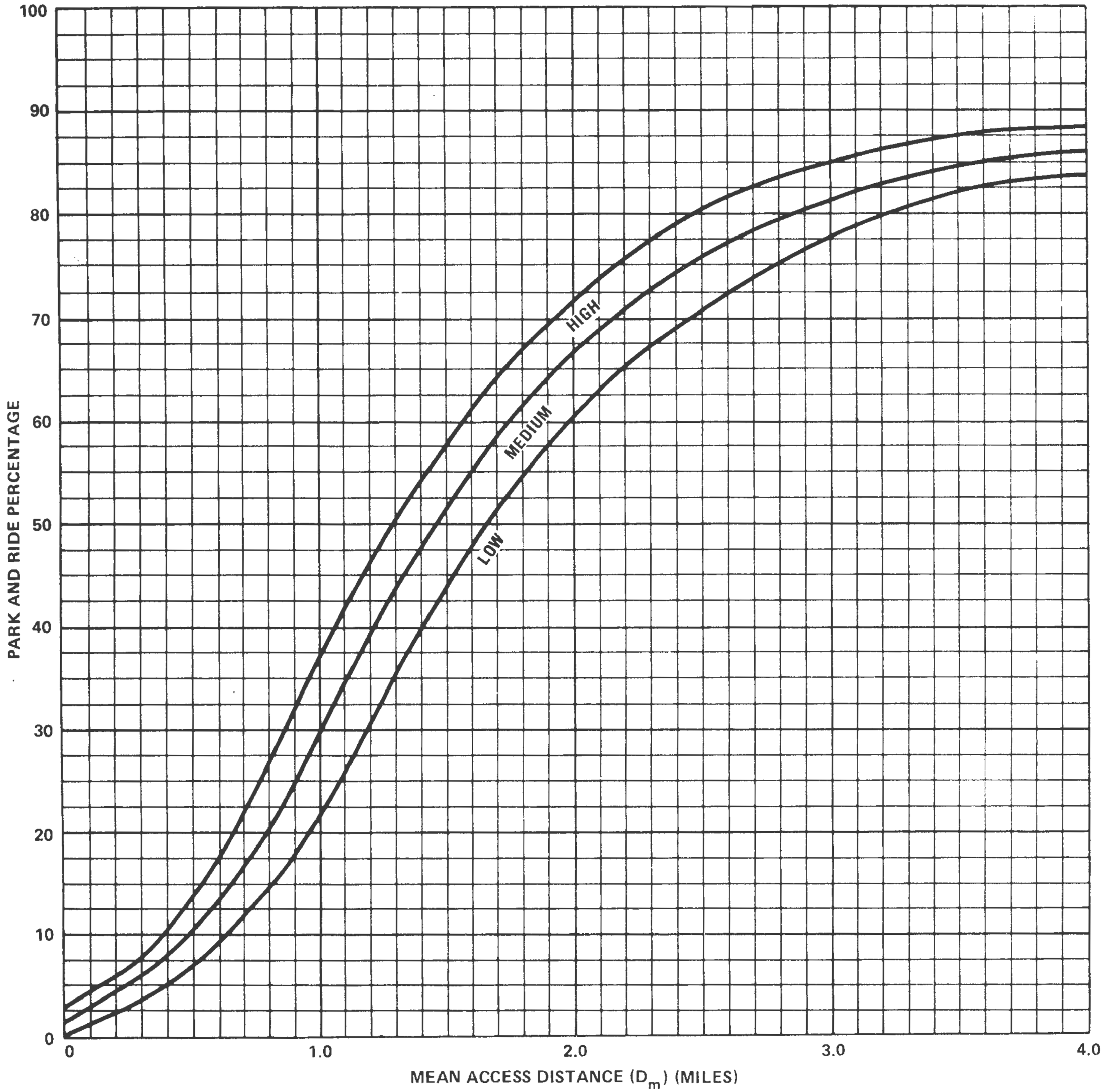
[1]Figure 5 was calibrated with data on fringe parking facilities which were not served by feeder bus service. It is not applicable for any candidate site for which feeder bus service exists or is proposed. For such sites, the planner must either calibrate another curve based on survey data from an existing site or use Figure 5 and apply the result to the total estimated number of candidate site patrons less an estimated number of feeder bus riders.

[2]Note that Figure 5 provides a set of three curves which yield high, medium, and low estimates of park-and-ride patrons (as a percentage of all facility users) for a given mean access distance. The high and low percentage estimates, multiplied by the total number of patrons, yields a range for the estimate of total park-and-ride patrons.



Source: Rasin K. Mufti, Charles D. Dougherty, and Lawrence S. Golfin. Projection of Future Demand for Fringe Parking Facilities in the Pennsylvania Portion of the Delaware Valley Region. Philadelphia: Delaware Valley Regional Planning Commission, August 1974, Figure A2.

FIGURE 5

ESTIMATION OF PARK AND RIDE PATRONS
AS A PERCENTAGE OF TOTAL FRINGE PARKING PATRONS

TABLE 6

ESTIMATION PROCEDURE FOR PARKING FACILITY REQUIREMENTS

STEP	EXAMPLE
I. COMPUTE MEAN ACCESS DISTANCE	
A. Assemble input data: . transportation planning zones . zonal population . highway distance (zone centroid to site) NOTE: Highway distance from each origin shed area zone centroid to the site may be estimated from airline or map distances or from a network distance skim tree.	See zone data below
B. Compute mean access distance (weighted average of distances) $D_m = \dfrac{\sum_{k=1}^{n}(P_k D_k)}{\sum_{k=1}^{n} P_k}$	See computation below

Zone	Population	Highway Distance, Zone Centroid to Site
118	1,386	2.0
119	1,260	0.8
120	995	0.5
127	1,622	2.2
128	1,122	2.0
134	822	2.5
135	961	1.6
136	722	1.2
137	814	0.3
Total Pop.:	9,704	

$$D_m = \frac{(1{,}386)(2.0) + (1{,}260)(0.8) + (995)(0.5) + (1{,}622)(2.2) + (1{,}122)(2.0) + (822)(2.5) + (961)(1.6) + (722)(1.2) + (814)(0.3)}{9{,}704}$$

$$= \frac{14{,}793.1}{9{,}704}$$

$$= 1.52$$

TABLE 6 (Continued)

STEP	EXAMPLE
where: D_m = mean access distance to candidate site D_k = access distance to candidate site from zone k n = number of zones in origin shed area $\sum$ = summation over all zones in origin shed area P_k = population in zone k	
II. ESTIMATE PARK-AND-RIDE PERCENTAGE OF TOTAL CANDIDATE SITE PATRONS	
Enter curve from Figure 5 with D_m to obtain high, medium, and low estimates of park-and-ride percentage of total candidate site patrons	High = 58.0% Medium = 52.0% Low = 44.5%

TABLE 6 (Continued)

STEP	EXAMPLE
III. COMPUTE PARKING FACILITY REQUIREMENTS	
A. Multiply park-and-ride percentage estimates from II above by total estimated site demand (output from modal split)	Total estimated site demand from Table 6 (daily round trip person trips) = 695 Estimated park-and-ride patrons: High = (695)(.580) = 403 Medium = (695)(.520) = 361 Low = (695)(.445) = 309
B. Estimate parking facility requirements by dividing number of estimated park-and-ride patrons by average auto occupancy	DVRPC average auto occupancy for auto access to a fringe parking site = 1.16 High = 403/1.16 = 347 spaces Medium = 361/1.16 = 311 spaces Low = 309/1.16 = 266 spaces

IV. ESTIMATING HIGHWAY ACCESS REQUIREMENTS AND PREPARING AN EVALUATION PROFILE

This section provides a method for estimating highway access requirements for candidate change-of-mode sites and presents a format for preparing an evaluation profile of these fringe parking sites.

ESTIMATING HIGHWAY ACCESS REQUIREMENTS

Three components of streets and highways are involved in fringe parking site access:

- arterial highways and freeways which are used by site patrons to reach the site;
- collector streets or direct site access streets on which patrons enter and leave the site; and
- streets and lanes within the site which are used for circulation within the fringe parking facility.

A requirements analysis of candidate fringe parking sites should consider the first and possibly the second of these components.

The estimation of access requirements for each candidate site provides an essential element for the overall evaluation of candidate change-of-mode sites. Access requirements are estimated in the following three steps:

- Estimate existing or forecast highway access capacity.
- Estimate total access requirements.
- Estimate new or additional access requirements.

The analyst has considerable flexibility in selecting the level of detail for accomplishing these three steps. The specific level of detail appropriate for a particular application is a function of the type of area in which the candidate site is to be located (urban, suburban, semi-rural, rural), the level of development of that area, the type of line-haul transit mode served by the fringe parking site, the type of access modes which serve the site, the estimated modal split for these access modes, and the type and characteristics of access highways serving the site. For a site expected to experience heavy demands, highway access requirements should be estimated for each individual access point. For slightly lower demand, it may be sufficient to estimate highway access requirements for each direction of approach. In many cases where site access is not expected to be a problem, an aggregate analysis of site access capacity across a cordon line around the site is sufficient. In general, candidate sites which serve commuter rail facilities fall into the first or second group. Sites which serve rapid transit lines are in the second group, and sites which serve express and local bus routes are in the third.

Regardless of the level of detail selected, the analytical approach remains the same. This approach is based on the performance of the three steps identified above and described in detail below. In each step in the analysis approach, the level of detail selected as appropriate for the analysis should remain consistent throughout.

Step 1: Estimate Existing or Forecast Highway Access Capacity

The first step in the analytical process involves two calculations: (1) estimating traffic capacity on existing highways serving the candidate fringe parking site and (2) estimating the reserve capacity on these highways after existing plus forecast nonsite-related traffic is subtracted from total capacity.

Highway capacity is typically expressed in terms of vehicles per hour for either a lane, a street in one direction, a street in both directions, a group of streets crossing a screen line, or a group of streets entering a particular area (crossing a cordon line). As discussed above, highway access capacity for candidate sites can be measured for all site access points or for individual access points if highway capacity is considered a special issue in the analysis of fringe parking sites. Capacity can therefore be measured for all lanes crossing a cordon line around the site or for inbound legs of intersections involving site service roads. The city or county traffic engineer can generally provide the necessary information to determine these estimates, or capacity can be estimated directly based on highway and intersection geometry and established highway and intersection capacity estimation procedures.[1]

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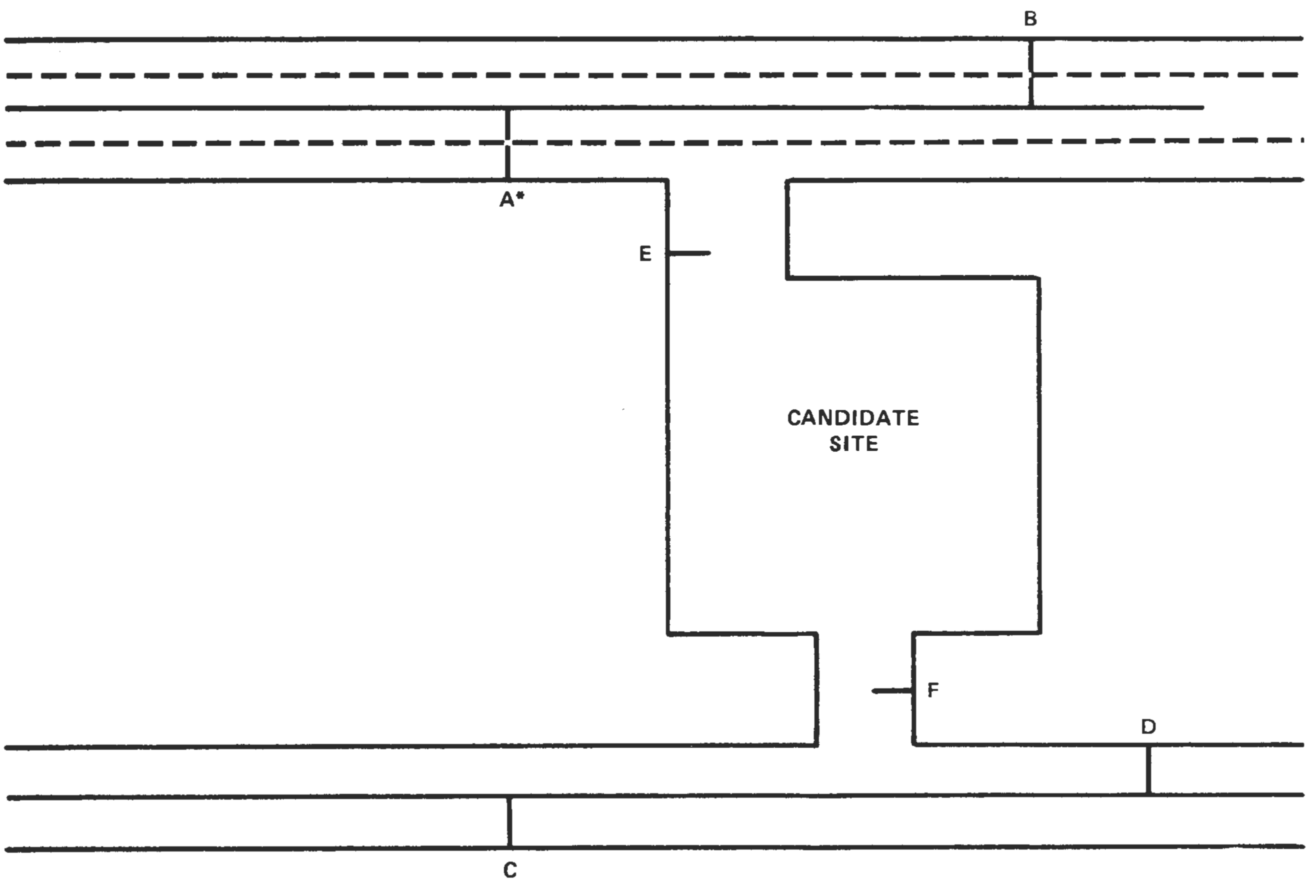
[1]See Highway Capacity Manual, Special Report 87, Highway Research Board, 1965; and Institute of Traffic Engineers, Transportation and Traffic Engineering Handbook, Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1976, Chapter 8.

Counts of average daily traffic (ADT) are generally available for most major arterial streets from the city or county traffic engineering department. In some cases, peak-hour traffic counts are available. If not, the traffic engineering department should be able to supply estimated factors for directional splits on individual streets and the proportion of 24-hour volumes which are counted in the peak hour. In an area where traffic growth is expected to occur, the peak-hour traffic counts should be expanded by a suitable growth factor to obtain forecast traffic volumes on individual streets or for a cordon line around a site.

The net capacity available to accommodate fringe parking site traffic (expressed in terms of vehicles per hour) is estimated as the total capacity minus existing or forecast peak-hour nonsite-related traffic volumes. For the analysis of a proposed new site, this procedure is straightforward. Capacities of access highways are estimated as a function of street and intersection geometrics and type of traffic control procedures at specific intersections. The forecast nonsite-related traffic, estimated from counts and expanded as noted below, is subtracted from total capacity to obtain reserve capacity available to accommodate fringe parking site traffic. This procedure is illustrated in Figure 6. The total capacity of the access highways is determined as the sum of estimated peak-hour capacities of the traffic lanes crossing traffic counters at points A, B, C, and D in the figure. Nonsite-related traffic volumes are determined as the sum of existing peak-hour traffic counts measured by these four counters and expanded to reflect the traffic growth expected for the local situation. The total reserve capacity available to accommodate fringe parking related traffic is then calculated as the difference between these two estimates.

For the expansion of an existing fringe parking site, the analyst still must obtain an estimate of reserve highway capacity available to accommodate total site demand associated with the expanded facility. However, the method to obtain forecast nonsite-related traffic mentioned above must be modified because the counts of existing traffic volumes <u>include</u> existing site traffic. Therefore, the analyst must obtain existing site traffic volume and subtract it from total existing traffic volume to obtain existing nonsite-related volume. This estimate can then be expanded as required by local conditions to obtain forecast nonsite-related traffic and the procedure described above to analyze new fringe parking sites can be implemented.

To illustrate, suppose the highway configuration shown in Figure 6 is serving an existing site at which line-haul service improvements



*A, B, C, D, E, and F indicate position of traffic counters.

FIGURE 6: EXAMPLE OF HIGHWAY ACCESS CONFIGURATION

are expected to induce additional demand. The highway access capacity and existing traffic volumes are measured at traffic counters at A, B, C, and D. The counters at E and F, however, measure existing site traffic volume at peak hours. Existing nonsite-related traffic volume is then obtained by subtracting the sum of the counts at E and F from the sum of the counts at A, B, C, and D. As before, the existing nonsite-related traffic volume can then be expanded as required to obtain forecast nonsite-related traffic, and reserve capacity available for total site traffic is then obtained by subtracting the forecast of nonsite-related traffic from total highway capacity.

Step 2: Estimate Highway Access Capacity Requirements

The second step in the process involves estimating the capacity required for highway access to the fringe parking site based on the demand for fringe parking (as estimated in the previous section) and the expected traffic peaking characteristics of a particular type of site. The following procedure is suggested for determining highway access capacity requirements for each candidate site.

Estimate Total Daily Vehicle Demand

The total daily vehicle demand for each site is determined as a direct output from the five-step parking requirements analysis described in the previous section. Although this analysis provides an estimate of daily demand, all or nearly all vehicles may be expected to arrive at the site in the morning peak period and leave the site in the afternoon peak period.

Estimate Peak-Hour Factors

A peak-hour factor expresses the proportion of daily person trips which may be expected to arrive at a candidate fringe parking site in the peak hour. The application of the peak-hour factor to the estimated daily demand of vehicles expected to use the site permits a comparison of peak-hour traffic volume with peak-hour highway access capacity.

The peak-hour factor may be estimated and used for those sites at which peaking characteristics are not expected to be severe. Fringe parking sites for high frequency line-haul service (such as a rapid transit line) or a service on which relatively low capacity vehicles operate (such as express bus) tend to experience less severe peaking than sites serving less frequently operated service or service on which high capacity vehicles operate (notably commuter rail). The peak-hour factor is most appropriate to use for the former type of site.

For sites which are expected to experience severe short-term peaking, a 15-minute peak-hour factor should be estimated and used. The 15-minute factor expresses the proportion of daily person trips which may be expected to arrive at the site in the peak 15 minutes but measures this demand in terms of vehicles per hour to permit a comparison with highway access capacity estimates.

The following example illustrates the estimation of the 15-minute peak-hour factor:

- Assume the daily parking space requirement for a commuter rail park-and-ride lot has been estimated to be 800 spaces. Six inbound trains are scheduled in the peak period and 30 percent of the daily inbound ridership occurs on the peak train.

- Assume, therefore, that 30 percent of the daily riders from the candidate site ride the peak train. It is reasonable to assume that their arrivals occur in the 15 minutes prior to the train's departure. Thus, 240 vehicles may be expected to arrive in the peak 15 minutes.

- Multiply the proportion arriving in the peak 15 minutes by four to obtain a peak-hour rate:[1]

  15-minute peak-hour factor = 0.30 x 4.0 = 1.20

The analyst should first determine whether traffic at the site can be expected to experience short-term peaks and select the appropriate peak-hour factor. Either factor can then be estimated by observing peaking characteristics on local transit line-haul modes.

[1]The 15-minute peak-hour factor represents a 15-minute flow rate. When expressed as a one-hour rate, this factor permits a comparison with highway capacity estimates, which are typically expressed in terms of vehicles per hour. However, an hourly flow obtained by multiplying the 15-minute factor by the daily vehicle demand would not actually occur, because the peak 15-minute flow is not expected to continue for an entire hour. A 15-minute peak-hour factor greater than 1.0, indicating an hourly flow greater than the total daily demand, is therefore possible, as shown in this example.

Estimate Peak-Hour Traffic Demand

Peak-hour traffic demand at the site is estimated by multiplying the total daily vehicle demand by the appropriate peak-hour factor.[1] If detailed analysis is required, as indicated in Step 1, the estimated peak-hour traffic demand must be distributed among the various site access highways or by direction of approach, as appropriate. This demand can be distributed in direct relation to the population distribution within the site's origin shed area.

Step 3: Estimate Additional Highway Access Capacity Requirements

The third step in the process involves estimating additional highway access capacity required to accommodate traffic resulting from new or expanded fringe parking sites. The additional traffic volume which must be accommodated is the net difference between the estimated highway access capacity requirements (from Step 2) and the existing or forecast available highway access capacity (from Step 1). The result is the peak-hour traffic volume (or a set of volumes) which, when added to the existing or forecast peak-hour traffic volume, is used as the basis for designing facilities to provide site access. The National Academy of Sciences' Highway Capacity Manual can be used to make rough estimates of the additional number of highway lanes and/or intersection capacity required to accommodate this total estimated peak-hour traffic volume.

DEVELOPING AN EVALUATION PROFILE

Based on the results of the parking space and highway access requirements analysis, an evaluation profile should be prepared to provide input for the comparison of candidate fringe parking sites. The results of these analyses can be compiled in a requirements analysis table in a format similar to that illustrated in Table 7. Entries in this table present output from the site inventory, parking facilities requirements analysis, and highway access requirements analysis. Additional entries or modifications to this format should be made to enhance the utilization of the analysis results for local evaluation purposes.

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[1]If the 15-minute peak-hour factor is used, an "equivalent" peak-hour traffic demand is obtained which expresses the peak 15-minute demand factored to a one-hour period.

TABLE 7

SAMPLE EVALUATION PROFILE FORMAT

SITE	ANALYSIS YEAR (SPECIFY EXISTING OR DESIGN YEAR)	LINE-HAUL SERVICE					ESTIMATED TRIP INTERCHANGE VOLUME (DAILY PERSON TRIPS)	ESTIMATED % VIA LINE-HAUL MODE	ESTIMATED LINE-HAUL DEMAND (DAILY PERSON TRIPS)	ESTIMATED % PARK AND RIDE	ESTIMATED PARK-AND-RIDE DEMAND (SPACES)[2]	EXISTING PARKING SUPPLY (SPACES)	NET ESTIMATED PARKING RQMNTS. (SPACES)	AUTOMOBILE ACCESS			
		Operator/ Report	Peak-Period Headway	Peak-Period Travel Time: Site-CBD (Mins.)	Number of Trips Sched. In Peak Period	Hours of Service[1] (Weekday)								Existing Peak-Hour Capacity (Cordon)	Peak-Hour Factor	Peak-Hour Demand (Vehicles)	Additional Access Required
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Normandy Blvd. and Lane Ave.	1985	MTA Rt. 15	15	25	8	5:30 AM-10:00 AM	2,045	34	695	52	311	0	311	400	.80	249	Access capacity adequate
Normandy Blvd. and Lane Ave.	1985	MTA Rt. 15	30	30	4	6:00 AM-9:00 AM	2,045	30	613	52	275	0	275	400	.80	220	Access capacity adequate
Western Ave. and I-10	1985	MTA Rt. 22	20	23	6	6:00 AM-9:00 AM Express (Local Service 5:00 AM-11:00 PM)	1,295	20	259	55	123	150	0	400	1.80	98	Access capacity adequate
. . .																	

NOTES:

[1]Time indicates arrivals at CBD time point.

[2]Factored by auto occupancy factor (1.16)

Evaluation of alternative fringe parking sites involves comparison of the column entries for each row in the evaluation profile. Each row illustrates the results of the analysis of a candidate site or additional site requirements (for an existing site) necessary to accommodate variations in line-haul service demand.

For example, one application of this analytical aid is to evaluate the implications of transit service improvements. Each alternative service level would result in a different set of parking and highway access requirements. The analyst may calculate these requirements for varying service levels and enter each as a row in the requirements analysis table. One candidate site might therefore have several entries in the table.

Similarly, a planner might want to compare the parking and access requirements (columns 14 and 18) under existing conditions with the requirements following major development in the market influence area. For such a candidate site, variations might occur in any or all of the following: line-haul service (columns 3 through 7), the estimated trip interchange volume (column 8), highway level of service [and therefore modal split (column 9)], and the access modal split (column 11).

The procedure used to evaluate the requirements for fringe parking sites and the level of sophistication of the evaluation procedure itself depends upon the particular application. The procedure can vary from a simple comparative analysis to a more elaborate method in which objectives are formally developed and weighted and each site is evaluated in relation to the achievement of these objectives. The results of the analysis may also be used to determine facilities requirements for a single site, in which case no comparative evaluation is required. If a comparison of alternative sites is required, the analyst may use one of several techniques that have been developed and utilized to evaluate transportation alternatives. The references listed below should be reviewed to set up a formal evaluation process suitable for the local application:

- "The Evaluation of Urban Transport Investments," chapter 10 in Principles of Urban Transport Systems Planning by B. G. Hutchinson (Washington, D.C.: Scripta Book Co., 1974);

- "Evaluating and Selecting Programs," chapter 6 in Urban Planning Analysis: Methods and Models by Donald A.

Krueckeberg and Arthur L. Silvers (New York: John Wiley and Sons, Inc., 1974);

- "An Approach to the Evaluation of Plans," a paper by John S. Hoffman delivered at the 1973 AIP Conference; and

- "Strategies for the Evaluation of Alternative Transportation Plans," a report by Edwin N. Thomas and Joseph L. Schofer published as National Cooperative Highway Research Program Report 96 (Washington, D.C: Highway Research Board, 1970).

V. SHORTCOMINGS AND LIMITATIONS

This analytical aid provides a complete procedure for estimating the requirements of major new or expanded fringe parking facilities. Its successful application depends on the availability of the required input data and either the availability of modal split and access modal split models or the use of the models included in this report. When deciding if this method is applicable, these factors must be considered.

DATA AVAILABILITY

The data required as input for this analytical aid should have been developed for every urban area in the country as a part of the comprehensive transportation planning process which each area was required to undertake in order to qualify for federal funding of transportation projects. Many of these plans, however, were developed several years ago, and the data obtained is now outdated (particulary trip tables, highway and transit interzonal times, highway terminal times, transit access and wait times, and modal split). Consequently, while the required data may be available, it will in many cases require careful review, updating, and adaptation for use in this analytical aid.

TRANSFERABILITY

The modal split and access modal split models included in this documentation were developed specifically for DVRPC's local use. They have been included, first, to suggest to the analyst the type of model which should be used for each step in the analytical aid and, second, as default models should locally calibrated models not be available.

These models have not been transferred for use in other urban areas, and their transferability is not assured. The methodology is general, however, and the model structure can be used with coefficients calibrated locally. If these models must be used directly, validation of the curves with a sample of locally available data is strongly recommended.

A more basic transferability issue involves the use of the default models presented here, which were calibrated using zonal data, to estimate modal and submodal split at an aggregate level (e.g., origin shed area to destination shed area interchange level). The user should be aware of the real potential for aggregation error implied by this technique.

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