FAA-EM-79-4

AIRPORT GROUND ACCESS

OCTOBER 1978

U.S. DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration
Washington, D.C. 20591

NOTICE

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EXECUTIVE SUMMARY

Airport access has been identified as a potential limitation to the growth of aviation. The Senate Committee on Appropriations in their Report No. 95-268, dated June 14, 1977, directed the "...FAA to undertake a comprehensive study on the constraints imposed on air travel and airport capacity by inadequate ground access....". This technical report is a result of that study.

The main objectives were as follows:

1. To identify and project the access capacity of representative airports.

2. To determine if access needs at these airports are adequately considered within the planning process.

3. To identify potential solutions to noted access problems; and

4. To identify projects for consideration by local public bodies and planning authorities which could improve airport access in selected cases.

To complete the above objectives, the Federal Aviation Administration and the Transportation Systems Center of the U.S. DOT have prepared case studies of sixteeen commercial airports of various sizes and locales.

Originally, Savannah (GA) Municipal Airport was also included, but the case study was later dropped due to its incompatibility with the case study methodology, and its access problems being informally solved.

The case studies are consistent with one another in both format and methodology, to facilitate comparison among airports and to enable synthesis of the individual conclusions.

Each case study is composed of seven sections -- a case study summary, a background section, a capacity analysis, a review of previously proposed solutions to the access problem, a concluding section, appendices, and a bibliography.

The following are conclusions from this study:

1. Inadequate ground access capacity currently causes excessive delay (congestion) to the air traveler at 13 of the 16 airports studied. This number will increase to 14 by 1995 even if improvements currently programmed are implemented. Table 1 shows a tabulation of these findings by case study airport.

2. Proposed access improvements at most airports have concentrated on major capital projects such as highways and rail transit. In part, this is because access problems are so severe that only major construction projects can relieve them. To a large degree, however, potential solutions involving Transportation Systems Management, pricing and service improvements have been hampered by jurisdictional problems and thus given low priority.

3. Currently, most airport access travel is via highways, and this will continue in the future. The dispersal of trip origins makes major transit investment impractical in most corridors leading to airports. However, funding for surface transportation is moving away from highways and toward mass transit. Therefore, airport access highway improvement projects often compete for a smaller portion of the available transportation funds than in the past.

4. For the most part, municipal governments support the funding of transportation programs which solve general local problems, such as local street repairs, CBD mass transit, etc. This tends to inhibit the implementation of off-airport ground access improvements which, unlike projects within airport boundaries, are heavily dependent on local priorities.

TABLE 1

Case Study Summary

Access Constraint

Airport	Current	Future (Before 1995)
LaGuardia, New York, NY	X	X
John F. Kennedy, New York	X	X
Newark International, Newark, NJ		X
Miami International Miami, Florida	X	X
Fort Lauderdale/Hollywood International, Fort Lauderdale, FL	X	X
Los Angeles International Los Angeles, CA	X	X
Logan International, Boston, MA	X	X
Stapleton International Denver, CO	X	X
O'Hare International Chicago, IL	X	X
Cleveland Hopkins Cleveland, OH	X	
Greater Pittsburgh Internatioal Pittsburgh, PA		X
Reno International, Reno, NV	X	X
Standiford Field, Louisville, KY	X	X
Portlan^d International Portland, OR	X	X
Ryan Field, Baton Rouge, LA		
Worcester Municipal, MA	X	X

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INTRODUCTION

A. The Airport Access Problem

The Senate Committee on Appropriations in their Report No. 95-268, dated June 14, 1977, directed the "...FAA to undertake a comprehensive study on the constraints imposed on air travel and airport capacity by inadequate ground access....". This technical report is a result of that study.

Airport access is defined as the process by which people and goods travel from their local origins to nearby airports. The people include air passengers, airport and airline employees, persons accompanying the air passenger to the airport, and casual visitors. The goods include freight, mail, fuel, and items used at the airport. The most critical of the access trips to the airport are generally conceded to be those of the air passenger; and it is air passenger access upon which this study is focused. 1/

A number of major airport authorities have identified inadequate access to their airports, beyond the airport boundaries, as a problem which could limit the growth potential of their facilities. In general, airport authorities lack direct responsibility for planning, building, and operating highway and transit systems beyond the airport boundaries. Service in these areas is the responsibility of authorities for whom the airport is generally only one of a number of major traffic generators. These circumstances and lack of responsibility can raise the question of whether present and future airport needs are being sufficiently considered in most planning environments.

The crux of this problem is whether existing and planned access facilities and systems are adequate. This question is difficult to answer because adequacy is defined differently by various airport users. Those who feel that airport access is inadequate include not only the frequent passenger who may lament that the trip to and from the airport takes longer than the flight; but also a percentage of professional airport planners.

On the other side of the debate are equally knowledgeable people who feel that the air passenger is not necessarily entitled to "Cadillac Service". They note that most access systems can be improved but that their improvement may not be the appropriate use of scarce resources.

This difference in perspective implies only that priorities as well as standards for defining adequacy differ among individuals and situations. It does not imply that adequacy is immeasurable. Indeed, numerous studies have sought to quantify the adequacy of access to individual airports and to compare airports as to the adequacy of their access systems.

1/ Airport access by others will also be considered, but only to the extent that it affects airport access of air passengers.

Among the measures that have been used to quantify the quality of airport access are the following:

- Average point-to-point travel time.
- Average variance in travel time.
- Average congestion delay (difference between peak and off-peak travel).
- Level of service of the access trip.
- Capacity of the access system.

The usefulness of any of these measures depends upon the context in which it is applied. Capacity of this access system and average point-to-point travel time will be the measures used in this study for reasons explained in subsequent paragraphs. Nevertheless, it is useful to summarize the other measures.

Average point-to-point travel time is an excellent measure for comparing the quality of access among airports or for comparing the quality of access before and after an improvement in the access system. It can be translated into economic benefits and is useful in estimating changes in airport activity.

Average variance in travel time is another measure of the reliability of the access system. Since it is correlated with the amount of time a passenger must allow between his arrival at the airport and his flight departure, its benefits as a measure of the quality of airport access are similar to those of average travel time. However, variance in travel time is both harder to measure and harder to predict.

Average congestion delay (difference between peak and off-peak travel time) is a third measure of the extent to which an airport's ground access system might be improved. It also can be translated into economic terms.

Level of service in the access trip is a fourth and abstract measure encompassing speed, time, safety, cost, and mental and physical stress upon the user. As such, its definition is as ambiguous as that of adequacy. Nevertheless, many researchers have attempted to measure or compute it in a fashion which correlates with the user's propensity to travel. More commonly, however, the standard definition provided in the Highway Capacity Manual is used which relates the level of service of the access system in terms of speed and volume to capacity.

Capacity, the yardstick used in this study, is the physical ability of a system to handle a given volume of traffic. Capacity is quite often used in airport master planning studies to assess the adequacy of the access system in the immediate vicinity of the airport. Capacity, in practical terms, is the principal consideration that determines a given level of service.

Capacity is an elusive concept, even in the case of a single road leading to the airport. If all passengers could be persuaded to come by bus, for example, many more passengers could be handled than if all passengers came by car. Furthermore, if passengers traveled to the airport before the peak period and waited for their flight rather than traveling at the most desirable hour, many more airport-bound passengers could be handled on the access system. As one moves away from the airport boundary any meaningful concept of airport access capacity becomes less and less absolute. As one segment of roadway approaches its capacity, airport travelers and others may switch to alternative, less convenient road segments or to alternative modes of transport.

There are three advantages to the capacity measure that are responsible for its widespread use. The first and most important one for airport planners, is that is presents an "absolute" criterion for assessing whether a given demand can be handled; thus it provides a stong argument for action whenever forecast demand exceeds capacity. Second, the impacts of inadequate capacity can be quantified economically through the estimation of delay, estimation of trips postponed to other-than-desired hours, and estimation of trips cancelled. Third, airport planners are used to thinking in terms of capacity because that is the way in which the adequacy of on-airport facilities have traditionally been measured. Indeed, even the Congressional language directing the FAA to undertake this study reflects this viewpoint:

> "...a comprehensive study on the constraints imposed on air travel and airport capacity by inadequate ground access...."

These advantages motivate the use of capacity in this study as a primary measure of the adequancy of airport ground access. However, the elusiveness of the concept must first be overcome. Consequently, access capacity and airport capacity are defined as volumes of airport passenger originations that can be handled by the access and airport systems, respectively, without significantly affecting the unconstrained behavior of air passengers, air carriers, and other users of the highway and transit systems. Where demand and airport capacity exceed access capacity, the inadequacy of the access system is defined and measured by the number of hours in which this situation exists, and by the number of passengers affected. The assumption of unconstrained user behavior in the definition of capacity recognizes that deviation from this behavior--for example, the use of less than preferred routes or modes--is a burden to the user and therefore has economic consequences. It does not imply, however, that these burdens should or must be removed.

From the Federal perspective, the capacity measure is an appropriate one. Through the Airport Development Aid Program, the Government spends millions of dollars every year to help expand the capacity of airports to meet forecasted growth. Nevertheless, a 1974 FAA study 1/ indicated that the existing access system to some airports may be saturated before this capacity is reached. In short, attention to the airport system has exceeded attention to the access system with the result that some airport capacity may remain unutilized.

1/ MITRE Corporation FAA Report on Airport Capacity. (NTIS: Springfield, VA). May 1974.

In this context, the objectives of this study are fourfold, as follows:

1. To identify and project the access capacity of representative airports;

2. To determine if access needs at these airports are adequately considered within the planning process;

3. To identify potential solutions to noted access problems; and

4. To identify projects for consideration by local public bodies and planning authorities which could improve airport access in selected cases.

The study methodology is as follows: First, the FAA and a large number of airports are contacted to determine their perception of the adequacy of access to their airport. Case study airports are then selected covering, to the degree possible, the types of airports with preceived access problem. Access capacity and airport capacity are computed as defined above and then compared in order to determine the adequacy of the access system.

Also included is supplement C which is a 1978 update of the ground access to airports report prepared by the Federal Highway Administration (FHWA). This report was completed at the request of the FAA to the FHWA and the update contains a compilation of travel time and travel speed information from the Central Business District (CBD) to the airport facility in 55 medium and large hub airports. In addition, the FHWA furnished the requested cost information on major Federal-Aid highway projects that have or will improve access to these airport facilities.

B. Method and Analysis

In order to portray the overall national picture of the airport access problem, it was felt that a detailed examination of the problem at several representative airports was required. Accordingly, case studies of ground access were undertaken at the airports listed in Table 2.

Airports were selected for inclusion in the case studies on the basis of the following factors:

FAA regional inputs;

Contacts with airport officials;

Magnitude and variety of problems;

Availability of data; and

Geographical dispersion.

Originally, Savannah (GA) Municipal Airport was also included, but the case study was later dropped due to its incompatibility with the case study methodology, its access problems being informally solved.

The central component of each case study is the capacity analysis. The capacity analysis directly addresses the potential constraints that ground access imposes on air travel and airport capacity at the case study airports. The constraint on air travel is illustrated by comparing unconstrained forecasts of passenger demand with capacities on the access roadway system. The constraint on airport capacity is illustrated by comparing the projected capacity of the airport's airside with roadway access capacity. To facilitate these comparisons, all three factors are expressed in terms of annual air passengers (enplaned and deplaned) as explained below.

As in traditional highway and airport practice, capacity is considered as a practical limit rather than a theoretical absolute. Airside capacity is based on prior estimates of the airport's PANCAP (Practical Annual Capacity) expressed in terms of aircraft operations, which are then converted to annual passengers using forecasts of the level of general aviation activity, aircraft mix, and enplaning load factor.

Ground access capacity is also defined in terms of annual enplanements and deplanements--specifically at the level of airport passenger activity which airport-related vehicles when combined with other traffic fill a given roadway segment to capacity. Two factors must be defined further--which roadway segments are of interest and what is meant by capacity? In response to the first question, it has been arbitrarily decided to consider those roadway segments over which at least 25% of air passengers travel. Generally, if fewer

Table 2

CASE STUDY AIRPORTS

Hub				Airports to be Studied	
No.	Name	Size 1/	Region	Code	Name
1	Baton Rouge, LA	S	Southwest	BTR	Ryan
2	Boston, MA	L	New England	BOS	Logan International
3	Chicago, IL	L	Great Lakes	ORD	O'Hare International
4	Cleveland, OH	L	Great Lakes	CLE	Cleveland Hopkins
5	Denver, CO	L	Rocky Mtns.	DEN	Stapleton International
6	Los Angeles, CA	L	Western	LAX	L.A. International
7	Louisville, KY	M	Southern	SDF	Standiford Field
8	Miami, FL	L	Southern	MIA	Miami International
				FLL	Ft. Lauderdale/Hollywood International
9	New York, NY	L	Eastern	LGA	LaGuardia
				JFK	John F. Kennedy International
				EWR	Newark International 2/
10	Pittsburgh, PA	L	Eastern	PIT	Greater Pittsburgh Int'l.
11	Portland, OR	M	Northwest	PDX	Portland Int'l.
12	Reno, NV	M	Western	RNO	Reno Int'l.
13	Worcester, MA	N	New England	WOR	Worcester

1/ Size: L = Large; M = Medium; S = Small; N = Non.

2/ Newark is considered by the FAA to be a large hub separated from New York; however, it is considered to be part of the New York hub for this study.

than 25% of the air passengers must pass through a segment of roadway operating at capacity, this bottleneck is not considered to have substantial effect on air travel. However, in some instances, particularly in response to local concerns, additional roadways have been considered to be part of the access system and were included in the capacity analysis.

In response to the second question, "what is meant by capacity," it is defined to be the maximum traffic flow that a roadway can generally handle at a given level of service. In the case studies, capacity is tabulated at levels of service "D" and "E". These levels of service are described in the Highway Capacity Manual (HCM) (Highway Research Board, Special Publication 87, 1965), as follows:

> "Level of service D approaches unstable flow, with tolerable operating speeds being maintained, though considerably affected by changes in operating conditions. Fluctuations in volume and temporary restrictions to flow may cause substantial drops in operating speeds. Drivers have little freedom to maneuver, and comfort and convenience are low, but conditions can be tolerated for short periods of time."

> "Level of service E cannot be described by speed alone, but represents operations at even lower operating speeds than in level D, with volumes at or near the capacity of the highway. At capacity, speeds are typically, but not always, in the neighborhood of 30 mph. Flow is unstable, and there may be stoppages of momentary duration."

Level of service "D" is commonly used to identify points at which existing urban highways need to be upgraded, supplemented, etc. Level of service "E" provides the maximum hourly throughput of vehicles.

A particular level of service is encountered on a given highway for a certain number of hours per year depending on the physical characteristics of the highway and the actual level of demand. In this study, levels of service "D" and "E" were calculated for traffic experienced or exceeded during the following hours:

30th highest - near holiday periods

200th highest - highest hour on a typical weekday

1000th highest - 3rd or 4th highest hours on a typical weekday

The 200th highest hour at service levels "D" and "E" generally was used in comparing capacity graphically.

Ground access capacity for airport travel was estimated by subtracting non-airport traffic from total highway capacity and then converting the remaining capacity from vehicles to annual air passengers. This conversion was based on the current ratio of annual air passengers using the airport to the average daily vehicle traffic within the airport, and upon the current or projected fraction of airport-related vehicles that use the highway in question. The latter figure is estimated by "flowing" passengers over the highway network in accordance with their local origins and destinations as obtained from in-flight passenger surveys.

In presenting the capacity analyses, use is made of graphs such as the hypothetical one shown in Figure 1. A graph such as this is created for each roadway segment of interest. It shows, on the same axis, the annual passenger capacity of the airside, the annual passenger demand, and the annual airport demand that could be handled if the given road segment is to operate above the specified level of service. Note the downward sloping ground access capacity. This is a general trend reflecting the fact that as non-airport traffic grows, a smaller and smaller amount of airport traffic is required to reach roadway capacity.

In this particular example, highway X is shown to operate at Level of Service "D" when the airport reaches 34 million annual passengers, and at Level of Service "E" when airport demand reaches 40 million annual passengers. Both service levels are exceeded during 200 hours of the year. This is not meant to imply that all 34 or 40 million passengers will use highway X; rather, it is assumed, in creating these curves, that the same percentage will use the highway as use it currently. While it would have been simpler to aggregate capacity of the entire ground access system, it could also have been misleading, since the capacity of some routes may never be utilized because airport users are not coming from that direction.

Of particular interest in Figure 1 are the points at which the demand curve crosses the capacity curves. In this particular example, demand equals LOS "D" capacity in 1981 and LOS "E" capacity in 1984, and airside capacity in 1985. Of particular concern is whether the intersection of demand and airside capacity precedes or follows the intersection of demand and access capacity. The intersection of airside and access capacity curves is the point at which limiting airport capacity switches from airside to groundside.

Because of the general absence of data on the local origins and destinations of employees at the airport, and because of the non-uniform relationship (even at a single airport) between passengers and employees, the methodology was designed to deal only indirectly with access problems faced by employees or caused by employees. To the extent that employee vehicles are counted in obtaining the ratio between air passenger and vehicular traffic at the airport, 1/ they are inherently assumed to remain in proportion to the volume of air travel and are assumed to be distributed upon the highway network as are the passenger vehicles. Those employee vehicles not counted in the ratio are counted as "non-airport-related traffic" and inherently assumed to increase at the same rate as other local traffic. In specific case studies where these inherent assumptions are judged to be inaccurate and may significantly affect the reliability of the conclusions, the impact of employee traffic is addressed specifically and qualitatively.

1/ In many cases, vehicular traffic counts are for the central terminal area only, and consequently miss many of the airport employee vehicles.

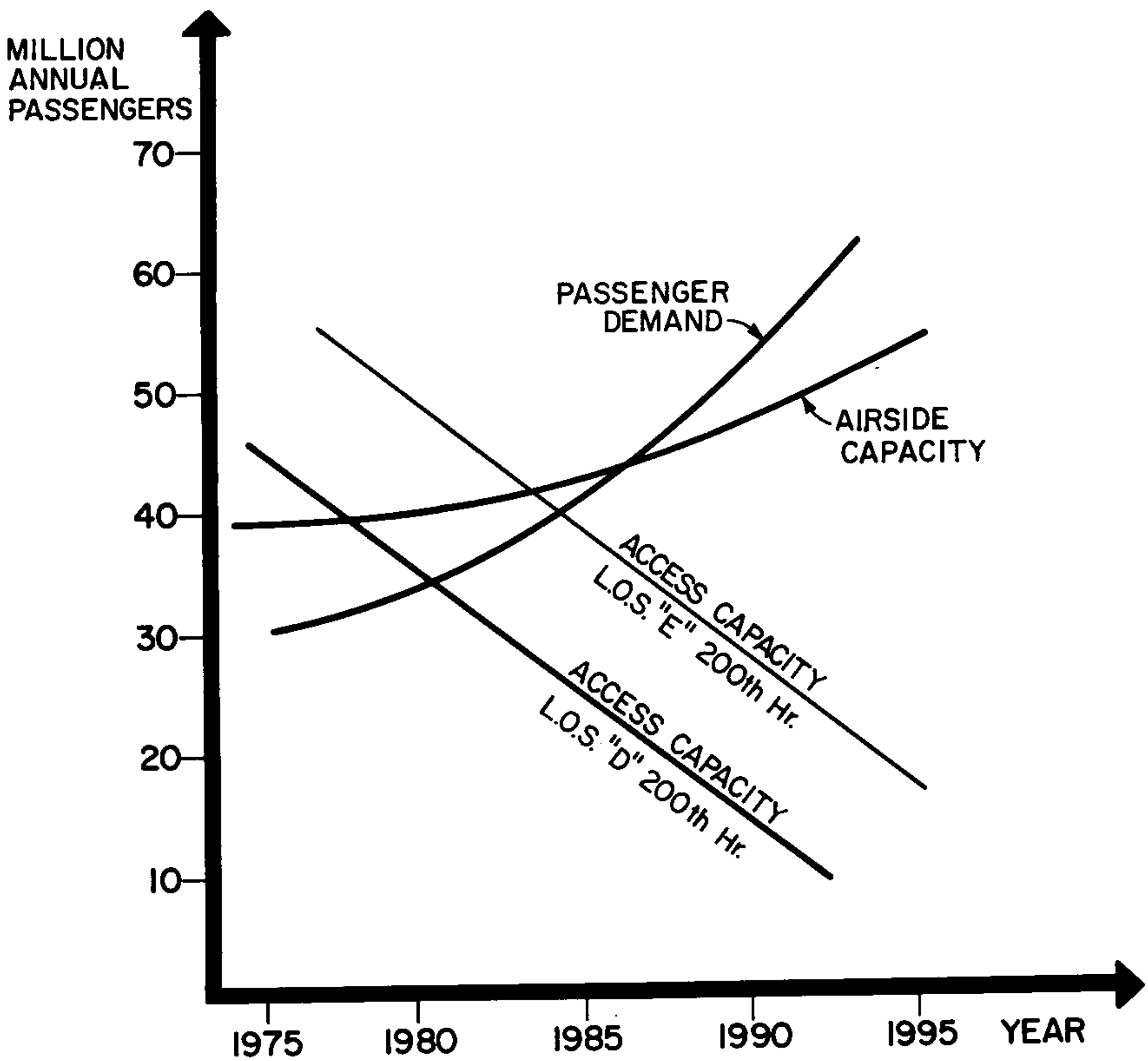

Figure 1

HYPOTHETICAL ACCESS CAPACITY
HIGHWAY CURVES

Highway X

Where ground access capacity constraints were discovered, a concerted effort was made to identify all alternatives that had already been proposed to deal with the problem. For each solution, the case study outlines who is doing the proposing, who is to provide the funding, who is to implement the project, how much the project will cost, and what is the current status.

II. Case Study Summaries

Baton Rouge--Ryan Airport

Ryan Airport is located approximately seven miles north of downtown Baton Rouge. Annual passenger enplanements plus deplanements on air carrier airlines in 1976 were 368,000 while general aviation accounted for an additional 90,000 total passengers in 1976. The current external surface access networks in interstate highways and major arterials result in good airport access, allowing essentially non-stop travel via Interstate Highways I-10 and I-110 between the Baton Rouge Central Business District (CBD), the south and east portions of East Baton Rouge Parish, and the Airport.

Baton Rouge's current access problems are mostly experienced inside the Airport boundary and primarily relate to roadway and parking lot conditions rather than inadequate capacity. These problems would be relieved by implementation of internal roadway and parking improvements recommended in the current Airport Master Plan.

Access is generally good outside the Airport because I-110 leads virtually to the entrance of the Airport--and is used by the vast majority of air passengers. Capacity on I-110 is likely to be sufficient for at least another 15-20 years. Traffic from areas to the east of Baton Rouge currently experiences congestion on Airline Highway (U.S. 61). However, this traffic comprises a fairly small percentage of total airport trips (about 10 percent). Relief to this highway is planned through traffic engineering improvements and construction of an outer belt highway as a reliever route.

Boston--Logan International Airport

The ground access problem at Logan International Airport is amplified by the separation of the Boston, Massachusetts, central business district (CBD) from the airport by Boston Harbor. Primary routes to the airport through the CBD are heavily traveled and presently perform at, or are rapidly approaching, unacceptable levels of service, especially during peak hours. In 1975, about 9.9 million annual passengers (MAP) generated an estimated 62,5000 daily vehicle trips to and from the airport; most projections expect demand to approximately triple by 1995. This increasing demand will place severe burdens on routes already operating at unacceptable levels of service, unless meaningful corrective measures are implemented.

Airside capacity at Logan is expected to be sufficient to handle passenger demand. However, future airport capacity could be seriously limited by the ground access system if the current levels of service are not improved . The low-capital programs initiated to reduce vehicle trips to the airport will not solve the problem of rapidly decreasing capacity due to increasing ambient traffic on the access road system. Programs designed to increase tunnel and airport road capacities or to improve rapid transit access, although contributing to the solution, are not in themselves sufficient.

Ground access to Logan Airport is primarily a general urban problem. Capital alternatives for dealing with this problem are desirable, but they face opposition due to economic, environmental, and social considerations. Current proposals aimed at short-term benefits may prove temporarily helpful, but the scope of the problem demands a concrete, long-range solution.

Chicago--O'Hare International Airport

Chicago-O'Hare International Airport is located approximately 17 miles northwest of the downtown Chicago Loop area and operated by the City of Chicago Department of Aviation. The Airport serves a metropolitan population of approximately 7.0 million and is provided primary groundside access by the Kennedy Expressway and Tri-State Tollway.

O'Hare International Airport is the world's busiest airport and served over 36 million enplaning plus deplaning passengers in 1976. Of total passengers carried at O'Hare, approximately 46% were transfers from other flights. Passenger traffic is projected by the FAA to grow at a rate of 5% annually for the next ten years. General Aviation activity comprises 6% of total operations at the Airport.

The capacity analyses indicated that the Kennedy and Eisenhower Expressways currently have severe access problems near downtown Chicago. Other roadways serving large numbers of air travelers will have moderate access problems by the mid-1980's and severe problems by the mid-1990's. The major entrance airport roadway (state Route 594) should remain adequate for many years. The major problem is the Kennedy Expressway which provides direct Airport-CBD access and handles about 40% of airport trips.

Proposals have been made to implement new highways, extend rapid transit service to the Airport, and to divert up to one-half of the short to medium passenger operations from O'Hare to Midway Airport, which would facilitate improve airport access. UMTA has recently approved funding to extend rapid transit along the Kennedy Expressway median to the Airport. The City of Chicago Dept. of Aviation is currently preparing a new Master Plan for O'Hare International Airport in order to define more clearly the future role of the Airport. However, the status of many of the highway proposals to improve airport access is still uncertain until detailed feasibility studies are completed.

Cleveland--Hopkins Airport

Cleveland-Hopkins Airport is located 13 miles southwest of the Cleveland, Ohio central business district and is operated by the City of Cleveland. Cleveland-Hopkins served 5.8 million total enplaned and deplaned passengers in 1976, about 35 percent of whom were transfers.

Currently, the Airport has good ground access from the City of Cleveland including the downtown area. Interstate 71 provides quick access from the Cleveland CBD and is complemented by a rapid transit system which was extended to he airport in 1968.

Access from other directions, including Akron and Cleveland's eastern suburbs (which generate over 20 percent of air passenger trips) is not nearly as good. Travel from the eastern suburbs is constrained by lack of a limited-access highway. Travel from east and south is constrained by at-grade crossings on Snow Road leading to the Airport and tight weaving distances on roads in the immediate vicinity of the Airport.

Two construction projects have been proposed to alleviate these problems. I-480, an east-west limited access highway running just north of the Airport property is now under construction and should be completed by the early 1980's. This facility will improve traffic flow from the eastern suburbs and also will create a new interchange for Airport-oriented traffic, thus relieving the Snow Road intersection. In addition, Snow Road itself is to be upgraded in the early 1980's with complete grade separation.

Denver--Stapleton International Airport

Stapleton International Airport is located in the City and County of Denver, Colorado about six miles east of the central business district. The airport has grown rapidly, and in 1976, served almost 13 million passengers. Denver is an airline transfer hub, with almost one out of every two passengers using the airport for tranfer only.

Access to Stapleton is through city streets, primarily 32nd Avenue and Quebec Street. Quebec Street links the airport to the interstate highway system at I70, about a mile north of the airport. Interstate 25 runs north-south just west of the CBD and connects to I70.

Currently, the major problem in the access to Stapleton is the inadequate capacity of Quebec Street. Several proposals to improve this capacity with grade separations at one or more intersections have been proposed, but have met opposition. The internal airport access system is also a problem and is now under study. Relocation of the terminal area or of the airport are under serious consideration, for reason of both access and airside capacity.

Because of Denver's rapid growth rate, severe congestion is expected by 1985 on I25 south of I70. This is a rather intractable urban transportation problem which will affect about twenty-six percent of the local airport passengers.

Airside capacity is also a problem at Stapleton and, according to some forecasts, may constrain the growth of the airport before it is constrained by the access system.

Los Angeles International Airport

Los Angeles International Airport is generally considered to have one of the worst ground access problem of major airports in the United States. The airport currently handles some 26 million annual passengers and this volume is expected to grow to 40 million by 1995, under the most conservative estimates.

Traffic congestion exists in seveal places in the ground access system--in the central terminal area, on the road network connecting the airport to the freeway system, and on the freeways themselves. The most immediate and severe problem exists in the central terminal area. However, steps are being taken to alleviate this problem. With planned improvements and the passage of time, the access bottleneck will move farther and farther from the airport boundary. Our analysis indicates that by 1990, congestion bottlenecks will exist at Century Boulevard (unless the Century Freeway is completed) and at the San Diego Freeway north of the Santa Monica Freeway. The bottleneck at Century Boulevard is most amenable to construction, TSM, pricing, and transit service improvement solution alternatives. The bottleneck at the San Diego Freeway, however, is expected to be even worse than that at Century Boulevard and to be less tractable. It is a general urban transportation problem of major proportions. Fortunately, it affects only about 25% of the airport passengers.

Louisville--Standiford Field

Standiford Field is a medium hub airport serving the city of Louisville, Kentucky, Jefferson County, and 51 other counties in the Kentucky and Indiana area. In 1975, the airport handled some 16.7 million passengers. Access to the airport is via the Watterson Expressway (I264), a near-circular highway surrunding downtown Louisville. The Watterson Expressway connects to both north-south and east-west interstate highways serving the region.

The major difficulty with airport access is congestion on the Watterson Expressway in the vicinity of the airport. This congestion is due in part to inadequate capacity and in part to the fact that the airport interchange is one of four major interchanges within a 1 1/2 mile stretch on the Expressway. Although congestion is moderate at present, it is expected to become severe (level of service "E" for at least four hours per weekday) by 1990 unless the Expressway is widened or unless the completion (expected in 1985) of the Jefferson Freeway (an outer loop about five miles beyond the Watterson) helps to funnel non-airport traffic off the Watterson Expressway.

Miami International Airport

Miami International Airport is located in the heart of Dade County, about six miles west of the Miami CBD and nine miles west of Miami Beach and is operated by the Dade County Aviation Department. In 1976, MIA had 12.6 million total passengers with a 37% transfer rate which is expected to increase to 40% by 1980 and 55% by 1995. There are over 24,000 people employed at the airport, a figure expected to more than double by 1995. The Airport is now preparing a new Master Plan for development.

Significant traffic congestion occurs at intersections along LeJeune Road, the primary access route for passengers and employees using the Terminal area. This arterial serves not only as the primary access to the Airport, but as a major north-south route as well. Congestion along the East-West Expressway (S.R. 836) both east and west of LeJeune Road is also a major current problem. Other current congestion points include access routes to the cargo and employee areas along the northwestern andd western boundaries of the Airport.

Highway construction projects have been proposed to alleviate these problems, including widening of the East-West Expressway and construction of a new arterial parallel to LeJeune Road. Implementation of these projects would provide significant relief to current and expected future traffic congestion. Plans to run the new Dade County Rapid Transit directly to the airport have been dropped, but may be reconsidered in the future. Shuttle service from the airport to the nearest transit station has been proposed.

Construction of a proposed parallel arterial east of LeJeune Road with a connector to the Terminal would provide significant relief. Relief to congestion on S.R. 836 would be provided by implementing current plans to widen that toll road. Capacity problems on the Airport Expressway should increase in frequency during the 1980's if the proposed highway widening does not take place.

Fort Lauderdale--Hollywood International Airport

Fort Lauderdale-Hollywood International Airport (FLL) has experienced extraordinary passenger growth (over 20% annually in the past 10 years) due to growth of Broward County, the Southeast Florida air passenger market and spillover from Miami International. Since the Airport was never planned to handle a high level of passenger volumes, many landside congestion problems have been experienced, thus prompting a plan to relocate the terminal complex from the eastern edge to the southwest corner of the Airport where room for expansion is available.

Major ground access problems are experienced at the internal roadways, which are unable to handle curb loading/unloading and adjacent traffic movement at a single level, and at the entrance to the terminal area which has a signalized intersection from U.S. 1 and an adjacent railroad grade crossing.

Capacity analyses indicate that FLL's airside components can handle forecast growth well into the future if some constraint is put on general avaiaton activities. However, ground access capacity may soon become a constraining factor, particularly on Interstate 95, the major north-south artery, due to expected growth in non-airport traffic. The I-95 problem is basically independent of the terminal area location. Airport planners have proposed an eventual tie-in with the Florida Turnpike, which is parallel to and west of I-95, to get additional North-South capacity. Currently, the terminal area relocation is being held up pending study of a proposed interchange between the relocated terminal and I-95.

These proposals and other highway improvements would go far toward improving FLL's access problem. However, the issue of terminal relocation and highway improvements are so unsettled at this time, that the future is difficult to predict. FLL's airport access problem is aggravated by the extraordinary growth of Broward County in general and air traffic in particular. The normal 8-10 year waiting period for study, design and constructon of highways is an inconvenience in most other areas, but imposes a real hardship at FLL where air and highway traffic are growing so quickly.

New York--LaGuardia Airport

LaGuardia Airport is one of three major air carrier airports serving the New York metropolitan region. Although it is the most conveniently located of the three airports, airside limitations have restricted it to short-haul air services. Nevertheless, in 1975, it served 14.1 million passengers, and this number is expected to increase, if unconstrained, to over 25 million by 1995.

The airport is located on the Grand Central Parkway, a major highway connecting to several east-west and north-south highways serving the region. Several routes exist to the Manhattan central business district (CBD) which is itself rather dispersed. New York generates a high percentage of its travel (about 30%) from the CBD. At LaGuardia, almost one-half of local trips are CBD oriented. Of these, more than half use the taxi mode, thus generating a relatively high requirement for ground access capacity.

LaGuardia is currently operating at its ground access capacity due to traffic congestion on the Grand Central Parkway on the way to Manhattan. This situation is expected to worsen only slowly, due to the slow growth in non-airport traffic and to the availability of alternate routes for most travelers. The airport is also currently operating at its airside capacity, and it is unclear whether the airside or the ground access system most constrains airport capacity and air travel.

Solutions to the access problem have been proposed recently, but no action has been taken. Capital programs proposed to increase capacity incude a highway connector from the Brooklyn-Queens Expressway to the airport and a people-mover system connecting the airport to existing public rail transport serving the New York region.

New York--John F. Kennedy International Airport

The John F. Kennedy International Airport (JFK) is the largest of the three major air carrier airports serving th New York metropolitan area. It is by far the most active U.S. port of entry and exit for international travel and international air cargo. In 1976, it handled some 21 million passengers and employed some 40 thousand ground and flight personnel.

The airport is located in th southern section of Queens County, New York, on Jamaica Bay. Primary access to the airport is via the Van Wyck expressway, a north-south highway which connects to most of the east-west highways in the New York region. Just north of the airport is the Southern Parkway, part of the "Belt System" of highways which surrounds Queens and Brooklyn. Access to the airport is also available directly from local streets in the vicinity.

The case study analysis identified ground access constraints on the capacity of JFK due to traffic congestion on the Van Wyck and Long Island Expressways. Both of these expressways are on the primary route to Manhattan, and the Van Wyck is on the primary route to the Bronx and the Westchester County and Connecticut suburbs. The Southern Parkway, handling the traffic to eastern

Long Island is also congested, but it was not analyzed because it carries less than 25% of the air passengers (although it carries a considerably higher percentage of the employees working at the airport).

Solutions proposed to deal with the access constraints include the completion of the Nassau Expressway, widening of the Southern and Laurelton Parkways, and the construction of a rail link to JFK plus a passenger distribution system within the CTA. The highway improvements are expected to cost about $85 million, and the rail system is expected to cost about $470 million. Although the impact of these alternatives on ground access has not been quantified in this case study, the Tri-State Regional Planning Commission believes that their implementation would relieve the access constraint through 1995.

New York--Newark International Airport

Newark International Airport is one of three major air carrier airports serving the New York Metropolitan area. In 1976, it served 6.8 million passengers, of which less than 5% connected to other flights.

Located in New Jersey, less than fifteen miles southwest of Manhattan, Newark International attracts only about 8% of the passengers originating in Manhattan, and derives over 75% of its passengers from points in New Jersey. The Tri-State Regional Planning Commission, the MPO for the New York Metropolitan area, has proposed the increased utilization of Newark as a means to offset and reverse growing ground access problems at LaGuardia and Kennedy Airports. However, in order to increase the utilization of Newark, more passengers will have to be attracted from Manhattan.

The primary access route to Newark International is the New Jersey Turnpike, a north-south toll highway used by about 54% of originating passengers. The Turnpike serves New York City via several bridges and tunnels, and directly serves the fast-growing suburbs to the south of the airport. Capacity analyses show that the turnpike will not be a problem until the 1990's.

U.S. Route 21, serving about one-quarter of the originating air passengers, is expected to reach level of service "E" for over 200 hours per year in the early 1980's; however, it is expected that level of service "E" will not reach 1000 hours per year until after 1995.

If Newark International is to attract more passengers from Manhattan, analyses show that the Lincoln and Holland Tunnels will operate at level of service "E" for more than 200 hours per year until the late 1980's and for more than 1000 hours per year thereafter. This makes it unlikely that Newark can significantly reduce the loads on the access highway systems of the other New York airports. Proposals to resolve the problem of inadequate ground access between New York and Newark International have centered around improved transit and taxi access. One solution that received a lot of attention was proposed construction of a passenger distribution system connecting the terminal with a proposed PATH station near the airport. However, it now appears unlikely that the PATH system will be extended. Consequently, the best active proposals are now the improvement of shuttle bus service between the airport and Penn Station Newark and the reduction of taxi fees between New York City and the airport.

Pittsburgh--Greater Pittsburgh International Airport

Greater Pittsburgh International Airport is located 16 miles west of downtown Pittsburgh and is operated by the Allegheny County Department of Aviation. The Airport serves a metropolitan population of 2.4 million.

In 1976, the Airport served approximately 8 million enplaning plus deplaning passengers, and of this total approximately 43% were transfers from other flights. Passenger traffic is projected to grow at a rate of 5% annually during the next twenty years. General aviation activity comprises about 29% of total operations at the Airport.

Capacity analyses indicate that the Airport's airside components can handle forecasted passenger growth well into the future. However, ground access capacity may become a constraining factor, particularly along the Fort Pitt Tunnel near downtown Pittsburgh and the Airport Parkway - the major Airport access roadway. The Fort Pitt Tunnel provides inadequate carrying capacity which results in traffic bottlenecks and airport access delays during peak travel periods. The Airport Parkway, a four-lane divided arterial near the Airport, is required to carry all east-west traffic in the Airport area. The location of two at-grade intersections, located at the Airport Entrance and Carnot and Beers School Road will begin to constrain both airport and non-airport traffic in the early 1980's.

Plans to implement new and expanded highway which would have facilitated improved airport access have been dropped due to limited State-Federal funding. Plans to improve the existing transit system will have a minimal airport access impact. The County Department of Aviation has initiated the development of a new Master Plan to analyze proposed alternative airport improvements including the possibility of relocating the terminal. However, the possibilities for terminal relocation and roadway improvements are very uncertain at this time.

Portland, Oregon--Portland International Airport

Portland International Airport (PIA), operated by the Port of Portland, is located approximately six miles north-east of the Portland central business district. The airport, classified by the FAA as a "medium hub", serves over three million passengers annually, of which about 75% originate or terminate their trips in Portland.

The airport is accessed via city streets (primarily 82nd Avenue) which connect it to the interstate system. The Banfield Freeway, I80, runs east-west about three miles south of the airport and I5 runs north-south about four miles west of the airport. A semicircular highway to the east of Portland, I205, is being constructed, and will offer direct access to the airport from the interstate system. The expected completion date for I205 is 1982.

Currently, access to the airport is difficult for most travellers. Level of service "E" bottlenecks exist on the Banfield Freeway and on 82nd Avenue. The completion of I205 is expected to resolve the problem of access between the Banfield Freeway and the airport, thus removing the bottleneck at 82nd Avenue and offering an alternative to 82nd Avenue. Plans are also underway to widen the Banfield Freeway which would eliminate the remaining points of congestion.

Reno International Airport

Reno International Airport is located about four miles southeast of the Reno, Nevada Central Business District (CBD). In 1977, the airport handled 1.2 million passengers annually, more per capita than any city other than Las Vegas. The airport serves the resort cities of Reno, Sparks, and Lake Tahoe (which also has some commercial air service). Reno and Sparks have been developing at the rapid rate of about 10% annually, and this rate is expected to continue through 1983, with even more rapid growth in the near term.

Because of Reno's rapid development, the city's arterial road system has not been able to keep pace with traffic demands. The airport access system is no exception. Several elements of the access system are currently at level of service "E" for about four hours per workday, and most other elements are expected to suffer similar problems by the early 1980's. Capital and TSM improvements are possible, but funds are lacking and local officials have been unable to agree on priorities for the limited funds available.

Savannah Municipal Airport

The Savannah Case Study when originally proposed, was to address jurisdictional problems which may affect airport access. The case study is to be deleted for two reasons. First, and foremost, the jurisdictional problems in Savannah have been informally resolved, as indicated in Appendix A to the Preliminary Report. The lack of a formal resolution led us to believe, incorrectly, that stresses remained and that there was perhaps something interesting that could be extracted from the problem itself or its resolution. While the case supports our recommendations, the Case Study Synopsis of Appendix A (op cit) provides as much detail and information as is necessary.

The second reason that the Savannah Case Study was dropped was that the Case Study Methodology is not appropriate to Savannah. The problem in Savannah is not congestion in the primary road system but rather a geometrical constraint imposed on the airport access system by planned improvements in the airside and terminal systems.

Worcester Municipal Airport, Massachusetts

Worcester Municipal Airport is a non-hub airport located on a plateau to the northwestern limits of the City of Worcester and approximately 300 ft. above the CBD.

The airport currently serves approximately 50,000 annual passengers on six daily scheduled flights to Boston, Manchester, New Hampshire, and LaGuardia Airport in New York. This airport was included in the present study because of its potential role in the Massachusetts airport system.

Airport access is over a network of urban and rural roads. Level of Service E is encountered at several critical intersections on the way from Worcester to the airport. There are at present no limited access connectors to the nearest freeways, I-290 and I-90.

Because of its favorable location above the city and because of its excellent airside facilities, the airport could, in principle, share in the growing demand of Boston's Logan Airport. In practice, however, the access problem precludes any significant expansion of activities at Worcester. Access has been identified in Master Plan studies as a major problem for the airport. Because of conflicting priorities, however, access to the airport has not been acted upon in the Unified Work Program. An access study by the Airport Commission has resulted in proposed access routes to the nearest freeway I-290 which, in turn, connects the routes to the airport's potential market areas. Future activity at the airport will depend on intergrated aviation systems of highway planning in Eastern Massachusetts and on the acceptance by the public of access road construction to the airport.

III. CONCLUSIONS

A. General

1. Inadequate ground access capacity currently causes excessive delay (congestion) to the air traveler at 13 of the 16 airports studied. This number increases to 14 in 1995 even if improvements currently programmed are implemented. Table 3 shows a tabulation of these findings by case study airport. Level of service "D" at the 200th hour was used in determining access constraints.

2. Proposed access improvements at most airports have concentrated on major capital projects such as highways and rail transit. In part, this is because access problems are so severe that only major construction projects can relieve them. To a large degree, however, potential solutions involving Transportation System Management, pricing and service improvements have been hampered by jurisdictional problems and thus given low priority.

3. Currently, most airport access travel is via highways, and this will continue in the future. The dispersal of trip origins makes major transit investment impractical in most corridors leading to airports. However, funding for surface transportation is moving away from highways and toward mass transit. Therefore, airport access highway improvement projects often compete for a smaller portion of the available transportation funds than in the past.

4. For the most part, municipal governments support the funding of transportation programs which solve general local problems, such as local street repairs, CBD mass transit, etc. This tends to inhibit the implementation of off-airport ground access improvements which, unlike projects within airport boundaries, are heavily dependent on local priorities.

Table 3

Case Study Summary

Airport	Access Constraint: Current	Access Constraint: Future (Before 1995)
LaGuardia, New York, NY	X	X
John F. Kennedy, New York	X	X
Newark International, Newark, NJ		X
Miami International Miami, Florida	X	X
Fort Lauderdale/Hollywood International, Fort Lauderdale, FL	X	X
Los Angeles International Los Angeles, CA	X	X
Logan International, Boston, MA	X	X
Stapleton International Denver, CO	X	X
O'Hare International Chicago, IL	X	X
Cleveland Hopkins Cleveland, OH	X	
Greater Pittsburgh Internatioal Pittsburgh, PA		X
Reno International, Reno, NV	X	X
Standiford Field, Louisville, KY	X	X
Portland International Portland, OR	X	X
Ryan Field, Baton Rouge, LA		
Worcester Municipal, MA	X	X

B. Airport Specific

1. Baton Rouge--Ryan Airport

External access capacity is not a problem at Ryan, but improvements on the airport property to increase parking spaces and upgrade roadways are urgently needed. Traffic engineering improvements at the airport entrance (Harding Blvd. and the I-110 off ramp) should be considered in the future if congestion warrants. Major improvements to this intersection such as grade separation may be warranted in the long-range future if commercial operations remain at Ryan Airport.

2. Boston--Logan International Airport

Many low capital improvements have been proposed to improve the access system at Logan. These actions will alleviate the problem in the short term. However, they do not address the general urban congestion experienced on the Central Artery that are considered to be the major constraint to airport growth. Further investigation is warranted to assess the impacts of a third harbor crossing which appears to be the only solution proposed to date that can resolve the problem on a long term basis.

3. Chicago--O'Hare International Airport

Capcity analyses in the case study indicate that O'Hare's access problems occur away from the Airport, are mostly CBD-related and are caused by general urban traffic congestion.

Extension of rail transit to O'Hare will help in decreasing traffic from the "loop" and also in providing a "safety valve" for CBD-Airport trips in peak hours. Congestion problems for non-CBD trips may occur in the more distant future if improvements are not made.

4. Cleveland--Hopkins Airport

Access from the east and south is poor and proposed improvements which provide grade separated access to the airport from these directions are neccessary. The improvements, plus completion of I-480, should alleviate current and future access capacity problems at Cleveland Hopkins. Access from downtown is good and the transit system provides an important safety valve for potential future airport-CBD congestion.

5. Denver--Stapleton International Airport

The ground access problem at Stapleton is severe and currently under study. Proposed grade separation of Quebec Street, especially at 32nd Avenue, is the most reasonable and likely solution.

6. Los Angeles International Airport

Internal congestion problems present the most immediate impediment to air travelers using the ground access system. Construction of a two-level internal roadway system and improvement of the local roads in the airport vicinity have just been authorized and should provide adequate internal capacity in several years for up to 40 million annual passengers, thus shifting the problem to the external roadways. If environmental and local concerns can be overcome, completion of I-105 would probably alleviate the anticipated bottleneck on the road network. Remedies need also be sought for congestion on the San Diego Freeway north of the Santa Monica Freeway.

7. Louisville--Standiford Field

Currently, the major constraints to airport access are the bottlenecks experienced just north of the airport on the Watterson Expressway. Widening of the Watterson would increase access capacity and provide efficient flow for both airport and non-airport related traffic. The Jefferson Freeway, now under construction, will also help divert traffic from the Watterson thus providing additional capacity for airport related vehicles. The airport roadway and proposed internal improvements should provide adequate access through 1995.

8. Miami International Airport

Miami International currently has considerable access problems with potential future capacity constraints. The most immediate congestion problems occur on LeJeune Road and construction of a parallel arterial and improvement of the LeJeune Road interchange with the Airport Expressway will help alleviate this congestion.

Miami International has two distinguishing characteristics; the large number of employees working at the various parts of the Airport, and the large proportion of travelers going to Miami Beach, most of whom do not own cars. Decreasing vehicle trips by employees could be accomplished through subscription bus service, or in the long term, by connecting the future rail transit system to MIA. Evaluating the effectiveness of such services would require a tabulation of employee residence data. (This is not currently available.)

Improved public transportation can help serve the large proportion of air travelers (currently about 45%) going to a fairly concentrated area such as Miami Beach. Since it appears unlikely that rail transit will be built to the Beach, more extensive limousine or bus service to points along the Beach should be investigated.

9. Fort Lauderdale--Hollywood International Airport

Access is currently hindered by inadequate curb frontage and an airport entrance having a signallized intersection with a railroad grade crossing. Relocation of the passenger terminal is necessary to solve internal capacity constraints, but external access will still remain a problem because of congestion on I-95.

If room for expansion were available at the present site, then long-range solutions such as construction of a grade-separated interchange with multi-level curbspace might be appropriate. However, since it appears that the terminal area will be relocated in the future, short-term TSM solutions appear more appropriate to alleviate congestion at the current site. Capacity of the entrance intersection needs to be increased by providing more extensive turning lanes and revisions to current signal timing. Current limousine service might also be expanded so that it is convenient from more points in the Ft. Lauderdale-Palm Beach Area. In the long term, capacity on I-95 should be increased and/or the airport should be connected to the Florida Turnpike.

10. New York--LaGuardia Airport

Ground access to LaGuardia is currently impeded by congestion along the Grand Central Parkway. Improvements to the access system -- especially a proposed highway connector from the Brooklyn-Queens Expressway to the airport and a proposed transit connector from the New York City subway system and Long Island Railroad -- will be necessary to keep congestion to a manageable level.

11. New York--John F. Kennedy International Airport

Currently, ground access to JFK is difficult because of traffic congestion on the Van Wyck and Long Island Expressways. Proposed highway development including the widening of the Laurelton and Southern Parkways will directly improve access fromm Eastern Long Island and indirectly improve access from other points by diverting traffic from the Van Wyck. A proposal for possible development of direct rail access from Manhattan into the terminal area and a passenger distribution system within the CTA would provide some relief for the Manhattan passenger, and would also relieve congestion on the Long Island and Van Wyck Expressways.

12. New York--Newark International Airport

Ground access to Newark International is currently satisfactory for the population now served by the airport. However, if the airport is to expected to serve regional demand (along with LaGuardia and Kennedy Airports) by attracting a significant portion of Manhattan travelers, these travelers will face access constraints in congestion in the tunnels between Manhattan and New Jersey, and in the relatively high taxi fares between Manhattan and the airport. Reduction of Manhattan taxi fares and the improvement of transit access would increase the attractiveness of the airport to the public. Although it is currently very low on New Jersey's list of priorities, the extension of PATH past the airport would not only increase the attractiveness of the airport, but also expand its access capacity. In addition, continuation of the bus service between the airport and Penn Station Newark ("Airlink") is warranted.

13. Greater Pittsburgh Airport

Access from most non-CBD points in the area is adequate. Capacity is constrained from the CBD in peak hours because the Fort Pitt tunnel is a major congestion point. The previous solution proposed to bypass this congestion was a busway on new right-of-way between the Airport and downtown. This project, like most others in the area, has been dropped due to lack of state funds. This project appears to be far down on the list of local priorities and a smaller scale project may be more appropriate. A section of busway in the West End area which would bypass the tunnel would solve the major problem, and buses could then be routed on to the Penn-Lincoln Parkway.

Moderate congestion occurs in the immediate vicinity of the Airport due to lack of a grade-separated interchange. Such an interchange is needed, particularly if relocation of the air terminal will not occur until well into the future.

14. Portland, Oregon--Portland International Airport

Internal access requirements are expected to be sufficient to handle projected demand beyond the study period (1995). Relief from the existing congestion of 82nd Avenue is expected with the opening of I205 in 1982. However, it is unlikely that the opening of I205 will directly relieve congestion on the Banfield Expressway. Based on this analysis, widening of the Banfield Expressway is required in order to provide adequate ground access to PIA.

15. Reno International Airport

The city of Reno is facing a major urban traffic problem precipitated by the dynamic growth in the hotel-casino industry and a general trend of increasing tourism. Extension of US395 from Mill Street to Virginia Street is the single most effective solution under consideration, offering a bypass to congestion south of the airport on Virginia Street and Kietzke Lane. Improved access for the CBD can be achieved to some extent by improvements to the existing roadway system and increased use of multi-passenger vehicles.

16. Worcester Municipal Airport

Ground access from the main market areas to the south and west is over congested city streets and intersections. Proposed solutions now under study involve a connector to the limited access highways I-290 and I-90. Additionally, negotiations are underway to extend city bus service to the airport.

SUPPLEMENT A

CAPACITY ANALYSIS METHODOLOGY

CAPACITY ANALYSIS METHODOLOGY

The Use of Capacity

The ground access system at each case study airport was evaluated by comparing the capacity of critical access highways to airside capacity and to the demand imposed by air passengers.

Capacity can be generally defined as the physical ability of a system to handle a given volume of traffic (vehicles, aircraft, pedestrians, etc.) and is in widespread use for three reasons. The first, and perhaps most important one for airport planners, is that it presents an absolute criterion for assessing whether a given demand can be handled; thus it provides a strong argument for action whenever forecast demand exceeds capacity. Second, the impacts of inadequate capacity can be quantified economically through the estimation to delay, estimation of trips postponed to other-than-desired hours, and estimation of trips cancelled. Third, airport and transportation planners are used to thinking in terms of capacity because that is the way in which the adequacy of airfield, highways and transit facilities have traditionally been measured. Indeed, even the Congressional language directing the FAA to undertake this study reflects this viewpoint:

"... a comprehensive study on the constraints imposed on air travel and airport capacity by inadequate ground access..."

From the Federal perspective, the capacity measure is an appropriate one. Through the Airport Development Aid Program, the Government spends millions of dollars every year to help expand the capacity of airports to meet forecasted growth. Nevertheless, a 1974 FAA study[1] indicated that the exisiting access system to many airports will be saturated long before this capacity will be utilized. In short, attention to the airport system has exceeded attention to the access system with the result that much of the airport capacity will remain unutilized.

In this study, access capacity and airport capacity are defined as volumes of air passengers that can be handled by the off-airport ground access and airfield systems, respectively, without signficantly affecting the unconstrained behavior of air passengers, air carriers, and other users of the highway and transit systems. Where demand and airport capacity exceed access capacity, the inadequacy of the access system is defined and measured by the number of hours in which this situation exists.

1/ MITRE Corporation FAA Report on Airport Capacity. (NTIS: Springfield, VA). May 1974.

It is recognized that airfield and ground access capacity expressed in terms of person trips are necessarily elastic concepts and are related to behavioral and economic as well as physical constraints. For example, an airport's airside capacity could be increased greatly if all aircraft were large jets completely full of passengers arriving at evenly-spaced intervals throughout the day. Likewise the airport's ground access capacity could be increased if all users took high-occupancy vehicles (HOV's) such as buses and scheduled their travel during off-peak periods. However, major capacity increases along these lines would require significant deviation in current user behavior whether the user be air passenger, airport employee or airline and such changes have not been assumed in this study.

On the ground access side, capacity considers current and definitely programmed highways and transit facilities. It assumes no deviation from current modal split, vehicle occupancy or use of the most convenient route to the airport.

Capacity Comparison

In each study, the ground access capacity, airside (primarily airfield) capacity and forecasts of air passengers are expessed in terms of annual air passenger (enplaned plus deplaned).

The comparison is shown graphically in five year increments between the present and 1995 (see Attachment A). Through this method, it can readily be observed when the airport's capacity is constrained by ground access or by airside conditions, and when passenger demand is forecast to exceed one or both of these constraints.

A separate graph was prepared for each highway deemed critical for access to the airport (generally those carrying at least 25 percent of airport bound traffic). While is would have been simpler to aggreate capacity of the entire ground access system, it could also have been misleading, since the capacity of some routes may never be utilized because airport users are not coming from that direction. Some of the airport have rail transit access, but transit capacity could not be considered as a constraint in any of the case studies.

All three factors have been expressed in terms of annual air passengers. While passenger forecasts are commonly expressed in annual passengers, both airside capacity and ground access capacity must be converted. The source of data and methods used for such conversions are explained in the remainder of this supplement.

Air Passenger Forecasts

Forecasts of annual air passengers are avai:albe in airport master plans, FAA Terminal Area Forecasts and often in other sources. When more than one recent forecast was available, both forecasts were plotted.

Airside Capacity

Airside capacity is defined in the study as the practical annual capacity of the airfield (PANCAP) as specified in the Airport Capacity Handbook (Airborne Instrumbents Laboratories, June, 1969, pp. 15-1 to 15-16). The practical annual capacity of an airport is reached when the annual average delay per aircraft reaches a pre-determined acceptable level. For example, the capacity techniques permit a 5-minute average delay for 4% of the Annual operations.

The actual computational procedures required to develop the PANCAP for each runway configuration are described in the Airport Capacity Handbook. These procedures determine the practical annual capacity of the airport after consideration of the following variables:

- PHOCAP (practical hourly capacity of each runway configuration).
- Frequency of use of each runway configuration, based on analysis of historic meteorological data.
- The average delay per aircraft and overload criteria (e.g. 4 minutes) to be used for the capacity analysis

PANCAP is then converted to annual passengers by multiplying by three factors:

1. Percent of annual operations made by air carrier aircraft
2. Average seats per aircraft
3. Enplaned load factor

The percent air carrier figure was obtained, where possible, from the airport master plan. If not available, it was calculated by assuning a reduction in general aviation operations as demand approaches airfield capacity. Average seats per aircraft will increase as aircraft sizes increase, and this factor is almost always available in the master plan.

The enplaned load factor is equal to the average number of seats occpied by enplaning (or deplanning) passengers at a given airport. A range of load factors have been assumed; the lower range is the current load factor over the year. The higher range is equal to the current load factor plus ten percent; reflecting more efficient aircraft use as demand approaches airfield capacity.

The analysis takes into account airfield capacity increases due to programmed airfield and ATC improvements having a high probability of implementation. It does not consider increases due to institutional changes such as an imposed spreading of peak activity.

Ground Access Capacity

The objective is to calculate the number of annual passengers at which the particular highway segment under study will reach capacity at given level of service during various peak periods. This involves calculating the capacity of the highway segment that is available for airport traffic and then converting this capacity from vehicles to annual air passengers. Mathmatically, thus may be shown as follows:

$$GAC = (HC - NAT) \times \left(\frac{EP + DP}{AT} \right) \div PER$$

Where:

GAC = Total ground access capacity of the airport in terms of annual air passengers based on capacity constraint for a given highway.

HC = Two-way daily highway capacity expressed in vehicles per day for particular level-of-service.

NAT = Non-airport related average two-way daily traffic on the access highway.

EP = Current annual enplaning passengers (including transfers).

DP = Current annual deplaning passengers (including transfers).

AT = Current average daily traffic entering and departing the airport.

PER = Percent of airport traffic carried on the given highway.

The first element in parenthesis (HC-NAT) calculates capacity available for airport traffic on the highway segment. The second element converts capactiy for vehicles per day to annual air passengers by applying the current ratio of annual air passengers to daily vehicles (EP & DP/AT). The third element (PER) converts the capacity on a given highway to total access capacity by dividing by the percentage carried on that particular highway.

Details of the process are explained in the remainder of this section and sample calculation and plots are shown in Attachements A and B.

1. Identification of highways critical to air access

Highways carrying or expected to carry a high percentage (usually over 25 percent) of total airport-bound traffic were identified. Initially airport traffic was assigned to area highways based on the trip origins of air passengers and employees. Generally, these data are available from surveys conducted at the airport.

2. Calculation of the total daily vehicular capacity of critical highways

The next step was calculation of the daily vehicular capacity (average daily traffic) available on the highways identified in step 1. Hourly oneway highway capacity was calculated at levels of service "D" and "E". These levels of service is in Highway Capacity Manual (HCM) (Highway Research Board, Special Publication 87, 1965), as follows:

> "Level of service D approaches unstable flow, with tolerable operating speeds being maintained, though consisderably affected by changes in operating conditions. Fluctuations in volume and temporary restrictions to flow may cause substantial drops in operating speeds. Drivers have little freedom to maneuver, and comfort and convenience are low, but conditions can be tolerated for short periods of time."

> "Level of service E cannot be described by speed along, but represents operations at even lower operating speeds than in level D, with volumes at or near the capacity of the highway. At capacity, speeds are typically, but not always, in the neighborhood of 30 mph. Flow is unstable, and there may be stoppages of momentary duration."

Level of service "D" is commonly used to identify points at which existing urban highways need to be upgraded, supplemented, etc. Level of service "E" provides the maximum hourly throughput of vehicles.

Three basic types of situations were encountered: limited-access freeways, urban arterials, and signallized intersections. The hourly capacity of limited-access highways was obtained from Table 9.1 of the HCM- and adjusted for percent trucks as shown in Table 9.3b. The capacity of urban arterials was obtained from Table 10-1 of the Manual and then arbitrarily reduced by one-third to account for traffic signals and the affect of frequent access and egree points. The capacity of critical intersections was obtained from Figure 6.8 of the HCM and adjusted using methods described in Chapter 6.

Hourly capacity at service levels "D" and "E" was convereted to average daily capacity by applying ratios of average daily traffic to peak hour traffic depending on the number of hours in a year that such traffic would be exceeded. Calculations were made for the year's 30th highest, 200th highest and 1,000th highest hours. Ingeneral, only the 200th highest hour (the daily peak hour) was plotted graphically.

3. Calculation of highway capacity which is available for airport traffic

Traffic not destined for the airport was subtracted from capacity at levels of service "D" and "E" to obtain the highway capacity available for airport traffic. Non-airport traffic was calculated by subtracting curent airport-destined traffic from current daily traffic count data. Current airport-destined traffic was calculated through traffic count data at airport entrances and exits. These volumes were then assigned to major access highways based on the shortest trip time from the origin and destination zones identified in Step 1. Current non-airport traffic was projected into the future (based on regional forecasts or an assumed annual growth rate) and then subtracted from the daily highway capacity calculated in step 2 to obtain future average daily highway capacity available for airport-bound vehicles.

4. <u>Conversion of available highway capacity in vehicles per day annunal air passengers</u>

The capacity of each critical highway expressed in average daily traffic (ADT) was converted to capacity in terms of annual air passengers by multiplying by the current ratio of annual enplaning and deplaning air passengers to ADT entering and exiting the airport entrances. It was assumed that this ratio would not change significantly in the future, although this was adjusted in certain cases, such as Chicago O'Hare where major transit improvement's have been programmed. The annual air passenger capacity of a given highway was converted to annual passengers by dividing by percentage of traffic on the critical highway.

The ADT used for the conversion was almost always counted at the principal airport entrance but not at every possible entry to the airport property. Therefore the ADT considers air passengers, visitors and employees using the main entrance. Employees and others entering at remote areas on the airport property are, therefore, considered as non-airport traffic.

SUPPLEMENT B

AIRPORT CASE STUDIES

RYAN AIRPORT

BATON ROUGE

CASE STUDY

CASE STUDY SUMMARY

Ryan Airport is located approximately seven miles north of downtown Baton Rouge. Annual passenger enplanements plus deplanements on air carrier airlines in 1976 were 368,000 while general aviation accounted for an additional 90,000 total passengers. The current external surface access network of interstate highways and major arterials results in good airport access, allowing essentially non-stop travel via Interstate Highways I-10 and I-110 between the Baton Rouge Central Business District (CBD), the south and east portions of East Baton Rouge Parish, and the Airport.

Baton Rouge's current access probems are mostly experienced inside the Airport boundary and primarily relate to roadway and parking lot conditions rather than capacity. These problems will be relieved by implementation of recently-funded internal roadway and parking improvements recommended in the current Airport Master Plan.

Access is generally good outside the Airport because I-110 leads virtually to the entrance of the Airport--and is used by the vast majority of Airport users. Capacity on I-110 is likely to be sufficient for at least another 15-20 years. Traffic from areas to the east of Baton Rouge currently experiences problems because of congestion on Airline Highway (U.S. 61). However, this traffic comprises a fairly small percentage of total airport trips (about 10 percent). Relief to this highway is planned through traffic engineering improvements and construction of an outer belt highway as a reliever route.

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RYAN AIRPORT - BATON ROUGE

A. BACKGROUND

1. General

Ryan Airport is located within East Baton Rouge Parish (County) approximately seven miles north of downtown Baton Rouge (see Figure 1). Originally constructed and used as a military airfield during World War II, Ryan Airport is managed by the East Baton Rouge Parish Airport Commission and provides air carrier and commuter airline services for the Baton Rouge area (1970 SMSA population - 406,374), comprising East Baton Rouge, West Baton Rouge, Iberville, Ascension and Livingston Parishes. In addition, Ryan Airport handles substantial amounts of general aviation traffic.

Regularly scheduled flights are provided by three airlines - Texas International, Delta, and Southern Airways. Commuter flights to New Orleans are provided by Gulf Coast Airlines. Annual passenger enplanements and deplanements on air carrier airlines in 1976 were 368,000, an increase of almost 20 percent over 1975. General aviation accounted for an additional 90,000 total passengers in 1976.

It is estimated that about 1/2 of the potential passenger traffic for Ryan Airport actually uses Moisant Field in New Orleans because of better flight frequency. Moisant is located 65 miles from downtown Baton Rouge on I-10.

In the long term, consideration is being given to relocation of commercial operations away from Ryan Field, because of limited room for expansion and adverse environmental impact to adjacent properties. A 1976 study (Reference 6) recommended three sites in East Baton Rouge Parish but all were rejected locally. The State Department of Transportation plans to fund a new site-selection study.

2. Transportation Planning Structure

Transportation planning for the Baton Rouge Region is conducted under the auspices of several agencies. The Louisiana Department of Transportation and Development, which includes a division of aviation, provides transportation planning at the State level. The Capital Region Planning Commission (CRPC) is designated the Metropolitan Planning Organization (MPO) for the Baton Rouge area and provides transportation as well as extensive land-use planning for the Metropolitan area. In addition, local planning is provided by the Baton Rouge Planning Commission and Department of Public Works. Transportation projects developed and recommended by these agencies are made to the Tranportation Policy Committee, comprised of elected officials from the Baton Rouge urbanized area, who assume local decision-making responsibilities for the approval or disapproval of transportation related work.

The CRPC "Comprehensive Plan of The Capital Region" incorporates and coordinates the programs and plans for Ryan Airport with other land-use and

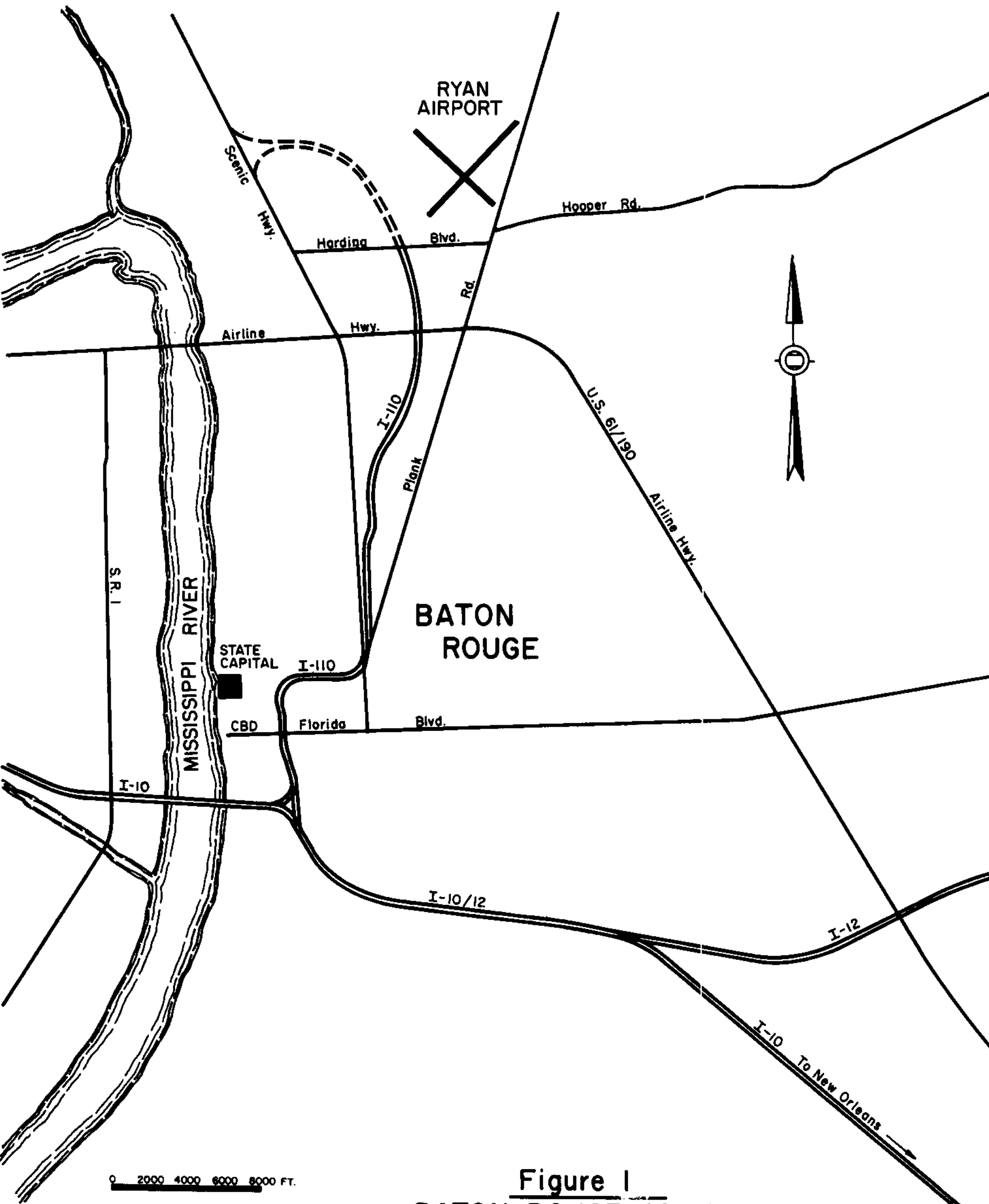

Figure 1
BATON ROUGE AREA

transportation projects and plans for the Baton Rouge area. Coordination of local transportation programs at the Federal level is essentially provided by the Intermodal Planning Group (IPG) which reviews the Region's unified work program.

Discussion with local officials indicated that CRPC has concentrated on highway and transit (particularly transit) planning and has initiated little in the area of aviation planning. The best medium for intermodal airport access planning appears to be at the State level, where aviation planning has recently been integrated with planning for other modes.

3. Highway Access

The current network of interstate highways and major arterials result in good access between Ryan Airport property and downtown Baton Rouge. The completion of Interstate Highway 110 to a temporary terminus at Harding Boulevard provides an exit directly onto Airbase Avenue and allows essentially non-stop travel via Interstate Highways I-10 and I-110 between the Baton Rouge Central Business District (CBD) the south and east portions of East Baton Rouge Parish and the Airport. Access time between the CBD and Ryan Airport via I-110 is ten minutes. However, congestion is experienced getting off the ramp to Ryan Airport since all traffic on I-110 currently exits at this ramp.

Airport access is also provided by several major arterials: Scenic Highway (Rt. 51) from the northwest, Airline Highway (Rts. 61 and 190) from the southeast and Plank Road (Rt. 67) from the northeast, although access along several of these routes is somewhat restricted due to congestion associated with strip commercial development. This does not present a major problem to the Airport on Plank Road and Scenic Highway, since airport-bound traffic from the north is quite small. However, congestion on Airline Highway is more significant since it serves the fast-growing eastern area of the Parish.

4. Transit Access

Access to Ryan Airport is predominately by private automobile. Taxis, limousines, and motel bus-vans comprise a small percentage, 12% of the airport access mode. Regularly scheduled public transit service is not provided. Buses run on Harding Boulevard, near the Airport entrance, but do not enter the Airport.

5. Internal Access

Virtually all airport traffic enters Ryan at the intersection of Harding Boulevard and Airbase Avenue (see Figure 2) and then uses 8th Street and 4th Street to the terminal. Airbase Avenue also serves industrial development which is located on part of the former Air Force Base. Deficiencies along this route include poor separation of terminal and industrial traffic and substandard horizontal alignment. Parking for 330 autos is provided in the terminal area in two unpaved and heavily rutted lots.

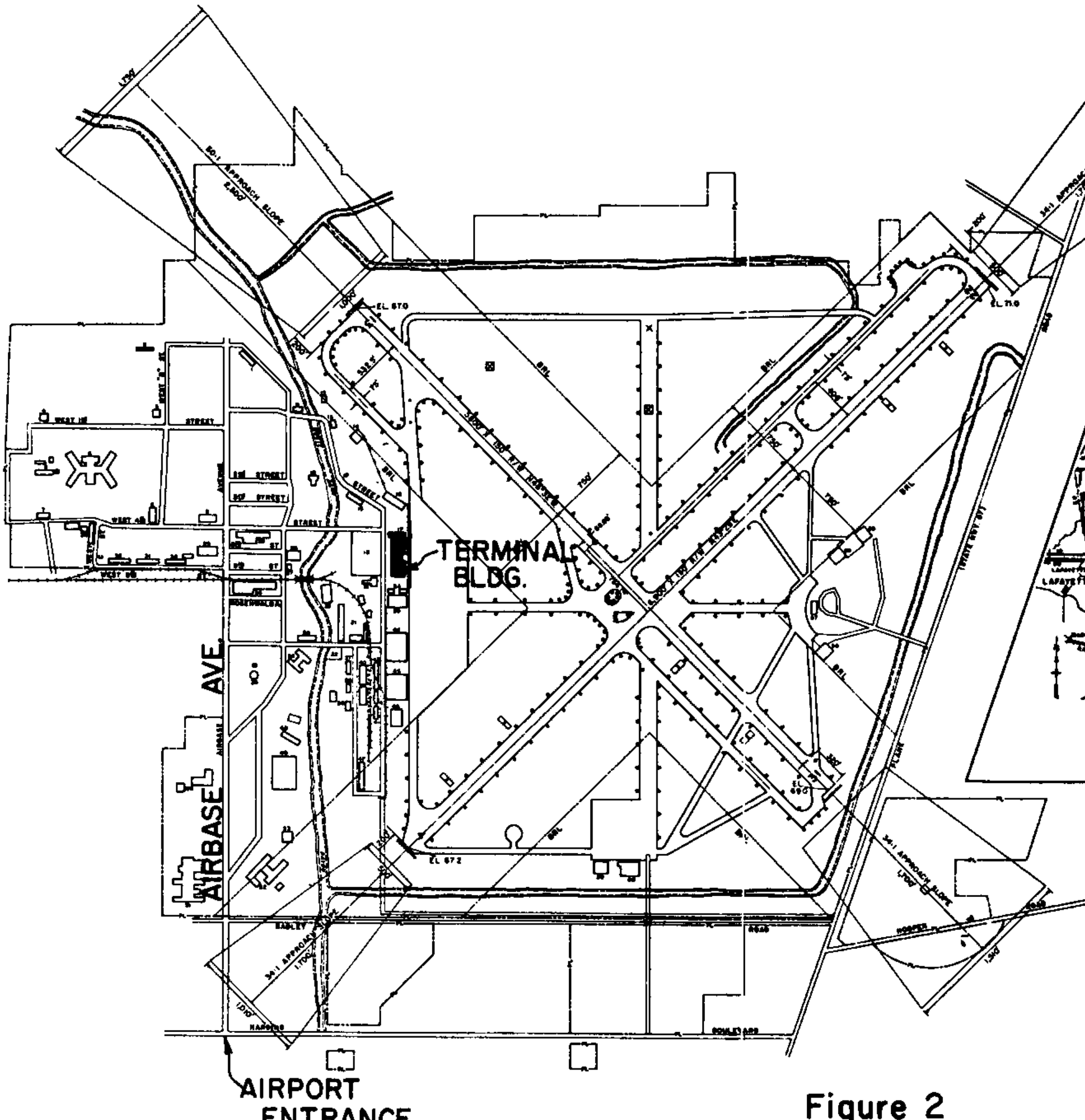

Figure 2
INTERNAL ACCESS

RUNWAY DATA

	Runway 13 Existing	Runway 13 Future	Runway 31 Existing	Runway 31 Future	Runway 4 Existing	Runway 4 Future	Runway 22 Existing	Runway 22 Future
[illegible]	[illegible]		5,9[illegible]		6,900		6,900'	
[illegible]	[illegible]		150		150		150	
[illegible]	[illegible]		-.09		.06		-.06	
[illegible]	[illegible]		5[illegible]4[illegible]		66 60		56.65	
[illegible]								
[illegible]								
[illegible]	[illegible]		MIRL		MIRL		MIRL	
[illegible]	[illegible]		NO		NO		NO	
[illegible]	[illegible]		34:1		34:1		34:1	
[illegible]	[illegible]		ASR		ASR		ASR	
[illegible]	[illegible]		1,000		500'		500'	
[illegible]	[illegible]		1,75[illegible]		900'		900'	
[illegible]	[illegible]		2,5[illegible]		2,000		2,000'	
[illegible]			320		0		0	

AIRPORT DATA

	EXISTING	FUTURE
AIRPORT ELEVATION (MSL)	71.0	
REFERENCE POINT (ARP) LAT [illegible]	[illegible]	
MEAN MAX TEMP OF HOTTEST MONTH	92.3°F	
AIRPORT AND TERMINAL NAVAIDS	ASR	
CLASSIFICATION	AIR CARRIER	
CRITICAL AIRCRAFT	B727-200	
[illegible] (LBS)	250,000	
TOTAL AREA (FEE TITLE) IN ACRES	1150	

BUILDING LEGEND

1	BATON ROUGE GUN CLUB & SKEET RANGE
2	PISTOL RANGE
3	JUNIOR DEPUTIES AND CORRAL
4	POLICE PISTOL RANGE & K-9 TRAINING CTR
5	JAIL ANNEX
6	PARISH PRISON
7	PRISON CANNERY
8	BUILDING VACANT
9	BUILDING VACANT
10	HOUSE
11	ATLANTIC INSULATION
12	BUILDING VACANT
13	STORAGE BUILDING
14	AERO TRANSPORT CO
15	BUILDING VACANT
16	AIR CARGO BUILDING
17	RYAN AIRPORT TERMINAL BUILDING
18	TERMINAL PARKING LOT
19	HERTZ CAR RENTAL
20	MILES-HOLLOWAY INC, BATON ROUGE AIRCR
21	MAINTENANCE YARD
22	AVIS CAR RENTAL
23	TRI METAL FABRICATION
24	[illegible] FURNITURE
25	BUILDING VACANT
26	INDUSTRIAL SANDBLASTING CO
27	BUILDING VACANT
28	NUGENT STEEL CO
29	DELTA FIELD INC
30	INSULATION SALES AND SERVICE
31	BATON ROUGE PRESSWAY
32	BESTWAY EXPRESS LOUISIANA DOOR CO
33	BUILDING DEMOLISHED
34	WILLIAMS-MC WILLIAMS INC
35	WATER TOWER
36	COMMUNITY ADVANCEMENT
37	STORAGE BUILDING
38	EXXON
39	FLOYD ELECTRICAL INC
40	WAY REFRACTORIES
41	INSULATION PRODUCTS
42	BUTLER FURNITURE
43	[illegible] FURNITURE
44	BATON ROUGE AIRCR. [illegible] FLYING SERVICE
45	BATON ROUGE AIRCR. [illegible] FLYING SERVICE
46	DUNHAM HANGER
47	[illegible] CHEMICAL CO
48	STORAGE BUILDING
49	LOUISIANA ARMY NATIONAL GUAR
50	ARMY RESERVE CENTER
51	FAMILY COURT
52	NAVY RESERVE CENTER
53	DIRECTOR'S HOUSE
54	FIRE STATION AND SECURITY OF
55	STATE HANGER
56	STATE HANGER
57	[illegible] COBB AIRCRAFT SALES
58	[illegible] COBB HANGER
59	LOUISIANA AIRCRAFT INC.
60	LOUISIANA AIRCRAFT INC

Parking lot and roadway construction to improve these conditions have recently been approved for funding by the FAA.

B. CAPACITY ANALYSIS

1. Passenger Forecasts

Passenger forecasts were taken directly from the recently completed Airport Master Plan (Reference 1). Passengers generated by general aviation operations have been added to air carrier and commuter totals because they comprise a large proportion of total passengers at BTR. Forecasts are shown in Table 1.

2. Airside Capacity

The airside capacity of BTR in terms of annual passengers was calculated by using data contained in the Master Plan. Again, passenger capacity considered air carrier commuter airline and itinerant general aviation operations. Practical Annual Airfield Capacity (PANCAP) was multiplied by the percentage of operations in each category and the average number of passengers per operation to obtain annual passenger capacity for each type of operation. These numbers were then added to provide total annual passenger capacity. Unlike most of the other case-study airports, forecasts of seat capacity and enplaning load factor were not available for BTR. Consequently, a range of load factors was not used and airside capacity was calculated as a single forecast.

In all years, airfield capacity exceeds passenger forecasts at BTR. If additional passenger capacity is required, it might be possible to divert general aviation operations to other local airports and to increase air carrier and/or commuter operations.

3. Ground Access Capacity

Only one highway, I-110, handles a significant proportion of airport-bound trips and therefore, capacity analysis was restricted to I-110 south of the Airport*.

Growth rate for non-airport traffic was taken from current and forecast 1990 traffic volumes taken from Reference 2. Traffic growth on I-110 was forecast to increase at an annual rate of 4 percent. Vehicle capacity available for airport trips was converted to air passengers by multiplying by the ratio of 1975 air passengers to 1975 airport ADT (406,000/1,350=300) and dividing by the proportion of traffic on each access road (I-110=87%) - The calculations are given in Appendix B. The results are shown graphically in Figure 3.

*The intersection of the Airport entrance, Harding Boulevard, and the I-110 off-ramp might provide a constraint on capacity in the future. However, sufficient data were not available to analyze this intersection.

TABLE 1

Forecast of Annual Air Passengers

	1975	1980	1985	1995
Enplaning Passengers	(Actual)			
Air Carrier	154,400	237,800	328,600	484,100
Commuter Airlines	3,008	4,840	6,600	9,680
General Aviation	45,580	101,250	140,800	205,000
TOTAL	202,988	343,890	476,000	698,780
Total EP & DP (millions)	0.40	0.69	0.95	1.40

TABLE 2

Calculation of Airside Capacity

Term	PANCAP (1)	Operation Type	Percent of Ops. (2)	Average Pass. Per Operation (2)	Annual Pass. Cap.
1975	180,000	AC	14.2	22.2	567,400
		CA	4.5	1.4	11,300
		GA (I)	42.4	2.2	167,900
		Total			746,600
1980	192,500*	AC	10.5	28.3	572,000
		CA	2.7	2.2	11,400
		GA (I)	50.5	2.5	243,000
		Total			826,400
1985	205,000*	AC	10.5*	38.8	716,800
		CA	2.4*	3.0	14,800
		GA (I)	47.0*	3.2	308,300
		Total			1,039,900
1990	217,500*	AC	10.6*	38.8*	894,500
		CA	2.3*	3.8*	19,100
		GA (I)	48.0*	3.6*	375,800
		Total			1,289,400

Term	PANCAP 1	Operation Type	Percent of Ops.	Average Pass. Per Operation	Annual Pass. Cap.
1995	230,000	AC	10.7	44.2	1,087,700
		CA	2.2	4.4	22,300
		GA (I)	48.7	4.1	459,200
		Total			1,569,200

LEGEND

AC = Air Carrier

CA = Commuter Airline

GA (I) - Itinerant General Aviation

*Interpolated

(1) Source: Ref. 1, Table 3.32

(2) Source: Ref. 1, Table 3.24

DEMAND/CAPACITY RELATIONSHIP
INTERSTATE 110 SOUTH

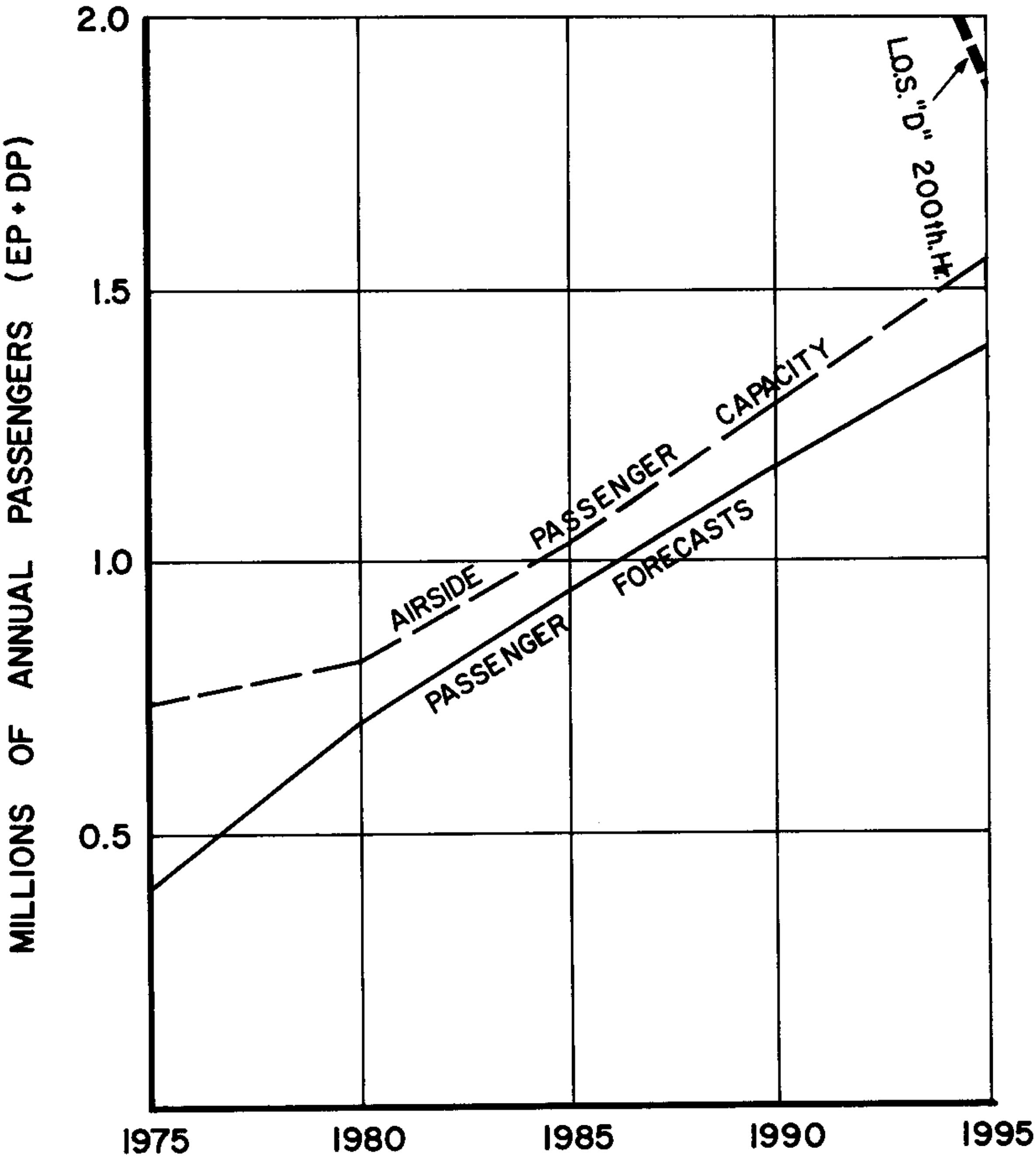

FIGURE 3

4. Interpretation

I-110 South: Figure 3 shows that capacity for airport traffic at a good level of service is available on I-110 beyond 1990. The slope of the curve for ground capacity is steep because airport traffic comprises a very small percentage of traffic on I-110.

C. PROPOSED SOLUTIONS

Table 2 lists currently planned solutions to access problems. The current major airport access problems occur on the Airport property itself and are proposed to be alleviated by reconstruction of Airbase Avenue and associated roads from Harding Boulevard to the terminal area.

Other highway solutions are not necessarily intended to improve airport access, but will help relieve problems. Extension of I-110 past the Airport to Scenic Highway will reduce traffic which now must exit at Harding Boulevard because it is the last I-110 exit. Traffic engineering (TSM) improvements are planned for Airline Highway to relieve congestion. Proposed construction of an Outer Belt highway about 3 miles outside of Airline Highway would serve as an alternate circumferential route and reduce traffic on Airline Highway.

D. CONCLUSIONS

Baton Rouge's current access problems are mostly experienced inside the Airport boundary and primarily relate to roadway and parking lot conditions rather than capacity. These problems will be relieved by implementation of recently-funded internal roadway and parking improvements recommended in the current Airport Master Plan.

Outside the Airport, access is generally good because I-110 leads virtually to the entrance of the Airport--and is used by the vast majority of Airport users. Capacity on I-110 is likely to be sufficient for at least another 15 - 20 years. Traffic from areas to the east of Baton Rouge currently experiences problems because of congestion on Airline Highway (U.S. 61). However, this traffic comprises a fairly small percentage of total airport trips (about 10 percent). Relief to this highway is planned through traffic engineering improvements and construction of an Outer Belt highway as a reliever route.

It appears that the only potential area of long-range concern could be the entrance to the Airport off Harding Boulevard. However, available data were insufficient to determine if an at-grade intersection at that location would cause any long-term problems. Also, since there is some uncertainty as to the long-term use of Ryan Airport, improvements involving major capital expenditures such as grade-separation at the entrance would not appear appropriate at this time.

TABLE 3

Proposed Solutions to Airport Access Problems

PROPOSED SOLUTION	INITIATOR	AGENCY RESP. FOR IMPLEM.	FUNDING SOURCES	EST. COST (MILLIONS)	STATUS
A. CONSTRUCTION					
1. I-110 Extension (Harding Blvd. to Scenic Hwy.)	State D.O.T.	State D.O.T.	Local and Federal	32.5	Final Design
2. Outer Belt Hwy.	*	State D.O.T.	*	*	Planning
3. Airbase Avenue Reconstruction	Airport Master Plan	State D.O.T.	FAA	1.8	Preliminary Design
B. TRANSPORTATION SYSTEMS MANAGEMENT					
1. Improvements to Airline Highway	CRPC	State D.O.T.	*	*	Planning

*Not Available or Unknown

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In summary, BTR does not currently have major external capacity problems and is not likely to have any for many years. The roadway and parking improvements planned inside the Airport boundary will solve the current access problems and should be sufficient until decisions on possible airport relocation are made.

APPENDIX A

ASSIGNMENT OF CURRENT AIRPORT GROUND TRIPS

Data showing a distribution of Airport users' origins and destinations were not directly available for BTR. Trips were assigned using past data on Baton Rouge resident air-travelers trip origins from a 1970 study by Arnold Thompson & Associates, Inc., and from discussions with the past Airport Manager. The resulting distribution is given below in Table A-1.

TABLE A-1

Distributions of Airport Access Trip Origins

Zone	Location	Percent of Trips
1	Ryan Airport and North	2%
2	West of Airline Highway/North Florida Boulevard	2%
3	State Capitol/Industry Area	40%
4	Downtown	25%
5	L.S.U.	18%
6	West of Downtown	5%
7	West of L.S.U.	2%
8	West of Airline Highway/South of Florida Boulevard	5%
	Total	100%

Traffic on I-110 was assumed to comprise all trips from Zones 3, 4, 5 and 7 and 1/2 from Zone 6. This accounted for 87 percent of all airport-bound trips.

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

The hourly traffic capacity for I-110 was read directly from the right-hand side of Table 9.1 of the Highway Capacity Manual, assuming a PHF = 0.91. To account for trucks - 5% on this highway - Table 9.3b of the HCM was used to get a T factor of .95. This was then converted to a daily VHC by dividing the hourly capacity by the peak hour percentage. Peak Hour (K) factors of 11.0% for the 30th highest hour, 9.6% for the 200th highest hour, and 7.4% for the 1,000th highest hour were used.

TABLE B1

AIRPORT ACCESS CAPACITY

I-110 (South)

L.O.S. (1)	Hrs./Yr (2)	Factor (3)	YEAR 1977 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	84,600	84,600	84,600	84,600	84,600
		2	45,215	50,870	61,900	75,280	91,600
		3	39,385	33,730	22,700	9,320	-
		4	13.6	11.6	7.8	3.2	-
	200	1	97,000	97,000	97,000	97,000	97,000
		2	45,215	50,870	61,900	75,280	91,600
		3	51,785	46,130	35,100	21,720	5,400
		4	17.9	15.9	12.1	7.5	1.9
	1,000	1	125,800	125,800	125,800	125,800	125,800
		2	45,215	50,870	61,900	75,280	91,600
		3	80,585	74,930	63,900	50,520	34,200
		4	27.8	25.9	22.0	17.4	11.8
E	30	1	103,600	103,600	103,600	103,600	103,600
		2	45,215	50,870	61,900	75,280	91,600
		3	58,385	52,730	41,700	28,320	11,000
		4	20.1	18.2	14.4	9.8	3.8
	200	1	118,800	118,800	118,800	118,800	118,800
		2	45,215	50,870	61,900	75,280	91,600
		3	73,595	67,930	56,900	43,520	27,200
		4	25.4	23.4	19.6	15.0	9.4
	1,000	1	154,000	154,000	154,000	154,000	154,000
		2	45,215	50,870	61,900	75,280	91,600
		3	108,785	103,130	92,100	78,720	62,400
		4	37.5	35.6	31.8	27.2	21.5

1] Per Highway Capacity Manual

2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

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4. Air Transportation in the Capital Region, Capital Region Planning Commission, August, 1968.

5. Environmental Statement Hoo-Shoo-Too Airport Site, Capital Region Planning Commission, July, 1971.

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7. Baton Rouge Metropolitan Area Transportation Study - Annual Report - Fiscal Year 1976, Louisiana Department of Highways.

BOSTON - LOGAN

INTERNATIONAL AIRPORT

CASE STUDY

CASE STUDY SUMMARY

Logan International Airport is located just east of the Boston, Massachusetts central business district (CBD). The ground access problem at Logan is amplified by the separation of the CBD from the airport by Boston Harbor. Primary routes to the airport through the CBD are heavily traveled and presently perform at, or are rapidly approaching, unacceptable levels of service, especially during peak hours. In 1975, about 11.0 million annual passengers (MAP) generated an estimated 62,500 daily vehicle trips to and from the airport; most projections expect demand to approximately triple by 1995. This increasing demand will place severe burdens on routes already operating at unacceptable levels of service, unless meaningful corrective measures are implemented.

Airside capacity at Logan is expected to be sufficient to handle passenger demand. However, future airport capacity could be seriously limited by the ground access system if the current levels of service are not improved. The low-capital programs initiated to reduce vehicle trips to the airport will not solve the problem of rapidly decreasing capacity due to increasing ambient traffic on the access road system. Programs designed to increase tunnel and airport road capacities or to improve rapid transit access, although contributing to the solution, are not in themselves sufficient.

Ground access to Logan Airport is primarily a general urban problem. Capital alternatives for dealing with this problem are desirable, but they face opposition due to economic, environmental, and social considerations. Current proposals aimed at short-term benefits may prove temporarily helpful, but the scope of the problem demands a concrete, long-range solution. The proposed third harbor crossing or a remedy of similar magnitude would be necessary to alleviate current and future congestion problems on the major airport access routes.

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BOSTON-LOGAN INTERNATIONAL AIRPORT

A. BACKGROUND

1. General

Logan International Airport is located just east of the Boston, Massachusetts CBD, and separated from it by Boston Harbor (see Figure 1). It is purported to be the eighth busiest airport in the world. In 1975, commercial airlines enplaned and deplaned some 11.0 million passengers at Logan. Logan is by far the busiest airport in New England and serves as the principal gateway for air service to five states. The airport is operated by the Massachusetts Port Authority, an agency of the Commonwealth of Massachusetts.

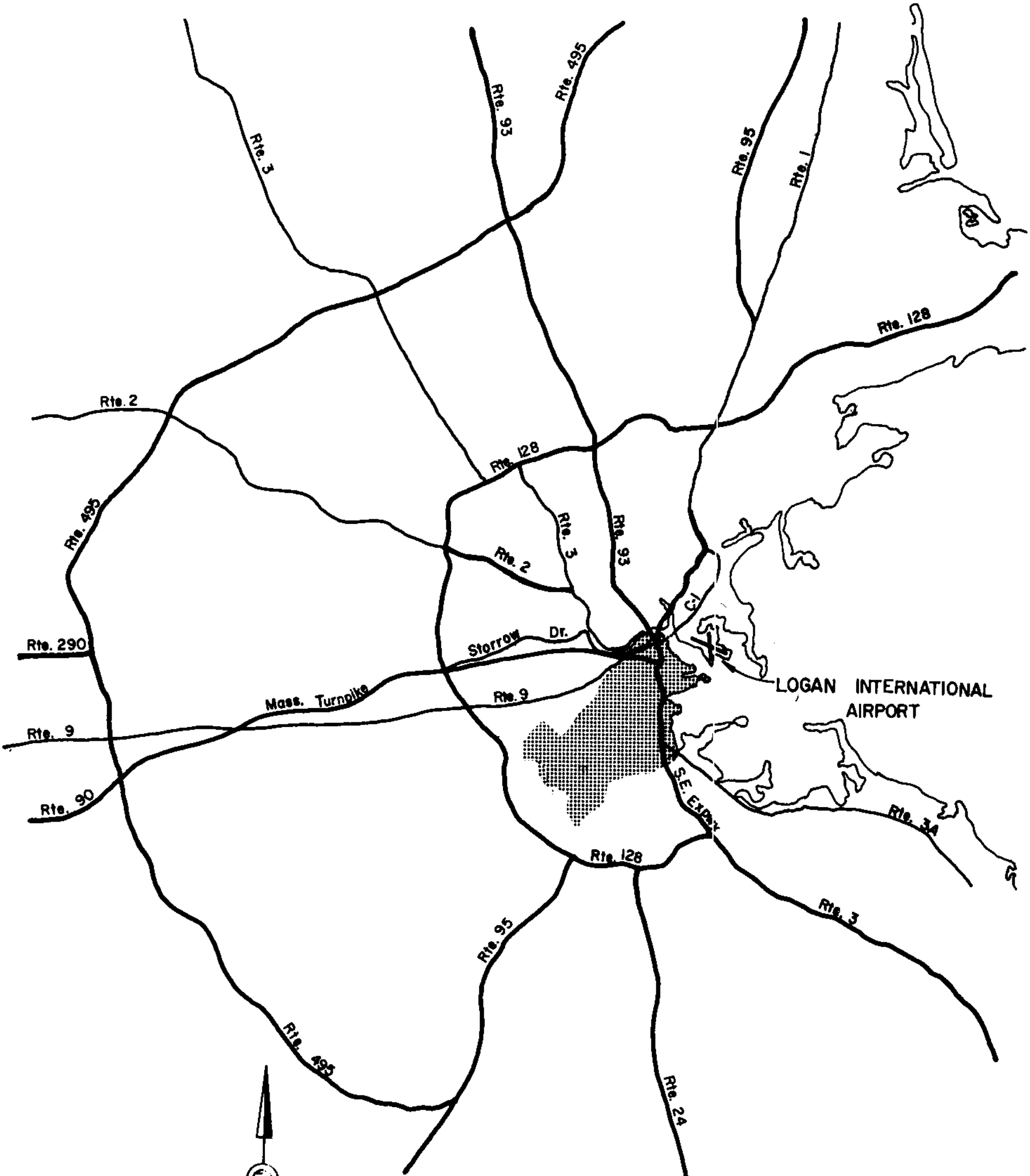
The most recent Draft Master Plan Study for Logan (1975) predicts that without air traffic control improvements the airport will operate at or near its airside capacity through 1985, and that if such improvements are made the airport will operate significantly below capacity. By contrast, the study finds that the major airport access routes will run out of capacity before 1980. It thus finds that, "the greatest single threat to the continued full functioning of Logan Airport may arise out of the prospective inability of passengers to get to and from it without serious delay and inconvenience." The draft plan also cites airport noise and community relations as problems and the continued concern of airport management.

2. Transportation Planning Structure

Airport access planning is not generally initiated from one centralized group. Rather it is a combined effort of local and Federal organizations to plan and implement actions necessary for efficient maintenance and development of intermodal ground access. In Boston, the Massachusetts Turnpike Authority, the Massachusetts Port Authority, and the Central Transportation Planning Staff, as well as various community groups and airport interests, are involved in transportation planning.

In 1973, an intermodal planning group (IPG) was developed representing the Federal Highway Administration (FHWA), the Urban Mass Transportation Administration (UMTA), the Federal Aviation Administration (FAA), the Federal Railroad Administration (FRA), the National Highway Transportation Safety Administration (NHTSA), and the United States Coast Guard (USCG). The IPG works with a planning agency comprised of the State Executive Office of Transportation and Construction (EOTC), the Massachusetts Bay Transportation Authority (MBTA), the MBTA Advisory Board, the Metropolitan Area Planning Council (MAPC), and the Department of Public Works (DPW).

These various agencies and organizations, involved with ground access, maintain individual approaches to the problem depending upon their modal orientation, jurisdiction, and responsibilities. It appears that most groups agree that Logan Airport is a major source of traffic generation in the



Figure

BOSTON REGION

metropolitan area. However, due to community and economic constraints no major access proposals are currently being implemented.

3. Highway Access

Figure 2 shows the principal highway access system serving the airport. Some 82% of the passengers reaching Logan Airport by ground mode use the heavily congested Sumner/Callahan Tunnels under the Boston Harbor. As a measure of the extent of this congestion, a recent update of the Federal Highway Administration's continuing airport access analysis program indicated that travel time from CBD to Airport was 19 minutes during peak periods while only 12 minutes in off-peak periods.

An alternate approach to the airport is over the Mystic-Tobin Bridge (I95) which is the only other harbor crossing. However, access between the bridge and the airport is over local city streets. Because of this, and because the tunnel route is much more direct, almost all air passengers use the Sumner/Callahan Tunnels. Although the Mystic-Tobin Bridge does provide an important alternative for non-airport traffic crossing Boston Harbor, it is also heavily congested. A third harbor crossing south of the tunnels has been considered but is unlikely to be built in the near future because of environmental concerns.

Feeding the Sumner/Callahan Tunnels at the Boston end is the Central Artery, a short congested urban highway with closely spaced access/egress ramps, narrow lanes, and steep grades. The Southeast Expressway serves the southern suburbs and sections of Boston. The Massachusetts Turnpike serves the western, southwestern and northwestern suburbs of Boston. Storrow Drive serves Cambridge, Brookline, western and downtown parts of Boston, and near-in western suburbs. Interstate 93 serves the northwestern and northern suburbs of Boston. The northeastern suburbs of Boston (the so-called North Shore) reaches the airport directly from U.S. Route 1 without having to traverse either the tunnels or the Central Artery.

4. Transit Access

Logan Airport is served to the airport boundary by the Blue Line of the Massachusetts Bay Transit Authority (MBTA) rapid rail system, and between the airport boundary and the terminal buildings by MBTA bus. The bus headway is seven minutes and bus fare is 25¢. Passengers from northern, western, or southern suburbs, and most passengers from downtown Boston have no direct access to the Blue Line, and most transfer to it from other lines. Thus, at least two transfers are required of most public transit riders to reach the airport. The rapid rail cars are not equipped with racks for luggage. Nevertheless, almost seven percent of air passengers use rapid rail for airport access.

5. Internal Access

Figure 3 shows the internal access roadway system at Logan. The major internal access road is a three-lane loop with an exit to parking facilities (over 7,000 long-term spaces). All terminals are served by separate loops

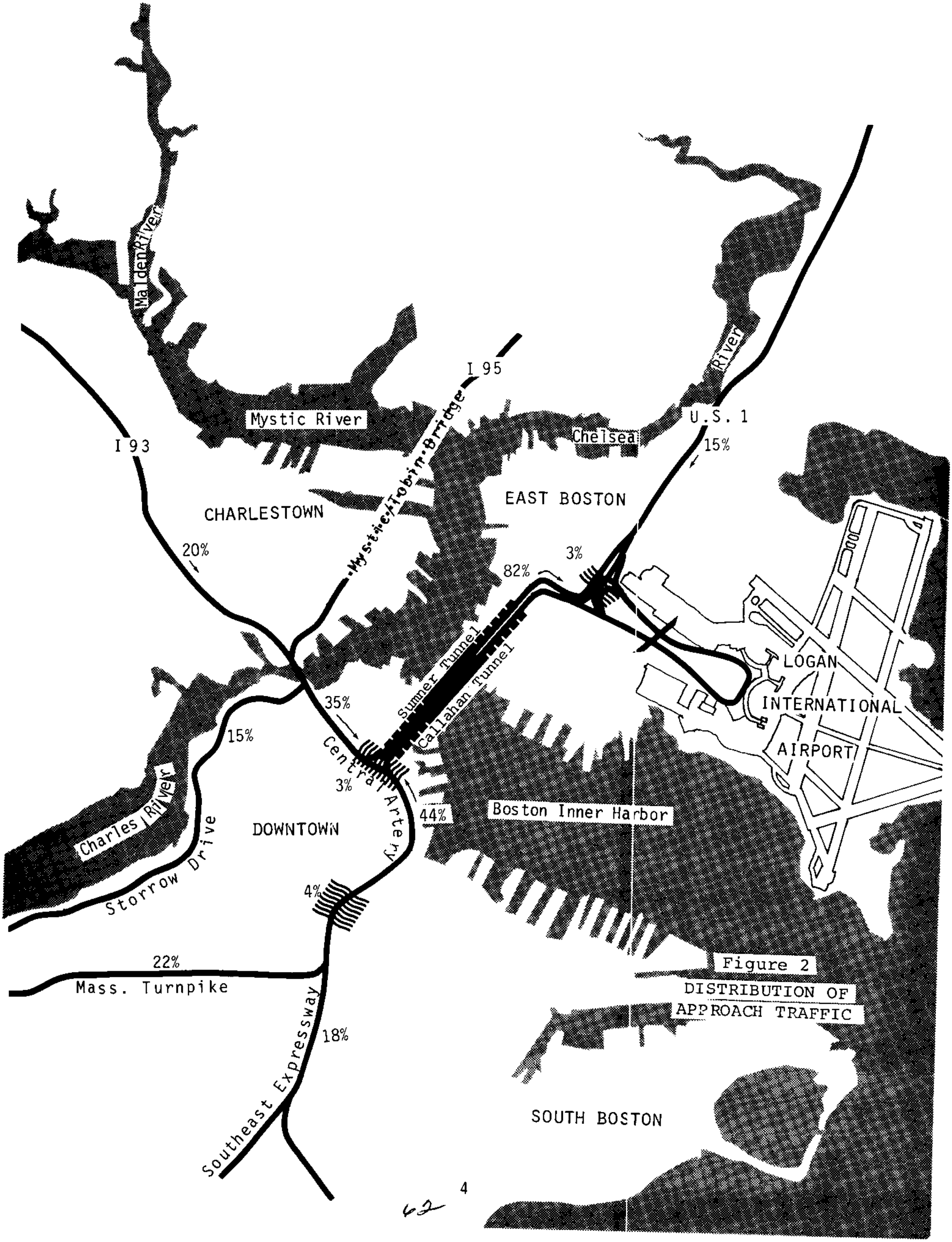


Figure 2
DISTRIBUTION OF
APPROACH TRAFFIC

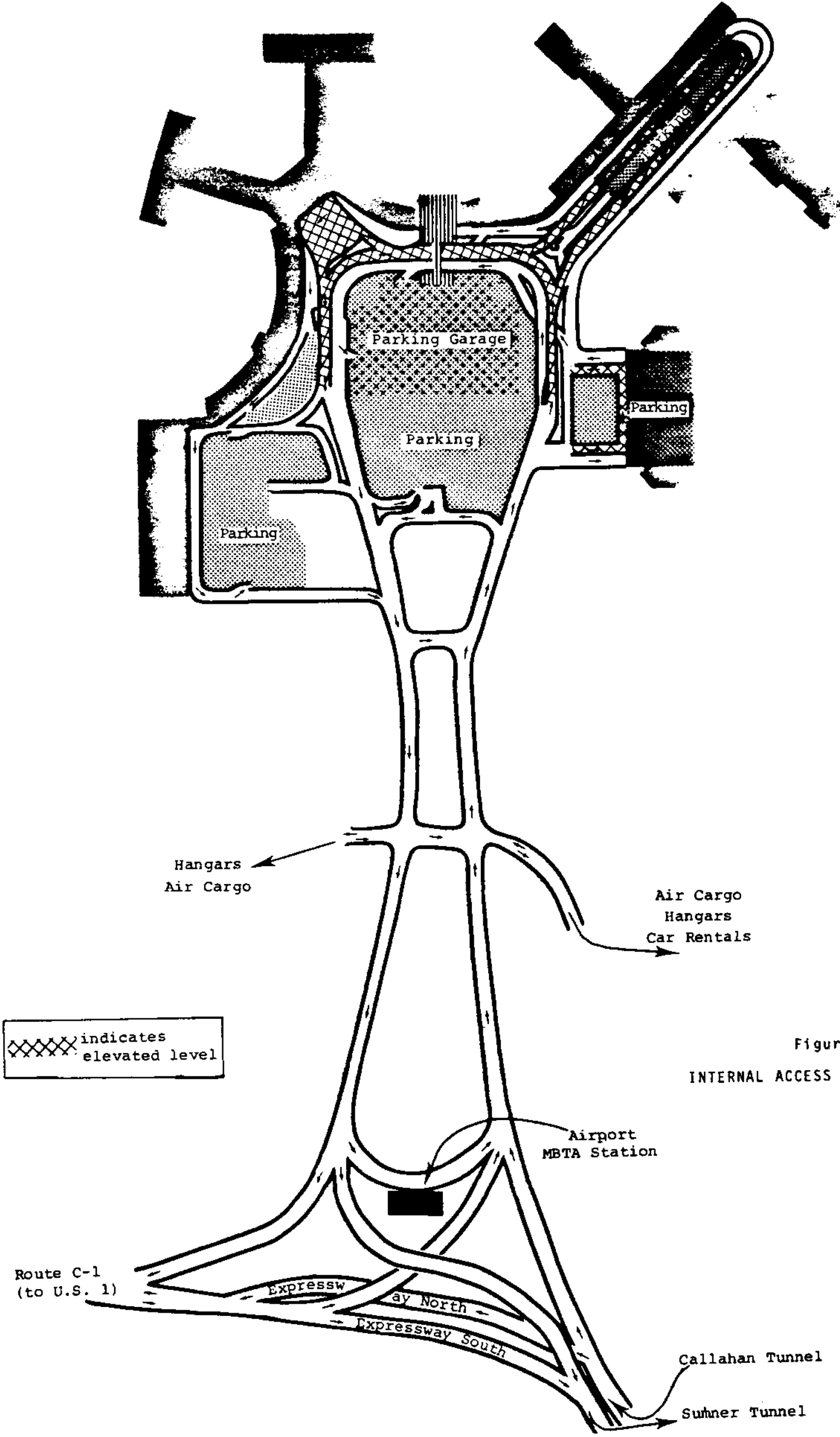


Figure 3

INTERNAL ACCESS ROADWAY SYSTEM

63

emanating from the main loop. Each of these except the roadway serving the international terminal is divided into arrival and departure lanes which meet the terminal at different levels. In addition, short-term parking is provided near the individual terminals.

B. CAPACITY ANALYSIS

1. Passenger Forecasts

Two passenger forecasts are presented in this study: one is of the FAA forecast from 1978 to 1988 (see Reference 14); the other is the forecast developed in the 1975 draft master plan after consideration of earlier forecasts (Reference 1, 6, and 7). The FAA forecast extends only to 1988 and is projected to 1995 at the 1983-1988 growth rate. The draft plan's forecast extends only to 1985 and is projected to 1995 at the 1980-1985 growth rate. Table 1 presents the extended forecasts.

2. Airside Capacity

The 1975 draft master plan presents two estimates of PANCAP, one assuming ATC improvements and one assuming no ATC improvements. These estimates through 1985 have been extended to 1995 assuming that PANCAP will remain constant beyond 1985. The airside forecasts assume that general aviation operations will remain constant at 17%.

PANCAP was converted to annual passengers by applying factors for percent air carrier operations, available seats per operation, and enplaning load factor (LF). Two load factors were used: the current annual load factor of 53% and the current load factor plus 10%. This differs somewhat from the assumption of the draft master plan which forecasts load factors to increase at an annual compounded rate of 1.75 percent per year to 1985. We have assumed, following the draft master plan, that annual average aircraft size will increase at a 4% rate.

Table 2 shows the computation of passenger capacity to the year 1995.

3. Ground Access Capacity

Current airport ground trips were assigned to major highways as shown in Appendix A. Three critical highway locations were identified: the Sumner/Callahan Tunnel, the Central Artery north of the tunnels, and the Central Artery south of the tunnels. Non-airport traffic was projected at a 2% annual growth based on data of 1971 and 1972 (Sumner/Callahan Tunnels were projected at 1% annual growth as indicated in Logan Master Plan Draft, 1975). Vehicle trips available for airport use were converted to air passengers by multiplying by the

TABLE 1

FORECAST OF DEMAND

(MILLION ANNUAL PASSENGERS)

Year	Draft Master Plan Extended	FAA Extended
(1)	(2)	(3)
1975	11.0 1/	11.0 1/
1980	14.8	13.4
1985	19.3	17.6 2/
1990	25.2 2/	24.1 3/
1995	33.0 2/	31.2 3/

1/ Actual.

2/ Interpolated.

3/ Extended.

TABLE 2

CALCULATION OF AIRSIDE CAPACITY

	Year	PANCAP	% Air Carrier	Seats/ Operation	Annual Passenger Capacity (MAP) LF = .53	LF = .63
	(1)	(2)	(3)	(4)	(5)	(6)
With no new ATC						
	1975	290,600	83%	93.11	11.9	14.1
	1980	275,300	83	113.29	13.7	16.3
	1985	261,100	83	137.83	15.8	18.8
	1990	261,100	83	167.69	19.3	22.9
	1995	261,100	83	204.02	23.4	27.9
With improved ATC						
	1975	303,000	83	93.11	12.4	14.8
	1980	351,000	83	113.29	17.5	20.8
	1985	351,000	83	137.83	21.3	25.3
	1990	351,000	83	167.69	25.9	30.8
	1995	351,000	83	204.02	31.5	37.4

1970 ratio of annual passengers to average daily traffic (at Boston: 9,372,625/ 1/ 34,077 2/) and dividing by the proportion of airport traffic that is carried by each critical highway. These calculations are given in Appendix B. The resulting graphs for each critical highway are shown in Figures 4 through 6.

4. Interpretation

a. Sumner/Callahan Tunnels: As Figure 4 shows, these tunnels present a real congestion problem. They are currently operating at level of service E for over 1,000 hours per year, or nearly four hours per weekday. Airside capacity may also be a problem but only if load factors do not increase and ATC improvements are not made.

b. Central Artery: As Figures 5 and 6 show, the Central Artery presents the most severe congestion problem to the Logan-bound passenger, particularly in future years. Since the artery now operates at level of service E for some 1,000 hours per year, and since airport traffic is just a small portion of total traffic on the artery, small increases in ambient traffic will make it more and more difficult for air travelers to reach the airport.

C. PROPOSED SOLUTIONS

Table 3 indicates a number of proposals that would directly or indirectly alleviate the ground access problem at Logan Airport. Of the proposed solutions, none of the construction alternatives is currently under way, nor has any received final study and approval. Of the remaining proposals, none would greatly affect the capacity of congested bottlenecks identified in this study, and none would significantly reduce non-airport-related traffic. Consequently, in the near future, any improvement in the capacity of the airport access system will be due primarily to an increase in the occupancy of airport related vehicles. That is, the capacity of the access system for airport-related vehicles will probably decline as forecast in Section B; however, due to greater vehicle occupancy, the capacity for passengers will not decline as rapidly.

1/ Massport Master Plan Study Team. Draft Logan Airport Master Plan. Sept. 1975.

2/ Coverdale and Colpitts. Logan Airport Travel Study. October 1972.

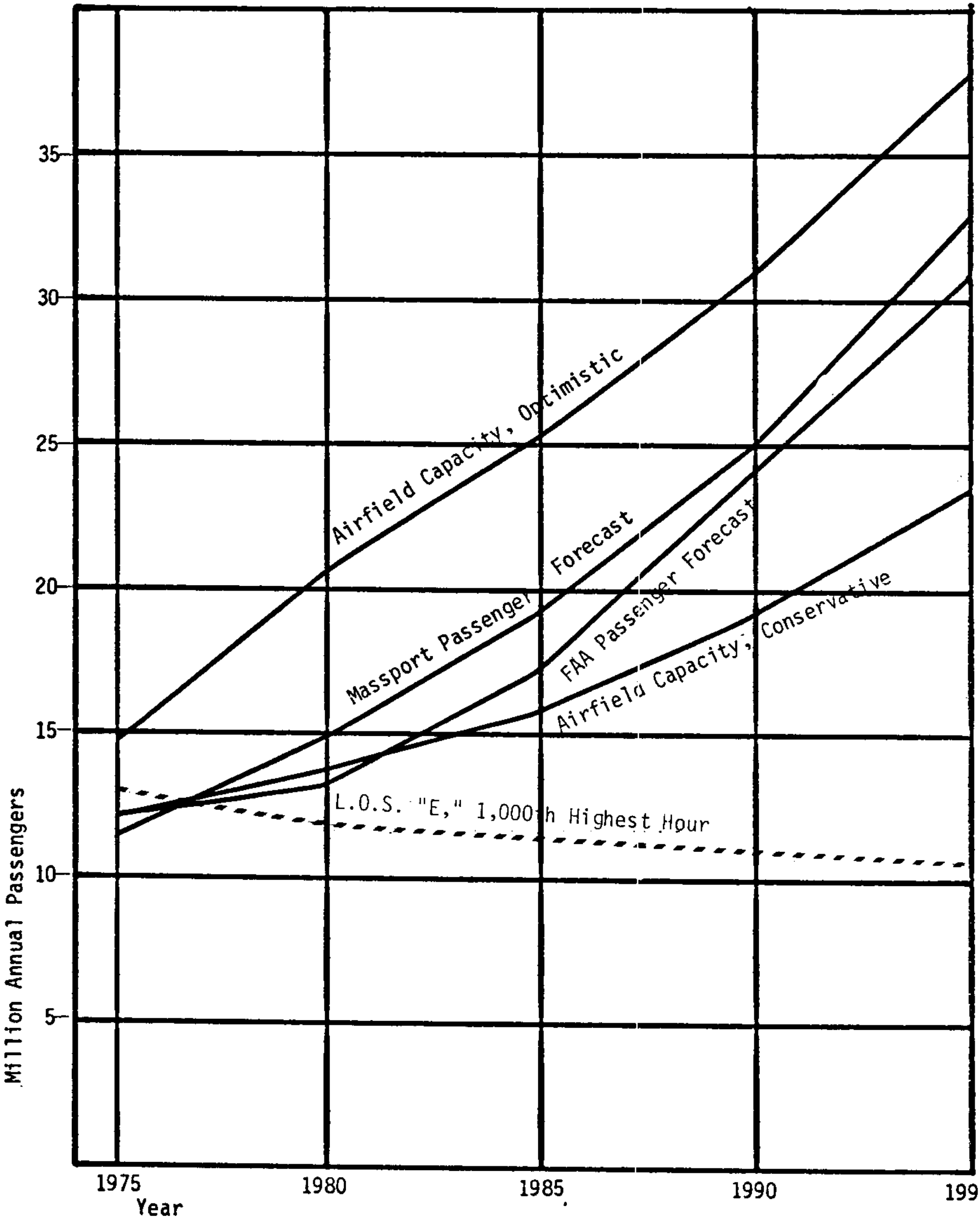


Figure 4

DEMAND/CAPACITY RELATIONSHIPS
Sumner/Callahan Tunnels

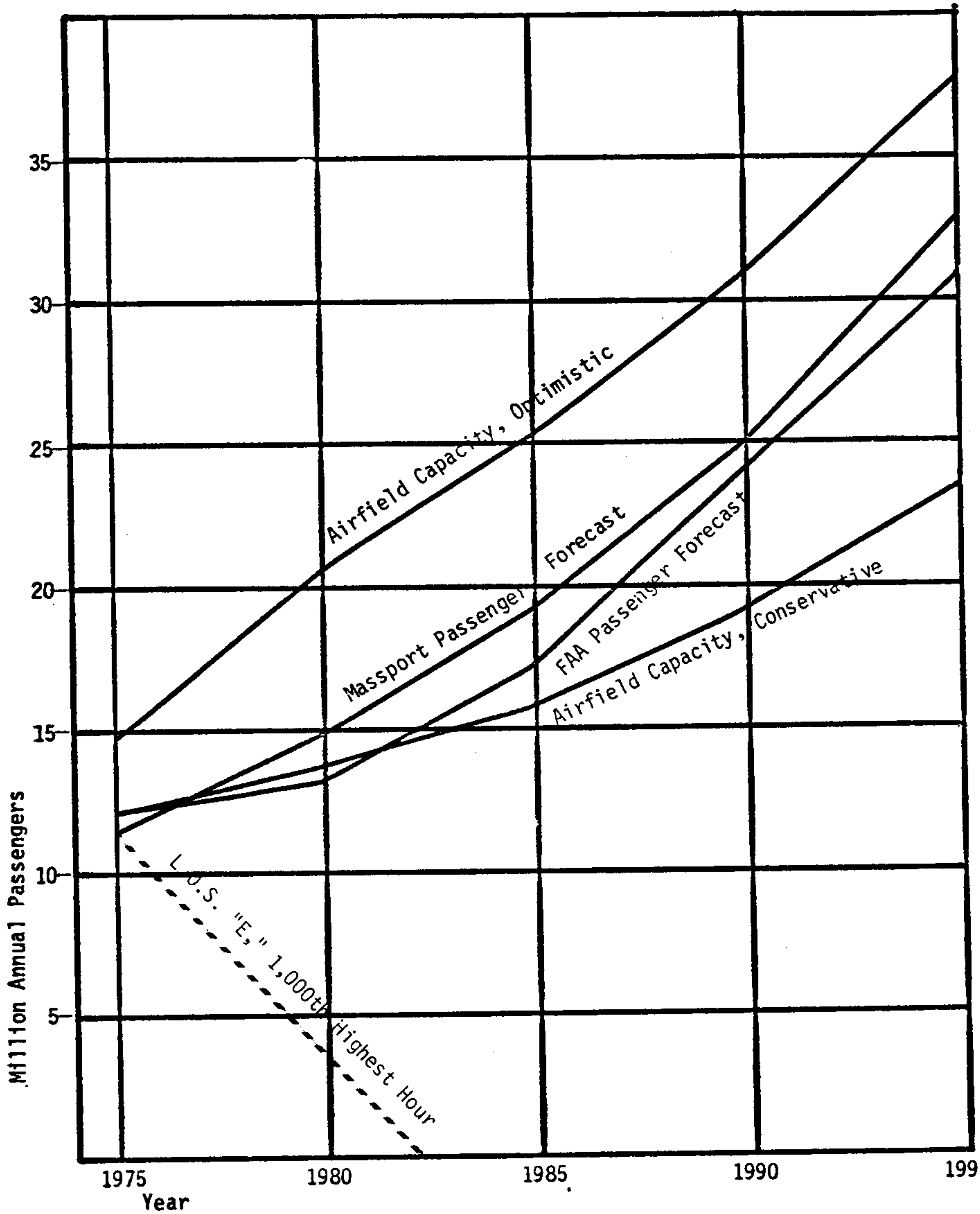


Figure 5

DEMAND/CAPACITY RELATIONSHIPS

Central Artery South

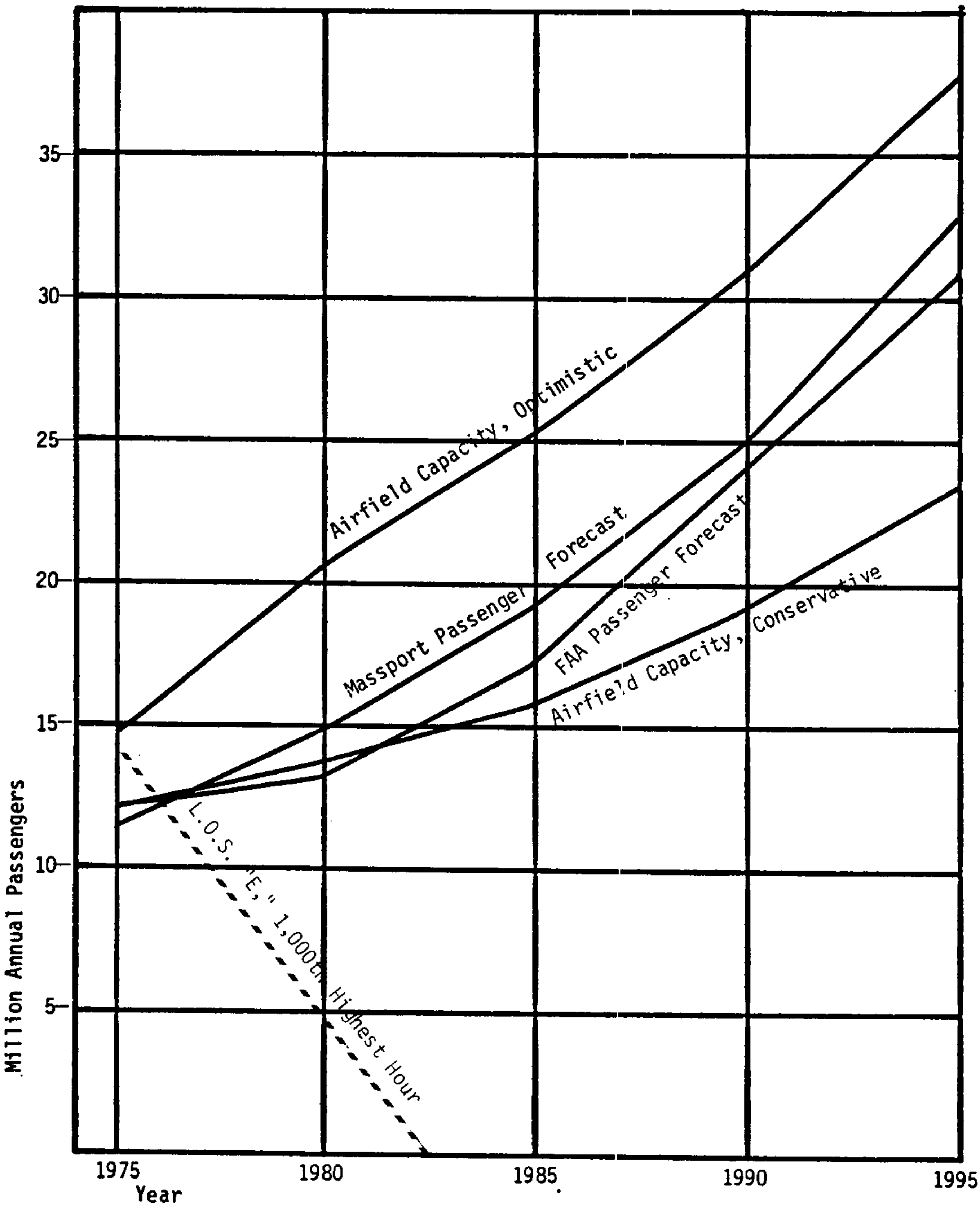


Figure 6

DEMAND/CAPACITY RELATIONSHIPS

Central Artery North

TABLE 3

PROPOSED SOLUTIONS TO AIRPORT ACCESS PROBLEMS

PROPOSED SOLUTIONS	INITIATOR	AGENCY RESP. FOR IMPLEM.	FUNDING SOURCES	ESTIMATED COST	STATUS
A. CONSTRUCTION					
1. Third Harbor Crossing	MTA, Massport	*	FHWA, bonds, tolls	*	To date has met with disapproval, major issues still to be resolved
2. Aircraft fuel supplied by pipeline rather than over-the-road trucks	Massport	Airlines, private industry	Private	*	Under negotiation
3. Major geometric improvements of the Sumner/Callahan Tunnel portals	MLDMP	MDPW, Massport, City of Boston	Tolls	*	Study needed
4. Extension of Blue Line rapid transit to North Shore	MDTA	MBTA	UMTA	$250 million	Under study
5. Fringe parking in suburbs expedited limo	MLDMP	Massport, MDPW, MDPU, MBTA, CTPS, private carriers	FHWA	$2.3-10.3 million	Needs legislation for licensing procedures - Inactive
B. TRANSPORTATION SYSTEMS MANAGEMENT					
1. Increased priority for multi-passenger vehicles on roads to and from the airport	MLDMP EPA	Massport, MTA, EPA	*	*	Inactive

*Not Available or Unknown

PROPOSED SOLUTIONS	INITIATOR	AGENCY RESP. FOR IMPLEM.	FUNDING SOURCES	ESTIMATED COST	STATUS
2. Improved road signs	MLDMP	Massport, MDPW	Massport Funds	*	Approval
3. Traffic Management in tunnels	MLDMP	MTA	*	*	*
4. Employee carpooling	Massport	Commonwealth of Mass. through Executive Office of Transportation, MDPW, and Massport	*	*	*
5. One way toll collections On Sumner/Callahan tunnels and Mystic River Bridge	Massport, MDPW, MTA	Massport, MTA	*	*	*
C. PRICING					
1. Flat rate access Toll on vehicles entering CTA	MLDMP	Massport	Self supporting	Zero	Inactive; waiting assessment of effectiveness of incentive programs to reduce proportion of single-occupant vehicles
2. Flexible Toll schedule based on type of vehicle or vehicle occupancy	MLDMP	Massport	Self supporting	Zero	Inactive; waiting assessment of effectiveness of incentive programs to reduce proportion of single-occupant vehicles
3. Increased parking rates	MLDMP	Massport	Self supporting	Zero	Approved and in effect

*Not Available or Unknown

PROPOSED SOLUTIONS	INITIATOR	AGENCY RESP. FOR IMPLEM.	FUNDING SOURCES	ESTIMATED COST	STATUS
D. SERVICE IMPROVEMENTS					
1. Improvements and expansion of bus and limousine service	Massport	Massport, private carriers, Boston	Private	*	Awaits new legislation expediting licensing process
2. Ferry Service	South Shore Chamber of Commerce	*	*	*	*
3. New Vehicles for Blue Line rapid transit	*	MBTA	UMTA	$31.5 million	Approved
4. Improved shuttle bus service from MBTA Blue Line Station to Logan by private operator	MLDMP	Massport, MBTA	Private	*	Bids to be solicited
E. RELOCATION					
1. Decentralization of Scheduled Air Operations	*	*	*	*	*
2. Car rental facilities in CTA	Massport	Massport, Boston	Private	*	Approved

*Not Available or Unknown

Key of Abbreviations:

CTPS = Central Transportation Planning Staff
EPA = Environmental Protection Agency
MBTA = Massachusetts Bay Transit Authority
MDPU = Massachusetts Department of Public Utilities
MDPW = Massachusetts Department of Public Works
MLDMP = Massport, Logan Draft Master Plan
MTA = Massachusetts Turnpike Authority

D. CONCLUSIONS

Boston-Logan International Airport currently has a severe access problem which is expected to become even worse in the near future. The findings of this study are in basic agreement with the 1975 Logan Airport Master Plan Study, insofar as ground access improvements are needed to serve today's existing levels of demand as well as any increases. Constraints imposed by the Sumner/Callahan Tunnels are those that have to date received the most attention and study. However, constraints imposed by the Central Artery are even more limiting, particularly if current non-airport traffic on the artery continues to grow at a rate of 2% in the future.

Many of the low capital improvements proposed such as improved limousine and bus service, carpooling, automobile disincentives, etc., may extend the time before air-related vehicles traveling through the tunnels reach capacity. However, these actions will not have any significant effect on non-airport related traffic reaching capacity on the central artery. This consideration is of paramount importance according to our analysis, even though the central artery congestion problem goes beyond airport access and presents a generally acknowledged major urban dilemma. It seems evident from our analysis that a far-reaching ground access program must be developed in order to improve the currrent levels of service and ensure that airside capacity will not be drastically limited by future ground access capacities.

Looking at the list of proposed low capital solutions presently under consideration, we find that their combined effect will provide only marginal relief on a long-term basis. Improvements on the rapid transit system would at least provide an alterative to the poor level of service that can be expected on the road access system in peak hours. However, these improvements would not substantially increase the capacity of the access system, since we cannot reasonably expect a large percentage of air passengers to use rapid transit in its present form, as described in Section A4 of this study.

Those proposals which aim to reduce the number of cars traveling to the airport would not be successful in resolving the problem at the central artery, since the capacity for airport related vehicles on the artery, at desirable levels of service, is rapidly falling to zero. This conclusion must, however, be evaluated with the realization that congestion on the artery may slow growth of non-airport traffic, or spread its peaking, sufficiently so that the problem does not become as severe as is anticipated in our analysis.

The proposed third harbor crossing represents what is, from our perspective, the only viable means, of those actions currently under consideration for providing the necessary access capacity to Logan. Basically, this alternative would not only provide another route to the airport, but would also be instrumental in diverting some of the non-airport traffic from the tunnels and the central artery.

Our purpose in this report is to observe ground access capacity with relation to airside growth. It is our conclusion that this growth will be limited by ground access and that a long-term solution is required.

APPENDIX A

Table A1

ROUTING OF AIRPORT ACCESS TRIPS
(EXCLUDING RAPID TRANSIT)
BY LOCAL ORIGIN/DESTINATION ZONE

Origin/Destination	Percent per Survey 1/	Routing 2/	Percent by Route
(1)	(2)	(3)	(4)
Boston			
Boston (General)	2	SD, CAN, CST	2
East Boston	3	Local Streets	3
Downtown	6	North End or Government Center, CST	3
		High St. and South Station, CAS, CST	2
		Charles St. or Arlington St., SD, CAN, CST	1
South Boston, Dorchester	4	SE or Mass Ave., CAS, CST	4
Roxbury, Mattapan, Hyde Park, Roslindale	1	Route 1, SD, CAN, CST	1
West Roxbury, Jamaica Plain	2	Huntington Ave., Mass Ave., CAS, CST	2
Brighton	1	SD, CAN, CST	1
Brookline	2	SD, CAN, CST	2
Cambridge	3	SD, CAN, CST	3

Other Massachusetts			
Northeast	16	Route 1	13
		I93, CAN, CST	3
Northwest	16	I93, CAN, CST	11
		SD, CAN, CST	5
West	16	MP, CAS, CST	16
Southwest	6	MP, CAS, CST	6
Southeast	12	SE, CAS, CST	12
Maine	2	I95, Route 1	2
New Hampshire	6	I93, CAN, CST	6
Rhode Island	2	SE, CAS, CST	2

1/ Coverdale and Colpitts. Logan Airport Travel Study. Table III, October 1972. Rounded to nearest integer; adjusted to add to 100 percent.

2/ Key:

CAN--Central Artery North

CAS--Central Artery South

CST--Callahan-Sumner Tunnels

MP---Mass. Pike (Massachusetts Turnpike)

SD---Storrow Drive

SE---Southeast Expressway

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

The hourly vehicular capacity of the Sumner/Callahan Tunnels is computed from the left hand side of Table 9.1 of the Highway Capacity Manual. The number of lanes, N, equals 4. The width adjustment factor, W = .66, was found from Table 9.2a of the Manual assuming 9 ft. lanes and no distance from traffic lane edge to obstruction. The PHF factor was assumed to be .91 and the working value at level of service "D" for restricted highway speed of 50 miles per hour was used. Level of Service "D" hourly capacity is then

$$2000 \times 4 \times .66 \times (.45 \times .91) = 2162$$

Level of Service "E" hourly capacity is

$$2000 \times 4 \times .66 = 5280$$

The hourly capacity of the Central Artery was estimated as half way between the capacity of 4-lane and 6-lane freeways under ideal conditions as provided by the right-hand side of Table 9.1 of the Manual. A more sophisticated calculation would require a detailed analysis of the effect of close and frequent access/egress ramps, truck traffic, significant grades and narrow lanes. It is felt that the assumption made in this analysis is conservative, i.e., that it overestimated that actual capacity of the artery.

Tables B1 through B3 show the detailed computation of airport access capacity.

Table B1

AIRPORT ACCESS CAPACITY

Sumner/Callahan Tunnels

Level of Service[1/]	Hrs./Year[2/]	Factor[3/]	Year 1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	19,655	19,655	19,655	19,655	19,655
		2	33,600	35,300	37,100	39,000	40,100
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	200	1	22,520	22,520	22,520	22,520	22,520
		2	33,600	35,300	37,100	39,000	40,100
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	1,000	1	29,216	29,216	29,216	29,216	29,216
		2	33,600	35,300	37,100	39,000	40,100
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
E	30	1	48,000	48,000	48,000	48,000	48,000
		2	33,600	35,300	37,100	39,000	40,100
		3	14,400	12,700	10,900	9,000	7,900
		4	4.83	4.26	3.66	3.02	2.65
E	200	1	55,000	55,000	55,000	55,000	55,000
		2	33,600	35,300	37,100	39,000	40,100
		3	21,400	19,700	17,900	16,000	14,900
		4	7.18	6.61	6.00	5.37	5.00
E	1,000	1	71,351	71,351	71,351	71,351	71,351
		2	33,600	35,300	37,100	39,000	40,100
		3	37,751	36,051	34,251	32,351	31,251
		4	12.66	12.09	11.49	10.85	10.48

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B2

AIRPORT ACCESS CAPACITY

Central Artery South

Level of Service[1/]	Hrs./Year[2/]	Factor[3/]	Year				
			1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	74,500	74,500	74,500	74,500	74,500
		2	117,800	130,100	143,600	158,600	175,200
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	200	1	85,400	85,400	85,400	85,400	85,400
		2	117,800	130,100	143,600	158,600	175,200
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	1,000	1	110,800	110,800	110,800	110,800	110,800
		2	117,800	130,100	143,600	158,600	175,200
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
E	30	1	90,900	90,900	90,900	90,900	90,900
		2	117,800	130,000	143,600	158,600	175,200
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
E	200	1	104,200	104,200	104,200	104,200	104,200
		2	117,800	130,000	143,600	158,600	175,200
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
E	1,000	1	135,100	135,100	135,100	135,100	135,000
		2	117,800	130,100	143,600	158,600	175,200
		3	17,300	5,000	NA	NA	NA
		4	10.70	3.09	NA	NA	NA

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B3

AIRPORT ACCESS CAPACITY

Central Artery North

Level of Service[1/]	Hrs./Year[2/]	Factor[3/]	Year				
			1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	74,500	74,500	74,500	74,500	74,500
		2	117,800	130,100	143,600	158,600	175,200
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	200	1	85,400	85,400	85,400	85,400	85,400
		2	117,800	130,100	143,600	158,600	175,200
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	1,000	1	110,800	110,800	110,800	110,800	110,800
		2	117,800	130,100	143,600	158,600	175,200
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
E	30	1	90,900	90,900	90,900	90,900	90,900
		2	117,800	130,100	143,600	158,600	175,200
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
E	200	1	104,200	104,200	104,200	104,200	104,200
		2	117,800	130,100	143,600	158,600	175,200
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
E	1,000	1	135,100	135,100	135,100	135,100	135,100
		2	117,800	130,100	143,600	158,600	175,200
		3	17,300	5,000	NA	NA	NA
		4	13.98	4.04	NA	NA	NA

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

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CHICAGO - O'HARE INTERNATIONAL AIRPORT

CASE STUDY

CASE STUDY SUMMARY

Chicago-O'Hare International Airport is located approximately 17 miles northwest of the downtown Chicago Loop area and is operated by the City of Chicago Department of Aviation. The Airport serves a metropolitan population of approximately 7.0 million and is provided primary groundside access by the Kennedy Expressway and Tri-State Tollway.

O'Hare International Airport is the world's busiest airport and served over 36 million enplaning plus deplaning passengers in 1976. Of total passengers carried at O'Hare, approximately 46% were transfers from other flights. Passenger traffic is projected by the FAA to grow at a rate of 5% annually for the next ten years. General Aviation activity comprises 6% of total operations at the Airport.

The capacity analyses indicated that the Kennedy and Eisenhower Expressways currently have severe access problems near downtown Chicago. Other roadways serving large numbers of air travelers will have moderate access problems by the mid-1980's and severe problems by the mid-1990's. The major entrance airport roadway (state Route 594) should remain adequate for many years. The major problem is the Kennedy Expressway which provides direct Airport-CBD access and handles about 40% of airport trips.

Proposals have been made to implement new highways, extend rapid transit service to the Airport, and to divert up to one-half of the short to medium passenger operations from O'Hare to Midway Airport. UMTA has recently improved funding to extend rapid transit along the Kennedy Expressway median to the Airport and this will provide an important alternative access route to the CBD although it probably cannot completely relieve the capacity problem on the Kennedy Expressway. The City of Chicago Dept. of Aviation is currently preparing a new Master Plan for O'Hare International Airport in order to define more clearly the future role of the Airport. However, the status of many of the highway proposals to improve airport access is still uncertain until detailed feasibility studies are completed.

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CHICAGO - O'HARE INTERNATIONAL AIRPORT

A. BACKGROUND

1. General

Chicago-O'Hare International Airport is located approximately 17 miles northwest of the downtown Chicago Loop area (Figure 1). The Airport lies in two counties, Cook County and DuPage County, on 6,925 acres of land.

The Airport is owned and operated by the City of Chicago. The day-to-day business of operating the Airport is administered by the City's Department of Aviation, which is also responsible for operating the City's two other airports: Midway Airport and Meigs Field.

O'Hare International Airport is the world's busiest airport serving over 36 million enplaning and deplaning passengers in 1976, of which 97.5% were domestic scheduled. This represented a 197 percent increase from 1962, or an average annual growth of over 8.5 percent. Furthermore, domestic scheduled enplanements at O'Hare International Airport account for over 95 percent of the total Chicago hub domestic scheduled enplanements. Passenger traffic at O'Hare is projected by the FAA to grow at a rate of about 5% annually during the next ten years (Reference 10).

The most significant characteristic of the Chicago hub is the historical pattern of development of Chicago as a connecting hub. The role of Chicago as a connecting hub developed initially because non-stop transcontinental journeys were impossible with early propeller-powered aircraft. This made Chicago a very attractive connecting hub from many points within the United States. Although jet aircraft have replaced propeller aircraft in the trunk carrier's fleet, Chicago remains the largest transfer hub in the Midwest. Because of this fact, transfers accounted for 46.0 percent of all enplaning domestic scheduled passengers in 1976. (Reference 9)

In 1974, the Federal Aviation Administration (FAA) initiated a study of the potential utilization of Midway Airport (Reference 2). The study concluded that Midway Airport could potentially serve an annual passenger volume of 10 million by the mid 1980's by shifting 42% of short-haul origin and destination trips from O'Hare to Midway, thus relieving potential airside and groundside congestion at O'Hare . However, the airlines have been hesitant to provide service at two airports. The Department of Aviation is currently preparing new Master Plans for both O'Hare International and Midway Airports in order to define the future roles of both Airports more clearly.

2. Transportation Planning Structure

Coordinated, regional transportation planning for the Chicago area is provided by three agencies: the Chicago Area Transportation Study (CATS), the Northeastern Illinois Planning Commission (NIPC), and the Northwestern Indiana Regional Planning Commission (NIRPC). The Chicago Area Transportation Study is

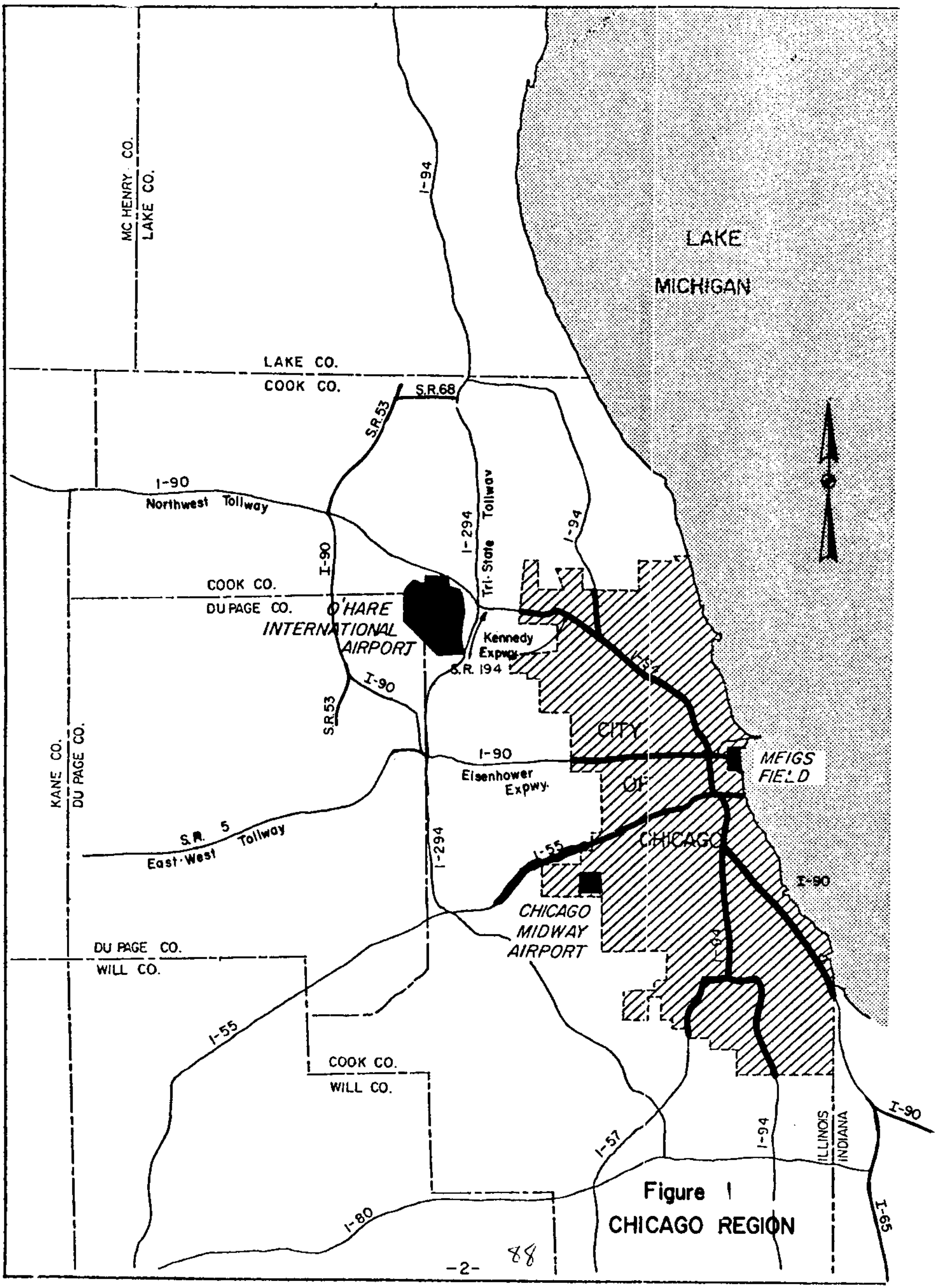

Figure 1
CHICAGO REGION

designated as the interim MPO and performs long-range planning, with the Governor of Illinois expected to make a final decision of MPO designation for the region by June, 1979. The Northeastern Illinois Planning Commission presently performs A-95 review, while the Northwestern Indiana Regional Planning Commission is designated the MPO for Northwest Indiana.

The Chicago Area Transportation Study is directed by a Policy Committee whose members represent the Councils of Mayors (representing 260 communities) six counties (Cook, DuPage, Kane, Lake, McHenry, and Will Counties), City of Chicago DPW, Regional Transportation Authority (RTA), Chicago Transit Authority (CTA), Illinois Department of Transportation (IDOT), NIPC, NIRPC, FHWA, and UMTA. Many of these organizations are also part of the Work Program Committee which provides direct transportation plans and programs, as well as policy recommendations to the Policy Committee for final approval.

Transportation planning and implementation for the City of Chicago is performed by three departments: Department of Public Works, Department of Aviation, and Department of Planning City and Community Development (DPCCD). The Department of Aviation is provided CATS representation through DPCCD representation to the Work Program Committee.

In 1974, the comprehensive 1995 Transportation System Plan was developed and adopted by CATS and NIRPC with the assistance of the DPCCD (then the Department of Development and Planning of the City of Chicago) and NIPC. Included in this plan were recommended improvements to four elements of the Region's transportation system: transit, highway, airport and freight (Reference 3).

3. Highway Access

The major access route from the east is the Kennedy Expressway - Interstate 94 and State Route 194. The Kennedy Expressway is an eight-lane (west of Edens Expressway) limited access highway providing direct access to the Airport from downtown Chicago.

The Eisenhower Expressway - Interstate 90, an eight-lane limited access highway, east of the Tri-State Tollway provides additional access from downtown. The Tri-State Tollway - Interstate 294 (6-lane limited access highway) provides primary Airport access from the north and south. The Mannheim Road, U.S. 12 and 45 (4-lane divided arterial) provides secondary north-south access. Access from northwest of the Airport is provided by the Northwest Tollway - Interstate 90 and State Route 194 (6-lane limited access highway), which intersects with the Tri-State Tollway north of the Airport. Access from the southwest is provided by the East-West Tollway-State Route 5 (6-lane limited access highway) which intersects with the Tri-State Tollway south of the Airport (See Figure 1).

The principal entrance into the Airport is provided by State Route 594 which intersects with the Kennedy Expressway 1 1/2 miles east of the Airport property and with the Tri-State Tollway 1/4 mile east of the Airport property.

The route is a four-lane limited access facility east of the Tri-State Tollway and expands to six lanes west of Tollway to the terminal facilities (Figure 2).

The 1995 Transportation System Plan recommends two major additions to the freeway system which would affect airport access. The Elgin to O'Hare extension from the Fox River Valley to the O'Hare vicinity would provide additional access capacity from west of the Airport. The extension of State Route 53 south and east to Interstate 55 would divert many non-airport trips from the Tri-State Tollway. Travel demand studies have been completed for both projects while location studes are presently underway. Both projects are several years from construction (Reference 3).

4. Transit Access

The private automobile is the primary mode used by passengers and employees at Chicago-O'Hare International Airport as shown in Table 1.

The Chicago Transit Authority (CTA) operates an express route (#40 O'Hare Express Bus Route) between the three airport terminals and Jefferson Park (an existing rapid transit terminal station). The route operates from 6:00 A.M. to 10:00 P.M. with 15 minute headways throughout the day, except for 30 minute headways after 7:00 P.M. The route presently carries a daily ridership of 2,500 (including an estimated 1,000 air passengers).

The Department of Public Works has recently received UMTA approval of a a Draft Environmental Impact Statement (DEIS) for an extension of rapid transit services beyond Jefferson Park to a new terminal station under the O'Hare Airport parking facility (an extension of 8.2 miles). The present one-way transit trip time of 45 minutes between Monroe/Dearborn and O'Hare would be reduced to 34 minutes. It is also projected that 12,300 daily air passengers would utilize the extension as compared to the 1,000 air passengers utilizing existing bus transit service. An additional 12,400 airport employees and visitors are expected to utilize the rapid transit extension on a daily basis (Reference 4).

5. Internal Access

The Airport Entrance Roadway (State Route 594) west of Mannheim Road provides both direct access into the Airport parking structure and lots and access to all three terminals. Roadway access to the terminals is provided by a two-level looping facility (3-lanes on each level) with the upper level for departures and the lower level for arrivals.

Figure 2

DISTRIBUTION OF APPROACH TRAFFIC ON SURFACE ACCESS SYSTEM

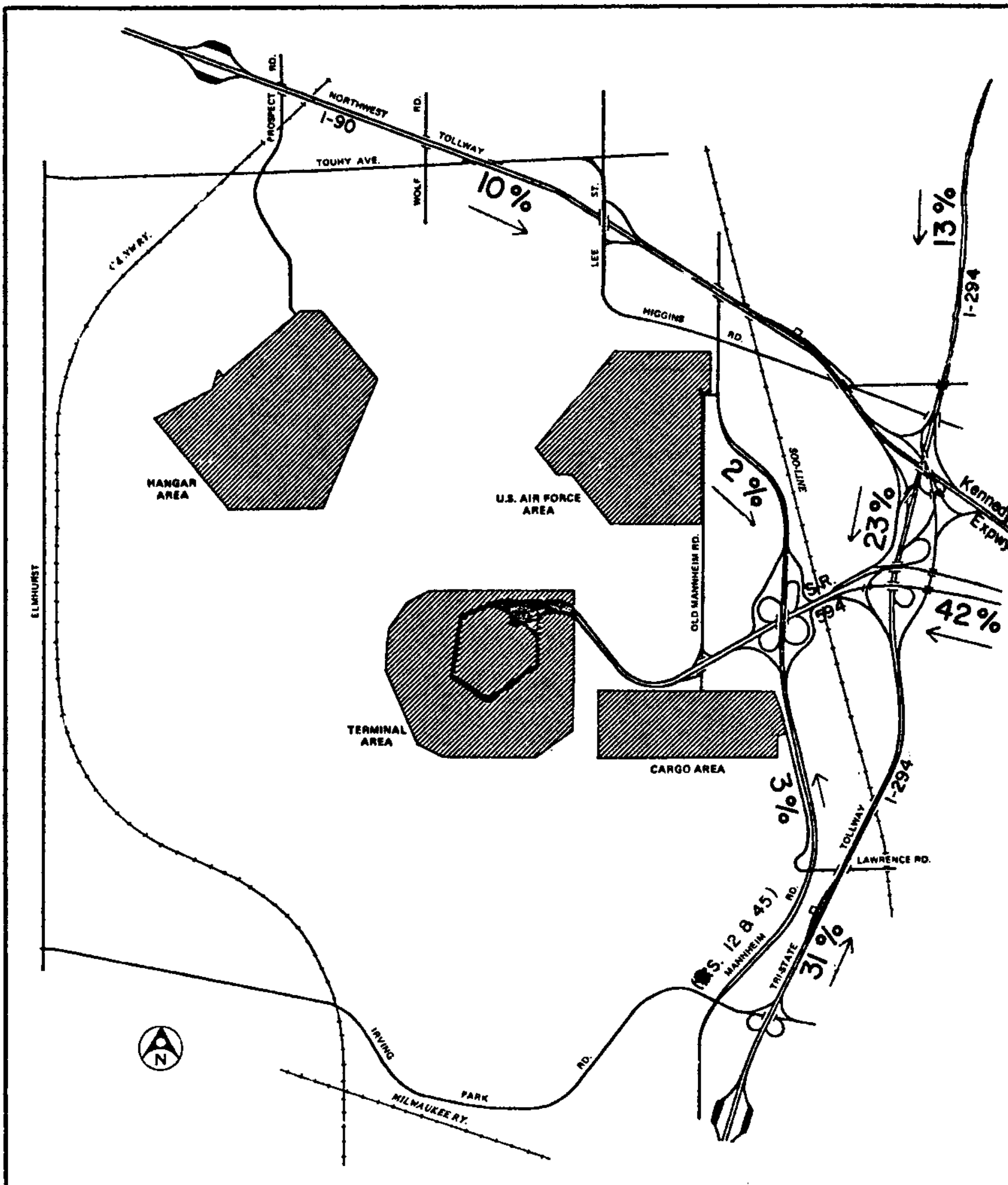

TABLE 1

Mode of Transportation for Air Passengers

MODE	Percent of Passengers
Private Auto	63.0
Taxi	10.7
Transit (Bus)	10.3
Limousine/Airport Bus/ Courtesy Car	8.6
Rental Car	6.8
Other, or Not Indicated	0.6
	100.0

Parking at O'Hare consists of a multi-level parking structure with adjacent ground-level lot and an annex lot. Capacity for the primary lot is 11,500 spaces, while the annex has space for an additional 1,500 vehicles. During February, 1977, a parking survey was conducted at O'Hare and found that vehicle parking demand exceeded capacity by 13 percent. The survey also found that 55% of all automobiles entering O'Hare property utilized the parking facilities (Reference 9).

B. CAPACITY ANALYSIS

1. Passenger Forecasts

The passenger forecast used in this analysis was from 1977 FAA Terminal Area Forecasts for Chicago-O'Hare International Airport (Reference 1). The FAA forecast extends only to 1988 and is projected to 1995 at the 1980 - 1988 growth rate. Table 2 shows the number of passengers expected.

2. Airside Capacity

The practical annual capacity (PANCAP) forecast for O'Hare is currently being developed as part of the new Master Plan. Since this information was not available prior to publication of this report, Airside Capacity was not calculated for O'Hare.

3. Ground Access Capacity

Current airport ground trips were assigned to major highways and arterials as explained in Appendix A. Six locations carrying substantial airport traffic were identified and analyzed: the Kennedy Expressway east of I-94 and State Route 194 junction, Kennedy Expressway west of State Route 43 (Harlem Avenue), the Eisenhower Expressway both east of State Route 50 (Cicero Avenue) and west of State Route 43 (Harlem Avenue), the Tri-State Tollway south of State Route 594, and State Route 594 west of the Tri-State Tollway. An annual growth rate of 2% for non-airport traffic was utilized for the Chicago region from 1976-1995 . This projected traffic growth rate conforms to recent Department of Public Works projections. Vehicle capacity available for airport trips was converted to air passengers by multiplying the ratio of 1976 annual passengers to 1976 airport ADT (33,300,000/50,500 = 660) and dividing by the proportion of total airport-bound ground traffic carried by each access road. A rapid transit extension along the Kennedy Expressway median to the Airport appears likely to be implemented and, therefore, was considered in the capacity analysis for the Kennedy Expressway. The calculations for the six locations are given in Appendix B. The capacity analyses for each location are shown graphically in Figures 3 through 8.

4. Interpretation

a. Kennedy Expressway (east of I-94 and S.R. 194 junction):

This ten-lane section of the Kennedy Expressway presently does not provide sufficient capacity overall to handle current traffic volumes at better

TABLE 2

AIR PASSENGER FORECASTS

Year	Millions of Air Passengers (enplaned and deplaned)
1976	36.2
1978	39.2
1979	41.4
1980	43.8
1983	48.6
1985	52.2 1/
1988	57.7
1990	62.0 2/
1995	73.2 2/

1/ Interpolated

2/ Extended

than level of service "E". Figure 3 indicates that this roadway is limited with severe congestion problems already a characteristic, particularly near downtown.

b. Kennedy Expressway (west of State Route 43):

Figure 4 indicates that this segment of the roadway near the Airport will be operating at level of service "D" at the 200th hour by the mid-1980's. Assuming rapid transit service within the roadway median, the figure shows that severe congestion problems will be deferred to the mid-1990's.

c. Eisenhower Expressway (east of State Route 50):

The analysis indicates that the capacity of this roadway near the downtown is limited and severe congestion problems are likely to occur in the early 1980's (see Figure 5). The figure shows that the roadway is presently operating below level of service "D" and approaching level of service "E" conditions. Since only 9% of total Airport trips utilize this expressway, the volume/capacity relationship is particularly dependent on non-airport traffic growth.

d. Eisenhower Expressway (west of State Route 43):

Figure 6 indicates that this segment of the Expressway is presently operating at level of service "D" at the 200th hour. Expected growth of non-airport traffic on the Eisenhower Expressway will begin to limit capapcity for airport traffic severely by the late-1980's when level of service "E" at the 200th hour is reached.

e. Tri-State Tollway (south of State Route 594):

The analysis show that capacity of the Tri-State Tollway will remain adequate until well into the late-1980's when level of service "D" at the 200th highest hour is reached. Severe congestion problems are not likely to occur until after 1995 when level of service "E" conditions are attained (Figure 7).

f. State Route 594 (west of Tri-State Tollway):

Figure 8 indicates that capacity on the primary Airport access roadway is substantially more than required.

C. PROPOSED SOLUTIONS

Table 4 indicates proposed projects affecting airport access. One very visible solution would involve diversion of about 30% of the short to medium haul operations from O'Hare International Airport to Midway Airport. This proposal would result in passenger volumes of approximately 10 million at Midway. However, a major obstacle to implementing this plan has been airline reluctance to provide service at two airports. The Department of Aviation is currently preparing a new Master Plan for O'Hare in order to define more clearly

Figure 3

DEMAND/CAPACITY RELATIONSHIP

KENNEDY EXPRESSWAY (EAST OF I-94 AND S.R. 194 JUNCTION)

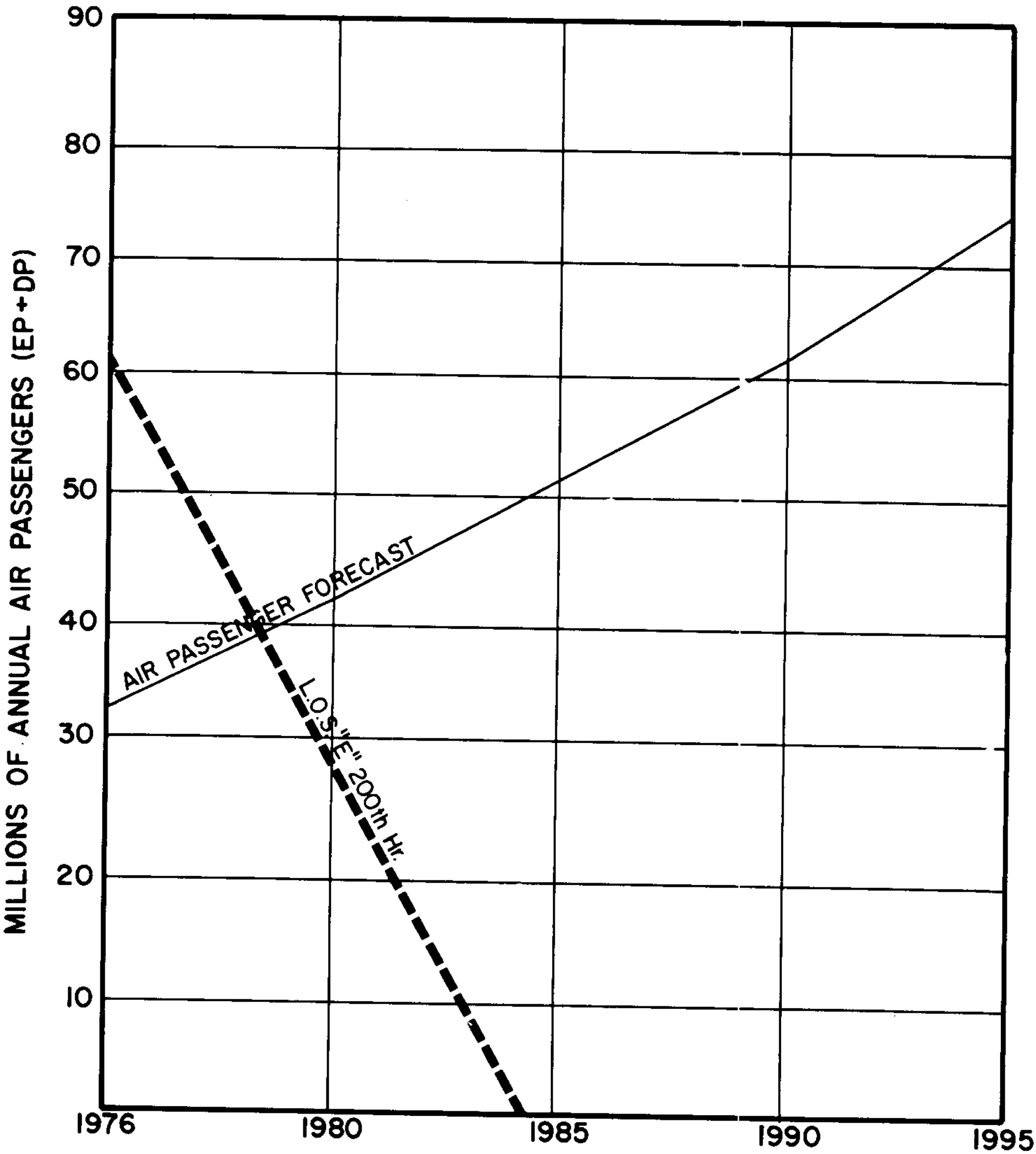

Figure 4

DEMAND/CAPACITY RELATIONSHIP

KENNEDY EXPRESSWAY (WEST OF STATE ROUTE 43)

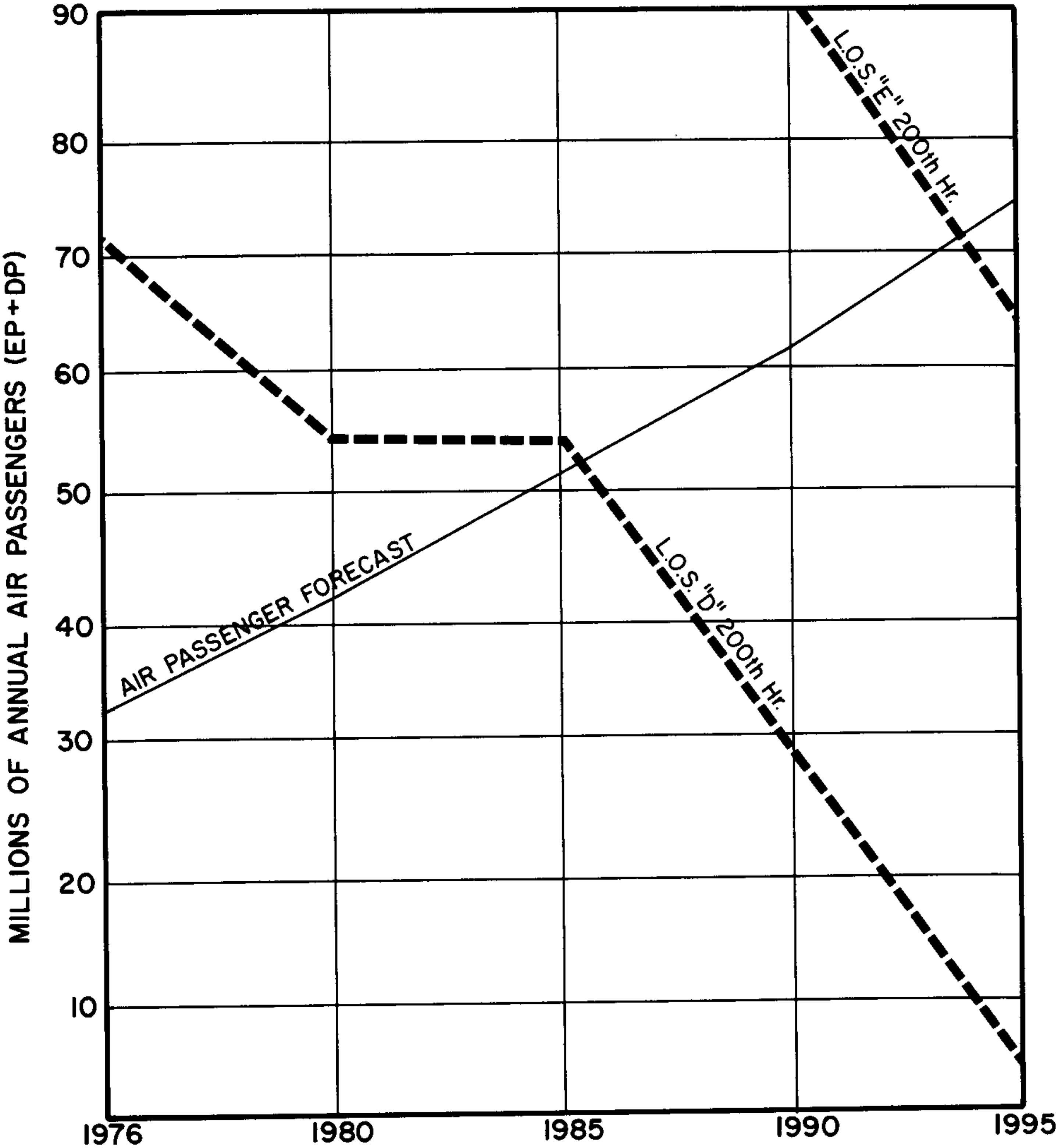

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Figure 5

DEMAND/CAPACITY RELATIONSHIP

EISENHOWER EXPRESSWAY (EAST OF STATE ROUTE 50)

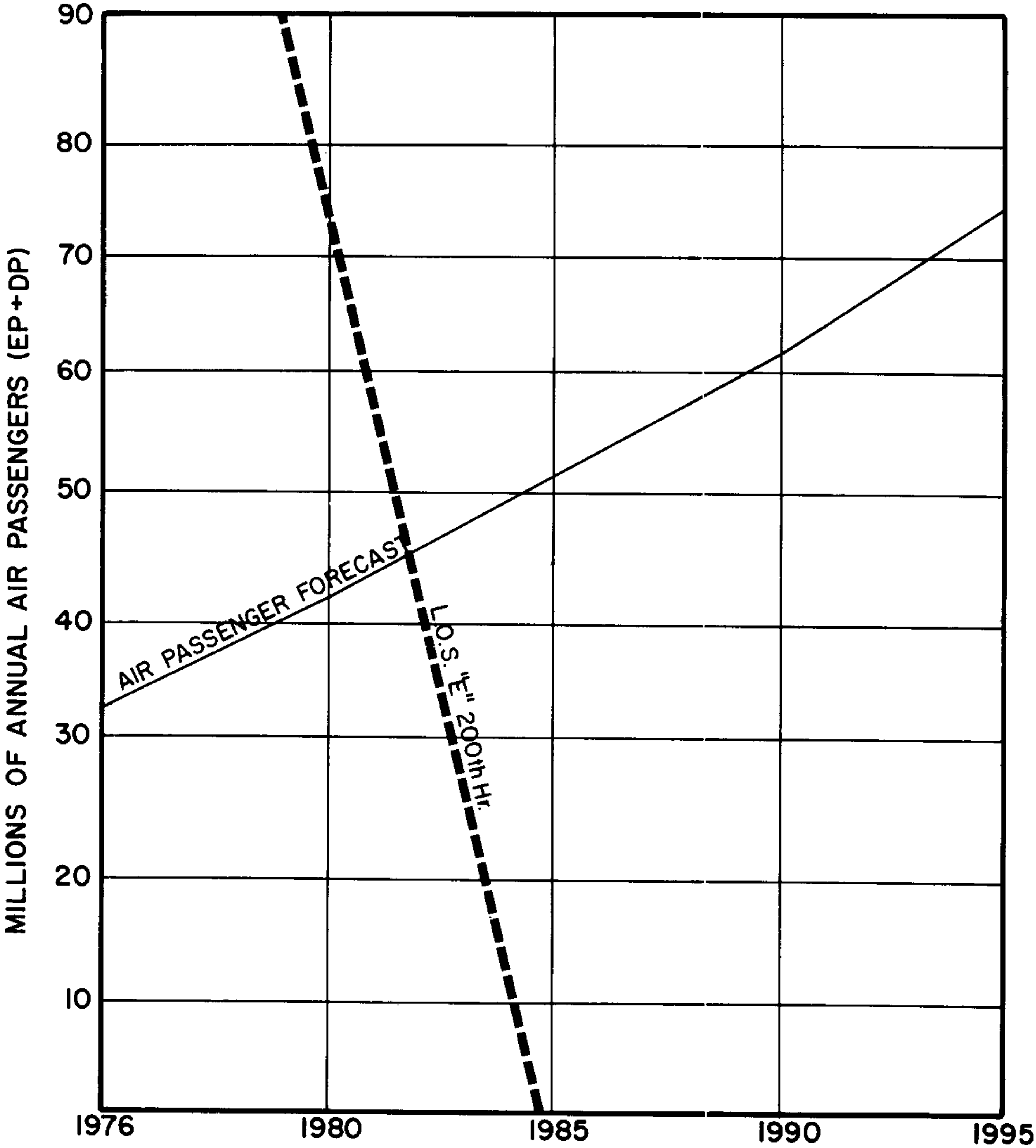

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Figure 6

DEMAND/CAPACITY RELATIONSHIP

EISENHOWER EXPRESSWAY (WEST OF STATE ROUTE 43)

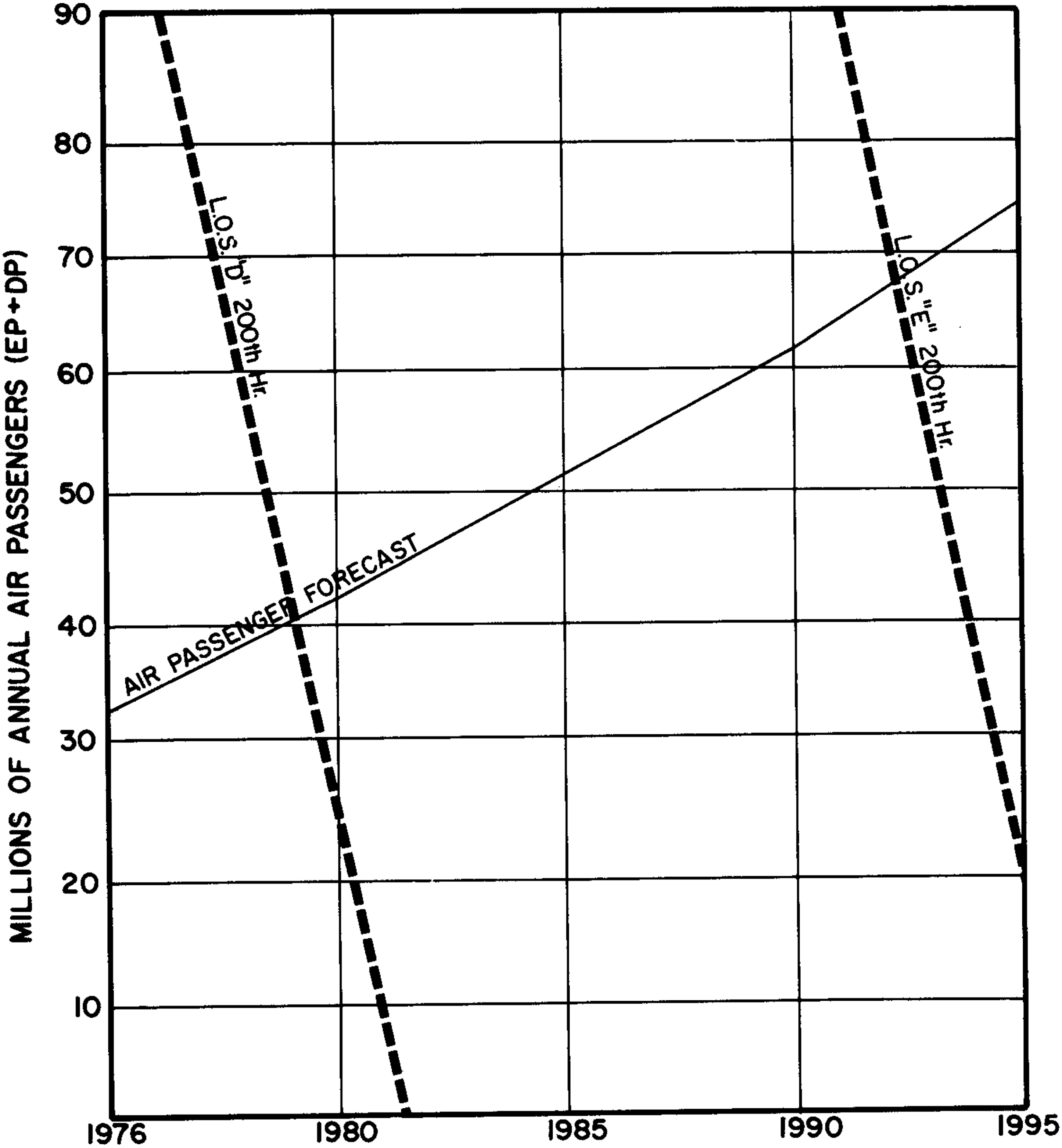

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Figure 7

DEMAND/CAPACITY RELATIONSHIP

TRI-STATE TOLLWAY (SOUTH OF STATE ROUTE 594)

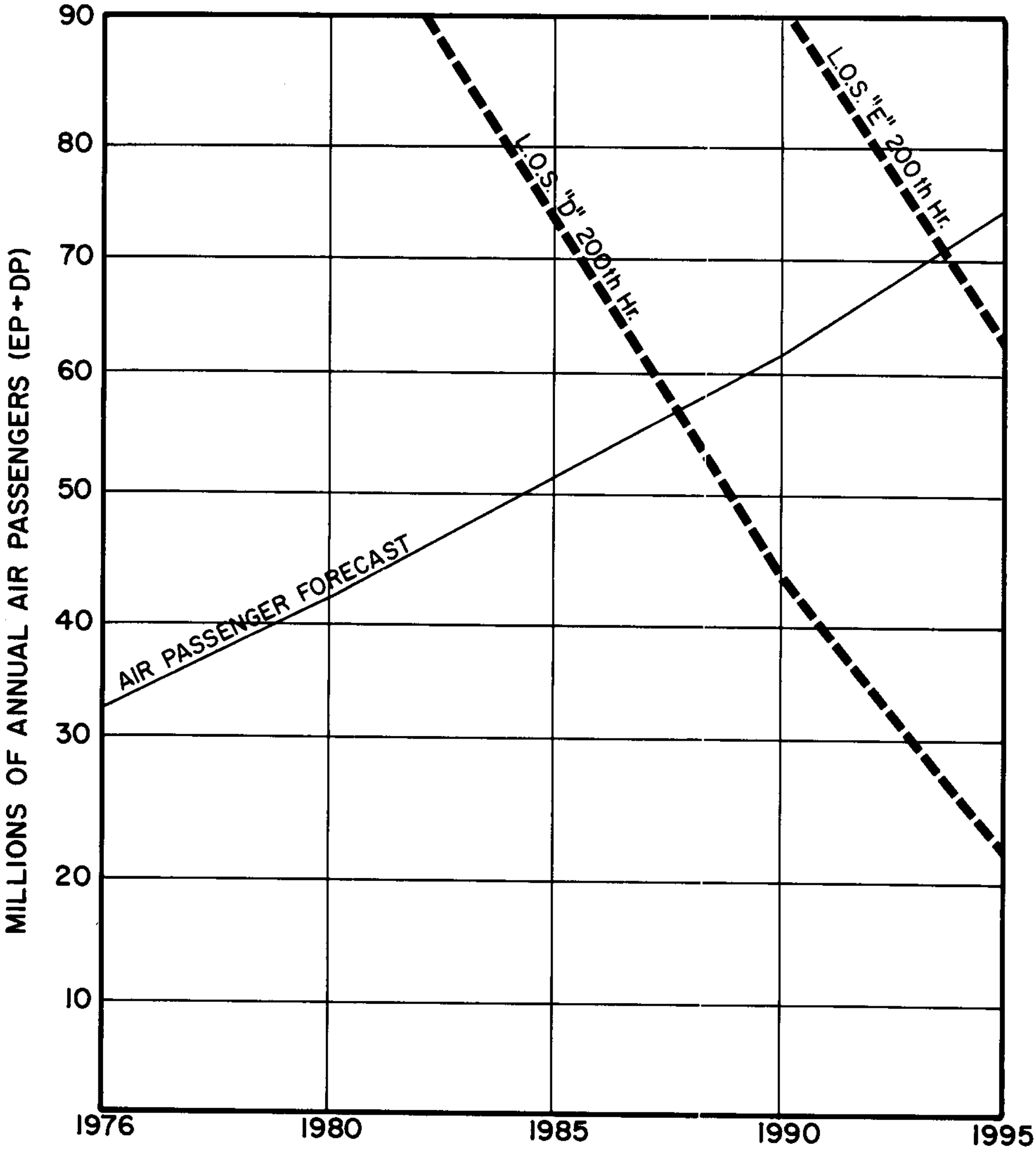

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Figure 8

DEMAND/CAPACITY RELATIONSHIP

STATE ROUTE 594 (WEST OF TRI-STATE TOLLWAY)

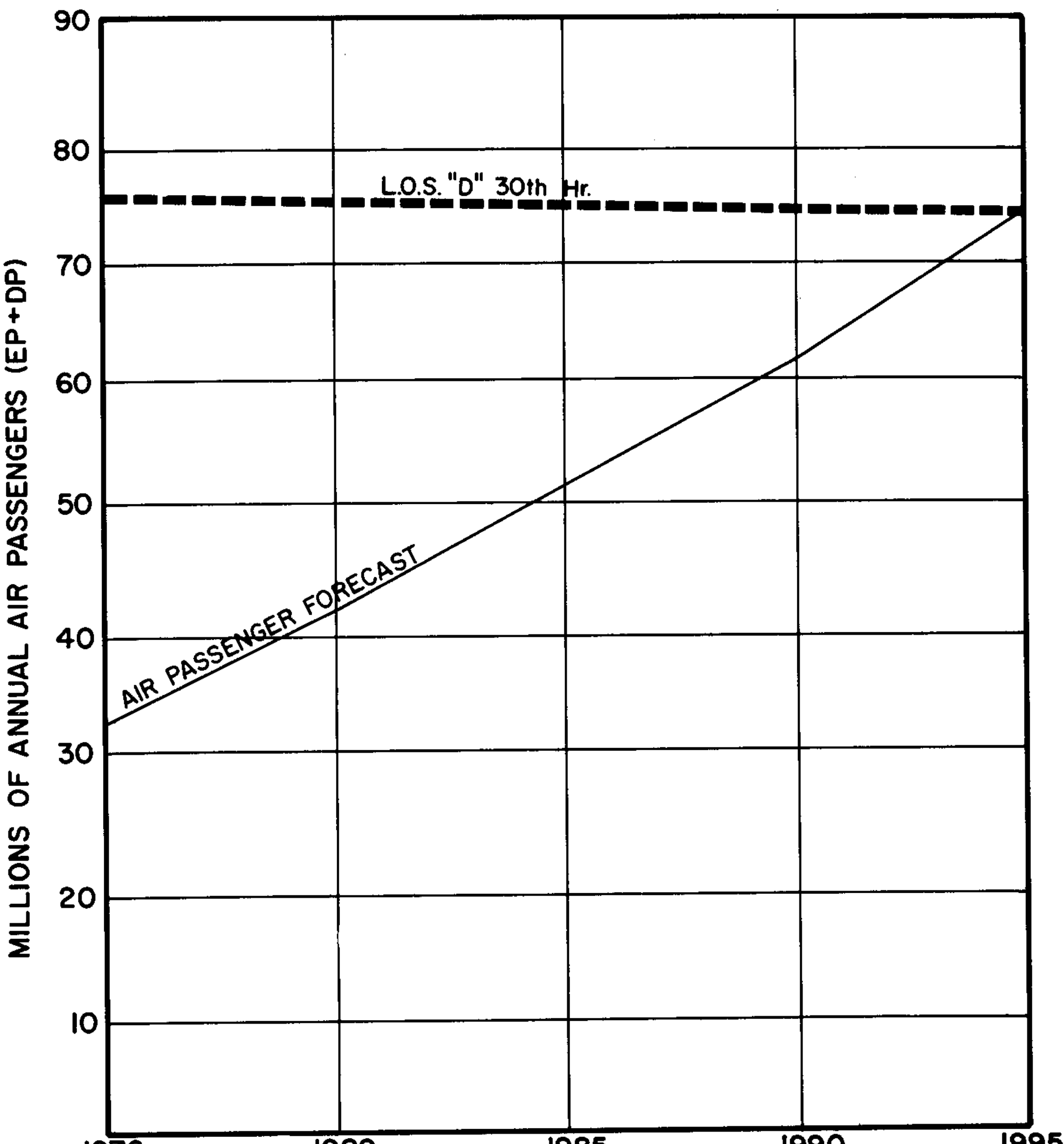

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TABLE 3

Proposed Solutions to Airport Access Problems

PROPOSED SOLUTION	INITIATOR	AGENCY RESP. FOR IMPLEM.	FUNDING SOURCES	EST. COST (MILLIONS)	STATUS
A. CONSTRUCTION					
1. Elgin to O'Hare Freeway Corridor	Illinois D.O.T.	Illinois D.O.T.	Interstate	*	Study
2. State Route 53 Extension South	Illinois D.O.T.	Illinois D.O.T.	Interstate	*	Study
3. State Route 53 Extension North	Illinois D.O.T.	Illinois D.O.T.	Interstate	*	Study
4. Rapid Transit Airport Extension	City D.P.W.	City D.P.W.	UMTA, State City	130	Final Design
B. TRANSPORTATION SYSTEMS MGMT.					
1. Express Buses from Regional Locations	1995 Transp. System Plan	R.T.A.	Authority Area	*	Proposal
C. RELOCATION					
1. Divert One-Half of Short and Medium Haul Flights to Midway Airport	FAA	City Dept. of Aviation	Revenue Bonds Illinois D.O.T. Funds ADAP	85	Completed Study

*Not Available or Unknown

the future role of the Airport with respect to proposed Midway Airport activities.

Another major solution involves a rapid transit extension beyond the Jefferson Park Terminus to the Airport via the Kennedy Expressway median. A Draft E.I.S. has been submitted and initial funding has been approved by UMTA. Past studies have projected a 15% diversion of airport-related traffic and a 7% diversion of non-airport related traffic to transit along the project corridor. Since the project appears likely to be implemented, it was considered in the capacity analysis for the Kennedy Expressway.

Most other solutions involve construction of highways. Projects to extend State Route 53 north of Dundee Road (S.R. 68) and south of Army Trail Road would help divert many non-airport and non-local trips from the Tri-State Tollway. For both extensions, travel demand studes have been completed with location analyses presently underway. The Elgin to O'Hare extension from the Fox River Valley to the O'Hare vicinity would provide additional highway capacity from west of the Airport. Travel demand studies have recently been completed for this project.

A proposal to improve regional transit access to he Airport from points outside the downtown area has not been fully developed. No funds have been allocated to implement this solution.

D. CONCLUSIONS

Capacity analyses indicate that most major access roadways to O'Hare are operating daily at better than level of service "D", the two major exceptions being Kennedy and Eisenhower Expressways which currently operate at or near level of service "E" conditions near the Downtown during peak hours. Traffic congestion on the Kennedy Expressway presents a particularly significant access problem for O'Hare, since about 40% of total airport trips utilize this highway.

The capacity analyses indicate that continued non-airport traffic growth will result in even greater congestion by the early 1980's on the radial highways (Kennedy and Eisenhower Expressways) near the Downtown. Furthermore, all roadways will be operating at level of service "D" by the late-1980's, and level of service "E" by the mid to late 1990's. In effect, the major airport access problem will be located several miles east of the airport and primarily caused by non-airport traffic growth. The capacity analysis indicated that the rapid transit extension to the airport will delay traffic congestion by about five years. The major airport entrance roadway (State Road 594) should remain adequate for many years to come.

Diverting some 30% of the short to medium haul operations from O'Hare to Midway would help to alleviate future air and groundside access problems at O'Hare. However, the private air carriers have been reluctant to split operations. In addition, developing annual passenger volumes of 10 million at Midway Airport would probably cause a new groundside access problem at Midway, particularly on Cicero Avenue, without modifying existing facilities. However, a plan has been proposed to construct an exclusive busway to Midway Airport from downtown, contingent upon proposed expansion of airside activities at Midway.

The extension of State Route 53 both north and south would divert many non-airport trips from the Tri-State Tollway and, thus, improve northbound and southbound airport access capacity. However, the most significant improvemnt would result from an increase of radial highway capacity from the Downtown. The only current proposal to improve Downtown oriented traffic capacity involves the potential construction of a new freeway along the Cicero Avenue Corridor. However, this proposal is a number of years away from implementation.

In summary, implementation of a number of current proposals would provide long-term relief to access problems at O'Hare International Airport. However, the status of many of these projects is still uncertain until further feasibility studies are completed. The only project likely to be implemented in the near future is the extension of rail transit to the Airport.

APPENDIX A

ASSIGNMENT OF CURRENT AIRPORT GROUND TRIPS

Assignment of access trips was based on a 1969 passenger origin survey developed by the City of Chicago Department of Public Works (Reference 6). The originating airport passenger volumes generated by zone within the City of Chicago, by municipality within the cordon line, and by county outside the cordon line were assigned to existing major access highways or arterials. Assignment of employee originating trips was based on both a 1968 employee residential distribution survey conducted by the Department of Public Works and the 1969 passenger origin survey. The data were assigned as shown below.

Location	Percent of Airport Vehicles
Kennedy Expressway (I-94 & S.R. 194)	
a. east of S.R. 194	37%
b. west of S.R. 43	42%
Eisenhower Expressway (I-90)	9%
Tri-State Tollway (I-294)	
a. north of S.R. 194	13%
b. north of S.R. 594	23%
c. south of S.R. 594	31%
d. south of S.R. 5	10%
Mannhein Road (U.S. 12/45)	
a. north of S.R. 594	2%
b. south of S.R. 594	
Northwest Tollway (I-90 & S.R. 194)	10%
East-West Tollway (S.R. 5)	5%

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APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

ROADWAY CAPACITY

Highways

The hourly capacity for the Kennedy and Eisenhower Expressways, the Tri-State Tollway, and State Route 594 leading into the Airport was read directly from the right hand side of Table 9.1 of the Highway Capacity Manual, assuming a PHF = 0.91. This was then converted to an average daily capacity (ADT) by dividing the hourly capacity by the peak hour percentage. Peak hour percentages of 8 1/2% for the 30th highest hour, 8% for the 200th highest hour, and 7 1/2% for the 1000th highest hour were used from traffic characteristic data for the Chicago region.

Arterials

The capacity for arterial roadways was estimated by using a table previously developed in other traffic studies to estimate the midblock capactiy of urban arterials. The hourly capacity for multi-lane arterials was estimated to be 2/3 of ideal conditions found in Table 10.1 of the Highway Capacity Manual. A more sophisticated calculation would require a detailed analysis of all access/egress points, intersections, traffic counts, truck traffic, and grades along all segments of the arterial.

AVAILABLE AIRPORT TRAFFIC CAPACITY AND PASSENGER VOLUMES

Traffic not destined for the airport was subtracted from roadway capacity at levels of service "D" and "E" to obtain highway capacity available for airport traffic. Non-airport traffic was calculated by subtracting current airport-destined traffic from current daily traffic count data . Current airport destined traffic was identified in Chicago through traffic counts at entrances leading to the airport. These volumes were then assigned to access roadways based on origin and destination data developed (see Appendix A). Current non-airport traffic was projected into the future by using an annual growth factor of 2%.

Vehicle capacity available for airport trips were converted to air passengers by utilizing procedures outlined in Section B, Ground Access Capability.

Since the project to extend rapid transit service to the Airport appears likely to be implemented, it is considered in the capacity analysis for the Kennedy Expressway. Utilizing data developed for evaluating the feasibility of rapid transit service to the Airport (Reference 4), a 15% Airport-vehicle diversion and a 7% non-airport vehicle diversion were calibrated for the Kennedy Expressway. Assuming rapid transit service is operational by the early 1980's, the diversion factors were incorporated within the procedures outlined above in order to calculate available airport vehcile capacity in terms of air passengers.

Tables B1 through B6 show the capacity calculations for all six locations.

Table B1

AIRPORT ACCESS CAPACITY

Kennedy Expressway (east of I-94 Junction)

L.O.S.[1]	Hrs./Yrs.[2]	Factor[3]	YEAR				
			1976	1980	1985[4]	1990[4]	1995[4]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	194,100	194,100	194,100	194,100	194,100
		2	216,000	233,800	250,000	276,000	304,700
		3	-	-	-	-	-
		4	-	-	-	-	-
D	200	1	206,300	206,300	206,300	206,300	206,300
		2	216,000	233,800	250,000	276,000	304,700
		3	-	-	-	-	-
		4	-	-	-	-	-
D	1000	1	220,000	220,000	220,000	220,000	220,000
		2	216,000	233,800	250,000	276,000	304,700
		3	4,000	-	-	-	-
		4	7.1	-	-	-	-
E	30	1	235,300	235,300	235,300	235,300	235,300
		2	216,000	233,800	250,000	276,000	304,700
		3	19,300	1,500	-	-	-
		4	34.4	2.7	-	-	-
E	200	1	250,000	250,000	250,000	250,000	250,000
		2	216,000	233,800	250,000	276,000	304,700
		3	34,000	16,200	-	-	-
		4	60.6	28.9	-	-	-
E	1000	1	266,700	266,700	266,700	266,700	266,700
		2	216,000	233,806	250,000	276,000	304,700
		3	50,700	32,900	16,700	-	-
		4	90.4	58.6	35.0	-	-

1] Per Highway Capacity Manual
2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.
3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.
4] Rapid transit extension to Airport in operation.

TABLE B2

AIRPORT ACCESS CAPACITY

Kennedy Expressway (west of S.R. 43)

L.O.S.[1/]	Hrs./Yrs.[2/]	Factor[3/]	YEAR 1976	1980	1985[4/]	1990[4/]	1995[4/]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	155,300	155,300	155,300	155,300	155,300
		2	119,800	129,600	135,200	149,200	164,800
		3	35,500	25,700	20,100	6,100	-
		4	55.7	40.3	37.1	11.3	-
D	200	1	165,000	165,000	165,000	165,000	165,000
		2	119,800	129,600	135,200	149,200	164,800
		3	45,200	35,400	29,800	15,800	200
		4	71.0	55.6	55.1	29.2	0.4
D	1000	1	176,000	176,000	176,000	176,000	176,000
		2	119,800	129,600	135,200	149,200	164,800
		3	56,200	46,400	40,800	26,800	11,200
		4	88.2	72.8	75.4	49.5	20.7
E	30	1	188,200	188,200	188,200	188,200	188,200
		2	119,800	129,600	135,200	149,200	164,800
		3	68,400	58,600	53,000	39,000	23,400
		4	107.4	92.0	97.9	72.1	43.2
E	200	1	200,000	200,000	200,000	200,000	200,000
		2	119,800	129,600	135,200	149,200	164,800
		3	80,200	70,400	64,800	50,800	35,200
		4	125.9	110.5	119.7	93.9	65.0
E	1000	1	213,300	213,300	213,300	213,300	213,300
		2	119,800	129,600	135,200	149,200	164,800
		3	93,500	83,700	78,100	64,100	48,500
		4	146.8	131.4	144.3	118.4	89.6

1] Per Highway Capacity Manual
2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.
3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic;
3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.
4] Rapid Transit Extension to Airport in operation.

TABLE B3

AIRPORT ACCESS CAPACITY

Eisenhower Expressway (east of S.R.50)

L.O.S.[1]	Hrs./Yrs.[2]	Factor[3]	YEAR 1976	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	155,300	155,300	155,300	155,300	155,300
		2	175,400	189,780	209,600	231,350	255,560
		3	-	-	-	-	-
		4	-	-	-	-	-
D	200	1	165,000	165,000	165,000	165,000	165,000
		2	175,400	189,780	209,600	231,350	255,560
		3	-	-	-	-	-
		4	-	-	-	-	-
D	1000	1	176,000	176,000	176,000	176,000	176,000
		2	175,400	189,780	209,600	231,350	255,560
		3	600	-	-	-	-
		4	4.3	-	-	-	-
E	30	1	188,200	188,200	188,200	188,200	188,200
		2	175,400	189,780	209,600	231,350	255,560
		3	12,800	-	-	-	-
		4	90.8	-	-	-	-
E	200	1	200,000	200,000	200,000	200,000	200,000
		2	175,400	189,780	209,600	231,350	255,560
		3	24,600	10,220	-	-	-
		4	174.4	74.9	-	-	-
E	1000	1	213,300	213,300	213,300	213,300	213,300
		2	175,400	189,780	209,600	231,350	255,560
		3	37,900	23,520	3,700	-	-
		4	268.7	172.3	27.1	-	-

1] Per Highway Capacity Manual
2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.
3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

TABLE B4

AIRPORT ACCESS CAPACITY

Eisenhower Expressway (west of S.R. 43)

L.O.S.[1]	Hrs./Yrs.[2]	Factor[3]	YEAR 1976	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	155,300	155,300	155,300	155,300	155,300
		2	149,300	161,540	178,410	196,930	217,530
		3	6,000	-	-	-	-
		4	42.5	-	-	-	-
D	200	1	165,000	165,000	165,000	165,000	165,000
		2	149,300	161,540	178,410	196,930	217,530
		3	15,700	3,460	-	-	-
		4	111.3	24.5	-	-	-
D	1000	1	176,000	176,000	176,000	176,000	176,000
		2	149,300	161,540	178,410	196,930	217,530
		3	26,700	14,460	-	-	-
		4	189.3	102.5	-	-	-
E	30	1	188,200	188,200	188,200	188,200	188,200
		2	149,300	161,540	178,410	196,930	217,530
		3	38,900	26,660	9,790	-	-
		4	275.8	189.0	69.4	-	-
E	200	1	200,000	200,000	200,000	200,000	200,000
		2	149,300	161,540	178,410	196,930	217,530
		3	50,700	38,460	21,590	3,070	-
		4	359.5	272.7	153.1	21.8	-
E	1000	1	213,300	213,300	213,300	213,300	213,300
		2	149,300	161,540	178,410	196,930	217,530
		3	64,000	51,760	34,890	16,370	-
		4	453.8	367.0	247.4	116.1	-

1] Per Highway Capacity Manual

2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

TABLE B5

AIRPORT ACCESS CAPACITY

Tri-State Tollway (south S.R. 594)

L.O.S.[1/]	Hrs./Yrs.[2/]	Factor[3/]	YEAR 1976	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	115,300	115,300	115,300	115,300	115,300
		2	73,200	79,200	87,470	96,550	106,650
		3	42,100	36,100	27,830	18,750	8,650
		4	89.6	76.8	59.2	39.9	18.4
D	200	1	122,500	122,500	122,500	122,500	122,500
		2	73,200	79,200	87,470	96,550	106,650
		3	49,300	43,300	35,030	25,950	15,850
		4	104.9	92.1	74.5	55.2	33.7
D	1000	1	130,700	130,700	130,700	130,700	130,700
		2	73,200	79,200	87,470	96,550	106,650
		3	57,500	51,500	43,230	34,150	24,050
		4	122.3	109.5	92.0	72.6	51.2
E	30	1	141,200	141,200	141,200	141,200	141,200
		2	73,200	79,200	87,470	96,550	106,650
		3	68,000	62,000	53,730	44,650	34,550
		4	144.6	131.9	114.3	95.0	73.5
E	200	1	150,000	150,000	150,000	150,000	150,000
		2	73,200	79,200	87,470	96,550	106,650
		3	76,800	70,800	62,530	53,450	43,350
		4	163.4	150.6	133.0	113.7	92.2
E	1000	1	160,000	160,000	160,000	160,000	160,000
		2	73,200	79,200	87,470	96,550	106,650
		3	86,800	80,800	72,530	63,450	53,350
		4	184.6	171.9	154.3	135.0	113.5

1] Per Highway Capacity Manual

2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

TABLE B6

AIRPORT ACCESS CAPACITY

State Route 594 (west of Tri-State Tollway)

L.O.S.[1]	Hrs./Yrs.[2]	Factor[3]	YEAR 1976	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	115,300	115,300	115,300	115,300	115,300
		2	5,000	5,410	5,980	6,600	7,290
		3	110,300	109,890	109,320	108,700	107,380
		4	76.6	76.3	75.9	75.4	74.5
D	200	1	122,500	122,500	122,500	122,500	122,500
		2	5,000	5,410	5,980	6,600	7,290
		3	117,500	117,090	116,520	115,900	115,210
		4	81.6	81.3	80.9	80.4	80.0
D	1000	1	130,700	130,700	130,700	130,700	130,700
		2	5,000	5,410	5,980	6,600	7,290
		3	125,700	125,290	124,720	124,100	123,410
		4	87.2	87.0	86.6	86.1	85.7
E	30	1	141,200	141,200	141,200	141,200	141,200
		2	5,000	5,410	5,980	6,600	7,290
		3	136,200	135,790	135,220	134,600	133,910
		4	94.5	94.3	93.9	93.4	92.9
E	200	1	150,000	150,000	150,000	150,000	150,000
		2	5,000	5,410	5,980	6,600	7,290
		3	145,000	144,590	144,020	143,400	142,710
		4	100.6	100.4	100.0	99.5	99.1
E	1000	1	160,000	160,000	160,000	160,000	160,000
		2	5,000	5,410	5,980	6,600	7,290
		3	155,000	154,590	154,020	153,400	152,710
		4	107.6	107.3	106.9	106.5	106.0

1] Per <u>Highway Capacity Manual</u>

2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

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CLEVELAND-HOPKINS

INTERNATIONAL AIRPORT

CASE STUDY

CASE STUDY SUMMARY

Cleveland-Hopkins Airport is located 13 miles southwest of the Cleveland, Ohio central business district and is operated by the City of Cleveland. Cleveland-Hopkins served 5.8 million total enplaned and deplaned passengers in 1976, about 35 percent of whom were transfers.

Currently, the Airport has good ground access from the City of Cleveland including the downtown area. Interstate 71 provides quick access from the Cleveland CBD and is complemented by a rail rapid transit system which was extended to the airport in 1968.

Access from other directions, including Akron and Cleveland's eastern suburbs (which generate over 20 percent of air passenger trips) is not nearly as good. Travel from the eastern suburbs is constrained by lack of a limited-access highway. Travel from east and south is constrained by at-grade crossings on Snow Road leading to the Airport and tight weaving distances on roads in the immediate vicinity of the Airport.

Two construction projects have been proposed to alleviate these problems. I-480, an east-west limited access highway running just north of the Airport property is now under construction and should be completed by the early 1980's. This facility will improve traffic flow from the eastern suburbs and also will create a new interchange for Airport-oriented traffic, thus relieving the Snow Road intersection. In addition, Snow Road itself is to be upgraded in the early 1980's with complete grade separation.

These improvements should provide sufficient ground capacity for the forseeable future at Cleveland-Hopkins. The capacity analysis indicates that airside capacity should prove more of a constraint on passenger growth than ground access capacity. The combination of radial highway/transit access from downtown plus a circumferential highway (I-480) for surburban traffic indicates good planning for airport access in Cleveland.

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III. List of Tables

A. BACKGROUND

1. General

Cleveland-Hopkins Airport is located 13 miles southwest of the Cleveland, Ohio central business district (see Figure 1) and is operated by the City of Cleveland. The seven county area of northeast Ohio served by the airport has a population of three million which is forecast by the Northeast Ohio Areawide Coordinating Agency (NOACA) to grow at less than 1% annually for the next 20 years.

There were about 5.8 million total enplaned and deplaned passengers at Cleveland-Hopkins in 1976. About 35 percent of enplaned passengers transfer at Cleveland and thus do not impact the ground transportation demand. Approximately 3,100 employees work at Cleveland-Hopkins, more than half of whom work in the Main Terminal Building. Approximately 30% of the airport employees are residents of the City of Cleveland while most of the remaining employees reside in the western suburbs of Cleveland that are located near the Airport.

In 1973, the Lake Erie Regional Transportation Authority (LERTA) contracted to study the feasibility, select a site, and develop a Master Plan for a new regional airport to serve Metropolitan Cleveland. LERTA's Board recently accepted its consultant's recommendation to locate a 2.4 billion dollar airport on reclaimed land in Lake Erie by the early 1990's.

Runway and taxiway improvements are planned to increase airside capacity at Cleveland-Hopkins. The principal improvement is the new close parallel (1,100 ft. separation) runway 5L-23R. These are expected to be completed prior to 1985 if federal funding is approved. Further major expansion of the airfield facilities at Cleveland-Hopkins is constrained due to the nature of adjacent land uses.

2. Transportation Planning Structure

The Northeast Ohio Areawide Coordinating Agency (NOACA) is the metropolitan planning agency for the City of Cleveland and the adjacent Counties of Cuyahoga, Geauga, Lake, Lorain, and Medina. It is a comprehensive planning and transportation agency formed for the purpose of coordinating and reviewing federal and state funded planning activities and proposals in northeast Ohio (A-95 Review). NOACA also serves as the area-wide program coordinator for the following federal agencies: U.S. Office of Management and Budget, U.S. Bureau of Census, U.S. Dept of Housing and Urban Development, and U.S. Dept. of Transportation. The Ohio Department of Transportation develops highway and transit plans in conjunction with NOACA's Transportation Improvement Program (TIP).

All five county members are represented on the NOACA Board by three commissioners as well as representatives of all cities and towns. Cleveland is represented by the mayor, five councilors, four appointed officials, and a representative of the Greater Cleveland Regional Transit Authority. This gives the City a greater vote, proportionally, than the other municipalities. The

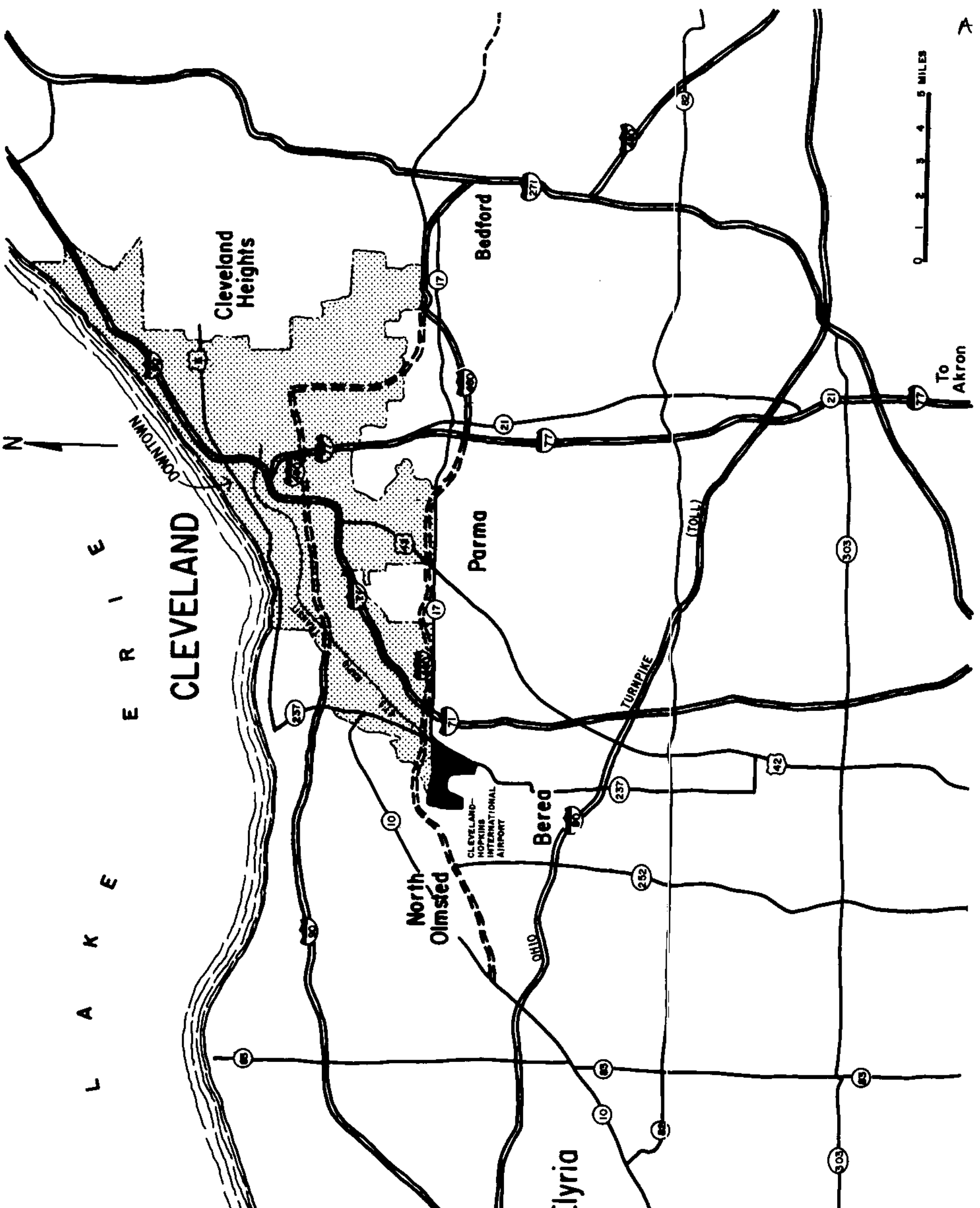

Figure 1
CLEVELAND REGION

Aviation Division is not represented on NOACA's Policy Board or Transportation Advisory Committee, but is indirectly represented by the City political representatives assigned to the NOACA Policy Board, and the three City Transportation Engineering Departments assigned to the NOACA Transportation Advisory Committee.

The Greater Cleveland Regional Transit Authority was created in 1975 to coordinate all public mass transportation in Cuyahoga County. GCRTA operates all former Cleveland Transit System and Shaker Heights Transit Lines, as well as bus lines, including the Airport rapid transit. GCRTA applies for UMTA funding based on long-range plans developed in conjunction with NOACA. The GCRTA has a nine member Board of Directors, four of whom represent the City of Cleveland.

An intermodal planning group (IPG) operates on the federal level. It is operated from Region 5, Chicago, and includes representatives from the FWHA, the Urban FAA, HUD, EPA, and the U.S. Coast Guard. The IPG meets monthly, but apparently covers Cleveland on only an annual basis and does not have much impact on transportation decisions.

3. <u>Highway Access</u>

Principal highway access today is by State Route 237, Interstate Route 71, Snow Road, Berea Freeway (also called Airport Freeway), and Brookpark Road (State Route 17). Traffic using I-71 from the north (the Cleveland CBD and most of the remainder of the City) can move unimpeded to the Berea Freeway and enter the terminal area from the north (see Figure 2).

A recent update of the Federal Highway Administration's continuing airport access analysis program indicated that travel time from CBD to airport was 19.5 minutes in off peak periods and 19.7 minutes during peak periods.

Traffic approaching the Airport from the south (Akron and the southern suburbs) via I-71 must exit at Snow Road and then proceed west on Snow Road, crossing two sets of railroad tracks (with frequent freight service) at-grade. These vehicles then make a right turn (northbound) onto Berea Freeway, merge left across three lanes in less than 1/4 mile and make a left turn into the Airport. This approach is currently unsatisfactory, but designs for ramps to eliminate problems are being prepared (see section "C" on Proposed Solutions). Trips from northern origins west of Cleveland approach via Rocky River Drive which becomes Berea Freeway. Vehicles from western and eastern origins approach via Brookpark Road to the Berea Freeway Southbound. These vehicles will be able to take I-480 when it is completed in the early 1980's (see Section "C").

Another airport traffic problem involves Brookpark Road. Since Brookpark Road does not have an interchange with I-71, a considerable proportion of eastbound traffic on Brookpark Road utilizes the airport internal roadway system in order to make a U-turn onto the Berea Freeway northbound and finally to the I-71 interchange to Cleveland. This problem should be eliminated when I-480 is completed.

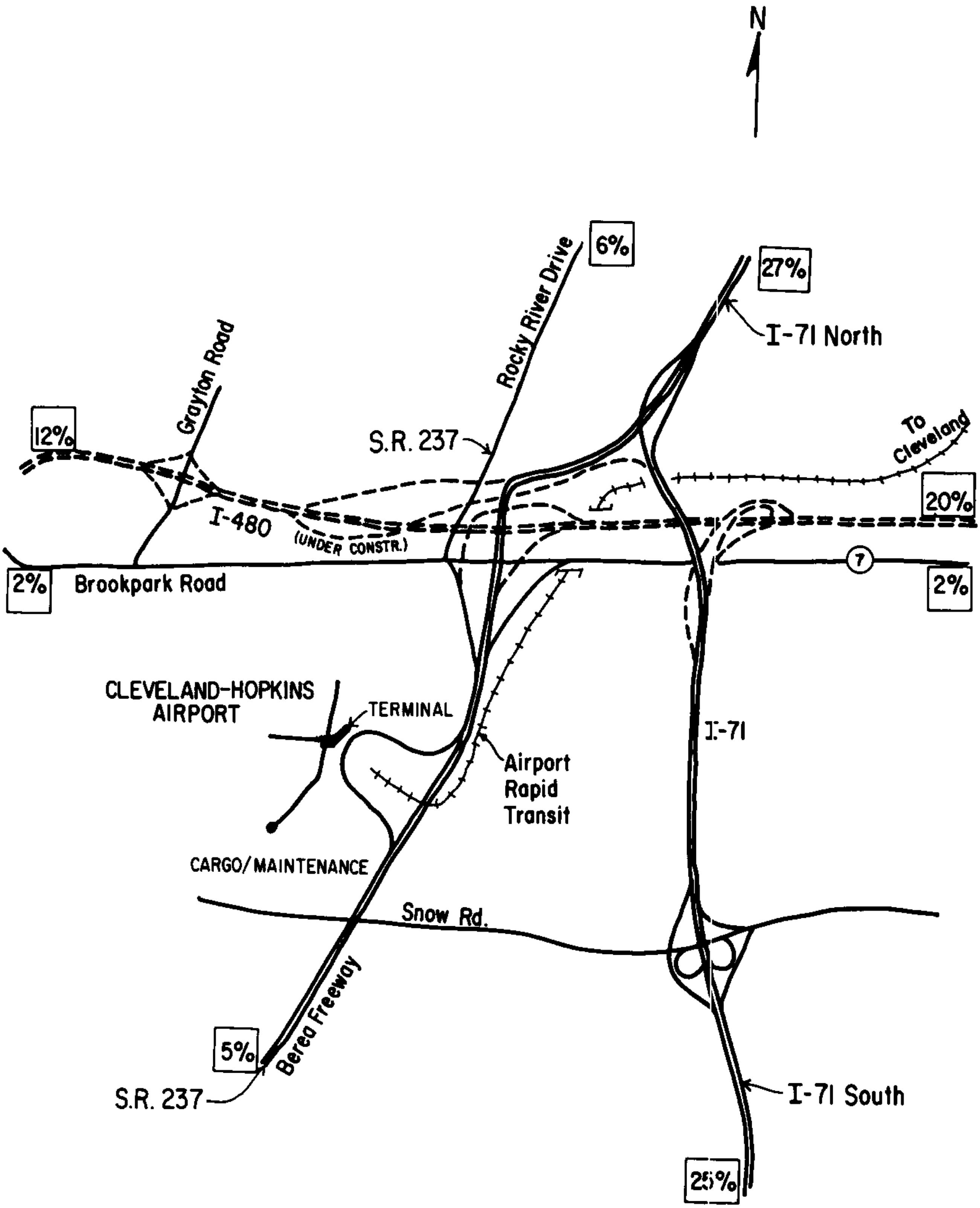

Figure 2

Percent of Airport Bound Trips Using Local Highways

4. <u>Transit Access</u>

Cleveland-Hopkins is served 24 hours a day by the Cleveland Transit System (CTS) Rapid, most of the day at between 6 and 15-minute intervals. This rapid transit system is a surface route on exclusive right-of-way extending from Cleveland-Hopkins to the City of East Cleveland. It has 19 miles of double track with 8 stations east of Cleveland Union Terminal and 9 stations west of the Terminal. Transfer at full fare can also be made to the Shaker Heights Rapid Transit which shares the CTS right of way on a segment of the system east of the Terminal.

The CTS Airport station is located near the entrance to the Main Terminal Building. An arriving passenger must only cross one covered roadway from the airport to enter the CTS rapid transit station. The 12-mile trip to downtown Cleveland takes approximately 22 minutes.

The Rapid System was extended to the airport in November, 1968 by the addition of three new stations. A study in 1969 (Ref. 7) determined that the Rapid accounted for nearly 10% of all person-trips to the Airport with a high proportion of trips made by air passengers without visitors and by casual visitors (sightseers). Table 1 (below) indicates that initially a high proportion of trips were made by air passengers and casual visitors (sightseers).

Ridership at the Airport Station has declined significantly since it opened (see Table 2). The ridership declined by 40 percent in the first two years, caused in great part by increasing fares from $.25 to $.55. The fare was then reduced to $.35 and ridership stabilized. This stabilization would appear to indicate that airport transit has a certain captive ridership that will not increase unless highway travel becomes more difficult. Currently Interstate I-71, which parallels the rapid transit, presents capacity problems for only short periods during the day.

5. <u>Internal Access</u>

Essentially, the internal road system at Cleveland-Hopkins is semi-circular, the northern portion being the main terminal area with a loop road and two access points, while the southern portion is cargo oriented and accessible at Snow Road. Interchange between the two areas is possible via a two-lane, bi-directional road.

Parking spaces have been inventoried as follows (Source: Ref. 9)

Long-Term:	3,835
Short-Term:	211
Employee:	2,073
Rental Car:	1,360
Motel:	200
Total	7,679

TABLE 1

Composition of Airport Transit Trips

	Percent of Airport Person Trips	Percent of Rapid Transit Trips
Air Passengers	37.4	57.6
Passenger Related Visitors	44.8	10.5
Employees	13.1	6.6
Casual Visitors	4.7	17.0
Non-Airport Related Ridership	-	8.3
	100.0	100.0

Source (Ref. 7)

TABLE 2

Passengers Using Airport Station

Year	Annual Passengers	Year	Annual Passengers
1969	699,845	1973	441,828
1970	565,190	1974	416,727
1971	443,095	1975	363,765
1972	452,750	1976	439,477

A four story parking garage with 2,260 spaces located between the Berea Freeway and loop road is provided for long-term parking. The structure is over 1,000 feet from the main entrance to the terminal, with about one-third of this distance served by a pair of Goodyear Speedwalks.

B. CAPACITY ANALYSIS

1. Passenger Forecasts

Two passenger forecasts have recently been made: one in the LERTA study (Ref. 13) and one for the Environmental Impact Analysis Report (EIAR) prepared by James C. Buckley, Inc. to analyze the impact of airfield improvements (Ref. 8). There is a wide disparity in these forecasts as shown in Table 3.

For purposes of this analysis, both forecasts have been used, with EIAR forecasts extrapolated linearly to the year 2000.

2. Airside Capacity

Airside capacity forecasts are derived primarily from LERTA information. Both LERTA and the EIAR reports contain equivalent calculations of hourly airfield capacity (PHOCAP) although only LERTA converts this to an annual capacity (PANCAP).

The airside forecasts assume that the programmed airfield improvements will be implemented in the early 1980's. They further assume that a large proportion of the general aviation operations (particularly local operations) will be diverted to other area airports as demand approaches airfield capacity.

PANCAP was converted to annual passengers by applying factors for percent air carrier operations, available seats per operation and enplaning load factor (LF). Two load factors were used: the current annual load factor of 48% and the current load factor plus 10 percent. The appropriate factors and results are shown in Table 4. These results are extrapolated to the year 1995.

3. Ground Access Capacity

Current airport ground trips were assigned to major highways by checking previous assignments (Ref. 16) with data from a previous origin and destination study (Ref. 7).

Three critical highway locations were identified: I-71 north of the airport, I-71 south of Snow Road, and the Berea Freeway just north of the airport. Current airport traffic volumes were assigned to these highways and subtracted from current average daily traffic (ADT) (Ref. 19) to provide current estimates of daily non-airport traffic.

Non-airport traffic in future years was then projected on a 1 1/2% annual compounded growth (taken from scattered Ohio DOT data available). As a check for sensitivity, growth rates of 1% and 2% were also calculated. The sensitivity analyses indicated only a small difference in capacity relationship which did not affect basic conclusions.

TABLE 3

Year	Air Passenger Forecasts Millions of Air Passengers (enplaned plus deplaned)	
	EIAR	LERTA
1975 (Actual)	5.6	5.6
1980	7.0	9.6
1985	8.4	12.2
1990	-	15.5
1995	-	19.0
2000	-	22.0

TABLE 4

Calculation of Airside Capacity

Year	PANCAP*	% Air Carrier*	Seats/ Oper**	Annual Pass. LF = .48	Capacity (Millions) LF - . 58
1975	288,506	54%	110	8.2	9.9
1980	250,914	67%	122	9.8	11.9
1985	285,687	70%	132	12.7	15.3
1990	264,819	71%	142	12.8	15.5
1995	data extrapolated			12.9	15.7

* LERTA

**EIAR

Vehicle trips available for airport use were converted to air passengers by multiplying by the current ratio of annual passengers to average daily traffic (at Cleveland: 5,600,000/29,000 = 193) and dividing by the proportion of airport traffic that is carried by each critical highway. These calculations are given in Appendix B. The resulting graphs for each critical highway are shown in Figures 3 through 5.

4. Interpretation

a. Berea Freeway: As Figure 3 shows, the main access highway to the airport does not present any major capacity problems. Based on the EIAR forecast, the highway will operate at better than level of service "D" until well beyond 1990. The LERTA forecast indicates that level of service "D" is reached by 1995. Figure 3 also indicates that airside capacity presents more of a constraint on airport capacity than does vehicle capacity on the Berea Freeway.

b. I-71 (North): The chart shows that annual level of service "D" will not be reached on a daily basis (the 200th highest hour) until the late 1980's. However, relief may be achieved in this corridor from construction of I-480 and from greater use of the airport rapid transit system. Both are important safety valves.

c. I-71 (South): Again, I-71 South does not appear to present major capacity problems. It will not operate at level of service "D" on a daily basis until 1991 (by LERTA forecasts) and past 1995 (by EIAR forecasts). Alternative means of access include I-480 and I-77.

C. PROPOSED SOLUTIONS

Table 5 indicates solutions proposed to alleviate airport access problems at Cleveland-Hopkins. The proposed solutions all are well on the way to implementation, so that a significant change to the current access system should occur in the near future. I-480, an east-west limited access facility north of the Airport property (and Brookpark Road), is now under construction and should be completed from the Ohio Turnpike to the far east side of Cleveland by the early 1980's. This facility results in two improvements: eastbound and westbound movements along Brookpark Road will be displaced, and the confluence of I-71 and I-480 will create a new interchange for Airport-oriented traffic, thus relieving the Snow Road intersection. In addition, two ramps leading to the Airport are due to be constructed soon. Snow Road, between the I-71 interchange and Berea Freeway, is to be upgraded with a grade separated ramp over the two sets of railroad tracks and Berea Freeway. Construction is set to begin in Fall, 1978. The second project will provide grade separated ramps for the Berea Freeway northbound traffic entering the airport and airport traffic turning northbound onto the Berea Freeway. Construction of this project is scheduled to begin in approximately two years.

D. CONCLUSIONS

Currently, Cleveland-Hopkins Airport has good ground access from the City of Cleveland including the downtown area. Interstate 71 provides quick access from the Cleveland CBD and is complemented by the rapid transit system which was extended to the airport in 1968.

Figure 3
DEMAND/CAPACITY RELATIONSHIP
BEREA FREEWAY

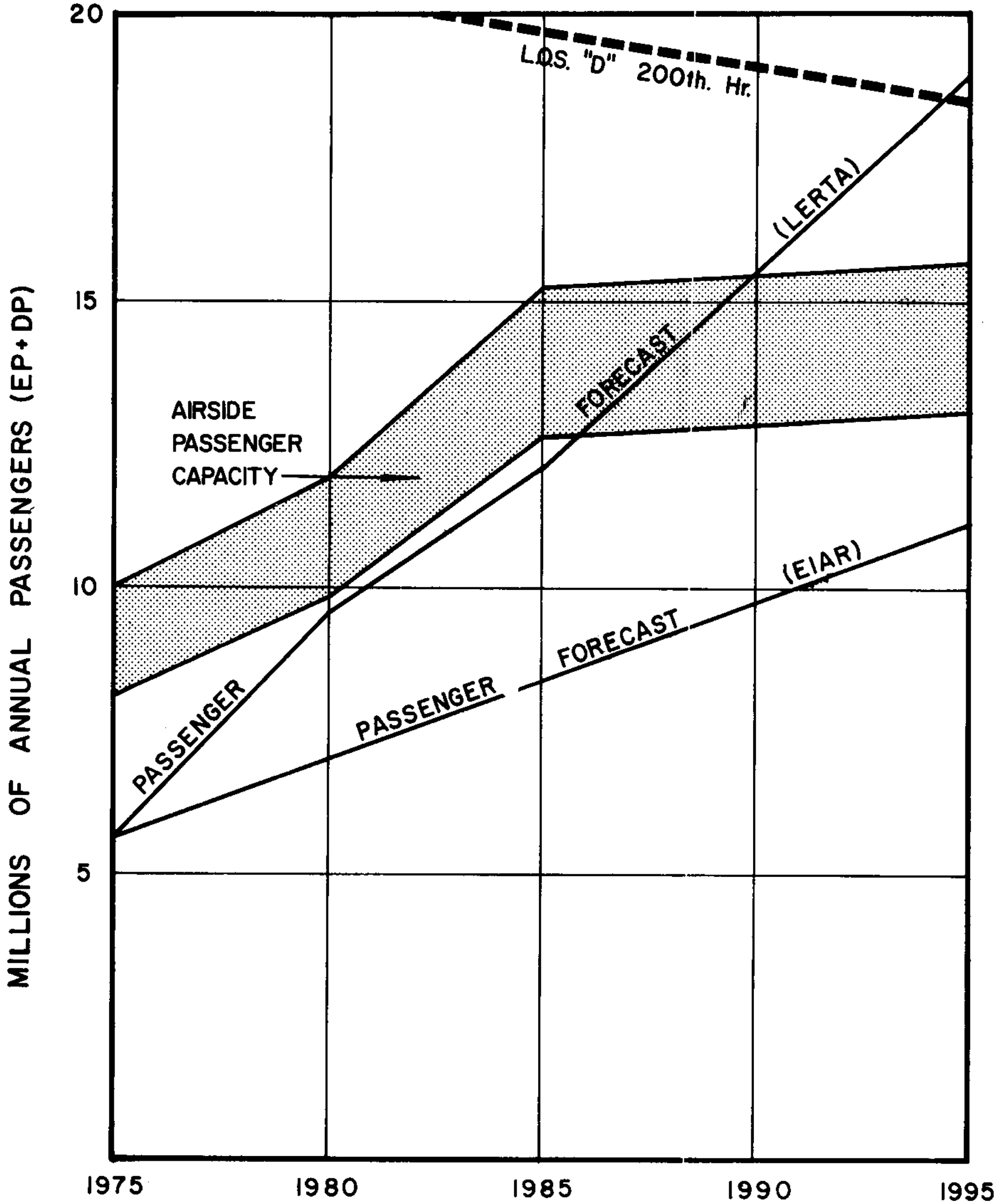

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Figure 4
DEMAND/CAPACITY RELATIONSHIP
INTERSTATE 71 (NORTH)

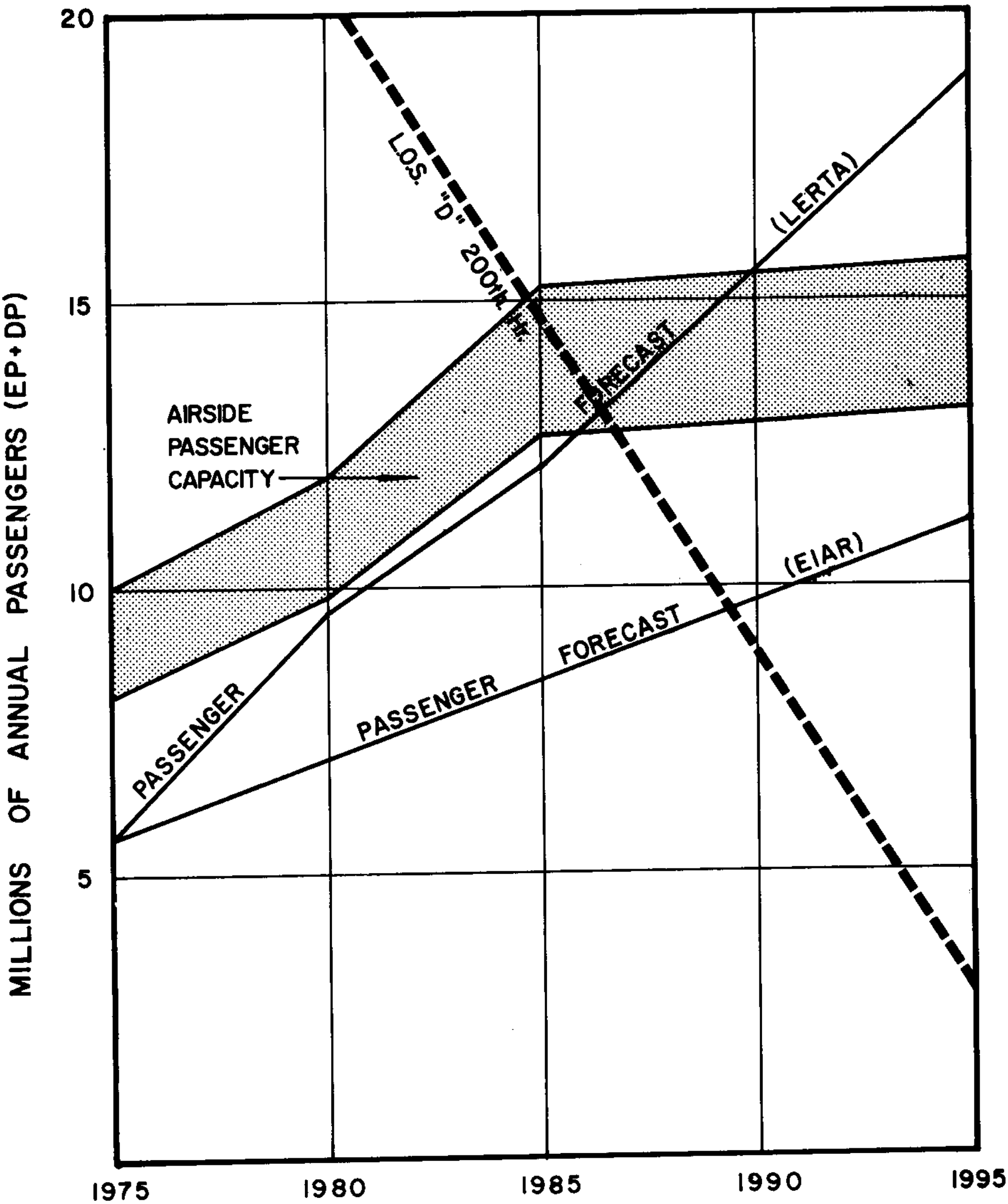

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Figure 5
DEMAND/CAPACITY RELATIONSHIP
INTERSTATE 71 (SOUTH)

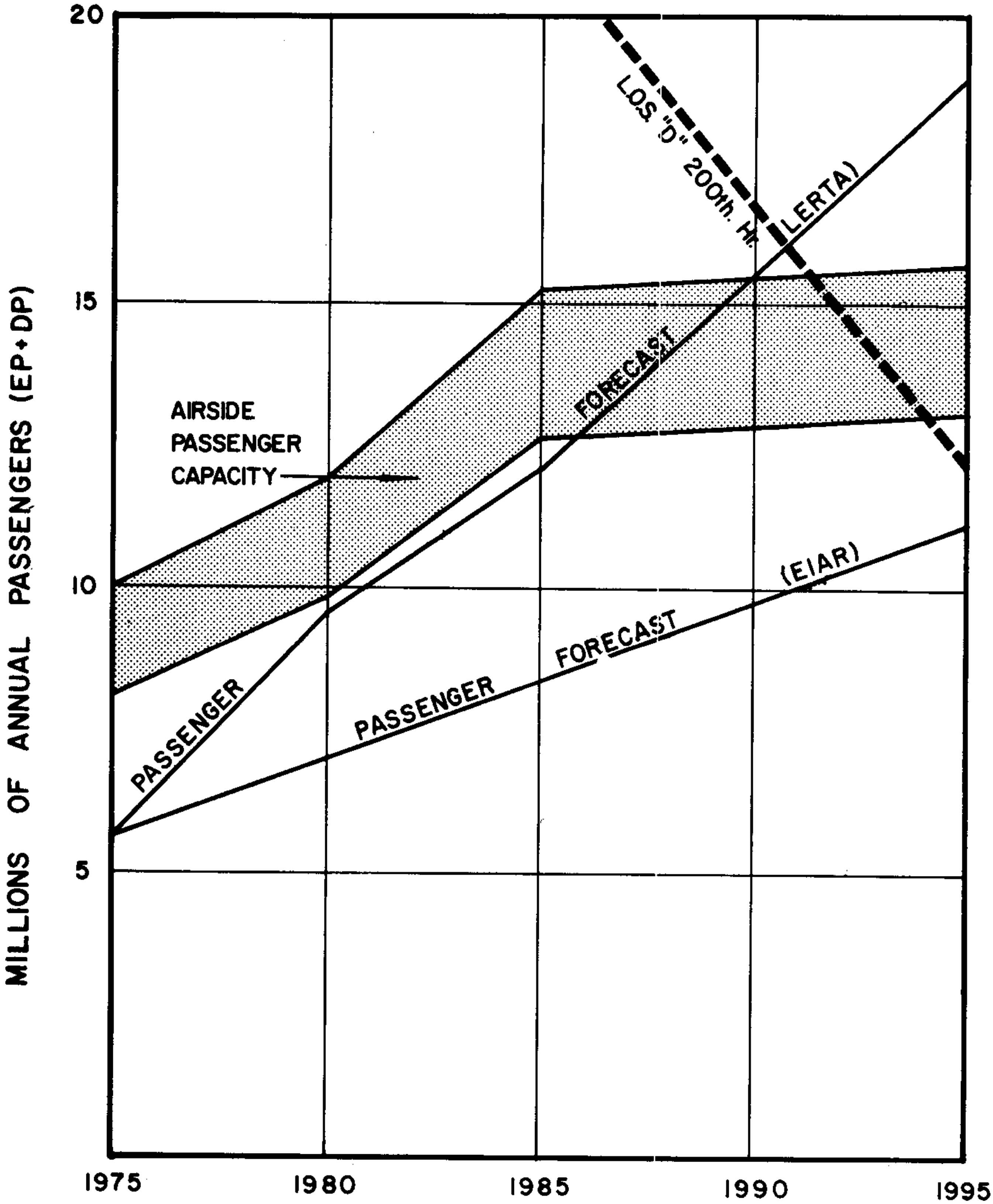

TABLE 5

Proposed Solutions to Airport Access Problems

Proposed Solution	Initiator	Agency Resp. for Impl.	Funding Sources	Est. Cost	Status
A. Construction					
1. Snow Road Ramp	Airport	State D.O.T.	Federal Aid Primary	*	Final Design
2. Berea Freeway Ramp	Airport	State D.O.T.	Federal Aid Primary	*	Final Design
3. Interstate 480	Federal	State D.O.T.	Federal Interstate	*	Construction

Access from other directions, including Akron and Cleveland's eastern suburbs (which generate over 20 percent of air passenger trips) is not nearly as good. Travel from the eastern suburbs is constrained by lack of a limited-access highway. Travel from east and south is constrained by at-grade crossings on Snow Road leading to the Airport and tight weaving distances on roads in the immediate vicinity of the Airport.

Two construction projects have been proposed to alleviate these problems. I-480, an east-west limited access highway running just north of the Airport property is now under construction and should be completed by the early 1980's. This facility will improve traffic flow from the eastern suburbs and also will create a new interchange for Airport-oriented traffic, thus relieving the Snow Road intersection. In addition, Snow Road itself is to be upgraded in the early 1980's with complete grade separation.

Analysis shows that these improvements should provide sufficient ground capacity for the foreseeable future at Cleveland-Hopkins. The capacity analysis indicates that airside capacity should prove more of a constraint of passenger growth than ground access capacity. The combination of radial highway/transit access from downtown plus a circumferential highway (I-480) for suburban traffic indicates good planning for airport access in Cleveland.

APPENDIX A

ASSIGNMENT OF AIRPORT GROUND TRIPS

The primary source used for the analysis was Reference 7 - which gave a distribution of trip origins for air passengers and employees in 1969. Reference 7 data were used to come up with the distribution of trips shown below:

Trip Origin Area	Percent of Air Passengers	Percent of Employees
Cleveland	24.5%	34.0%
Remainder of Cuyahoga County	9.9	22.5
South	9.3	29.3
East	20.8	2.5
Lorain County	4.3	8.8
Lake County	5.0	.7
Summit County	10.8	.3
Stark County	1.8	0.0
All Other	13.6	1.9
TOTAL	100.0%	100.0%

These numbers were combined according to overall proportion of passenger and employee vehicle trips and then assigned to major highways. The results were compared to an assumed future distribution given in Reference 16 and adjusted where appropriate. The resulting distribution is shown in Figure 2.

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

The hourly traffic capacity for I-71 and Berea Freeways was read directly from the right hand side of Table 9.1 of the Highway Capacity Manual, assuming a PHF = 0.91. The resulting capacity was reduced to account for trucks - 10% on I-71 and 5% on the Berea Freeway. This was then converted to a daily VHC by dividing the hourly capacity by the peak hour percentage. Peak Hour (K) factors of 11.0% for the 30th highest hour, 9.6% for the 200th highest hour, and 7.4% for the 1,000th highest hour were used.

TABLE B1

AIRPORT ACCESS CAPACITY

I-71 (SOUTH)

Service[1] (1)	Hrs/Yrs[2] (2)	Factor[3] (3)	YEAR				
			1974 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	81,070	81.070	81,070	81,070	81,070
		2	56,350	61,590	66,380	71,510	77,030
		3	24,720	19,480	14,690	9,560	4,040
		4	19.1	15.0	11.3	7.4	3.1
D	200	1	92,890	92,890	92,890	92,890	92,890
		2	56,350	61,590	66,380	71,510	77,030
		3	36,540	31,300	26,510	21,380	15,860
		4	28.0	24.2	20.5	16.5	12.2
D	1000	1	120,510	120,510	120,510	120,510	120,510
		2	56,350	61,590	66,380	71,510	77,030
		3	64,160	58,920	54,130	49,000	43,480
		4	49.5	45.5	41.8	37.8	33.6
E	30	1	99,270	99,270	99,270	99,270	99,270
		2	56,350	61,590	66,380	71,510	77,030
		3	42,920	37,680	32,890	27,760	22,240
		4	33.1	29.1	25.4	21.4	17.2
E	200	1	113,750	113,750	113,750	113,750	113,750
		2	56,350	61,590	66,380	71,510	77,030
		3	57,400	52,160	47,370	42,240	36,720
		4	44.3	40.3	36.6	32.6	28.3
E	1000	1	147,570	147,570	147,570	147,570	147,570
		2	56,350	61,590	66,380	71,510	77,030
		3	91,220	85,980	81,190	76,060	70,540
		4	70.4	66.4	62.7	58.7	54.5

1] Per Highway Capacity Manual

2] Number of hours/years during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway capacity; 2) = nonairport related traffic; 3) = capacity for airport related vehicles; 4) = million annual passenger associated with 3.

TABLE B2

AIRPORT ACCESS CAPACITY

I-71 (NORTH)

L.O.S.[1]	Hrs/Yrs[2]	Factor[3]	YEAR 1974	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	109.200	109.200	109,200	109,200	109,200
		2	88,680	96.930	104,470	112,530	121,220
		3	20,520	12,270	4,730	-	-
		4	14.7	8.8	3.4	-	-
D	200	1	125,130	125,130	125,130	125,130	125,130
		2	88,680	96,930	104,470	112,530	121,220
		3	36,450	28,200	20,660	12,600	3,910
		4	26.1	20.2	14.8	9.0	2.8
D	1000	1	162,320	162,320	162,320	162,320	162,320
		2	88,680	96,930	104,470	112,530	121,220
		3	73,640	65,390	57,850	49,790	41,100
		4	52.6	46.7	41.4	35.6	29.4
E	30	1	132,360	132,360	132,360	132,360	132,360
		2	88,680	96,930	104,470	112,530	121,220
		3	43,680	35,430	27,890	19,830	11,140
		4	31.2	25.3	19.9	14.2	8.0
E	200	1	151,670	151,670	151,670	151,670	151,670
		2	88,680	96,930	104,470	112,530	121,220
		3	62,990	54,740	47,200	39,140	30,450
		4	45.0	39.1	33.7	28.0	21.8
E	1000	1	196,760	196,760	196,760	196,760	196,760
		2	88,680	96,930	104,470	112,530	121,220
		3	108,080	99,830	92,290	84,230	75,540
		4	77.3	71.4	66.0	60.2	54.0

1] Per Highway Capacity Manual

2] Number of hours/years during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway capacity; 2) = nonairport related traffic; 3)= capacity for airport related vehicles; 4) = million annual passenger associated with 3

TABLE B3

AIRPORT ACCESS CAPACITY

BEREA FREEWAY

L.O.S.[1/] (1)	Hrs/Yrs[2/] (2)	Factor[3/] (3)	YEAR 1974 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	84,640	84,640	84,640	84,640	84,640
		2	21,640	23,650	25,490	27,460	29,580
		3	63,000	60,990	59,150	57,180	55,060
		4	17.4	16.8	16.3	15.8	15.2
D	200	1	96,980	96,980	96,980	96,980	96,980
		2	21,640	23,650	25,490	27,460	29,580
		3	75,340	73,330	71,490	69,520	67,400
		4	20.8	20.2	19.7	19.2	18.6
D	1000	1	125,810	125,810	125,810	125,810	125,810
		2	21,640	23,650	25,490	27,460	29,580
		3	104,170	102,160	100,320	98,350	96,230
		4	28.7	28.2	27.7	27.1	26.5
E	30	1	103,640	103,640	103,640	103,640	103,640
		2	21,640	23,650	25,490	27,460	29,580
		3	82,000	79,990	78,150	76,180	74,060
		4	22.6	22.0	21.5	21.0	20.4
E	200	1	118,750	118,750	118,750	118,750	118,750
		2	21,640	23,650	25,490	27,460	29,580
		3	97,110	95,100	93,260	91,290	89,170
		4	26.8	26.2	25.7	25.2	24.6
E	1000	1	154,050	154,050	154,050	154,050	154,050
		2	21,640	23,650	25,490	27,460	29,580
		3	132,410	130,400	128,560	126,590	124,470
		4	36.5	36.0	35.4	34.9	34.3

1] Per Highway Capacity Manual

2] Number of hours/years during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway capacity; 2) = nonairport related traffic; 3) = capacity for airport related vehicles; 4) million annual passenger associated with 3

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DENVER

STAPLETON INTERNATIONAL AIRPORT

CASE STUDY

CASE STUDY SUMMARY

Stapleton International Airport is located in the City and County of Denver, Colorado, about six miles east of the central business district. The airport has grown rapidly, and in 1976, served over 13 million passengers. Denver is an airline transfer hub, with almost one out of every two passengers using the airport for transfer only.

Access to Stapleton is through city streets, primarily 32nd Avenue and Quebec Street. Quebec Street links the airport to the interstate highway system at I70, about a mile north of the airport. Interstate 25 runs north-south just west of the CBD and connects to I70.

Currently, the major problem in the access to Stapleton is the inadequate capacity of Quebec Street. Several proposals to improve this capacity with grade separations at one or more intersections have been proposed but have met opposition. The internal airport access system is also a problem and is now under study. Relocation of the terminal area or of the airport are under serious consideration, for reasons of both access and airside capacity.

Because of Denver's rapid growth rate, severe congestion is expected by 1985 on I25 south of I70. This is a rather intractable urban transportation problem which will affect about twenty-six percent of the local airport passengers.

Airside capacity is also a problem at Stapleton and, according to some forecasts, may constrain the growth of the airport before it is constrained by the access system.

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A. BACKGROUND

1. General

Stapleton International Airport is located in the state of Colorado, within the county and city of Denver, approximately six miles east of the central business district (see Figure 1). Although several interstate highways are situated near the airport, no direct highway connection to the airport is currently available. Rather, ground access to Stapleton is accomplished by a dense arterial street system.

In 1976, Stapleton Airport enplaned and deplaned over 13 million annual passengers (MAP). Historically, only 55% of these passengers originated or terminated their trips in the Denver area, reflecting Stapleton's role as a major transfer hub. This role is expected to persist and to grow as congestion increases in Chicago (another major transfer point) and national traffic increases.

In addition, Denver itself is growing rapidly. Population in the Denver region grew at a 4.3% annual rate through the 1960's, more than double the national average. Growth during the 1970's has been somewhat slower, but still continues to outpace the national average by more than a two to one margin.

2. Planning Structure

Stapleton is operated by the City and County of Denver. Administratively, it is a division of the City and County Department of Public Works (DPW).

The Metropolitan Planning Organization (MPO) for the Denver region is the Denver Regional Council of Governments (DRCOG). Airport authorities do not, as a rule, attend DRCOG meetings but do participate in technical committees on matters affecting the airport.

To receive Federal funding for roadway construction, a proposed project must first be made part of the Denver Transportation Improvement Plan (TIP), a five-year plan. Longer-range plans may first be made part of the Long Range Plan Restatement System, componements of which continually update the TIP. In the creation of the TIP, the airport is represented by the DPW.

In matters relating to State and Federal highways adjacent to the airport, airport authorities deal directly with the State Department of Highways.

3. Highway Access

Figure 2 1/ shows the principal highway access system serving the airport. Interstate 70 is the major east-west highway, running just north of the airport and the CBD. Interstate 25 runs north-south just west of the CBD.

1/ Source: Appendix A

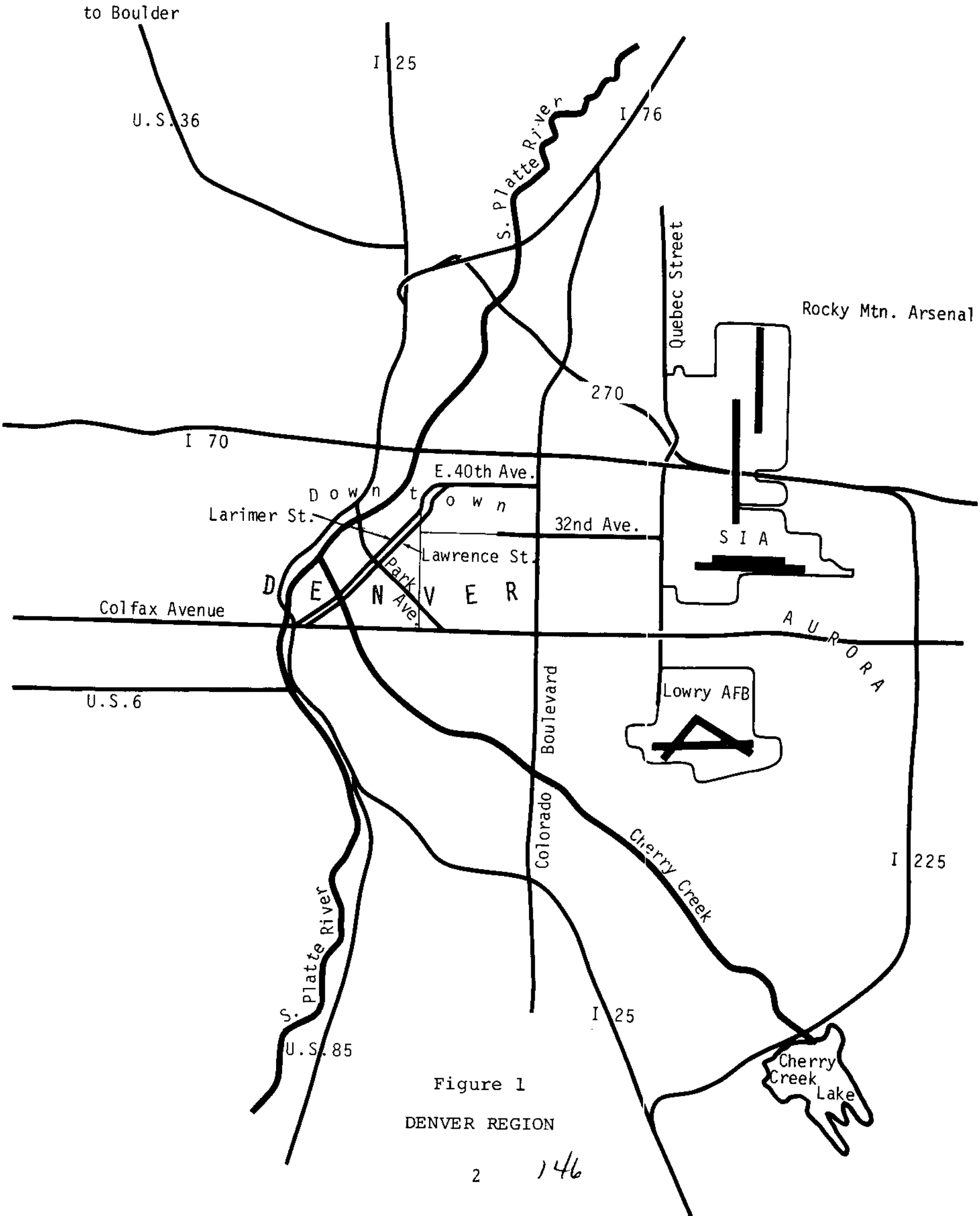

Figure 1

DENVER REGION

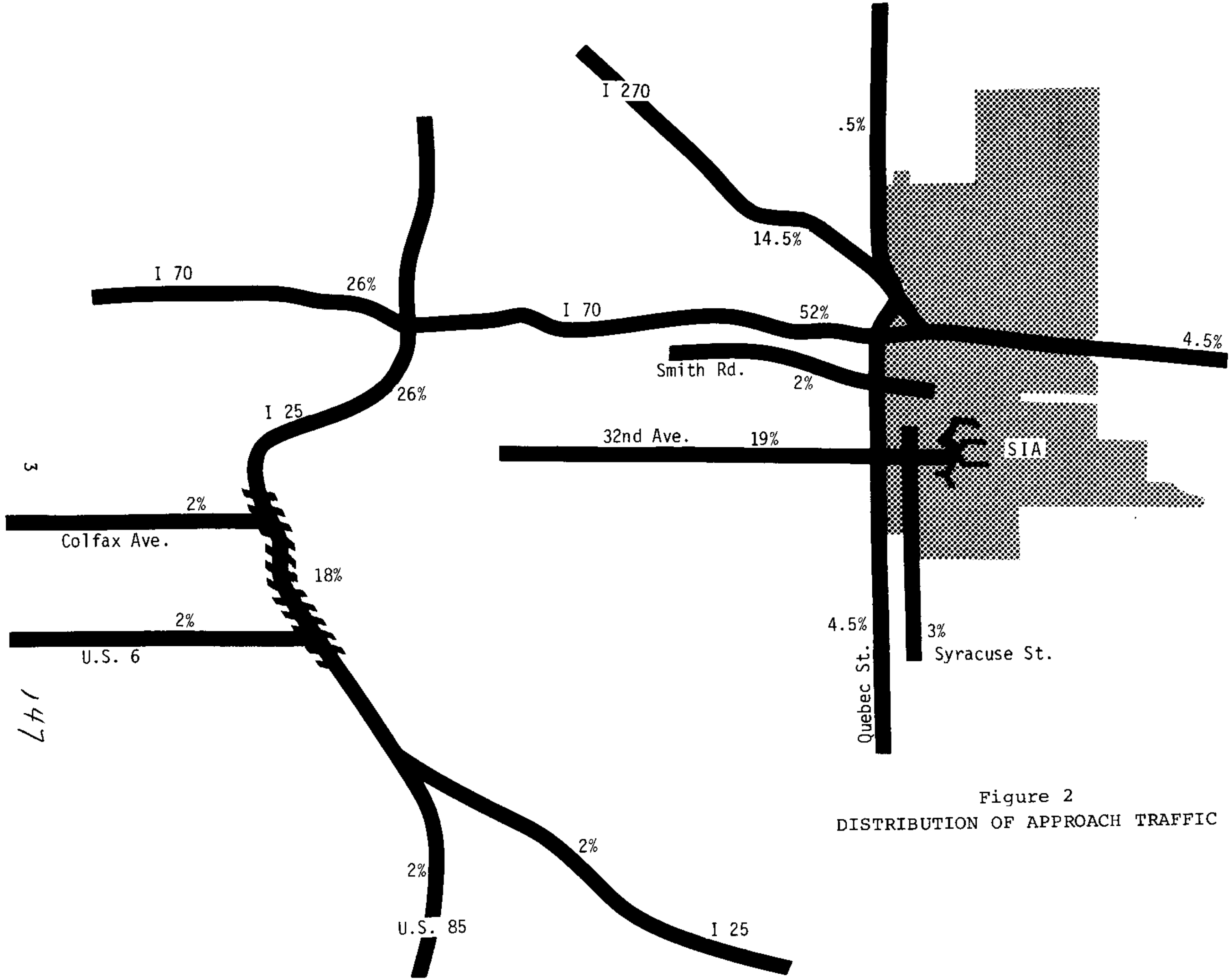

Figure 2
DISTRIBUTION OF APPROACH TRAFFIC

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The airport is served indirectly from I70 via Quebec Street, a six-lane signalized arterial. Almost three-quarters of air passengers at Stapleton usethe interstate system and Quebec Street to access the airport. The main airport entrance intersects Quebec Street about one mile south of I70.

Access from the central business district to the airport is via local streets. The great majority of passengers from the CBD use 32nd Avenue, a six-lane signalized arterial and the signed route to the airport. However, there exist several other viable local routes.

The intersection of 32nd Avenue and Quebec Street, at the airport entrance, is commonly conceded to be one of the major bottlenecks to airport access. The airport has sought to build an interchange at this intersection to facilitate traffic flow. However, local opposition is strong against such a plan, and it is unlikely that an interchange will be built in the near future.

4. Transit Access

Stapleton is hooked into the Regional Transportation District via local and express buses. In addition, public transportation is provided by hotel and motel limousines and by shuttle buses that run between the airport and two off-airport, privately-operated parking lots. There is one inter-area bus company (Continental Trailways) providing scheduled service at the airport, as well as three taxicab companies.

5. Internal Access

Stapleton International Airport has three components to its internal circulation system, as shown in Figure 3.

The first and most heavily used element is the one-way multiple-lane traffic loop providing direct connection between the 32nd Avenue and Quebec Street intersection and the Terminal Building and public parking area.

The second element is Syracuse Street, a north-south roadway parallel to Quebec Street, which functions both as an internal roadway and as an external access facility. This north-south roadway intersects most east-west arteries except Smith Road. The connection to Smith Road has been eliminated to provide room for expansion of aircraft maintenance facilities. Syracuse Street intersects both eastbound and westbound Terminal Building access roadways, thereby, limiting the capacity of this roadway loop to the capacity of these intersections.

The third component of the airport circulation system is a group of disparate access points: Smith Road at Quebec Street, Cargo Road at Syracuse Street, and access along the south side of the airfield on Montview Boulevard and Clinton Street.

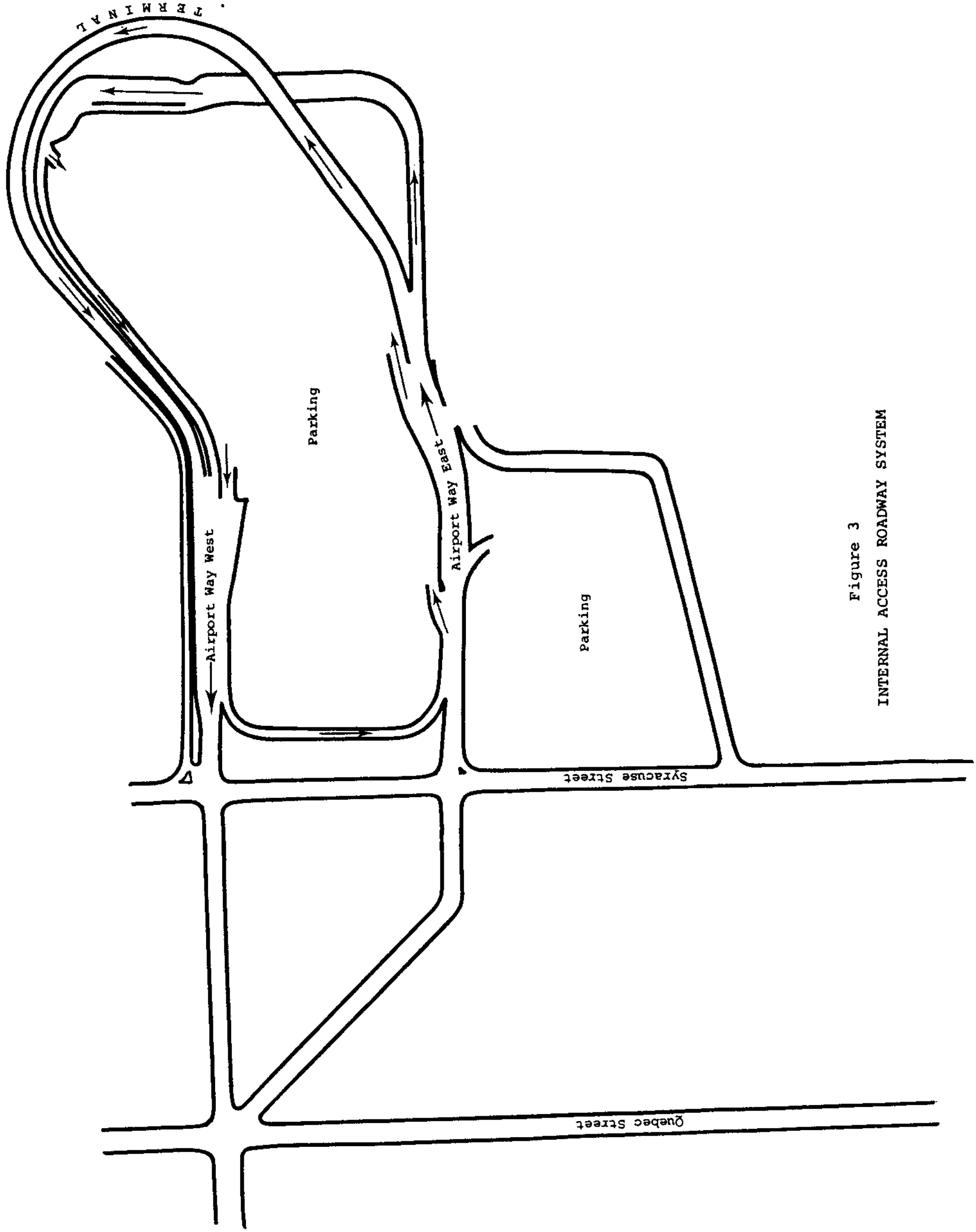

Figure 3
INTERNAL ACCESS ROADWAY SYSTEM

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B. CAPACITY ANALYSIS

1. Passenger Forecast

The passenger forecasts presented in Table 1 were taken from a 1977 forecast by R. Dixon Speas Associates (Denver Forecast) and the latest FAA forecast. These forecasts are substantially different, with the Denver forecast being almost 50% greater than the FAA forecast by 1995.

2. Airside Capacity

Table 2 shows the airside capacity projected for Stapleton. No major airfield construction is anticipated through 1995. PANCAP was converted to annual passengers by applying factors for percent air carrier operations, available seats per operation, and the enplaning load factor (LF). Two load factors were used (1) the current load factor of 46 percent 1/ and (2) the current load factor plus 10%.

3. Ground Access Capacity

Current airport ground trips were assigned to major highways as described in Appendix A. The following five critical highway locations were identified:

(1) Quebec St. north of 32nd Avenue;

(2) I70 between Quebec St. and I25;

(3) I70 west of I25;

(4) I25 south of I70;

(5) 32nd Avenue just west of Quebec St.

The last location noted, 32nd Avenue, is not a critical location according to the criterion generally followed in the airport access case studies: it does not carry 25% of the airport traffic. However, because it does carry the CBD traffic and is popularly considered to be one of the major access routes, it is included in the following analysis.

Figures 4 through 8 present the results of the ground access capacity analysis for the critical highway locations. Appendix B explains the assumption used to derive these figures and presents the detailed calculations.

1/ Calculated from data in Airport Activity Statistics of Certificated Route Air Carriers, 12 months ended December 31, 1975, Civil Aeronautics Board, U.S. Department of Transportation, Federal Avaiation Administration (Annual enplaned passengers/performed departures) divided by average seats per operation.

TABLE 1

FORECAST OF DEMAND
(Million Annual Passengers)

Year	Denver	FAA
(1)	(2)	(3)
1975	11.3 1/	11.3 1/
1980	18.9	15.3 2/
1985	26.2	20.0 2/
1990	34.4	26.2 3/
1995	44.2	29.9 3/

1/ Actual.

2/ Interpolated.

3/ Extended.

Sources: Air Trade Demand Forecast, R. Dixon Speas Associates, March 1977.

FAA. Terminal Area Forecast, 1978-1988.

TABLE 2

CALCULATION OF AIRSIDE CAPACITY

Year	PANCAP 1/	% Air Carrier	Average 2/ Seats/Operation		Annual Passenger Capacity (Millions) LF = .46	LF = .56
(1)	(2)	(3)	(4)		(5)	(6)
1975	476,000	.52	122.5	3/	13.9	17.0
1980	476,000	.52	148.0		16.9	20.5
1985	476,000	.52	166.5	3/	19.0	23.1
1990	476,000	.52	185.0		21.1	25.6
1995	476,000	.52	209.5	3/	23.9	29.0

1/ Per airport records--mix of existing capacity (475,869) and that of Future A (477,422) the year 2000 scenario assuming GA is same percent of total traffic at present.

2/ Denver Regional Airport System Plan, Vol. 3, p. 45.

3/ Interpolated linearly.

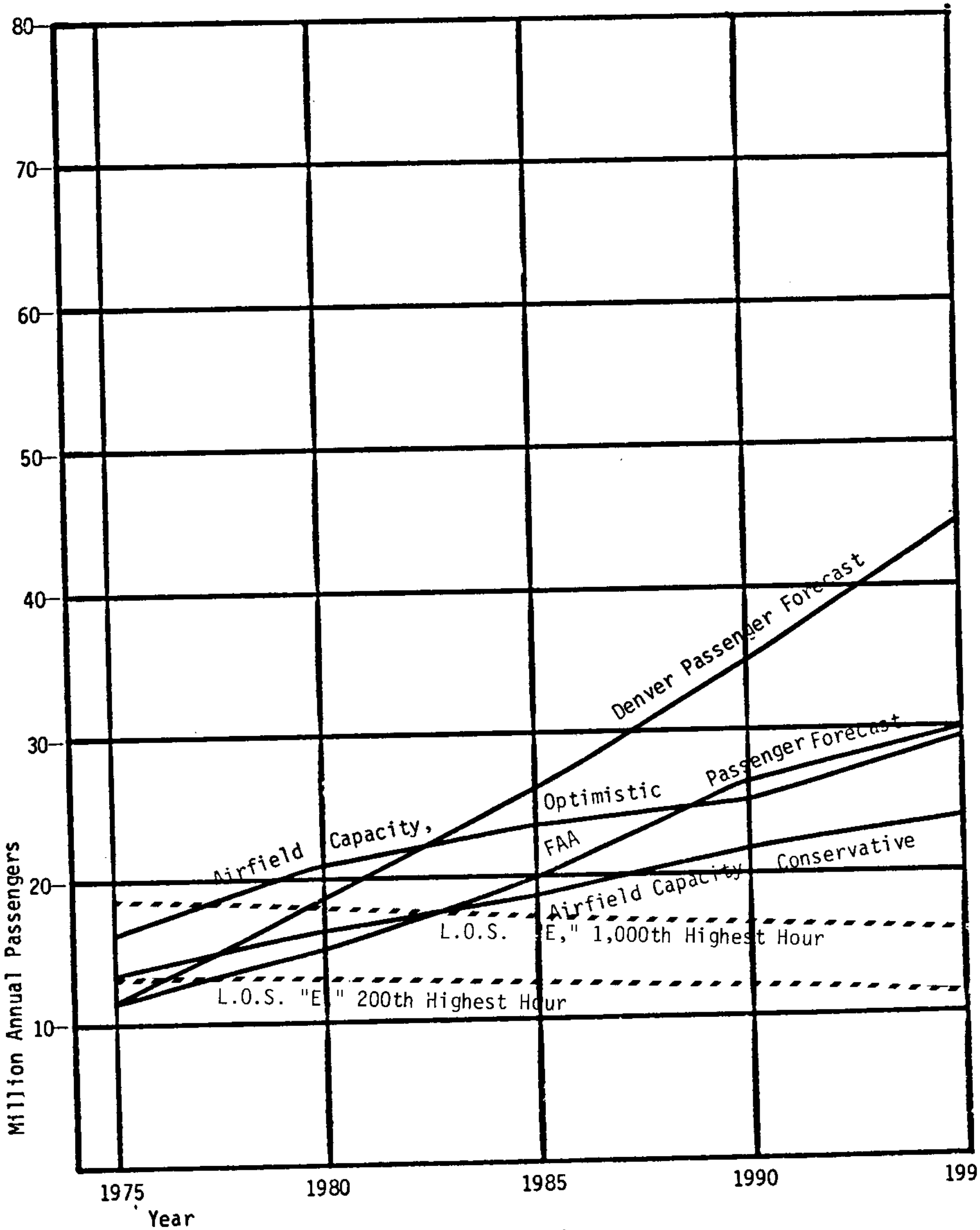

Figure 4

DEMAND/CAPACITY RELATIONSHIPS
Quebec North of 32nd

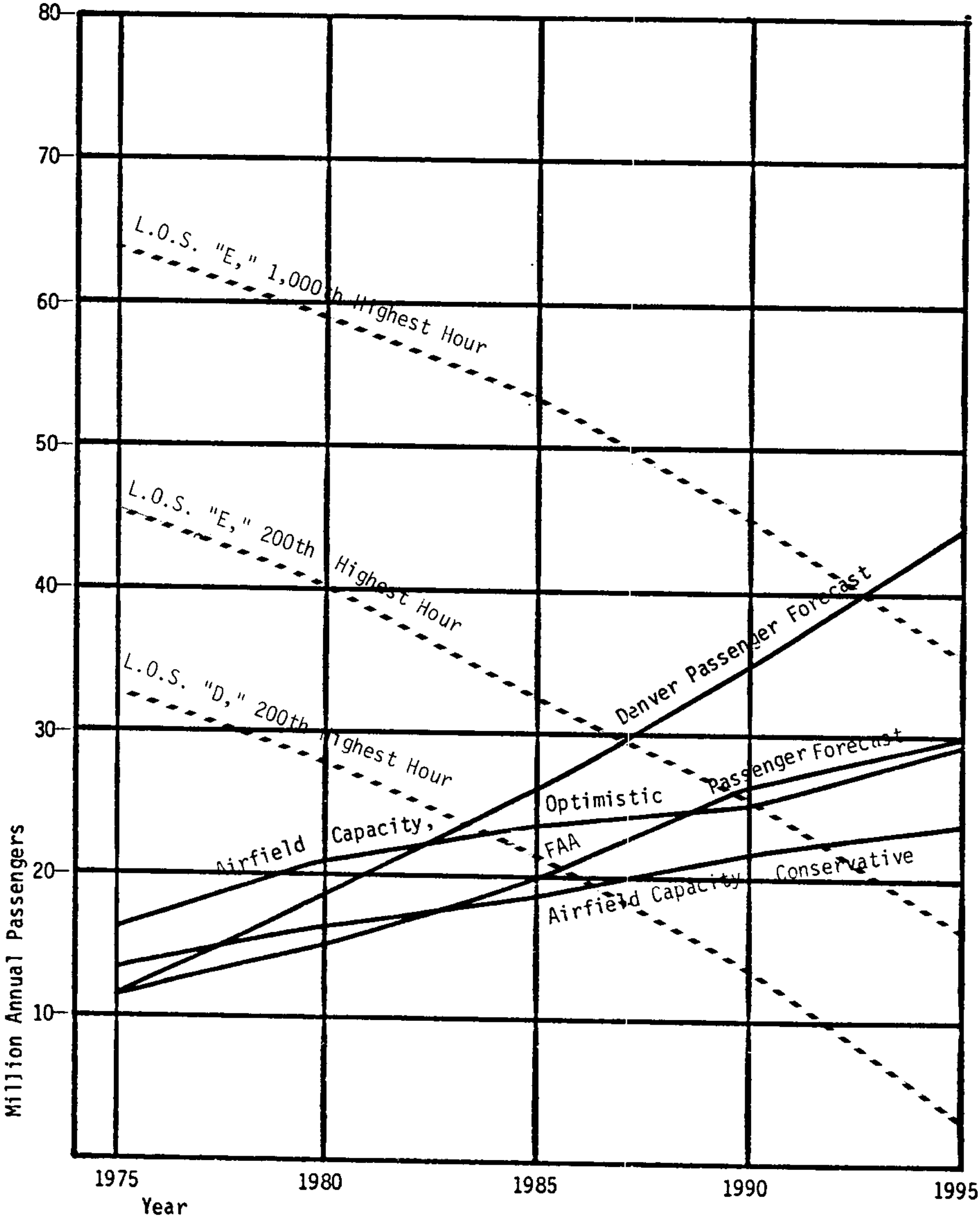

Figure 5
DEMAND/CAPACITY RELATIONSHIPS
I70 Between Quebec and I25

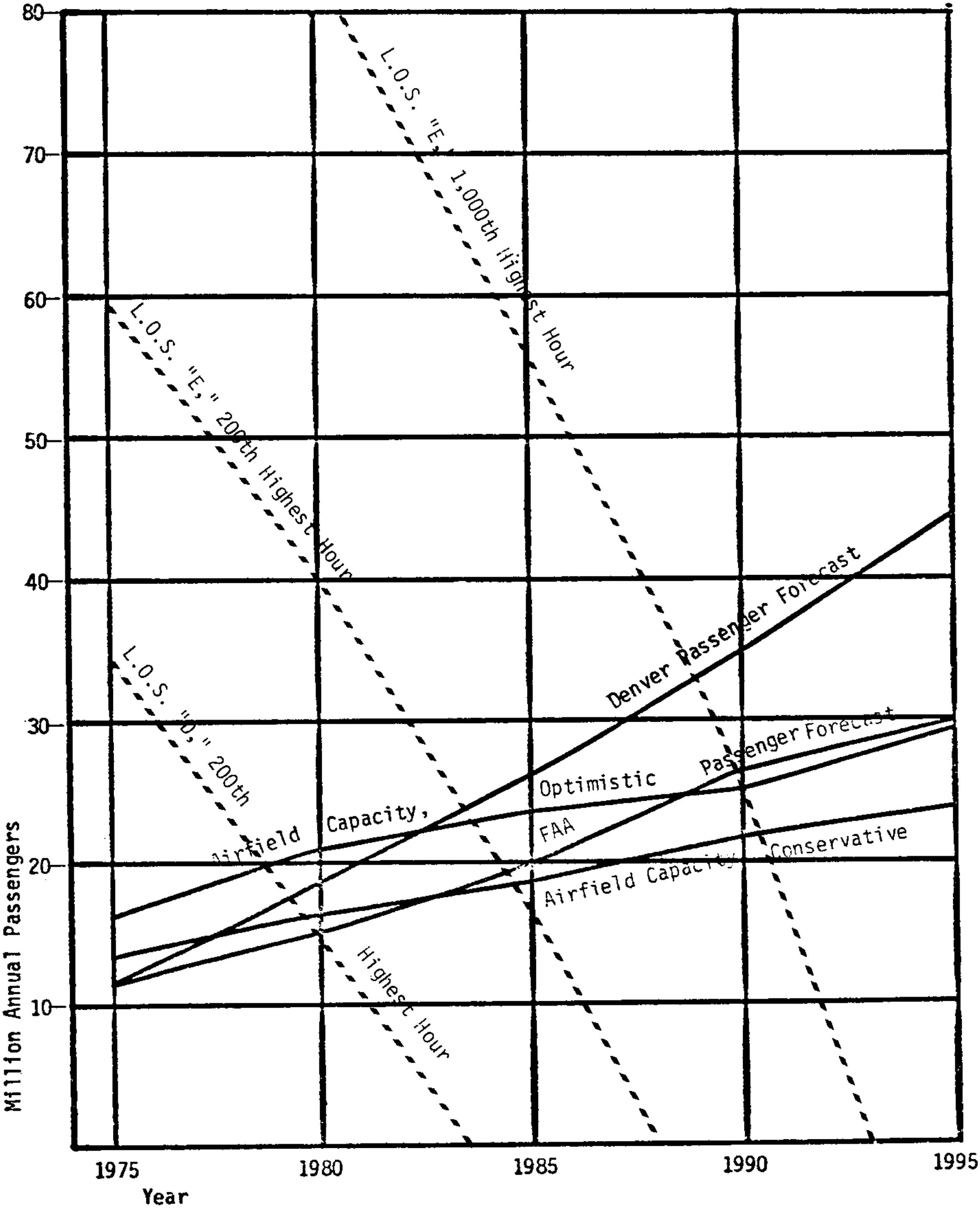

Figure 6

DEMAND/CAPACITY RELATIONSHIPS

I70 West of I25

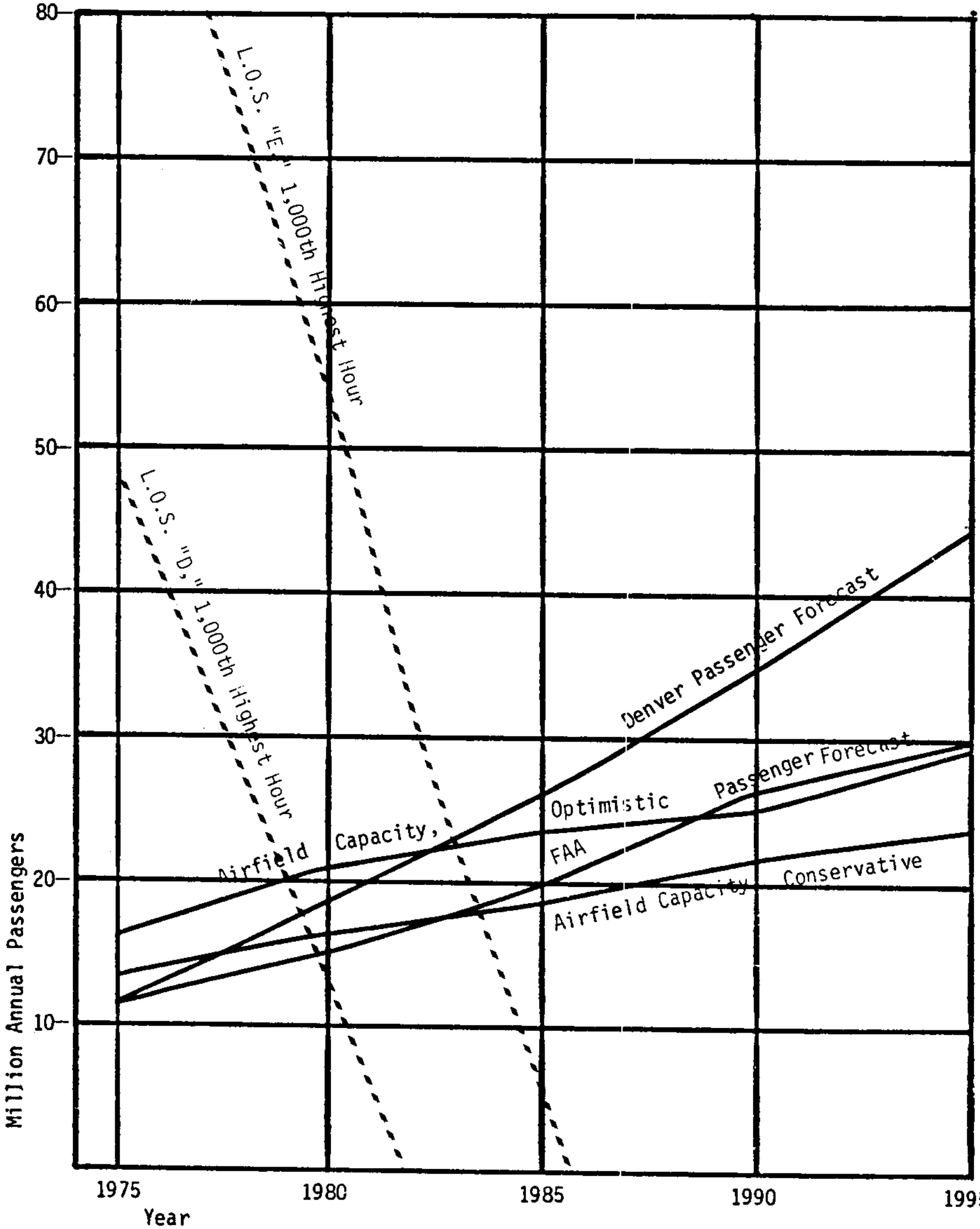

Figure 7

DEMAND/CAPACITY RELATIONSHIPS

I25 South of I70

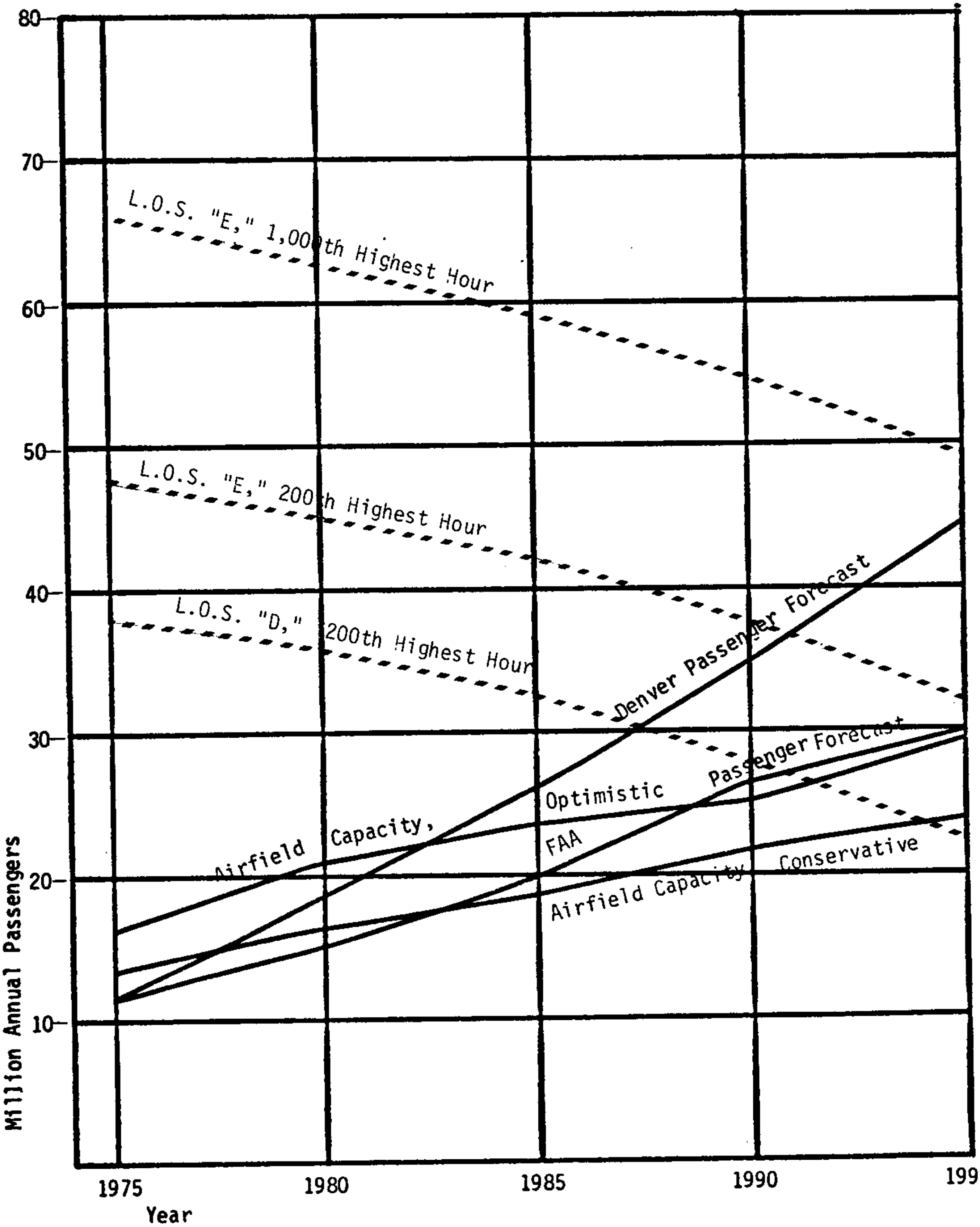

Figure 8

DEMAND/CAPACITY RELATIONSHIPS

32nd Avenue

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4. Interpretation

a. Quebec St. North of 32nd Avenue

It is expected that Quebec St. will operate at Level of Service "E" for 1,000 hours or more a year by about 1980. No matter which forecast of demand is believed, it is apparent that nearly 75% of those passengers originating or terminating their trips in Denver will be seriously inconvenienced by this bottleneck. Although the passenger trip along Quebec St. is only about one mile long, delays in access to the airport could conceivably back up traffic into I70 and I270. This problem is somewhat mitigated by the fact that the southbound traffic has four lanes while the northbound traffic has only two. Thus, more delay is expected in egress from the airport, with backups onto airport property. This problem, too, is mitigated by the easier turn between Quebec St. and 32nd Ave. for traffic leaving the airport than for traffic entering the airport.

The Quebec Street problem is amenable to construction alternatives, particularly grade separation at intersections, especially at its intersection with 32nd Avenue. While this solution has been studied, there is currently no consensus as to which of several proposed alternatives (including the null alternative) to pursue.

b. I70 Between Quebec St. and I25

This segment of I70 currently has ample capacity. However, if the Colorado State Highway Department's projection of a 4.5% annual growth in vehicle-trip-miles is correct, and if that growth is manifest equally around the highway system, non-airport traffic will quickly use up capacity available for airport trips. If the FAA's forecast is right, this segment (carrying 52% of the airport passengers) will reach level of service "E" for 200 or more hours/year by 1990. If the Denver forecast is right, the crunch will come closer to 1985.

c. I70 West of I25

This segment of I70 is currently closer to capacity than the segment between I25 and Quebec St. Level of service "E" is expected to be reached for at least 200 hours/year before 1985. Again, this forecast is sensitive to the assumed growth in non-airport vehicles on the segment.

d. I25 South of I70

This segment is currently running close to capacity at level of service "E" for 200 hours per year. Should non-airport growth continue at the level assumed, there will be no capacity available for airport traffic at this level of service by 1980. Before 1985, level of service "E" will occur over 1,000 hours of the year. This bottleneck will directly affect over one-quarter of the airport passengers and is likely to result in long delays over extended periods of time. Alternative routings on surface streets or via I225 may be required if air travel originating in regions currently using this airport approach is to continue to grow.

e. 32nd Avenue

The capacity analysis indicates that 32nd Avenue will not be a major bottleneck to ground access until 1990 or beyond. This result is buttressed by the fact that there are a host of alternative access routes for those currently using 32nd Avenue, namely Colfax to Syracuse or Colfax to Quebec heading north. Consequently, it is unlikely that 32nd Avenue will become a major bottleneck to airport access.

f. Airside

Figures 4 through 8 show that airside capacity may be as great a problem as ground access capacity. Assuming conservative assumptions on demand and airside capacity, airside problems arise before 1985, when only Quebec and I25 are experiencing severe congestion (level of service "E" for 1,000 hours per year) on the ground side. If the Denver passenger forecast is correct, airside problems arise before 1980, and become quite severe by 1985.

Assuming the optimistic forecast for airside capacity, airside demand is satisfactory to about 1995 per the FAA passenger forecast and to about 1982 per the Denver passenger forecast. In this scenario, again only Quebec St. and I25 are experiencing similar problems on the ground access system.

C. PROPOSED SOLUTIONS

The ground access problem at Stapleton is currently under study, but as yet there have been few solutions proposed. One solution to the ground access problem, and other problems seriously under consideration, is the relocation of the airport to a point farther from the city. Another drastic solution is to move the terminal building to the north with a direct access onto I70, although it is unlikely that the terminal area would be relocated without actually relocating the airport. Finally, various improvements to Quebec Street have been suggested but none has yet received approval. Table 3 summarizes the solution alternatives proposed to date.

D. CONCLUSIONS

Currently the access problem at Stapleton is severe, with level of service "E" being experienced on Quebec Street nearly 1000 hours/year. This route is used by nearly three-quarters of the local airport passengers. Several proposals to alleviate the problem have been forwarded, including primarily the grade separation of Quebec and 32nd Avenue and Quebec and other cross streets. Improvements to Quebec have met opposition and it is unclear when or if they will ever be implemented. Also under consideration is the relocation of the terminal building or of the airport itself.

TABLE 3

PROPOSED SOLUTIONS TO AIRPORT ACCESS PROBLEMS

Proposed Solutions (1)	Initiator (2)	Agency Resp. for Implem. (3)	Funding Source (4)	Est. Cost (1976 Dollars) (5)	Status (6)
A. CONSTRUCTION					
1. Interchange at Quebec and 32nd Ave. (3 alternatives	DDPW	CDOH	FHWA	$8,800,000 to $12,300,000	Has been studied; further study underway; has encountered neighborhood opposition.
2. Other improvements to Quebec St. (limited access)	DDPW	CDOH	FHWA	*	*
3. PRT system along Colfax St. with spur to airport	JRPP, DRCOG	DRTD	UMTA	*	Inactive
4. Internal access improvements--new lanes	DDPW	DDPW	ADAP, Airport Revenues	*	*
5. Remote parking lot north of I70	DDPW	DDPW	ADAP, Airport Revenues, User Fees	*	*

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Proposed Solutions	Initiator	Agency Resp. for Implem.	Funding Source	Est. Cost (1976 Dollars)	Status
B. RELOCATION					
1. Terminal area north of I70	DRCOG	DDPW	ADAP	$641 million 1/	Under study
2. Airport relocation	DRCOG	DDPW DRCOG	ADAP	Depends on site; about $650 million 1/	Under study

*Not available or unknown.

1/ 1973 dollars.

Key of Abbreviations:

ADAP	Airport Development Aid Program.
CDOH	Colorado Department of Highways.
DDPW	Denver Department of Public Works.
DRCOG	Denver Regional Council of Governments.
DRTD	Denver Regional Transit District.
FHWA	Federal Highway Administration.
JRPP	Joint Regional Planning Program.
UMTA	Urban Mass Transportation Administration.

Although not currently a problem, by the early 1980's, if Denver's growth persists, I25 south of I70 may become a bottleneck through which some 26% of the local airport passengers must pass. This is an urban transportation problem not easily amenable to solution.

In the early 1980's, according to some forecasts, growth of Stapleton will be constrained by its airside capacity to a greater degree than by its ground access capacity. However, according to other forecasts, airside capacity will not be a problem until about 1990.

APPENDIX A

ROUTING OF AIRPORT ACCESS TRIPS

BY LOCAL ORIGIN/DESTINATION ZONE

Data on passenger originations and destinations by local zone were obtained from a survey conducted at the airport by Speas Associates and Alan M. Voorhees & Associates during March 1976. The location of local zones is shown in the map in Figure A1. Table A1 reports the survey results, shows how the percentage from each zone was adjusted so as to sum to one-hundred, and shows how passengers were assumed to route themselves to the airport.

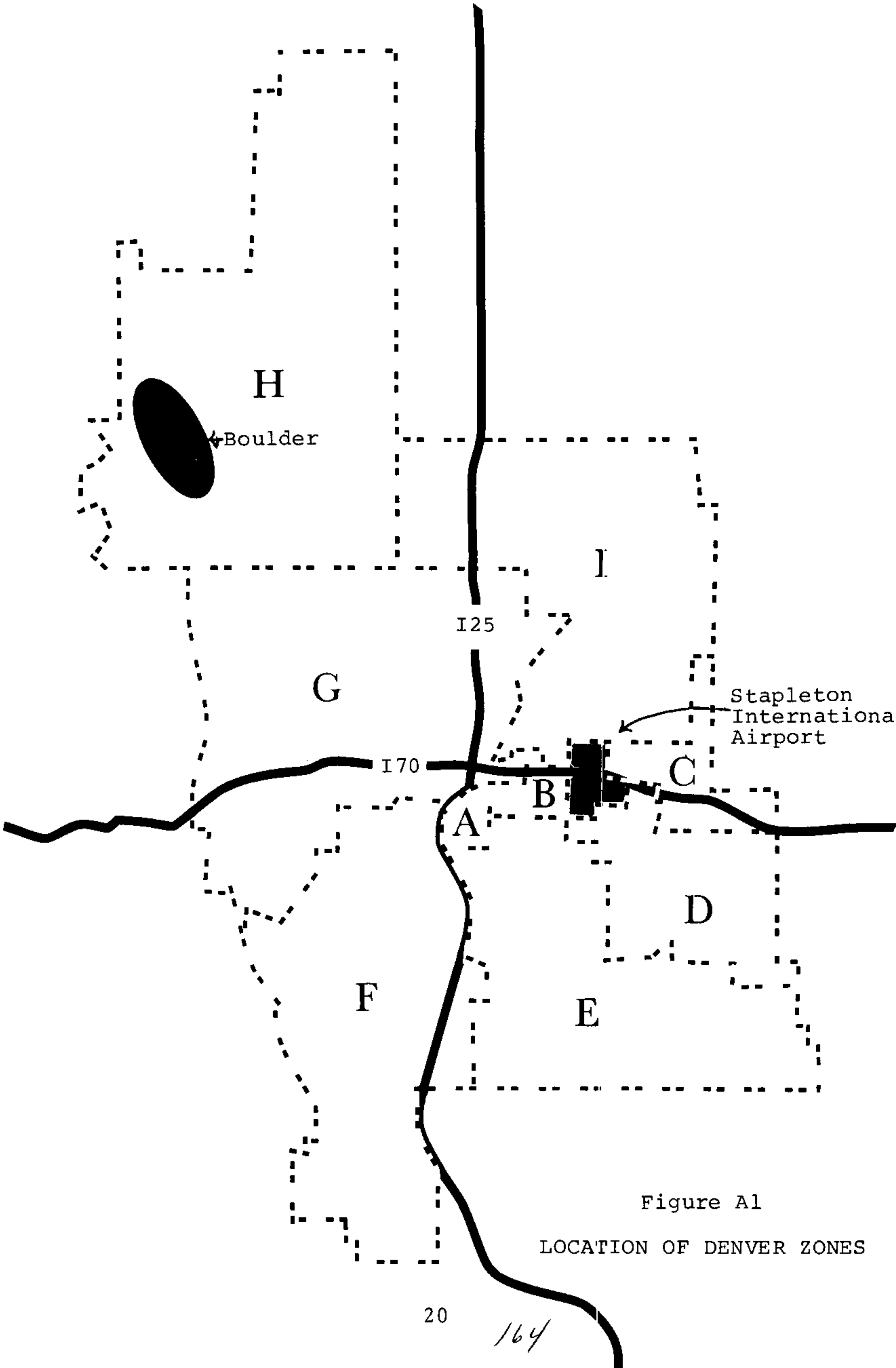

Figure A1

LOCATION OF DENVER ZONES

TABLE A1

ROUTING OF AIRPORT ACCESS TRIPS

BY LOCAL ORIGIN/DESTINATION ZONE

Zone	Percent Per Survey	Percent as Distributed	Routing	Percent by Route
(1)	(2)	(3)	(4)	(5)
A	8.6	10	AV32	6
			CA, QS	1
			CA, CB, AV32	1
			CA, MSP, AV32	1
			CA, SS	1
B	6.3	7	AV32	5
			SR, QS	2
C	0.6	1	CA, QS	0.5
			I70, QS	0.5
D	3.8	4	I225, I70, QS	3
			MSP, AV32	1
E	19.5	22	I25, I70, QS	14
			MSP, AV32	2
			MSP, CA, QS	2
			MSP, CA, SS	2
			CB, AV32	2

Zone	Percent Per Survey	Percent as Distributed	Routing	Percent by Route
F	8.6	10	I25, I70, QS	4
			CA, I25, I70, QS	2
			RT6, I25, I70, QS	2
			AA, CB, AV32	1
			AA, CB, CA, QS	1
G	10.3	11	I70, QS	11
H	5.7	6	RT, I270, QS	6
I	0.6	1	RT75, I270, QS	0.5
			RT2, QS	0.5
South of Denver	2.5	3	RT25, I70, QS	2
			RT85, I70, QS	1
North of Denver	7.2	8	RT25, I270, QS	8
East of Denver	0.8	1	I70, QS	1
West of Denver	14.1	16	I70, QS	15
			RT285, RT85, I25, I70, QS	1

Key:

AA	Alameda Ave.
AV32	32nd Ave.
CA	Colfax Ave.
CB	Colorado Blvd.
In	Interstate n
MSP	Monaco St. Pkwy.
QS	Quebec St.
RTn	Route n
SR	Smith Road
SS	Syracuse St.

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

The capacities at Level of Service "E" of Quebec St. and I70 at several locations were supplied by the Colorado Division of Highways. The capacity of Quebec St. under Smith Road and the through capacity of I70 at Quebec St. were used for Quebec and I70, respectively. The capacity of 32nd Avenue just west of Quebec was assumed equal to the capacity of Quebec since both arterials are six lanes wide. The capacity of I70 east of I25 and the capacity of I25 south of I70 were calculated from the Highway Capacity Manual assuming a PHF of .91.

Traffic counts for 1975 (average weekday total) were supplied by the Colorado Division of Highways at many points on the surface network. Traffic counts used were as follows:

(1) Quebec St., just north of 32nd Ave.;

(2) 32nd Ave., just west of Quebec St.;

(3) I70 between Quebec and I25, just west of Quebec;

(4) I70 west of I25, just west of I25;

(5) I25 south of I70, just south of I70.

Average weekday totals were converted to average daily totals by multiplying by .93, as suggested by the Denver State Department of Highways.

Total traffic entering and leaving the airport (38,550 ADT for 1975) was obtained from counts arrived at by Hunnicut and Neale in 1974, and extended to 1975 at the same growth rate as enplaned passenger from 1974 to 1975. The 1975 Map (11.3) was taken from Airport Activity Statistics of Certificated Route Air Carriers, 1975 by the Civil Aeronautics Board and the Federal Aviation Administration.

Tables B1 through B5 provide a detailed computation of airport access capacity.

Table B1

AIRPORT ACCESS CAPACITY

Quebec North of 32nd

Level of Service[1/]	Hrs./Year[2/]	Factor[3/]	Year[4/]				
			1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	28,977	28,977	28,977	28,977	28,9[illegible]
		2	4,495	5,602	6,981	8,699	10,84[illegible]
		3	24,482	23,375	21,996	20,278	18,13[illegible]
		4	9.76	9.32	8.77	8.09	7.23
D	200	1	33,204	33,204	33,204	33,204	33,204
		2	4,495	5,602	6,981	8,699	10,840
		3	28,709	27,602	26,223	24,505	22,364
		4	11.45	11.01	10.46	9.77	8.92
D	1,000	1	43,075	43,075	43,075	43,075	43,075
		2	4,495	5,602	6,981	8,699	10,840
		3	38,580	37,473	36,094	34,376	32,235
		4	15.39	14.94	14.39	13.71	12.86
E	30	1	34,091	34,091	34,091	34,091	34,091
		2	4,495	5,602	6,981	8,699	10,840
		3	29,596	28,489	27,110	25,392	23,251
		4	11.80	11.36	10.81	10.13	9.27
E	200	1	39,063	39,063	39,063	39,063	39,063
		2	4,495	5,602	6,981	8,699	10,840
		3	34,568	33,461	32,082	30,364	28,223
		4	13.79	13.34	12.79	12.11	11.26
E	1,000	1	50,676	50,676	50,676	50,676	50,676
		2	4,495	5,602	6,981	8,699	10,840
		3	46,181	45,074	43,695	41,977	39,836
		4	18.42	17.98	17.43	16.74	15.89

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

4/ Assume 4.5% annual growth in nonairport-related traffic.

Table B2

AIRPORT ACCESS CAPACITY

I70 Between Quebec and I25

Level of Service[1/]	Hrs./Year[2/]	Factor[3/]	Year[4/] 1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	84,375	84,375	84,375	84,375	84,375
		2	36,870	45,947	57,258	71,354	88,920
		3	47,505	38,428	27,117	13,021	NA
		4	26.78	21.66	15.29	7.34	NA
D	200	1	96,680	96,680	96,680	96,680	96,680
		2	36,870	45,947	57,258	71,354	88,920
		3	59,810	50,733	39,422	25,326	7,760
		4	33.72	28.60	22.22	14.28	4.37
D	1,000	1	125,422	125,422	125,422	125,422	125,422
		2	36,870	45,947	57,258	71,354	88,920
		3	88,552	79,475	68,164	54,068	36,502
		4	49.92	44.80	38.42	30.48	20.58
E	30	1	102,273	102,273	102,273	102,273	102,273
		2	36,870	45,947	57,258	71,354	88,920
		3	65,403	56,326	45,015	30,919	13,353
		4	36.87	31.75	25.38	17.42	7.53
E	200	1	117,188	117,188	117,188	117,188	117,188
		2	36,870	45,947	57,258	71,354	88,920
		3	80,318	71,241	59,930	45,834	28,268
		4	45.28	40.16	33.78	25.84	15.93
E	1,000	1	152,027	152,027	152,027	152,027	152,027
		2	36,870	45,947	57,258	71,354	88,920
		3	115,157	106,080	94,769	80,673	63,107
		4	64.91	59.80	54.42	45.48	35.57

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 - highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

4/ Assume 4.5% annual growth in nonairport-related traffic.

Table B3

AIRPORT ACCESS CAPACITY

I70 West of I25

Level of Service[1/] (1)	Hrs./Year[2/] (2)	Factor[3/] (3)	Year[4/] 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	89,091	89,091	89,091	89,091	89,091
		2	71,816	89,495	111,528	138,984	173,200
		3	17,275	NA	NA	NA	NA
		4	19.47	NA	NA	NA	NA
D	200	1	102,083	102,083	102,083	102,083	102,083
		2	71,816	89,495	111,528	138,984	173,200
		3	30,267	12,588	NA	NA	NA
		4	34.12	14.19	NA	NA	NA
D	1,000	1	132,432	132,432	132,432	132,432	132,432
		2	71,816	89,495	111,528	138,984	173,200
		3	60,616	42,937	20,904	NA	NA
		4	68.33	48.41	23.56	NA	NA
E	30	1	109,090	109,090	109,090	109,090	109,090
		2	71,816	89,495	111,528	138,984	173,200
		3	37,274	19,595	NA	NA	NA
		4	42.02	22.09	NA	NA	NA
E	200	1	125,000	125,000	125,000	125,000	125,000
		2	71,816	89,495	111,528	138,984	173,200
		3	53,184	35,505	13,472	NA	NA
		4	59.95	40.02	15.19	NA	NA
E	1,000	1	162,162	162,162	162,162	162,162	162,162
		2	71,816	89,495	111,528	138,984	173,200
		3	90,346	72,667	50,634	23,178	NA
		4	101.85	81.92	57.08	26.13	NA

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 - highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

4/ Assume 4.5% annual growth in nonairport-related traffic.

Table B4

AIRPORT ACCESS CAPACITY

I25 South of I70

Level of Service[1/] (1)	Hrs./Year[2/] (2)	Factor[3/] (3)	Year[4/] 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	120,000	120,000	120,000	120,000	120,000
		2	135,242	168,536	210,027	261,731	326,165
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	200	1	137,500	137,500	137,500	137,500	137,500
		2	135,242	165,536	210,027	261,731	326,165
		3	2,258	NA	NA	NA	NA
		4	2.55	NA	NA	NA	NA
D	1,000	1	178,378	178,378	178,378	178,378	178,378
		2	135,242	168,536	210,027	261,731	326,165
		3	43,136	9,842	NA	NA	NA
		4	48.63	11.09	NA	NA	NA
E	30	1	145,455	145,455	145,455	145,455	145,455
		2	135,242	168,536	210,027	261,731	326,165
		3	10,213	NA	NA	NA	NA
		4	11.51	NA	NA	NA	NA
E	200	1	166,667	166,667	166,667	166,667	166,667
		2	135,242	168,536	210,027	261,731	326,165
		3	31,425	NA	NA	NA	NA
		4	35.43	NA	NA	NA	NA
E	1,000	1	216,216	216,216	216,216	216,216	216,216
		2	135,242	168,536	210,027	261,731	326,165
		3	80,974	47,680	6,189	NA	NA
		4	91.28	53.75	6.98	NA	NA

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 - highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

4/ Assume 4.5% annual growth in nonairport-related traffic.

Table B5

AIRPORT ACCESS CAPACITY

32nd Avenue

Level of Service 1/ (1)	Hrs./Year 2/ (2)	Factor 3/ (3)	Year 4/ 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	28,977	28,977	28,977	28,977	28,977
		2	7,742	9,648	12,023	14,983	18,671
		3	21,235	19,329	16,954	13,994	10,306
		4	32.76	29.82	26.16	21.59	15.90
D	200	1	33,204	33,204	33,204	33,204	33,204
		2	7,742	9,648	12,023	14,983	18,671
		3	25,462	23,556	21,181	18,221	14,533
		4	39.28	36.34	32.68	28.11	22.42
D	1,000	1	43,075	43,075	43,075	43,075	43,075
		2	7,742	9,648	12,023	14,983	18,671
		3	35,333	33,427	31,052	28,092	24,404
		4	54.51	51.57	47.91	43.34	37.65
E	30	1	34,091	34,091	34,091	34,091	34,091
		2	7,742	9,648	12,023	14,983	18,671
		3	26,349	24,443	22,068	19,108	15,420
		4	40.65	37.71	34.05	29.48	23.79
E	200	1	39,063	39,063	39,063	39,063	39,063
		2	7,742	9,648	12,023	14,983	18,761
		3	31,321	29,415	27,040	24,080	20,302
		4	48.32	45.38	41.72	37.15	31.46
E	1,000	1	50,676	50,676	50,676	50,676	50,676
		2	7,742	9,648	12,023	14,983	18,671
		3	42,934	41,028	38,653	35,693	32,005
		4	66.24	63.30	59.64	55.07	49.38

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

4/ Assume 4.5% annual growth in nonairport-related traffic.

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LOS ANGELES

LOS ANGELES INTERNATIONAL AIRPORT

CASE STUDY

CASE STUDY SUMMARY

Los Angeles International Airport is generally considered to have one of the worst ground access problems of major airports in the United States. The airport currently handles some 26 million annual passengers and this volume is expected to grow to 40 million by 1995, under the most conservative estimates.

Traffic congestion exists in several places in the ground access system--in the central terminal area, on the road network connecting the airport to the freeway system, and on the freeways themselves. The most immediate and severe problem exists in the central terminal area. However, steps are being taken to alleviate this problem. With planned improvements and the passage of time, the access bottleneck will move farther and farther from the airport boundary. Our analysis indicates that by 1990, congestion bottlenecks will exist at Century Boulevard (unless the Century Freeway is completed) and at the San Diego Freeway north of the Santa Monica Freeway. The bottleneck at Century Boulevard is most amenable to construction, TSM, pricing, and transit service improvement solution alternatives. The bottleneck at the San Diego Freeway, however, is expected to be even worse than that at Century Boulevard and to be less tractable. It is a general urban transportation problem of major proportions. Fortunately, it affects only about 25% of the airport passengers.

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III. List of Tables

A. BACKGROUND

1. General

Los Angeles International Airport (LAX), located on the Pacific Coast southwest of the Los Angeles central business district, is the major commerical airport in Southern California. In 1975, LAX domestic and international flights accounted for almost 24,000,000 enplaned and deplaned passengers, making it one of the busiest airports in the county. Approximately 75% of these passengers originated or terminated their air trips at LAX, thus requiring utilization of the ground access system.

Ground access consists of an intricate network of freeways and surface streets linking the airport to the surrounding areas (see Figure 1a). Passengers are widely distributed throughout the region, with surprisingly few originations from the central business district (almost 2%). The primary concentration of air passengers is north of the airport in the Wilshire, West Hollywood, and Santa Monica areas, although significant numbers originate in the south and southwest.

LAX is one of six air carrier airports operating within the Southern California Association of Governments (SCAG) region (see Figure 1b). Although LAX is by far the largest airport in terms of enplaned and deplaned passengers, Hollywood-Burbank, Orange County (Santa Ana) and Ontario International Airports each handle over one million passengers. Long Beach Airport and Palm Springs Municipal also serve commercial airlines, and provisions have been made to increase the number of airports handling air carriers.

General Aviation within the SCAG region is highly developed and expected to grow from 11,000 based aircraft in 1975 to 15,000 in 1985. Van Nuys, Long Beach and Orange County airports rank number one, two and three, respectively, for general aviation itinerant operations in the nation; and rank number three, four, and two, respectively, in total aircraft operations.

Although the total airport system helps to distribute airport activity throughout the region, the major generator of airport-related ground traffic is LAX. Ground access to LAX has become one of the primary regional and local concerns, and has been the subject of several recent studies. Since the overwhelming majority of passengers travel to or from the airport by automobile, it is not surprising that remedial actions developed to improve ground access are directed primarily toward this vehicle mode. The necessity for positive action to deal with the access problem at LAX becomes apparent when considering the magnitude of the problem. The 1978 Draft Environmental Impact Assessment Report 1/ states "LAX suffers from serious impediments in ground access which affect its vitality and may undermine its role in the state and national air transport system". Additionally, SCAG considers LAX to have the greatest ground access problem in the nation. 2/

1/ Vol. I, page I-1.

2/ L. Goodman and M. Westfall, Southern California Association of Governments, Ground Access to Airports in the SCAG Region, Preliminary Draft, June 17, 1977. Cited in Ibid.

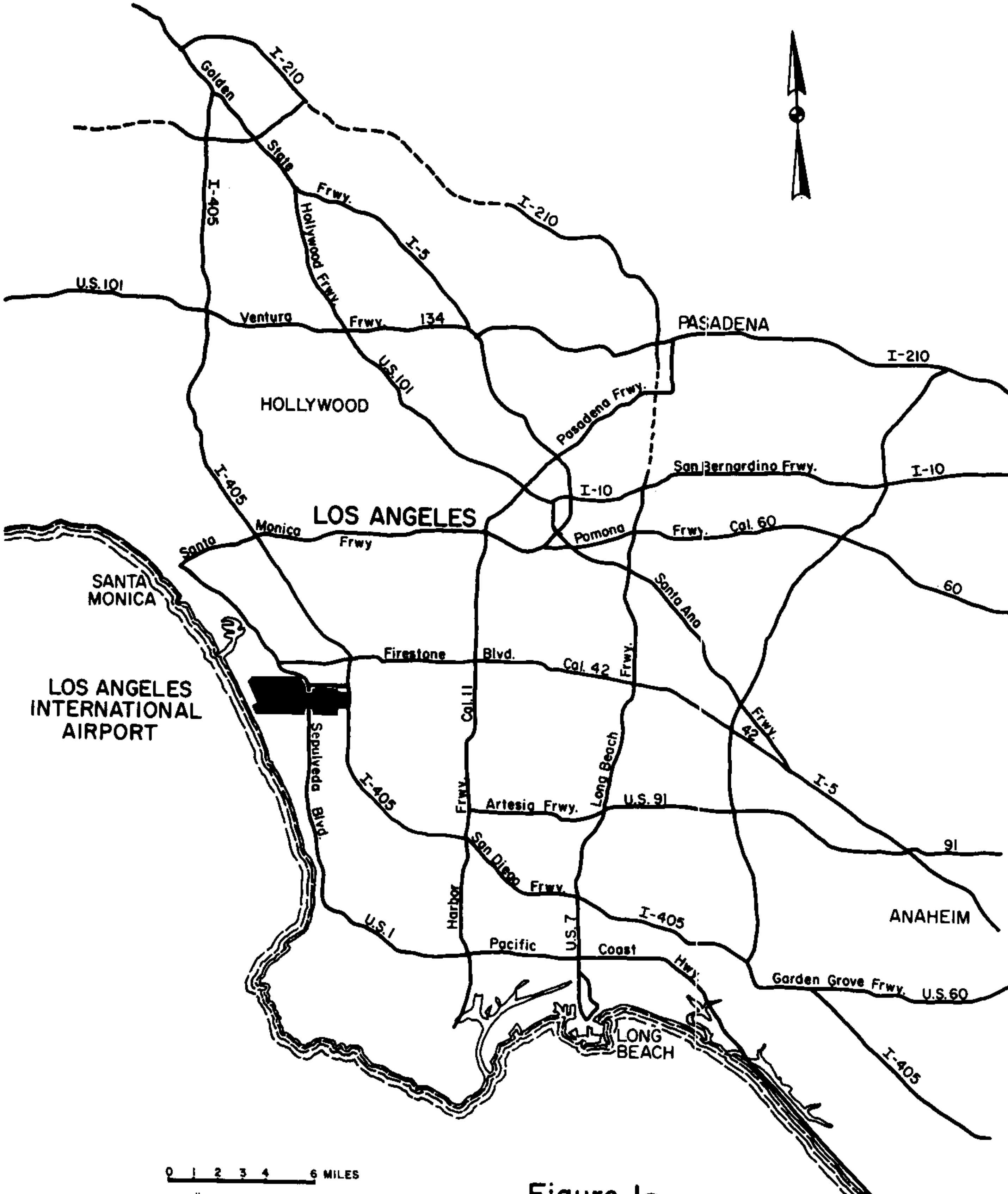

Figure 1a

LOS ANGELES & VICINITY

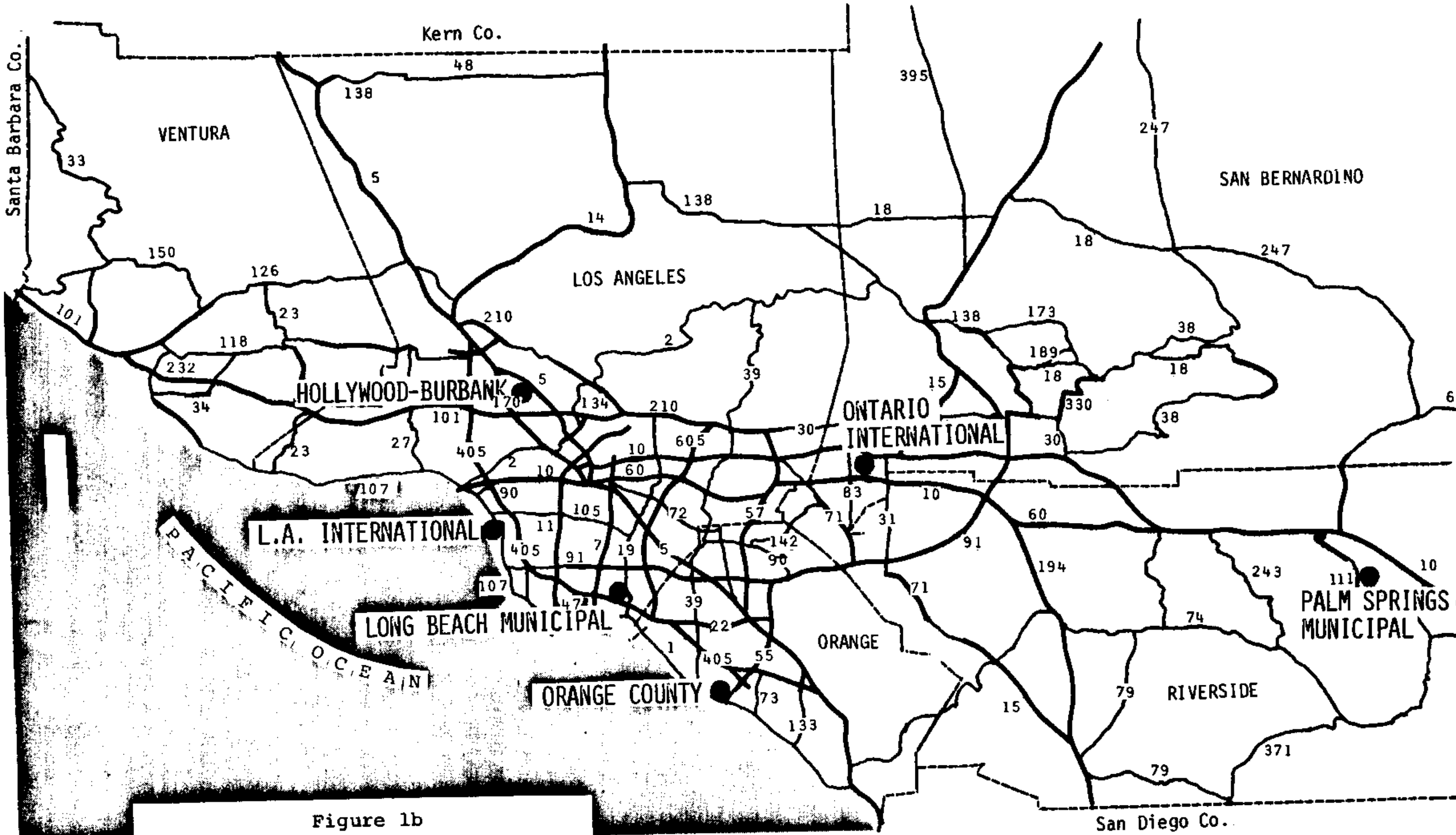

Figure 1b

SCAG REGION AIR CARRIER AIRPORTS
AND RELATED ACCESS HIGHWAYS

2. Planning Structure

There are several organizations and agencies participating in the planning process for access improvement to LAX. Each participant contributes to the process in varying degrees, depending upon its particular interest, jurisdiction, and orientation. The Los Angeles Department of Airports is the operator for LAX as well as the airports at Ontario, Van Nuys, and Palmdale. It has actively promoted actions to improve ground transportation to and from the airport and to alleviate congestion at the central terminal area.

The Southern California Association of Governments (SCAG) is the regional planning agency responsible for the regional transportation plan and unified work program. SCAG has authority to review proposed projects and assure their consistency with developmental goals within the area.

The California Department of Transportation (Caltrans) acts to bring together various modal groups, areas, and agencies in order to outline problems and determine equitable solutions. Caltrans has multi-modal planning responsibility as well as implementation authority regarding highways. The recent Environmental Impact Assessment Report (March 1978) was prepared for the Los Angeles Department of Airports through a grant from Caltrans.

The Los Angeles County Transportation Commission (CTC) is a county agency engaged in short-term planning and programming of transportation projects. The CTC functions to ensure that county goals and objectives are considered within the planning process. Other local level agencies and groups provide input regarding ground access policies and decisions depending upon their interest or jurisdiction.

On the federal level, the three agencies most involved in ground access and related programs are the Federal Highway Administration (FHWA), the Urban Mass Transportation Administration (UMTA), and the Federal Aviation Administration (FAA). The FHWA participated heavily in planning for the uncompleted Century Freeway and has funded the right-of-way.

3. Highway Access

The major access routes employed by airport-related vehicles are presented in Figure 2. Although, the Southern California Freeway System provides general ground access from the major outlying regions utilizing LAX, the final segment of trips to the airport must be made by surface street connections. Virtually all of the major access routes to LAX are currently operating at undesirable levels of service for significant periods during the average week.

As a measure of the extent of the access systems congestion problem, a recent update of the Federal Highway Administration's continuing airport access analysis program indicated that travel time from central business district to airport was 47 minutes during peak periods, but only 30 minutes in off-peak periods.

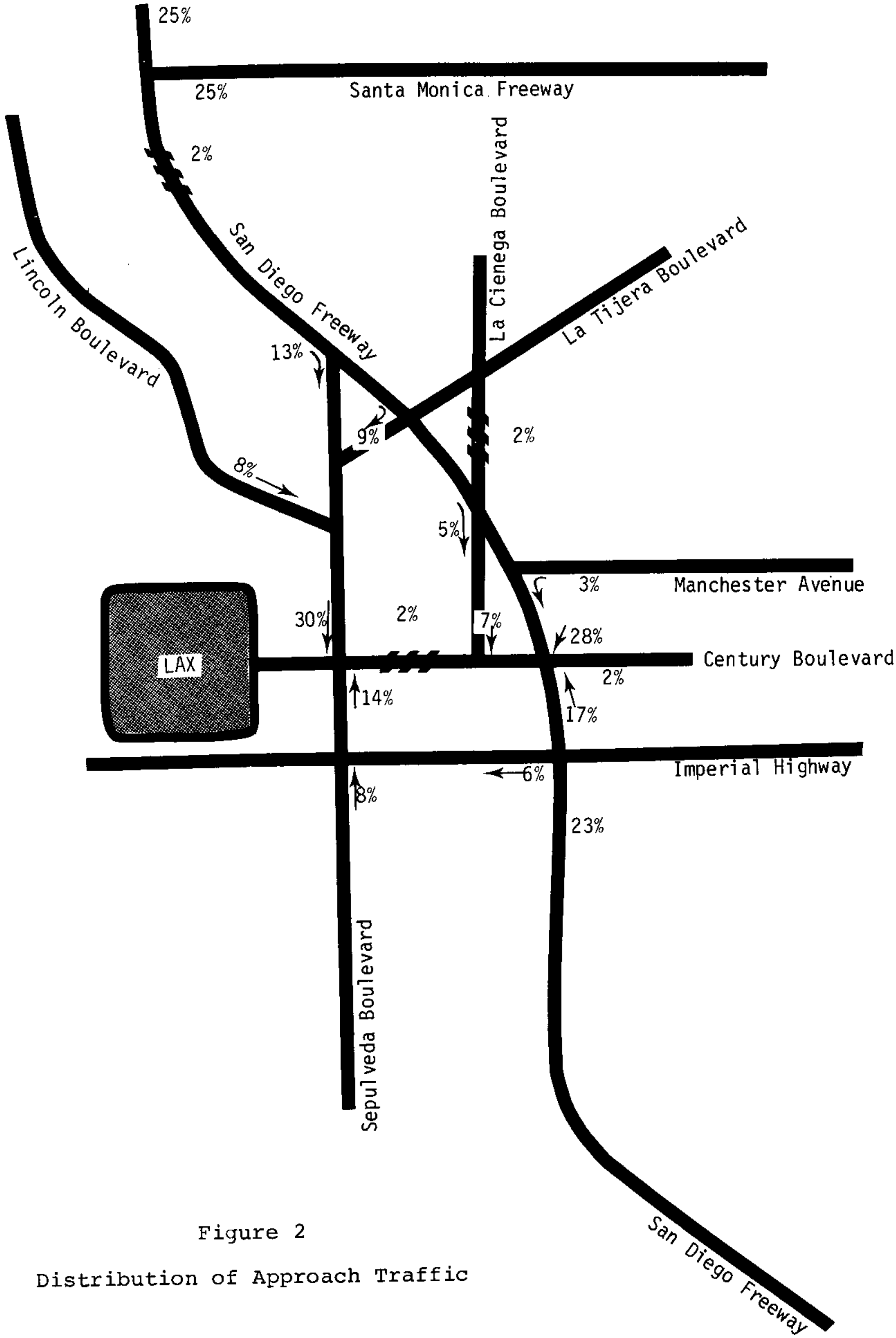

Figure 2

Distribution of Approach Traffic

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As the major route leading into the airport, Century Boulevard, an eight-lane artery between LAX and the San Diego Freeway, carries 56% of all traffic entering or leaving the central terminal area. Additionally, a network of surface streets affords several alternatives to the San Diego Freeway-Century Boulevard routing and provides direct routes for the areas closely surrounding LAX. Of this network, Sepulveda Boulevard, the Imperial Highway, Lincoln Boulevard, La Tijera Boulevard, and La Cienega Boulevard are the most heavily employed.

Approximately fifty percent of LAX passengers originate from the areas north of the Sepulveda-San Diego Freeway intersection. The primary routes for these travelers are the Santa Monica and San Diego Freeways. Since these freeways are currently operating near or over design capacity for the segments observed in this study, there is a very real possibility that airport growth will be constrained by the lack of adequate ground access.

One noteworthy capital alternative under consideration to improve access to LAX is construction of the Century Freeway (I-105) from Route 605 to Sepulveda Boulevard. In its 1977 Regional Transportation Plan, SCAG supports construction of I-105 as part of the area's long-term development program. The controversial project, planned and designed by Caltrans, has been ongoing for many years and has yet to be approved for completion, subject to environmental and community concerns.

4. Transit Access

Table 1 shows the passenger and vehicle split at LAX. Automobiles are undoubtedly the major mode of transportation to and from the airport, accounting for about 84.5% of all passenger trips. Usage of bus and limousine modes is significantly less than usage of non-private auto modes (i.e., rental car and taxi), suggesting that much of the transit market for non-resident travelers remains untapped. Currently, a significant percentage (20%) of the automobile passengers park their cars in peripheral lots, thus entering the CTA in shuttle buses. Many solutions to congestion in the CTA have focused on expanding the use of local and regional peripheral lots through pricing schemes, improved shuttle services, and increased peripheral lot capacity.

5. Internal Access

The layout of the LAX central terminal area (CTA) is shown in Figure 3. LAX is one of the few airports of its size whose internal access roads do not separate enplaning and deplaning passengers. The existing internal roadway system, curbside capacities, and location of ticket buildings relative to parking lots are several of the factors cited as sources of traffic congestion at the airport. 1/ Since it is estimated that the CTA is currently operating at its theoretical capacity, further airside growth could be limited unless substantial improvements can be made to rectify the access situation.

1/ 1978 Environmental Impact Assessment Report, Vol. I, page I-3.

TABLE 1

PASSENGER MODE SPLIT

JUNE 1977

Mode	Air Passenger Share		Share in Vehicles in CTA	
(1)	(2)		(3)	
Private Auto	64.2		78.1	
Enter CTA		55.9		76.9
Use Peripheral Lots		8.3		1.2
Rental Car	16.2		9.6	
Enter CTA		11.7		7.5
Use Shuttle Bus		4.5		2.1
Taxi	4.1		3.8	
Airport Limo/Bus	3.9		1.8	
Hotel/Motel Bus	7.6		1.8	
Public Bus	1.2		0.5	
Other	2.8		4.4	
Total	100.0		100.0	

Source: LAX Ground Access Study, Draft EIAR, Vol. II.

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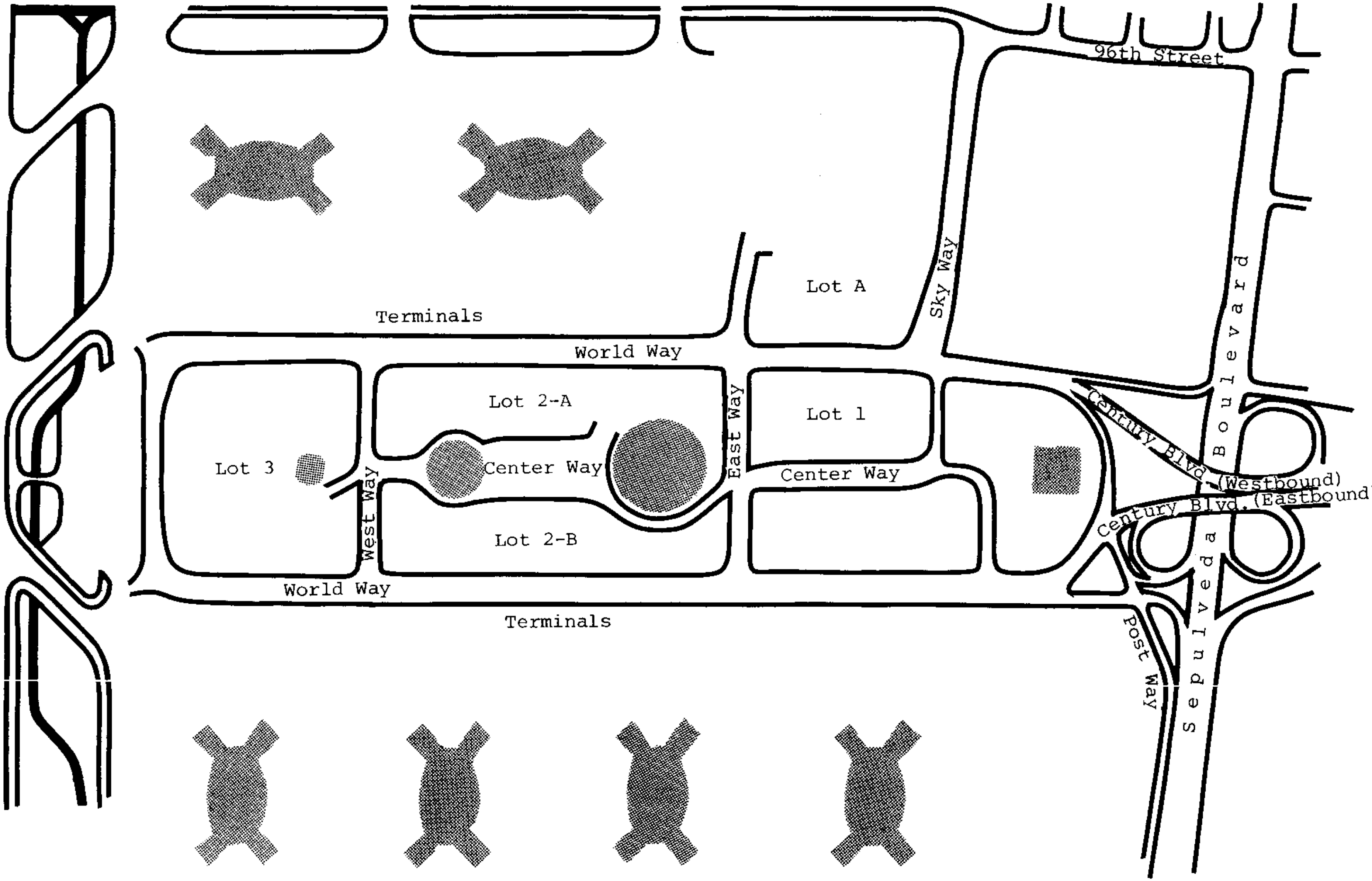

Figure 3

INTERNAL ACCESS ROADWAY SYSTEM

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The CTA has been one of the primary focal points of recent ground access studies. In recent years, actions have been taken to improve access within the CTA. Most notably, improvements to the CTA roadways, expansion of peripheral lots, increased bus service, and various low capital improvements have helped to keep pace with increased airside demand. Plans and actions are currently in process to maintain the CTA at 1977 levels of service for increases up to 40 million annual passengers.

B. CAPACITY ANALYSIS

1. Passenger Forecast

The passenger forecasts presented in this study were taken from the 1977 SCAG Regional Transportation Plan (RTP) and the 1976 FAA forecast. The SCAG RTP presented a range of passenger demand for 1985 and 1995. The high and low extremes were used, and 1980 and 1990 projections were interpolated from this information. The FAA forecast extends only to 1987 and is projected to 1995 at the 1982-1987 growth rate. These forecasts are shown in Table 2.

2. Airside Capacity

In 1967-1968, revised airport projections determined the LAX passenger limit based upon runway capacity to be 80 million annual passengers (MAP). It was also reported that terminal and access roadway capacities would be reached well before 80 MAP. Observing the passenger demand projections presented by SCAG and the FAA (Table 2), it becomes apparent that even using the least conservative forecast of MAP, airside capacity will not present a constraint to LAX growth until ater 1995. Consequently, we have assumed that airside capacity will remain constant at 80 MAP between 1975 and 1995.

3. Ground Access Capacity

Current airport ground trips were assigned to major highways as shown in Figure A1. The following six critical highway locations were identified:

(1) Century Boulevard east of Sepulveda Boulevard;

(2) Sepulveda Boulevard north of Century Boulevard;

(3) the San Diego Freeway north of Century Boulevard;

(4) the San Diego Freeway south of the Imperial Highway;

(5) the San Diego Freeway north of the Santa Monica Freeway; and

(6) the Santa Monica Freeway east of the San Diego Freeway.

Non-airport traffic was conservatively projected at a .5% annual growth rate based upon a SCAG projection of 1.3% annual growth in regional person trips and a Caltrans projection of .65% annual traffic growth (including airport

TABLE 2

FORECAST OF DEMAND

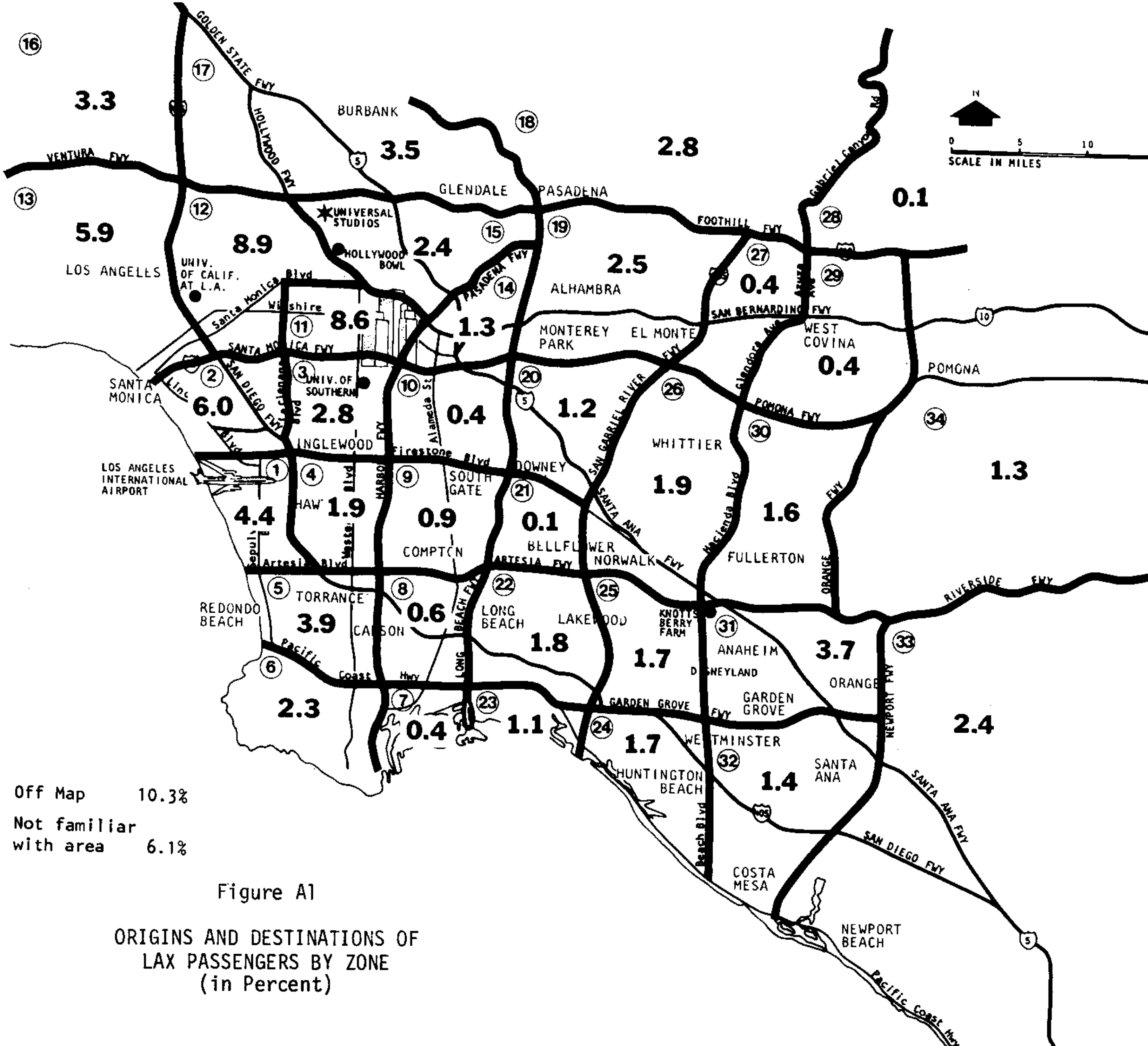
(Million Annual Passengers)

Year	1977 SCAG Regional Transportation Plan Low	1977 SCAG Regional Transportation Plan High	FAA Extended
(1)	(2)	(3)	(4)
1975	23.7 1/	23.7 1/	23.7 1/
1980	26.7 2/	30.8 2/	32.0 2/
1985	30.0	40.0	42.7 2/
1990	34.6 2/	44.8 2/	58.0 3/
1995	40.0	50.0	78.8 3/

1/ Actual.

2/ Interpolated.

3/ Extended.



Off Map 10.3%

Not familiar with area 6.1%

Figure A1

ORIGINS AND DESTINATIONS OF LAX PASSENGERS BY ZONE (in Percent) traffic) on the San Diego Freeway in the airport vicinity. Calculations and methodology are presented in Appendix B. The resulting graphs for the critical highway locations are shown in Figures 4 through 9.

4. Interpretation

a. Century Boulevard: The congestion problem at Century Boulevard is depicted graphically in Figure 4. Century is currently operating at level of service E for over 1,000 hours per year, or nearly four hours per weekday. Although Century has a greater number of lanes and handles more traffic than does Sepulveda Boulevard, it should be noted that its capacity is less than Sepulveda's because of intersections and turn channelization. It should also be noted, however, that the distance between the San Diego Freeway and LAX on Century Boulevard is less than two miles, thus making the severe congestion somewhat tolerable.

b. Sepulveda Boulevard: The congestion experienced on Sepulveda Boulevard, shown in Figure 5, has not reached the proportions of the problem at Century. However, corresponding levels of congestion to those experienced presently on Century Boulevard will be reached before 1985, using the FAA MAP forecast.

c. San Diego Freeway: The variety of possible routings from the San Diego Freeway to LAX made it necessary to examine several different points along this route. Figures 6, 7, and 8 present the demand capacity relationships for three critical locations along the freeway. The San Diego Freeway, at the areas observed, operates at level of service D for more than 1,000 hours a year and level of service E for over 200 hours. Since airport traffic represents a small portion of total traffic on the freeway, small increases in non-airport traffic will make it increasingly difficult for air travelers to reach LAX. Also, because most air travelers travel farther along the freeway than on surface streets, the problem of high levels of congestion becomes magnified.

d. Santa Monica Freeway: The Santa Monica Freeway in the area just east of the San Diego Freeway appears to have the least servere congestion problem of the freeway locations examined in this study. However, the Santa Monica Freeway, too, is operating at level of service D for more than 1,000 hours annually.

C. PROPOSED SOLUTIONS

The ground access problem at LAX has been under consideration for some time. An extensive ground access study by DeLeuw Cather and Company in association with the Ralph M. Parsons Company and Gin Wong Associates was recently conducted (March, 1978) to study policy options and alternative projects for relief of LAX ground congestion. These alternatives are listed in this section (Table 3) along with some additional proposed solutions to improve ground access to LAX. Consideration of these suggested access improvements, both internal and external, is currently in process, and determination of the most feasible alternatives is forthcoming. To date, several TSM alternatives

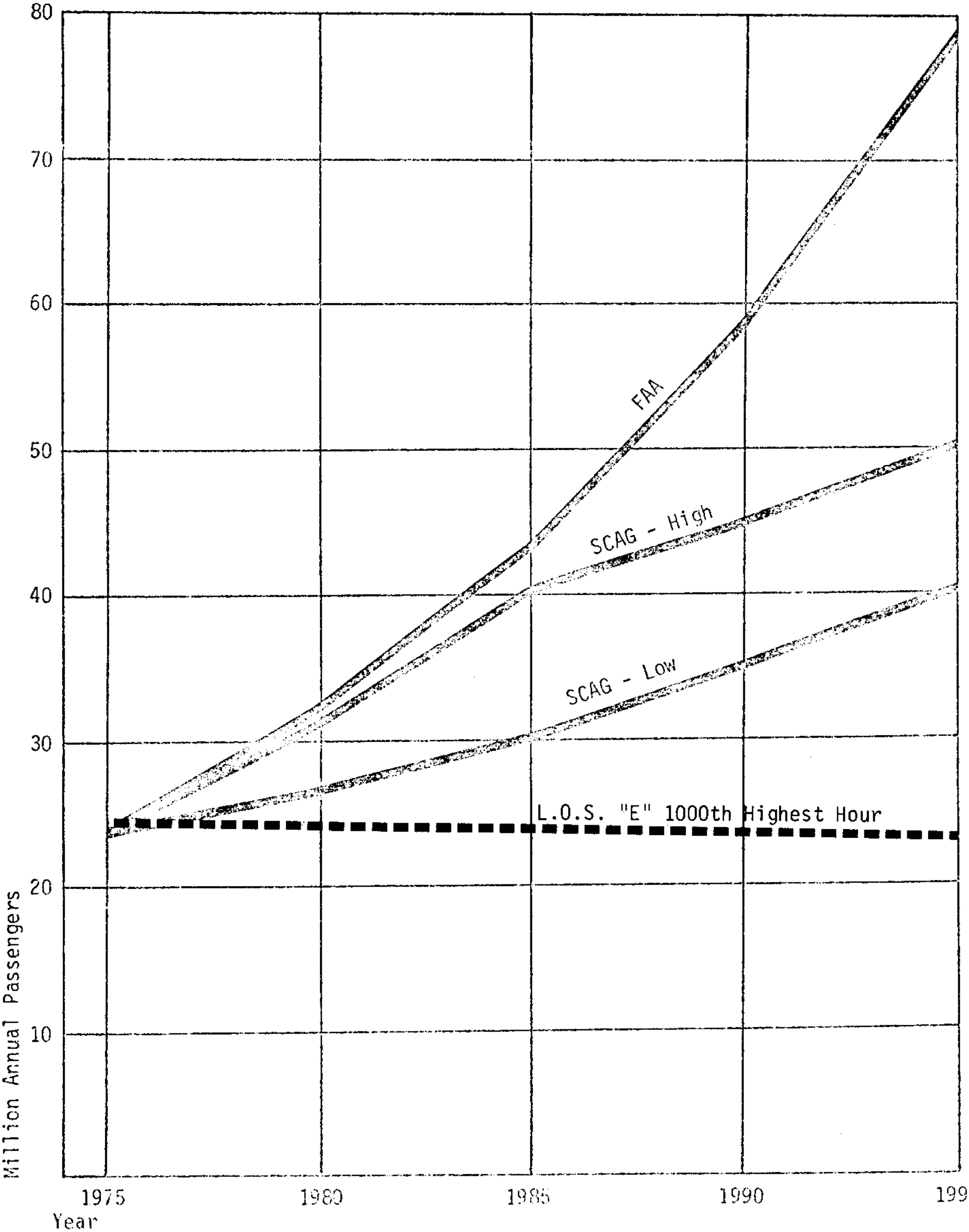


Figure 4

DEMAND/CAPACITY RELATIONSHIPS
Century Boulevard

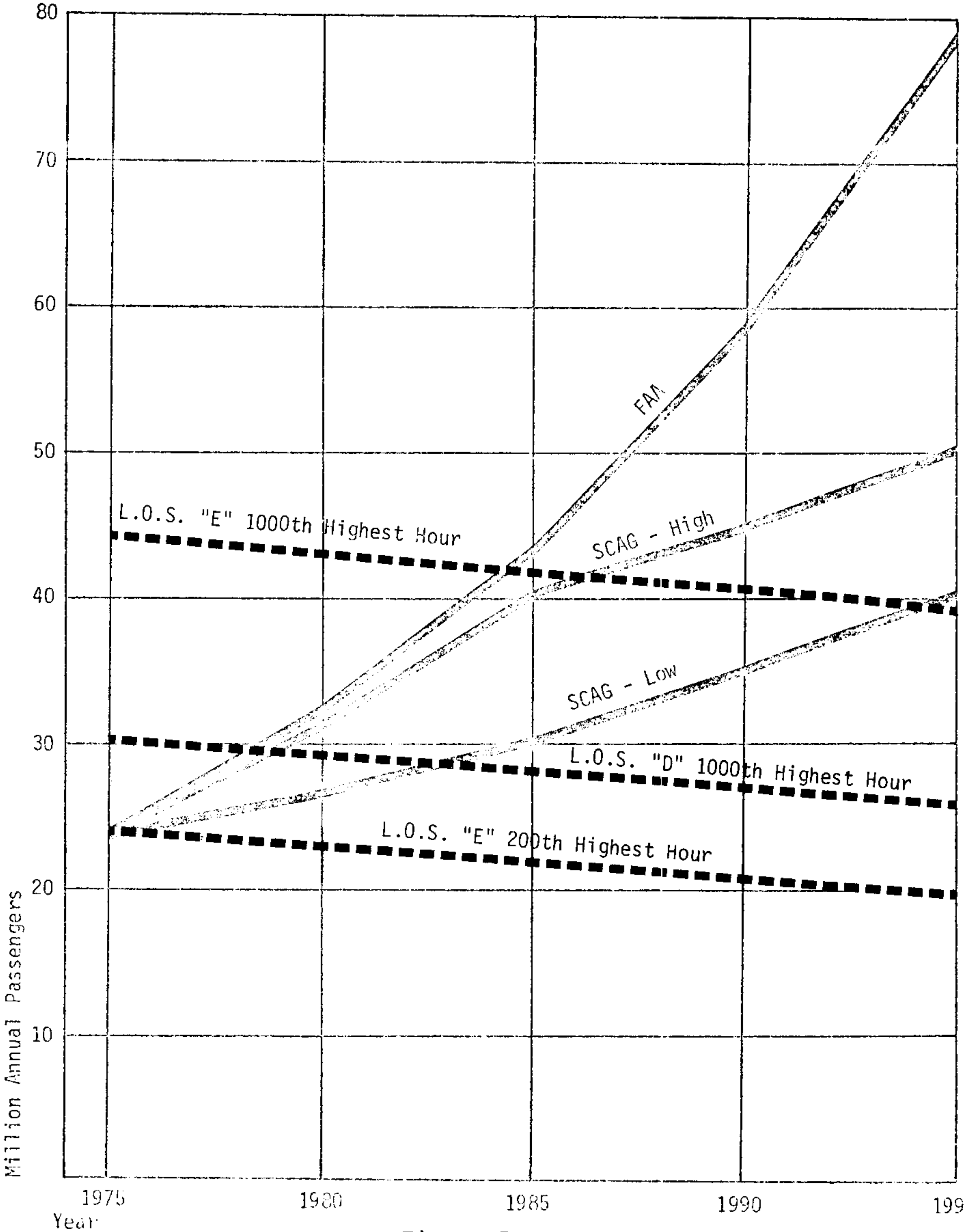


Figure 5

DEMAND/CAPACITY RELATIONSHIPS
Sepulveda Boulevard

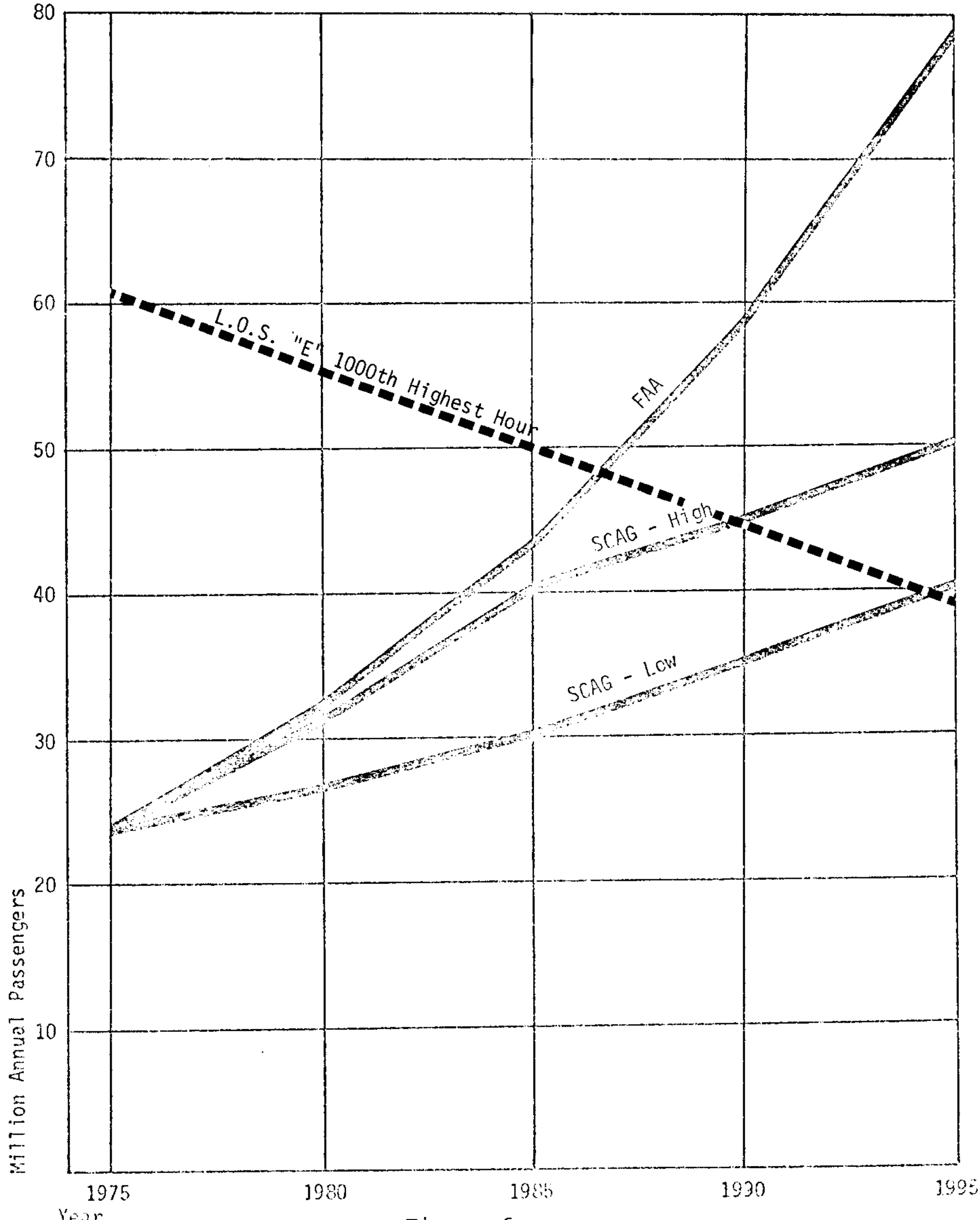


Figure 6

DEMAND/CAPACITY RELATIONSHIPS
San Diego Freeway (Just North of Century Boulevard)

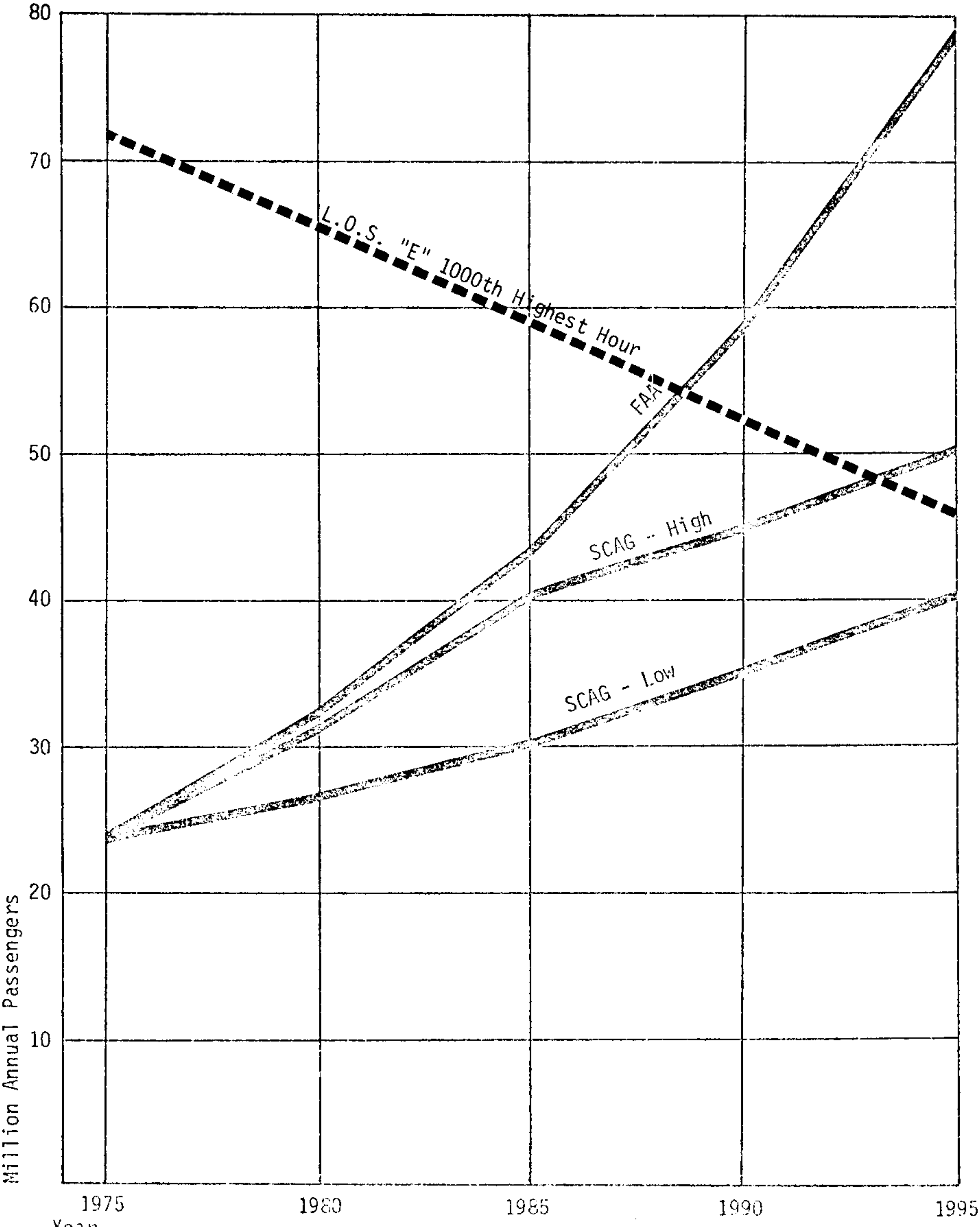


Figure 7

DEMAND/CAPACITY RELATIONSHIPS
San Diego Freeway (Just South of Imperial Highway)

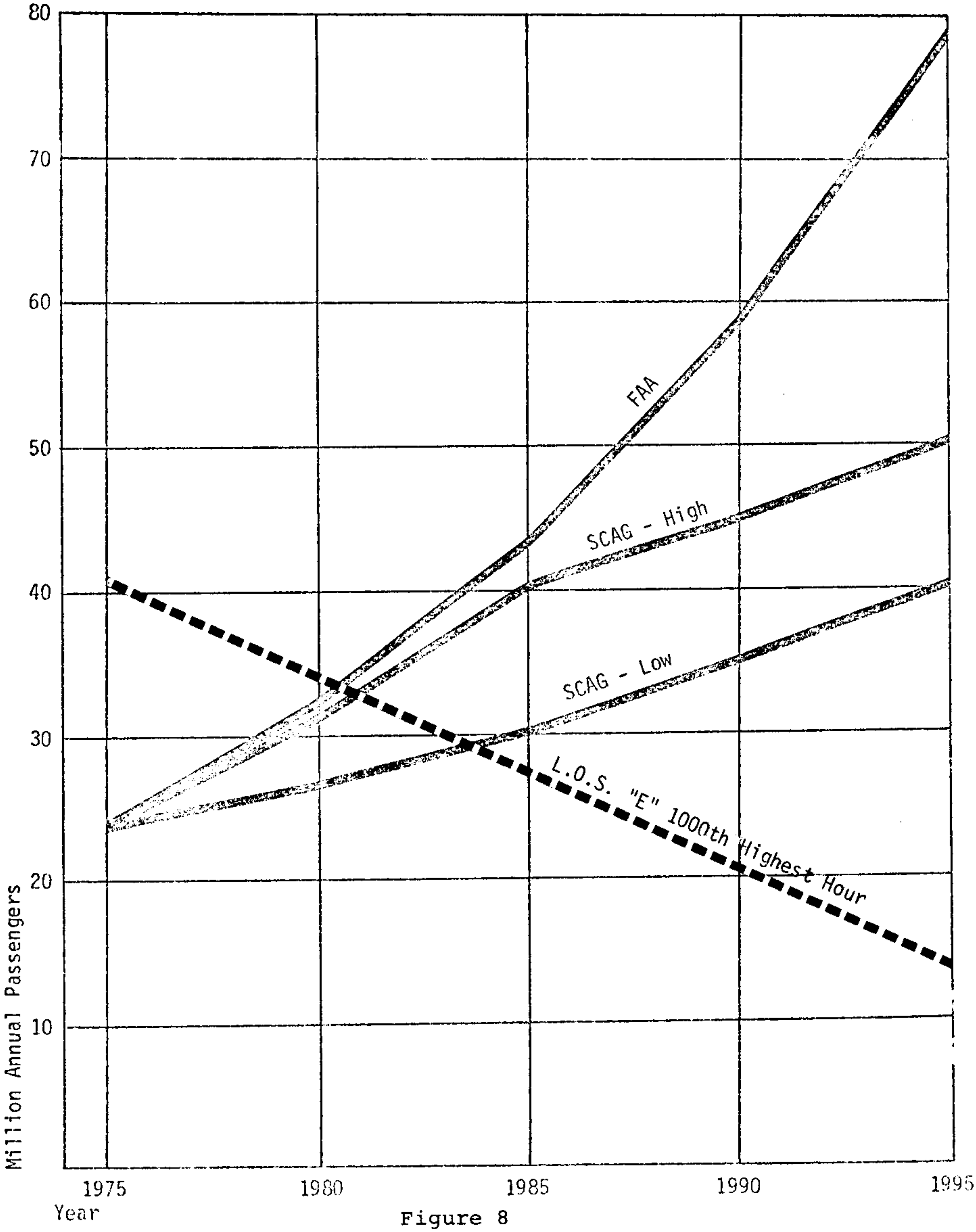


Figure 8

DEMAND/CAPACITY RELATIONSHIPS
San Diego Freeway (Just North of Santa Monica Freeway)

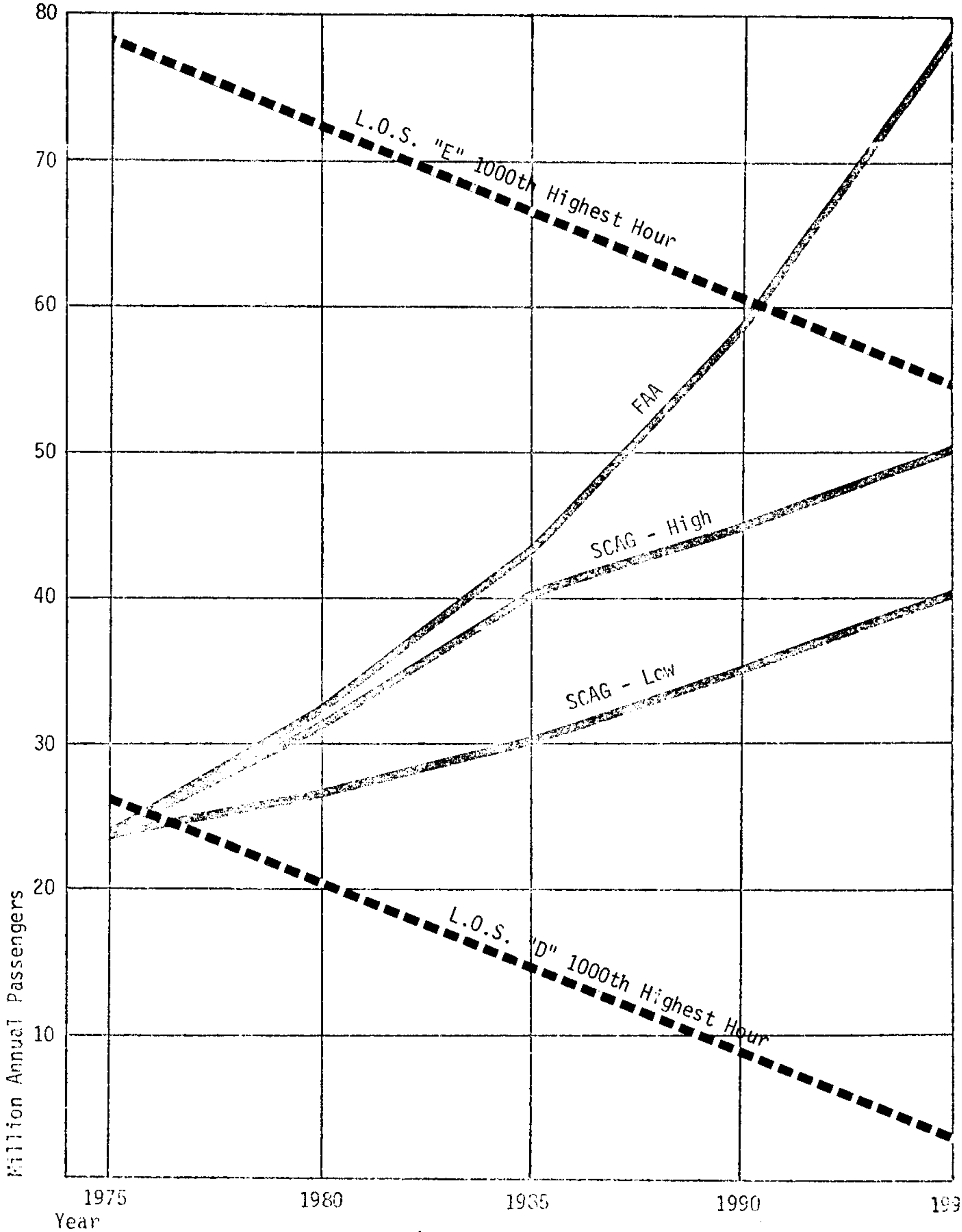


Figure 9

DEMAND/CAPACITY RELATIONSHIPS
Santa Monica Freeway (Just East of San Diego Freeway)

TABLE 3

PROPOSED SOLUTIONS TO AIRPORT ACCESS PROBLEMS

Proposed Solutions	Initiator	Agency Resp. for Implem.	Funding Sources	Est. Cost (1976 Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
A. CONSTRUCTION					
1. CTA and External Roadways Improvements					
. Airport Blvd. Widening	LGAS	City of LA	FAU Funds, State Gas Tax, Airport Revenues	See Note A	Recommended by LGAS. Preliminary work authorized by LADOA
. 96th St. Widening (Airport to Sepulveda)	LGAS	City of LA	FAU Funds, State Gas Tax, Airport Revenues	See Note A	Recommended by LGAS. Preliminary work authorized by LADOA
. Arbor Vitae Widening (Airport to I405)	LGAS	City of LA	FAU Funds, State Gas Tax, Airport Revenues	See Note A	Recommended by LGAS. Preliminary work authorized by LADOA
. Arbor Vitae Extension (Lincoln to Pershing)	LGAS	City of LA	FAU Funds, State Gas Tax, Airport Revenues	See Note A	Optionally recommended by LGAS
. Sky Way Reconstruction	LGAS	LADOA	Airport Revenues, Airport Revenue Bonds, ADAP	See Note A	Recommended by LGAS. Preliminary work authorized

Proposed Solutions	Initiator	Agency Resp. for Implem.	Funding Sources	Est. Cost (1976 Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
. Center Way Extension (North Half)	LGAS	LADOA	Airport Revenues, Airport Revenue Bonds, ADAP	See Note A	Recommended by LGAS. Prelim-inary work authorized
. Center Way/Century Realignment	LGAS	LADOA	Airport Revenues, Airport Revenue Bonds, ADAP	See Note A	Recommended by LGAS. Prelim-inary work authorized
. CTA West End Modification	LGAS	LADOA	Airport Revenues, Airport Revenue Bonds, ADAP	$1,959,000	Recommended by LGAS. Prelim-inary work authorized
. I-105 Freeway	CALTRANS, SCAG	CALTRANS	FHWA, State Fuel Taxes, State Vehicle Taxes	$481,000,000	Began 1963, currently at various com-pletion levels. Environmental and community problems
. Arbor Vitae/I-405 Interchange	CALTRANS, SCAG	CALTRANS	FHWA, State Fuel Taxes, State Vehicle Taxes	*	Under prelim-inary study by CALTRANS
2. Parking					
. New CTA Parking Structures	LGAS	LADOA	Airport Revenues, Airport Reveneue Bonds, User Fees, ADAP	$17,006,000	Recommended by LGAS with option for deferral

Proposed Solutions	Initiator	Agency Resp. for Implem.	Funding Sources	Est. Cost (1976 Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
. Expand Lots "C" and "VSP"	LGAS	LADOA	Airport Revenues, Airport Revenue Bonds ADAP, User Fees	*	Recommended by LGAS
. Construct Regional Lots	LGAS	LADOA	Airport Revenues, Airport Revenue Bonds User Fees, ADAP	$9,344,000	Originally recommended by LGAS
3. CTA Pedestrian Overpass	LGAS	LADOA	Airport Revenues, Airport Revenue Bonds ADAP	$2,875,000	Recommended by LGAS. Prelim-inary work authorized
4. Elevated CTA Busway/ Guideway and Stations	LGAS	LADOA	CALTRANS Proposition 5 Funds, Airport Revenues & Revenue Bonds, User Fees, ADAP	$1,193,000	Not recommended by LGAS
5. Elevated CTA Roadway	LGAS	LADOA	Airport Revenues, Airport Revenue Bonds, ADAP	$17,006,000	Recommended by LGAS. Prelim-inary work authorized
6. Multimodal Terminal in Lot "C"	LGAS	LADOA	Airport Revenues, Airport Revenue Bonds User Fees, ADAP	$6,625,000	Recommended by LGAS, Prelim-inary work authorized

Proposed Solutions	Initiator	Agency Resp. for Implem.	Funding Sources	Est. Cost (1976 Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
7. Ticket Building Modifications					
. Second Level Lobby	LGAS	LADOA	Airport Revenues, Airport Revenue Bonds, ADAP	$1,823,000	Recommended by LGAS. Preliminary work authorized
. Second Level Ticketing/ Check In	LGAS	LADOA	Airport Revenues, Airport Revenue Bonds, ADAP	$12,288,000	Recommended by LGAS. Preliminary work authorized
8. Satellite 1 and West Terminal Facilities	LGAS	LADOA	Airport Revenues, Airport Revenue Bonds, ADAP	*	Recommended by LGAS. Preliminary work
9. Automated People Mover	LGAS	LADOA	Airport Revenues, Airport Revenue Bonds, User Fees, ADAP, UMTA, California Proposition 5 funds	See Note C	Negative recommendation by LGAS
B. TSM					
1. Maintenance and Operation of Parking and Curbside Areas	LGAS	LADO	User Charges	$7,662,000 Annually	Recommended by LGAS
2. Improved Information Signing	LGAS	LADO	*	See Note B	Recommended by LGAS

Proposed Solutions	Initiator	Agency Resp. for Implem.	Funding Sources	Est. Cost (1976 Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
3. Stop and Yield Signing	LGAS	LADO	*	See Note B	Recommended by LGAS
4. Improved Signalization	LGAS	LADO	*	See Note B	Recommended by LGAS
C. PRICING					
1. Adjust parking rates to encourage peripheral parking	LGAS	LADOA	None required	Zero	Recommended by LGAS
D. SERVICE IMPROVEMENTS					
1. Medium Capacity Buses	LGAS	LADOA	*	See Note D	20 new vehicles recommended by LGAS
2. High Capacity Buses	LGAS	LADOA	*	Cost per bus: Capital $75 thousand; Annual operating. $49,000	Negative recommendation by LGAS
3. Flyaway Type Buses	LGAS	LADOA	*	See Note D	8 new vehicles recommended by LGAS

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Proposed Solutions	Initiator	Agency Resp. for Implem.	Funding Sources	Est. Cost (1976 Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
E. RELOCATION					
1. Rental Car Relocation	LGAS	*	*	*	Recommended by LGAS

Notes: A. Estimated cost for seven items totals $4,347,000.

B. Estimated cost for three items totals $809,000.

C. Capital cost includes required terminal and parking lot modifications, intermodal terminals, guideway, electrification and controls. Capital cost totals $63,420,400. Annual operating cost is $6,460,000.

D. For two items (28 buses), capital cost is $1,225,000. Annual operating cost is $3,290,000.

*Not available or unknown.

Key of Abbreviations:

CALTRANS = California Department of Transportation.

FAU = Federal Aid Urban.

LGAS = LAX Ground Access Study.

LADOA = LA Department of Airports.

SCAG = Southern California Association of Governments.

and some internal roadway improvements have been implemented as short-term remedies to access in the central terminal area. The Board of Airport Commissioners has just authorized preliminary work on a proposed second-level roadway to separate enplaning and deplaning auto traffic. The $75 million project would include a four-lane roadway and sidewalk located above the World Way, which circles the terminal complex.

D. CONCLUSIONS

Los Angeles International Airport currently has a severe access problem which is expected to become even worse in the near future. For the next few years, the primary bottleneck in ground access will be within the CTA; however, with the completion of planned improvements in the CTA, the bottleneck will move out to the external access system.

Our analysis shows that in the near future, Century Boulevard will be the primary constraint to airport growth. However, this conclusion must be tempered by the knowledge that many alternative routes exist for passengers currently using, and projected to use, Century Boulevard. Nevertheless, these alternative routes do not provide unlimited relief. As we have shown, these alternates are also at or near level of service E capacity for many hours throughout the year. In short, the secondary road network connecting the airport to the freeway system is at or near capacity and is expected to constrain airport growth.

It is interesting to note that the secondary road network connecting the airport to the freeway system is used about equally by airport related and non-airport related vehicles. Thus, solution alternatives designed to reduce the number of airport-related vehicles (e.g., by improving vehicle occupancy with pricing schemes, share-a-ride taxi system, limousines, or remote-park/bus alternatives) would be quite productive in reducing congestion. It should also be noted that the distance between the San Diego Freeway and the Airport is less than two miles along Century Boulevard. Thus, even at level of service E, congestion delays should not exceed one-half hour on this segment. In addition, capital improvements to Century Boulevard might also be feasible.

Our analysis shows that even if the low forecast of passenger demand is correct, the San Diego Freeway, just north of the Santa Monica Freeway, will, by about 1982, be a bottleneck for a large fraction of the airport passengers and will operate at level of service E for 1,000 hours per year. It should be noted that this conclusion is quite sensitive to our estimate of the Freeway's capacity (although it is validated by the current level of congestion) and to our estimate of the growth in non-airport related traffic. However, if our estimates are accurate, this bottleneck is a matter of great concern since it will be caused by general urban traffic that generally is unaffected by solutions that can be initiated or implemented by airport authorities.

Among the solution alternatives currently under consideration, we find that improvements within the CTA are warranted. In addition, completion of I-105 would eliminate the bottleneck anticipated in the secondary road network. However, we have seen no solution alternatives designed to reduce or eliminate congestion on the San Diego Freeway north of the Santa Monica Freeway.

APPENDIX A

ROUTING OF AIRPORT ACCESS TRIPS

BY LOCAL ORIGIN/DESTINATION ZONE

Data on June 1977, passenger originations and destinations by zone were obtained from the LAX Ground Access Study. 1/ These data are reproduced here as Figure A1. Table A1 shows how the data were adjusted to sum to one hundred percent and how the passengers were assumed to route themselves to the airport. Routings in the vicinity of the airport correspond to those observed in the Draft Environmental Impact Assessment Report (2).

1/ DeLeuw Cather & Co. et al. LAX Ground Access Study. "Survey of LAX Passengers Mode of Ground Transportation and Place of Origin and Destination". June, 1977.

TABLE A1

ROUTING OF AIRPORT ACCESS TRIPS

BY LOCAL ORIGIN/DESTINATION ZONE

Zone	Percent Distributed	Routing	Percent Per Route
(1)	(2)	(3)	(4)
1	5	SB	3
		CB	3
2	7	LB-SB	5
		SDF-X	2
3	4	LCB-CB	2
		MB-SDF-X	2
4	2	CB	2
5	5	SB	3
		SDF-Y	2
6	2	PCH-SB	2
7	1	HF-SDF-Y	1
8	1	SDF-Y	1
9	1	HF-SDF-Y	1
10	1	MA-SDF-X	1
11	10	SMF-SDF-X	10
12	10	SMB-SDF-X	7
		SDF-X	3
13	7	SDF-X	4
		LB-SB	3
14	2	SMF-SDF-X	2
15	3	PF-SMF-SDF-X	3

Zone	Percent Distributed	Routing	Percent Per Route
16	4	SDF-X	4
17	4	VF-SDF-X	3
		SDF-X	1
18	3	VF-SDF-X	3
19	3	SMF-SDF-X	3
20	1	SMF-SDF-X	1
21	0	-	0
22	2	SDF-Y	2
23	1	GGF-LBF-SDF-Y	1
24	2	SDF-Y	2
25	2	SDF-Y	2
26	3	SAF-SMF-SDF-X	2
		AF-LBF-SDF-Y	1
27	1	SMF-SDF-X	1
28	0	-	0
29	1	PF-SMF-SDF-X	1
30	2	AF-LBF-SDF-Y	1
31	4	GGF-SDF-Y	4
32	2	SDF-Y	2
33	3	SDF-Y	3
34	1	PF-SMF-SDF-X	1
X	55	CB	28
		SB	13
		LTB-SB	9

Zone	Percent Distributed	Routing	Percent Per Route
		LCB-CB	5
Y	23	CB	17
		IH-SB	6

Key:

AF	Artesia Fwy.
CB	Century Blvd.
GGF	Garden Grove Fwy.
HF	Harbor Fwy.
IH	Imperial Hy.
LB	Lincoln Blvd.
LBF	Long Beach Fwy.
LCB	La Cienega Blvd.
LTB	La Tijera Blvd.
MA	Manchester Ave.
PCH	Pacific Coast Highway
PF	Pomona Fwy.
SAF	Santa Ana Fwy.
SB	Sepulveda Blvd.
SDF	San Diego Fwy.
SMF	Santa Monica Fwy.
VF	Ventura Fwy.
X	Artificial Zone--SDF north of CB
Y	Artificial Zone--SDF south of CB

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

The hourly vehicular capacities of the surface streets (Century and Sepulveda Boulevards) were determined by using the hourly intersection capacities given in the LAX Draft Environmental Impact Report. These capacities were given for level of service D and converted to level of service E by dividing by .85.

For the freeways' capacities, calculations were based on 8 through lanes and converted by employing Table 9.1 of the Highway Capacity Manual. A more sophisticated calculation would require a more detailed analysis of the switching from 8 to 10 lanes, depending upon the freeway segment, location of access and egress ramps, truck traffic, etc. The assumption of 8 through lanes with no penalty being assessed for freeway exit and entrance was made due to widening from 8 to 10 lanes at various freeway segments.

Traffic counts on roads of interest were obtained from CALTRANS. Vehicle trips available for airport use were converted to air passengers by multiplying by the 1975 ratio of annual passengers (23.7, per Reference 5) to average daily traffic at the airport (68,000, per Reference 2, Vol. I, p. III-87) and dividing by the proportion of airport traffic that is carried by each critical highway.

Tables B1 through B6 provide a detailed computation of airport access capacity.

Table B1

AIRPORT ACCESS CAPACITY

Century Boulevard

Level of Service[1/] (1)	Hrs./Year[2/] (2)	Factor[3/] (3)	Year[4/] 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	35,455	35,455	35,455	35,455	35,455
		2	22,320	22,883	23,461	24,054	24,661
		3	13,135	12,572	11,994	11,401	10,794
		4	8.18	7.83	7.47	7.10	6.72
D	200	1	40,625	40,625	40,625	40,625	40,625
		2	22,320	22,883	23,461	24,054	24,661
		3	18,305	17,742	17,164	16,571	15,964
		4	11.40	11.05	10.69	10.32	9.94
D	1000	1	52,703	52,703	52,703	52,703	52,703
		2	22,320	22,883	23,461	24,054	24,661
		3	30,383	29,820	29,242	28,649	28,042
		4	18.92	18.57	18.21	17.84	17.46
E	30	1	41,712	41,712	41,712	41,712	41,712
		2	22,320	22,883	23,461	24,054	24,661
		3	19,392	18,829	18,251	17,658	17,051
		4	12.08	11.73	11.37	11.00	10.62
E	200	1	47,794	47,794	47,794	47,794	47,794
		2	22,320	22,883	23,461	24,054	24,661
		3	25,474	24,911	24,333	23,740	23,133
		4	15.87	15.52	15.16	14.79	14.41
E	1000	1	62,004	62,004	62,004	62,004	62,004
		2	22,320	22,883	23,461	24,054	24,661
		3	39,684	39,121	38,543	37,950	37,343
		4	24.72	24.37	24.01	23.64	23.26

1/ Per Highway Capacity Manual.
2/ Number of hours/year during which level of service is equal to or worse than that shown in column 1.
3/ Key: 1=highway capacity; 2= nonairport-related traffic; 3 =capacity for airport-related vehicles; 4 =million annual passengers associated with 3.
4/ Assume .5% annual growth in nonairport-related traffic.

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Table B 2

AIRPORT ACCESS CAPACITY

Sepulveda Boulevard

Level of Service[1/] (1)	Hrs./Year[2/] (2)	Factor[3/] (3)	Year[4/] 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	43,636	43,636	43,636	43,636	43,636
		2	38,300	39,267	40,258	41,275	42,317
		3	5,336	4,369	3,378	2,361	1,319
		4	6.20	5.08	3.92	2.74	1.53
D	200	1	50,000	50,000	50,000	50,000	50,000
		2	38,300	39,267	40,258	41,275	42,317
		3	11,700	10,733	9,742	8,725	7,683
		4	13.60	12.48	11.32	10.14	8.93
D	1000	1	64,865	64,865	64,865	64,865	64,865
		2	38,300	39,267	40,258	41,275	42,317
		3	26,565	25,598	24,607	23,590	22,548
		4	30.89	29.77	28.61	27.43	26.22
E	30	1	51,336	51,336	51,336	51,336	51,336
		2	38,300	39,267	40,258	41,275	42,317
		3	13,036	12,069	11,078	10,061	9,019
		4	15.16	14.04	12.88	11.70	10.49
E	200	1	58,824	58,824	58,824	58,824	58,824
		2	38,300	39,267	40,258	41,275	42,317
		3	20,524	19,557	18,566	17,549	16,507
		4	23.86	22.74	21.58	20.40	19.19
E	1000	1	76,312	76,312	76,312	76,312	76,312
		2	38,300	39,267	40,258	41,275	42,317
		3	38,012	37,045	36,054	35,037	33,995
		4	44.20	43.08	41.92	40.74	39.53

1/ Per Highway Capacity Manual.
2/ Number of hours/year during which level of service is equal to or worse than that shown in column 1.
3/ Key: 1=highway capacity; 2=nonairport-related traffic; 3=capacity for airport-related vehicles; 4=million annual passengers associated with 3.
4/ Assume .5% annual growth in nonairport-related traffic.

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Table B 3

AIRPORT ACCESS CAPACITY

San Diego Freeway (Just north of Century Blvd.)

Level of Service[1/]	Hrs./Year[2/]	Factor[3/]	Year[4/] 1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	120,000	120,000	120,000	120,000	120,000
		2	166,960	171,176	175,497	179,928	184,471
		3	NA	→			
		4	NA	→			
D	200	1	137,500	137,500	137,500	137,500	137,500
		2	166,960	171,176	175,497	179,928	184,471
		3	NA	→			
		4	NA	→			
D	1000	1	178,378	178,378	178,378	178,378	178,378
		2	166,960	171,176	175,497	179,928	184,471
		3	11,418	7,202	2,881	NA	NA
		4	14.22	8.97	3.59	NA	NA
E	30	1	145,455	145,455	145,455	145,455	145,455
		2	166,960	171,176	175,497	179,928	184,471
		3	NA	→			
		4	NA	→			
E	200	1	166,667	166,667	166,667	166,667	166,667
		2	166,960	171,176	175,497	179,928	184,471
		3	NA	→			
		4	NA	→			
E	1000	1	216,216	216,216	216,216	216,216	216,216
		2	166,960	171,176	175,497	179,928	184,471
		3	49,256	45,040	40,719	36,288	31,745
		4	61.36	56.11	50.73	45.21	39.55

1/ Per Highway Capacity Manual.
2/ Number of hours/year during which level of service is equal to or worse than that shown in column 1.
3/ Key: 1=highway capacity; 2=nonairport-related traffic; 3=capacity for airport-related vehicles; 4=million annual passengers associated with 3.
4/ Assume .5% annual growth in nonairport-related traffic.

Table B4

AIRPORT ACCESS CAPACITY

San Diego Freeway (Just south of Imperial Highway)

Level of Service 1/	Hrs./Year 2/	Factor 3/	Year 4/				
			1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	120,000	120,000	120,000	120,000	120,000
		2	168,360	172,611	176,968	181,437	186,018
		3	NA	→	→	→	→
		4	NA	→	→	→	→
D	200	1	137,500	137,500	137,500	137,500	137,500
		2	168,360	172,611	176,968	181,437	186,018
		3	NA	→	→	→	→
		4	NA	→	→	→	→
D	1000	1	178,378	178,378	178,378	178,378	178,378
		2	168,360	172,611	176,968	181,437	186,018
		3	10,018	5,767	1,410	NA	NA
		4	15.19	8.74	2.14	NA	NA
E	30	1	145,455	145,455	145,455	145,455	145,455
		2	168,360	172,611	176,968	181,437	186,018
		3	NA	→	→	→	→
		4	NA	→	→	→	→
E	200	1	166,667	166,667	166,667	166,667	166,667
		2	168,360	172,611	176,968	181,437	186,018
		3	NA	→	→	→	→
		4	NA	→	→	→	→
E	1000	1	216,216	216,216	216,216	216,216	216,216
		2	168,360	172,611	176,968	181,437	186,018
		3	47,856	43,605	39,248	34,779	30,198
		4	72.58	66.13	59.52	52.75	45.80

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in column 1.

3/ Key: 1=highway capacity; 2=nonairport-related traffic; 3=capacity for airport-related vehicles; 4=million annual passengers associated with 3.

4/ Assume .5% annual growth in nonairport-related traffic.

Table B 5

AIRPORT ACCESS CAPACITY

San Diego Freeway (Just north of the Santa Monica Freeway)

Level of Service 1/	Hrs./Year 2/	Factor 3/	Year 4/ 1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	120,000	120,000	120,000	120,000	120,000
		2	187,000	191,722	196,561	201,524	206,613
		3	NA	→			
		4	NA	→			
D	200	1	137,500	137,500	137,500	137,500	137,500
		2	187,000	191,722	196,561	201,524	206,613
		3	NA	→			
		4	NA	→			
D	1000	1	178,378	178,378	178,378	178,378	178,378
		2	187,000	191,722	196,561	201,524	206,613
		3	NA	→			
		4	NA	→			
E	30	1	145,455	145,455	145,455	145,455	145,455
		2	187,000	191,722	196,561	201,524	206,613
		3	NA	→			
		4	NA	→			
E	200	1	166,667	166,667	166,667	166,667	166,667
		2	187,000	191,722	196,561	201,524	206,613
		3	NA	→			
		4	NA	→			
E	1000	1	216,216	216,216	216,216	216,216	216,216
		2	187,000	191,722	196,561	201,524	206,613
		3	29,216	24,494	19,655	14,692	9,603
		4	40.76	34.17	27.42	20.50	13.40

1/ Per Highway Capacity Manual.
2/ Number of hours/year during which level of service is equal to or worse than that shown in column 1.
3/ Key: 1=highway capacity; 2=nonairport-related traffic; 3=capacity for airport-related vehicles; 4=million annual passengers associated with 3.
4/ Assume .5% annual growth in nonairport-related traffic.

Table B 6

AIRPORT ACCESS CAPACITY

Santa Monica Freeway (Just east of the San Diego Freeway)

Level of Service 1/	Hrs./Year 2/	Factor 3/	Year 4/				
			1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	120,000	120,000	120,000	120,000	120,000
		2	160,000	164,040	168,181	172,427	176,781
		3	NA	→			
		4	NA	→			
D	200	1	137,500	137,500	137,500	137,500	137,500
		2	160,000	164,040	168,181	172,427	176,781
		3	NA	→			
		4	NA	→			
D	1000	1	178,378	178,378	178,378	178,378	178,378
		2	160,000	164,040	168,181	172,427	176,781
		3	18,378	14,338	10,197	5,951	1,597
		4	25.64	20.00	14.23	8.30	2.23
E	30	1	145,455	145,455	145,455	145,455	145,455
		2	160,000	164,040	168,181	172,427	176,781
		3	NA	→			
		4	NA	→			
E	200	1	166,667	166,667	166,667	166,667	166,667
		2	160,000	164,040	168,181	172,427	176,781
		3	6,667	2,627	NA	NA	NA
		4	9.30	3.66	NA	NA	NA
E	1000	1	216,216	216,216	216,216	216,216	216,216
		2	160,000	164,040	168,181	172,427	176,781
		3	56,216	52,176	48,035	43,789	39,435
		4	78.43	72.79	67.02	61.09	55.02

1/ Per Highway Capacity Manual.
2/ Number of hours/year during which level of service is equal to or worse than that shown in column 1.
3/ Key: 1=highway capacity; 2=nonairport-related traffic; 3=capacity for airport-related vehicles; 4=million annual passengers associated with 3.
4/ Assume .5% annual growth in nonairport-related traffic.

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LOUISVILLE

STANDIFORD FIELD

CASE STUDY

CASE STUDY SUMMARY

Standiford Field is a medium hub airport serving the city of Louisville, Kentucky, Jefferson County, and 51 other counties in the Kentucky and Indiana area. In 1975, the airport handled some 1.7 million passengers. Access to the airport is via the Watterson Expressway (I264), a near-circular highway surrounding downtown Louisville. The Watterson Expressway connects to both north-south and east-west interstate highways serving the region.

The major difficulty with airport access is congestion on the Watterson Expressway in the vicinity of the airport. This congestion is due in part to inadequate capacity and in part to the fact that the airport interchange is one of four major interchanges within a 1 1/2 mile stretch on the Expressway. Although congestion is moderate at present, it is expected to become severe (level of service "E" for at least four hours per weekday) by 1990 unless the Expressway is widened or unless the completion (expected in 1985) of the Jefferson Freeway (an outer loop about five miles beyond the Watterson) helps to funnel non-airport traffic off the Watterson Expressway.

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A. BACKGROUND

1. General

Standiford Field is located in the city of Louisville, Kentucky, (see Figure 1) approximately seven miles south of the central business district (CBD). The Henry Watterson Expressway (I264) and the North-South Expressway (I65) intersect just northeast of the airport, constituting the major routes used by travelers to and from the airport. Although Standiford Field is located in Jefferson County and operated by the Louisville and Jefferson County Air Board, it has a significant regional impact, serving 52 counties in the surrounding Kentucky and Indiana areas.

In 1975 Standiford Field enplaned and deplaned approximately 1.7 million passengers. More than three-quarters of these passengers originated or terminated their trips locally. Of these, 4% came from the CBD and over 50% originated in Jefferson County.

2. Transportation Planning Structure

The Louisville and Jefferson County Air Board, an independent agency created by State statute, is Standiford Field's operator and primary participant in the airport planning process.

In 1970, the Air Board was made an advisory member to the Council of Government's Technical Coordinating Committee for the Louisville Metropolitan Comprehensive Transportation and Development Program. In 1973, when the Council of Governments was expanded and became the Kentuckiana Regional Planning and Development Agency (KIPDA), the Air Board was appointed as a voting member of the Technical Coordinating Committee of the "Transportation Study". The Air Board is also a full voting member of the Transportation Policy Committee of KIPDA which makes recommendations regarding transportation-related developments directly to the KIPDA Board of Directors. KIPDA is the Metropolitan Planning Organziation for the Louisville region.

The Air Board deals with KIPDA in formulating regional access plans and in assessing the impact of other regional transporation plans on airport access. In planning for highway changes in the immediate vicinity of the airport, the Board deals primarily with the Kentucky Department of Transporation (Division of Aeronautics and Bureau of Highways).

At the Federal level, the Intermodal Planning Group meets annually in Atlanta to consider the Unified Work Program (UWP). The Air Board works through KIPDA to formulate the UWP as well as a five-year Transportation Improvement Program.

3. Highway Access

The Watterson Expressway is the major route providing direct ground access to Standiford Field. Approximately 86% of all passenger vehicles arrive

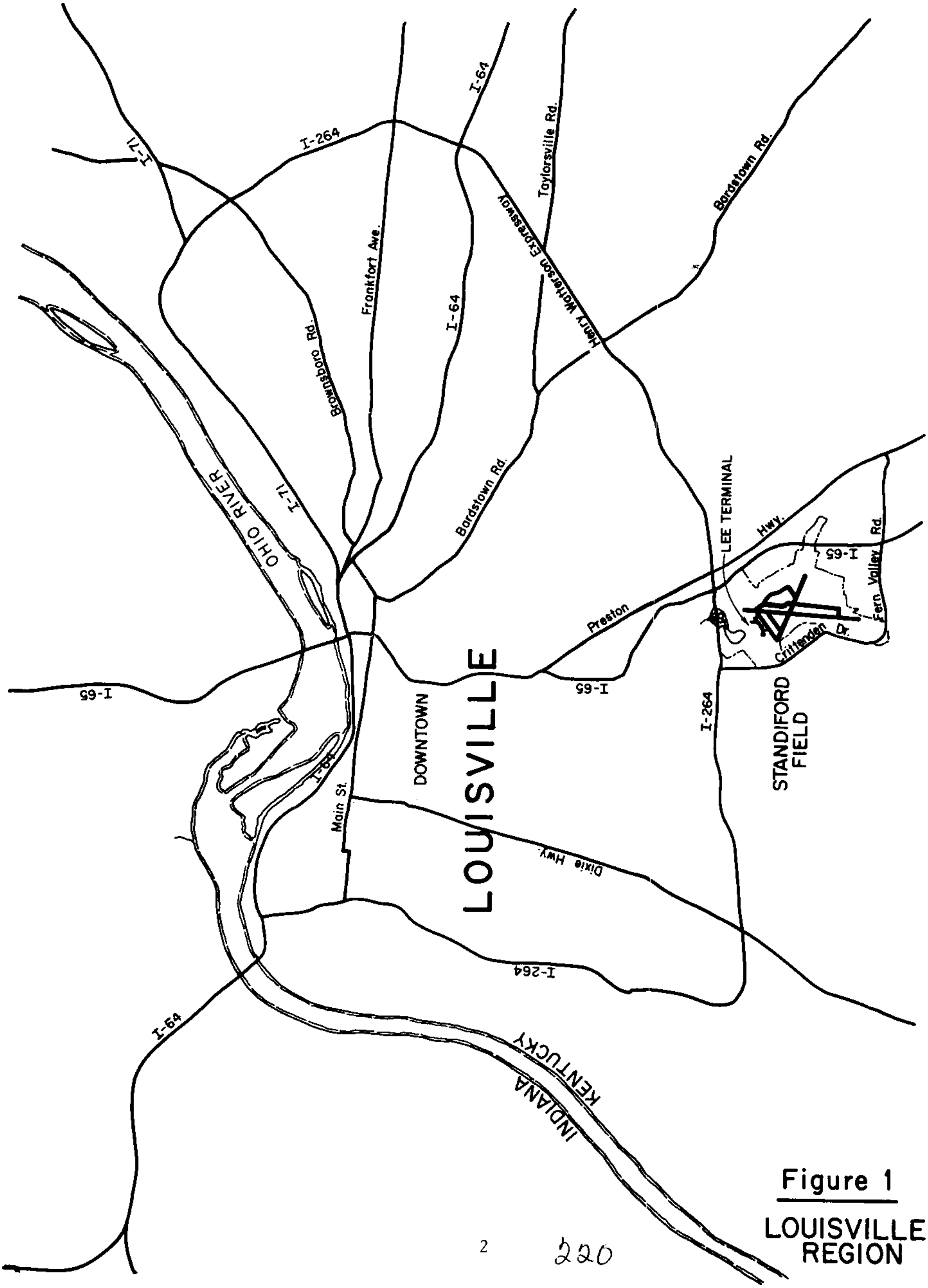

Figure 1

LOUISVILLE REGION

at the airport via the Watterson Expressway. The remaining 14% enter by way of Harding Avenue, a two-lane surface street principally used to reach the airport cargo facilities. The major routes and the percentage of airport-related vehicles per route are presented in Figure 2.

Route I65, the major north-south connector from the CBD, appears to have sufficient capacity for the amount of total traffic projected to 1995. However, travelers from the CBD may encounter problems once they reach the Watterson Expressway. The major bottleneck exists due to the location of four intersections within a 1 1/2 mile segment of the Watterson Expressway just north of Standiford Field. Vehicles entering and exiting the Watterson along this segment produce major weaving and merging patterns that significantly limit the capacity for through traffic and increase congestion problems. This congestion in the airport vicinity is further aggravated by the proximity of Kentucky Fair and Exposition Center, another major traffic generator, just north of the airport.

4. Transit Access

Private automobiles are undoubtedly the major means of ground access to the airport, transporting approximately 70% of all passengers. Rental cars and taxis are the next most popular modes of travel, each representing a service utilized by almost 8% of all air passengers. Buses, courtesy cars, and limousines comprise the remaining significant ground access modes.

5. Internal Access

The internal access roadway system at Standiford Field is shown in Figure 3. The main airport road provides circular access to and egress from the parking lots and terminal area. The main parking lot provides 1,020 spaces, the adjacent perferred parking lot accommodates 200 vehicles, and the long-term parking lot has a 700 space capacity. Freedom Way, the main access roadway connecting the circulation roadway system to the Watterson Expressway, is considered to have sufficient capacity through 1995. The existing single-level internal circulation roadway does not separate enplaning and deplaning passengers, and is not expected to provide adequate capacity in its present form. The main bottleneck is due to vehicles stopping in front of the terminal to drop off or pick up passengers. Action has been taken to alleviate this problem and the proposed additional 20 feet of roadway width for a parking lane on the Terminal Frontage Road 1/, should provide the required capacity through the study period.

1/ Peat, Marwick, Mitchell and Co., Passenger Terminal Platform Planning Requirements for Standiford Field, Louisville, Kentucky, January 1975.

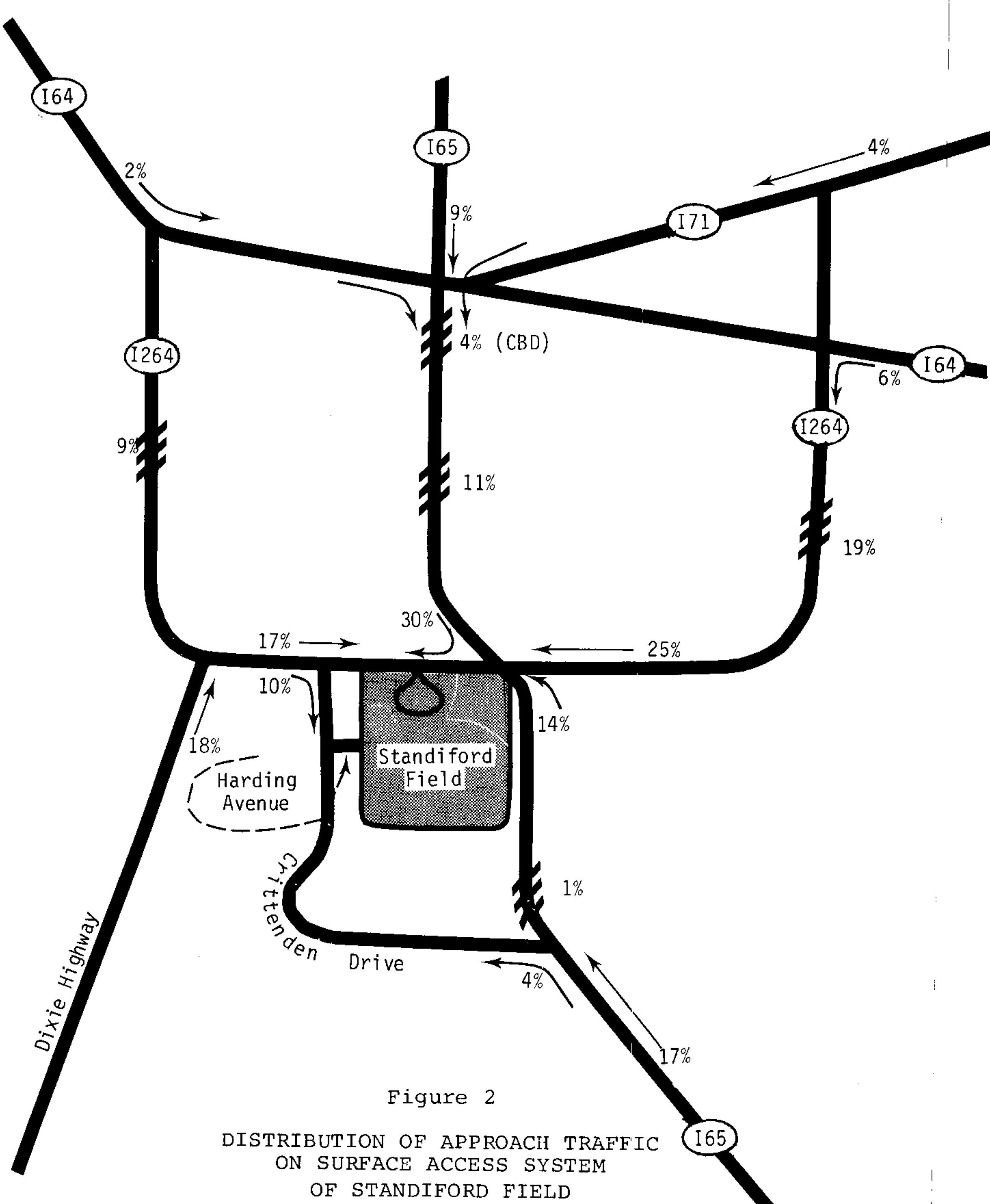

Figure 2

DISTRIBUTION OF APPROACH TRAFFIC
ON SURFACE ACCESS SYSTEM
OF STANDIFORD FIELD

Note: Not to scale.

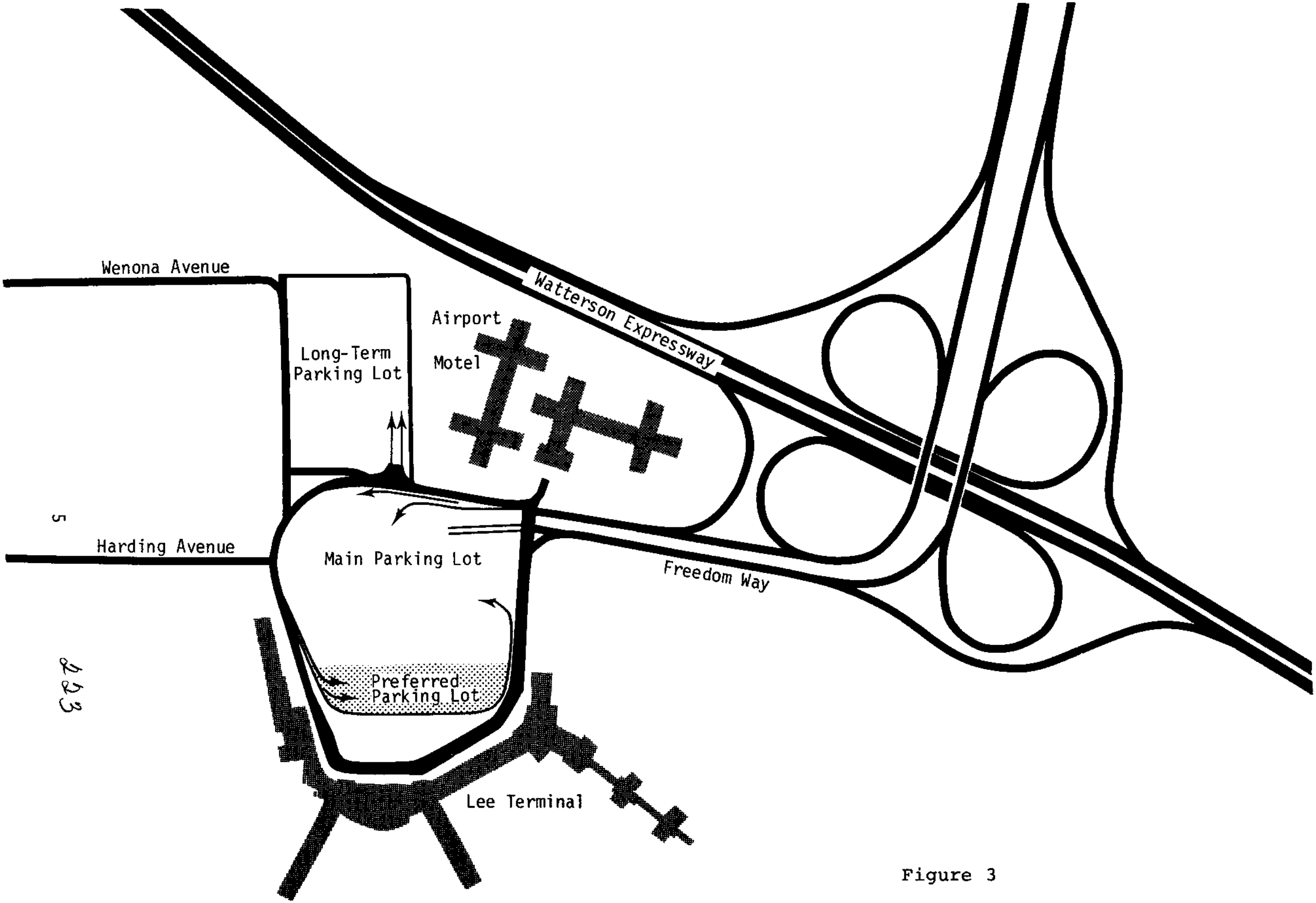

Figure 3

INTERNAL ACCESS ROADWAY SYSTEM

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B. CAPACITY ANALYSIS

1. Passenger Forecast

The two passenger forecasts used in this study were taken from the most recent FAA forecast and a forecast prepared by Peat, Marwick, Mitchell, & Co. for the Louisville and Jefferson County Air Board. 1/

The FAA forecast extends only until 1988 and is projected to 1995 at the 1983-1988 growth rate. The Peat, Marwick, Mitchell, & Co. forecast extends to the year 2000 and is interpolated for 1995. Table 1 presents these passenger forecasts.

2. Airside Capacity

Airside capacity was calculated under the assumption that taxiway improvements currently underway will be completed by the end of 1978. PANCAP 2/ was converted to annual passengers by applying factors for percent air carrier operations, available seats per operation, and enplaning load factor (LF). Two load factors were used, (1) the current load factor of 32% and (2) the current load factor plus 10%. These calculations are presented in Table 2.

3. Ground Access Capacity

Current airport ground trips were assigned to major highways as shown in Appendix A. Four critical highway locations were identified:

(1) The Watterson Expressway (I264) east of the Dixie Highway;
(2) I264 west of the North-South Expressway (I65);
(3) I264 east of I65;
(4) I65 north of I264.

Non-airport traffic was projected to 1995 using a KIPDA forecast for 1995 and interpolating. Calculations and methodology are presented in Appendix B. The resulting graphs for the critical highway segments are presented in Figures 4 through 7. As explained in Appendix B, our estimates of ground access capacity are likely to be generous.

1/ This forecast has yet to receive official sanction, but is considered by Air Board planners to be a reasonably accurate forecast.

2/ Transplan, Inc. Airport Requirements and Terminal Redesign. August 1974. Assume "Mix 3". Although Peat, Marwick, Mitchell model estimates higher capacity (approximately 250,000), PANCAP was used for conservatism and to maintain consistency with other case studies.

TABLE 1

FORECAST OF DEMAND

(Million Annual Passengers)

Year	FAA	Louisville
(1)	(2)	(3)
1972	1.7 1/	1.7 1/
1975	1.7 1/	1.7 1/
1980	2.2	2.5
1985	2.9 2/	3.2
1990	3.8 3/	4.0
1995	4.9 3/	4.7 2/

1/ Actual.

2/ Interpolated.

3/ Extended.

Sources: FAA Terminal Area Forecasts, 1978-1988.

Airport Activity Statistics of Certificated Air Carriers, 1972 andd 1975.

Peat, Marwick, Mitchell, & Co. Model.

TABLE 2

CALCULATION OF AIRSIDE CAPACITY

Year	PANCAP	% Air Carrier	Seats/ Operation	Annual Passenger Capacity (Millions) LF = .32	Annual Passenger Capacity (Millions) LF = .42
(1)	(2)	(3)	(4)	(5)	(6)
1975	176,000	43	95.63	2.3	3.0
1980	195,000	43	115.00	3.1	4.0
1985	195,000	43	135.00	3.6	4.8
1990	195,000	43	146.00	3.9	5.1
1995	195,000	43	163.00	4.4	5.7

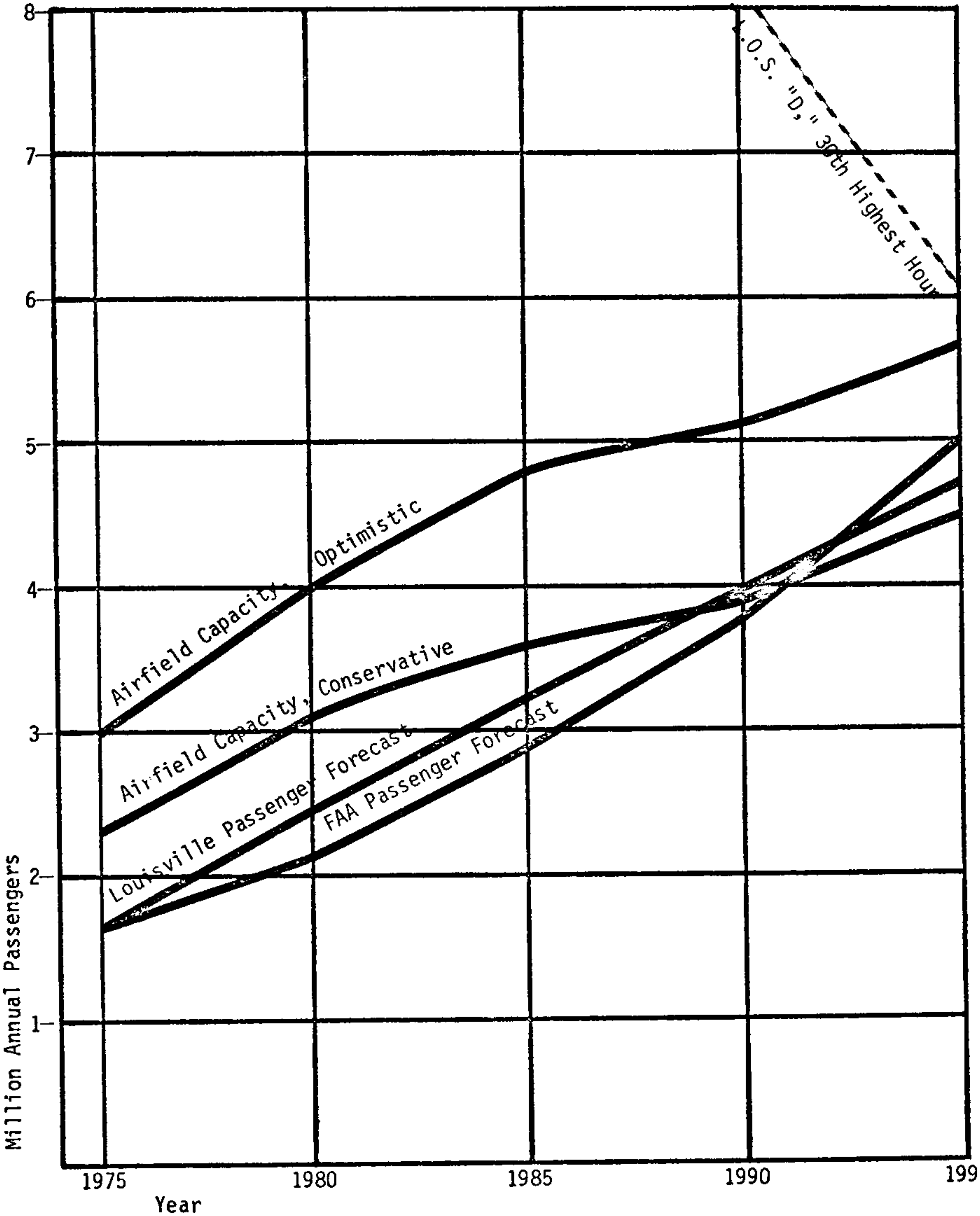

Figure 4
DEMAND/CAPACITY RELATIONSHIPS
Watterson Expressway (I264) East of Dixie Highway

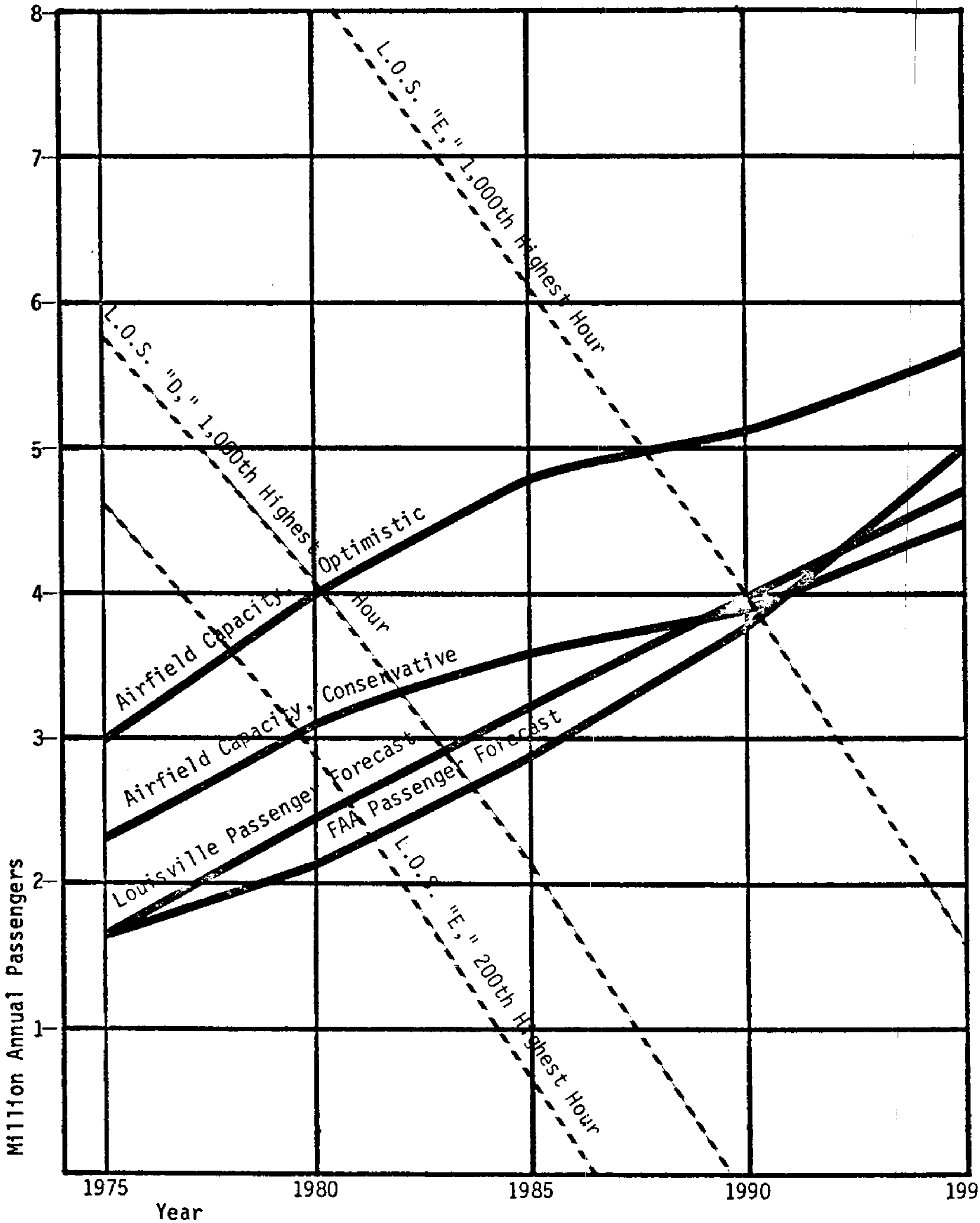

Figure 5
DEMAND/CAPACITY RELATIONSHIPS

Watterson Expressway (I264) West of I65

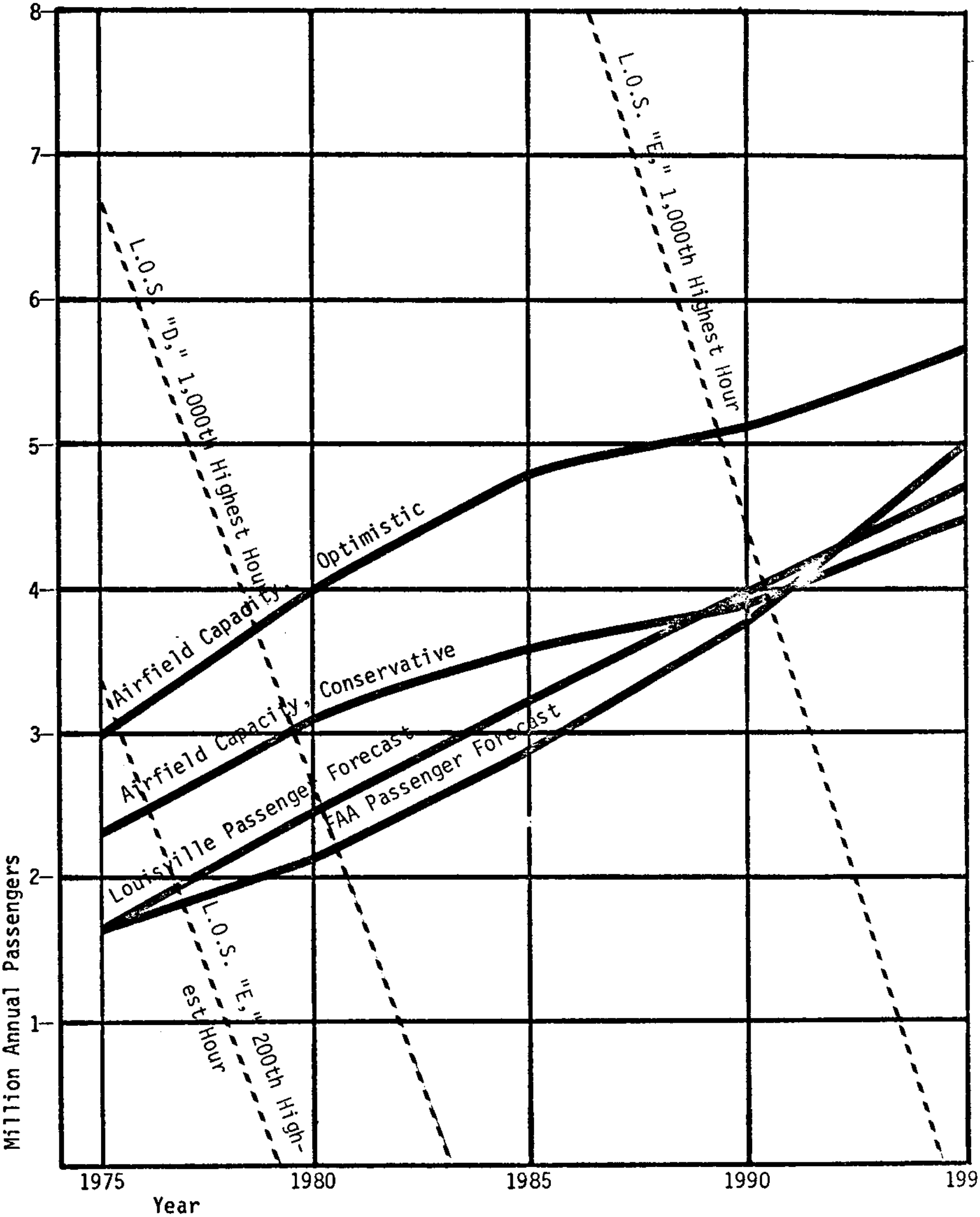

Figure 6

DEMAND/CAPACITY RELATIONSHIPS

Watterson Expressway (I264) East of I65

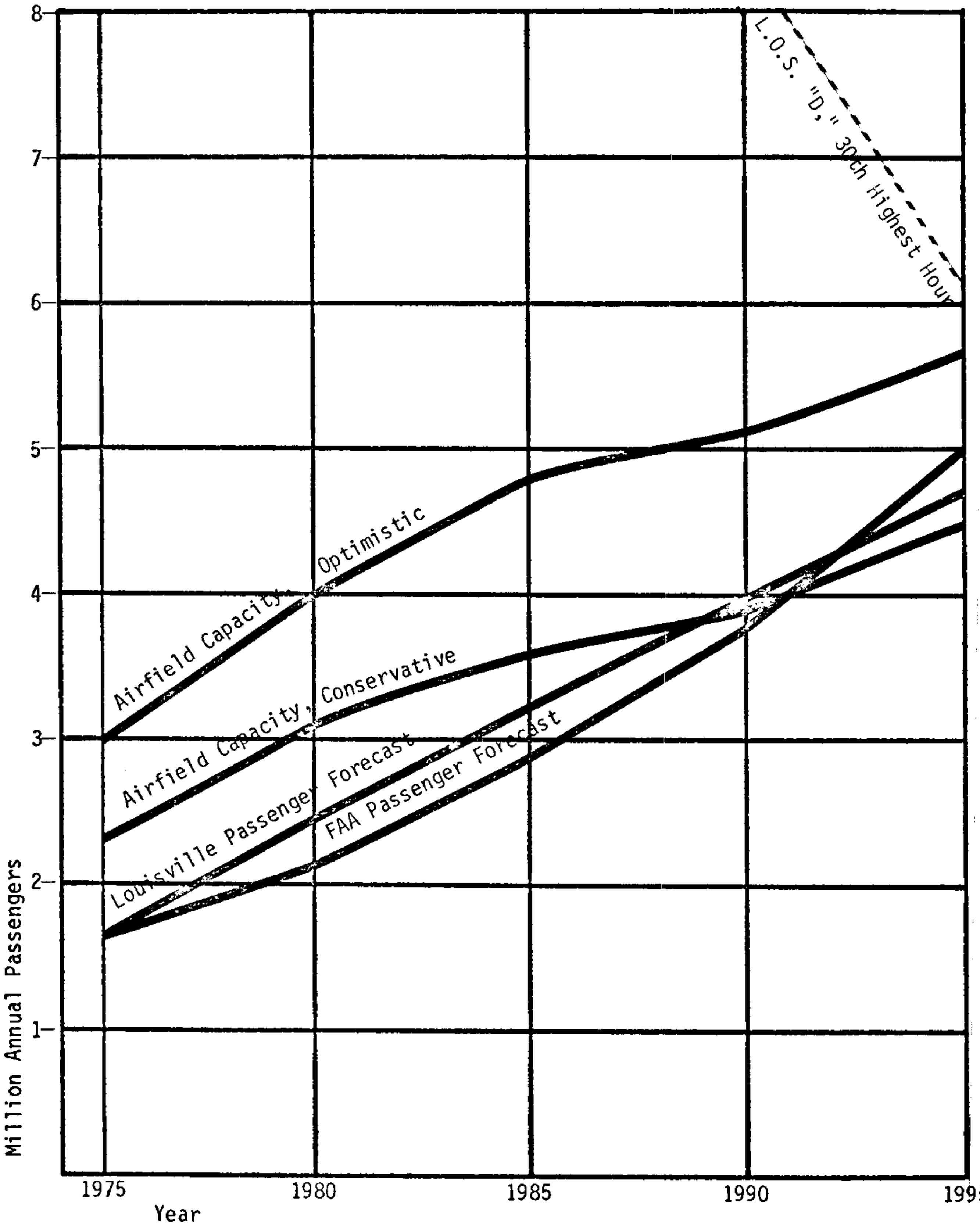

Figure 7

DEMAND/CAPACITY RELATIONSHIPS
North-South Expressway (I65) North of I264

4. Interpretation

a. The Watterson Expressway

Three segments of the Watterson Expressway were considered in this analysis. The first location east of the Dixie Highway appears to have sufficient capacity to handle projected traffic volumes at better than level of service "D" through 1995. The second segment of the Watterson Expressway, west of I65, presents a greater congestion problem. Significant levels of congestion are currently being experienced on this highway segment. This congestion problem is expected to worsen as traffic volumes in the vicinity increase. Level of service "D" is expected for over 1,000 hours per year before 1985 and level of service "E" for 1,000 hours per year is probable by 1990, if current highway capacities remain constant. The third point considered along the Watterson Expressway is just east of I65. This segment of the Watterson currently experiences the most serious congestion problem of those observed, with level of service "E" experienced for over 200 hours/year.

b. The North-South Expressway

The North-South Expressway (I65) appears to have sufficient capacity to accomodate existing and projected traffic volumes. However, it should be noted that bottlenecks for airport-related traffic occur at the intersection of I65 and the Watterson Expressway and can cause substantial congestion during peak hours.

C. PROPOSED SOLUTIONS

Some of the proposals that would directly or indirectly improve ground access to Standiford Field are listed in Table 3. Currently, the major constraints to airport access are the bottlenecks experienced just north of the airport on the Watterson Expressway. Widening the Watterson at this critical location would increase access capacity and proivde more efficient flow for both airport and non-airport related traffic.

The Jefferson Freeway, already under construction, will also help to divert traffic from the Watterson Expressway. The Jefferson Freeway will circumvent the Watterson Expressway, forming an outer circle approximately five miles beyond the Watterson Expressway between Route 42 and the Dixie Highway.

Several solutions have also been proposed regarding the terminal area and internal roadway system. Notably, the proposed terminal relocation to the south side of the airport will not be implemented. Terminal relocation was originally considered to provide additional airside capacity to meet the growing demand for airport services. As a side effect, it would have increased ground access capacity by improving the direct access from I65. However, the completion of new taxiways, scheduled for the fall of 1978, should provide sufficient airside capacity to meet passenger demand well beyond 1995, forestalling the need for the terminal relocation.

TABLE 3

PROPOSED SOLUTIONS TO AIRPORT ACCESS PROBLEMS

Proposed Solution	Initiator	Agency Resp. for Implem.	Funding Sources	Est. Cost (Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
A. CONSTRUCTION					
1. Watterson Expressway Widening	KDOA	KDOA, FHWA	FHWA	*	Preliminary Planning
2. Move Terminal to South Side of Airport	LJCAB	LJCAB	ADAP	*	Will not build
3. Jefferson Freeway	KDOT	KDOT	FHWA, KDOT	$175,000,000	Partially complete. Completion expected by 1985.
4. On airport roadway improvements	LJCAB	LJCAB	Airport Revenues	(see note)	Design awaiting approval
5. Curb rearrangement in front of terminal area	LJCAB	LJCAB	Airport Revenues	(see note)	Design awaiting approval
6. Median rearrangement	LJCAB	LJCAB	Airport Revenues	(see note)	Design awaiting approval

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PROPOSED SOLUTIONS TO AIRPORT ACCESS PROBLEMS

Proposed Solution	Initiator	Agency Resp. for Implem.	Funding Sources	Est. Cost (Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
B. RELOCATION					
1. Move rent-a-car return from front of terminal area to northeast of terminal area	LJCAB	LJCAB	Airport Revenues	(see note)	Design awaiting approval

Note: Part of total project to increase parking and traffic circulation (estimated cost = $90,000)

*Not available or unknown

Key of Abbreviations:

ADAP = Airport Development Aid Program

FHWA = Federal Highway Administration

KDOA = Kentucky Division of Aeronautics (of the KDOT)

KDOT = Kentucky Department of Transportation

LJCAB = Louisville and Jefferson County Air Board

D. CONCLUSIONS

Standiford Field currently has a moderate access problem due to urban congestion on the Watterson Expressway. This problem is expected to worsen due to the growth of non-airport related traffic on the expressway. Specifically, most passengers on their way to or from the airport will have to pass through one or more segments of roadway that operate at level of service "E" for about four hours out of every weekday. Delays are likely to be extensive.

One thing that may serve to lessen the expected congestion is the scheduled completion of the Jefferson Freeway in 1985. Although it will not be a major part of the airport access system, the Freeway may reduce the non-airport traffic that currently competes with airport traffic for use of the Watterson Expressway.

Proposed solutions to the congestion problem have centered around construction alternatives. Of these the widening of the Watterson Expressway is the most likely means of forestalling or eliminating the problem.

APPENDIX A

ROUTING OF AIRPORT ACCESS TRIPS BY LOCAL ORIGIN/DESTINATION ZONE

Passenger data for local originations and destinations were obtained from a 1972 in-flight survey conducted by the Louisville and Jefferson County Air Board. It was necessary to divide the Jefferson County survey population (50% excluding CBD) into four sectors with the air passengers apportioned per sector as indicated in Table A1. All other passenger routing assumptions are listed by zone and distributed to account for the remaining 50% of passenger trips to and from the airport.

TABLE A1

ROUTING OF AIRPORT ACCESS TRIPS

BY LOCAL ORIGIN/DESTINATION ZONE

Zone	Percent Distributed	Routing	Percent Per Route
(1)	(2)	(3)	(4)
Jefferson County (Louisville CBD)	4	I65	4
Jefferson County (E)	20	I264	19
		I65	1
Jefferson County (NE)	10	I65	10
Jefferson County (W, NW)	10	I264	9
		I65	1
Jefferson County (S)	10	I65	10
Clark County	6	I65	6
Floyd County	2	I64, I65	2
Hardin County	18	Dixie Hwy., I264	16
		I65	2
Henry County	1	I71, I65	1
Oldham County	1	I71, I65	1
Shelby County	1	I64, I264	1
Other Kentucky Areas	14	I65	5
		I64, I264	5
		Dixie Hwy., I264	2
		I71, I65	2
Other Indiana Areas	3	I65	3

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

The hourly vehicular capacities for the Watterson expressway (I-264) and the North-South Expressway were computed from Table 9.1 of the Highway Capacity Manual (H.C.M.). The Watterson Expressway capacity was computed for a four-lane freeway using a peak hour factor (PHF) of .91 for level of service D, and level of service "E" capacity was calculated based on the same four-lane assumption. The North-South Expressway capacity was based on a .91 PHF for a six-lane freeway as indicated in the H.C.M.

It should be noted that the assumption of four and six through lanes is considered very conservative, especially in the case of the Watterson Expressway. The existence of four intersections within 1 1/2 miles in the area adjacent to Standiford Field cuts down considerably the number of vehicles that can pass freely through this segment of I264. Such an extreme weaving and merging situation presents serious flow problems as the traffic volumes increase. However, the detailed analysis required to accurately measure the impact of exiting and entering vehicles is beyond the scope of this study. In light of this limitation, calculations were made assuming a greater highway capacity than actually exists.

Vehicle trips available for airport use were converted to air passengers by multiplying by the 1972 ratio of annual passengers (1,745,136 per Reference 1) to average daily traffic entering and leaving the airport (11,830, per Reference 3) and divided by the proportion of airport traffic that is carried by each critical highway. Tables B1 through B4 present the detailed computations of airport access capacities by route.

Table B1

AIRPORT ACCESS CAPACITY

I264 (East of Dixie Highway)

Level of Service[1/] (1)	Hrs./Year[2/] (2)	Factor[3/] (3)	Year 1972 (4)	1975 (5)	1980 (6)	1985 (7)	1990 (8)	1995 (9)
D	30	1	60,000	60,000	60,000	60,000	60,000	60,000
		2	32,359	34,203	37,491	41,069	44,962	48,940
		3	27,641	25,797	22,509	18,931	15,038	11,060
		4	15.10	14.09	12.30	10.34	8.22	6.04
D	200	1	68,750	68,750	68,750	68,750	68,750	68,750
		2	32,359	34,203	37,491	41,069	44,962	48,940
		3	36,391	34,547	31,259	27,681	23,788	19,810
		4	19.88	18.88	17.08	15.12	13.00	10.82
D	1,000	1	89,189	89,189	89,189	89,189	89,189	89,189
		2	32,359	34,203	37,491	41,069	44,962	48,940
		3	56,830	54,986	51,698	48,120	44,227	40,249
		4	31.05	30.03	28.25	26.29	24.16	21.99
E	30	1	72,727	72,727	72,727	72,727	72,727	72,727
		2	32,359	34,203	37,491	41,069	44,962	48,940
		3	40,368	38,524	35,236	31,658	27,765	23,787
		4	22.06	21.05	19.25	17.30	15.17	13.00
E	200	1	83,333	83,333	83,333	83,333	83,333	83,333
		2	32,359	34,203	37,491	41,069	44,962	48,940
		3	50,974	49,130	45,842	42,264	38,371	34,393
		4	27.85	26.84	25.05	23.09	20.97	18.79
E	1,000	1	108,108	108,108	108,108	108,108	108,108	108,108
		2	32,359	34,203	37,491	41,069	44,962	48,940
		3	75,749	73,905	70,617	67,039	63,146	59,168
		4	41.39	40.38	38.58	36.63	34.50	32.33

1/ Per Highway Capacity Manual.
2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.
3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.
4/ Growth rate interpolated from 1972 actual counts and 1995 KIPDA forecasts.

Table B2

AIRPORT ACCESS CAPACITY

I265 (West of I65)

Level of Service 1/ (1)	Hrs./Year 2/ (2)	Factor 3/ (3)	Year 1972 (4)	1975 (5)	1980 (6)	1985 (7)	1990 (8)	1995 (9)
D	30	1	60,000	60,000	60,000	60,000	60,000	60,000
		2	56,838	61,526	69,806	79,194	89,713	100,406
		3	3,162	NA	NA	NA	NA	NA
		4	.68	NA	NA	NA	NA	NA
D	200	1	68,750	68,750	68,750	68,750	68,750	68,750
		2	56,838	61,426	69,806	79,194	89,713	100,406
		3	11,912	7,324	NA	NA	NA	NA
		4	2.55	1.57	NA	NA	NA	NA
D	1,000	1	89,189	89,189	89,189	89,189	89,189	89,189
		2	56,838	61,426	69,806	79,194	89,713	100,406
		3	32,351	27,763	19,383	9,995	NA	NA
		4	6.92	5.94	4.14	2.14	NA	NA
E	30	1	72,727	72,727	72,727	72,727	72,727	72,727
		2	56,838	61,426	69,806	79,194	89,713	100,406
		3	15,889	11,301	2,921	NA	NA	NA
		4	3.40	2.42	.62	NA	NA	NA
E	200	1	83,333	83,333	83,333	83,333	83,333	83,333
		2	56,838	61,426	69,806	79,194	89,713	100,406
		3	26,495	21,907	13,527	4,139	NA	NA
		4	5.66	4.68	2.89	.88	NA	NA
E	1,000	1	108,108	108,108	108,108	108,108	108,108	108,108
		2	56,838	61,426	69,806	79,194	89,713	100,406
		3	51,270	46,682	38,302	28,914	18,395	7,702
		4	10.96	9.98	8.19	6.18	3.93	1.65

1/ Per *Highway Capacity Manual*.
2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.
3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.
4/ Growth rate interpolated from 1972 actual counts and 1995 KIPDA forecasts.

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Table B3

AIRPORT ACCESS CAPACITY

I264 (East of I65)

Level of Service[1/]	Hrs./Year[2/]	Factor[3/]	Year 1972	1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
D	30	1	60,000	60,000	60,000	60,000	60,000	60,000
		2	64,575	77,510	84,585	92,241	100,660	109,349
		3	NA	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA	NA
D	200	1	68,750	68,750	68,750	68,750	68,750	68,750
		2	64,575	77,510	84,585	92,241	100,660	109,349
		3	4,175	NA	NA	NA	NA	NA
		4	2.46	NA	NA	NA	NA	NA
D	1,000	1	89,189	89,189	89,189	89,189	89,189	89,189
		2	64,575	77,510	84,585	92,241	100,660	109,349
		3	24,614	11,679	4,604	NA	NA	NA
		4	14.53	6.89	2.72	NA	NA	NA
E	30	1	72,727	72,727	72,727	72,727	72,727	72,727
		2	64,575	77,510	84,585	92,241	100,660	109,349
		3	8,152	NA	NA	NA	NA	NA
		4	4.81	NA	NA	NA	NA	NA
E	200	1	83,333	83,333	83,333	83,333	83,333	83,333
		2	64,575	77,510	84,585	92,241	100,660	109,349
		3	18,758	5,823	NA	NA	NA	NA
		4	11.07	3.44	NA	NA	NA	NA
E	1,000	1	108,108	108,108	108,108	108,108	108,108	108,108
		2	64,575	77,510	84,585	92,241	100,660	109,349
		3	43,533	30,598	23,523	15,867	7,448	NA
		4	25.69	18.06	13.88	9.36	4.40	NA

1/ Per Highway Capacity Manual.
2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.
3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.
4/ Growth rate interpolated from 1972 actual counts and 1995 KIPDA forecasts.

Table B4

AIRPORT ACCESS CAPACITY

I65 (North of I264)

Level of Service[1/] (1)	Hrs./Year[2/] (2)	Factor[3/] (3)	Year: 1972 (4)	1975 (5)	1980 (6)	1985 (7)	1990 (8)	1995 (9)
D	30	1	89,091	89,091	89,091	89,091	89,091	89,091
		2	58,763	60,842	64,462	68,286	72,325	76,451
		3	30,328	28,249	24,629	20,805	16,766	12,640
		4	14.91	13.89	12.11	10.23	8.24	6.22
D	200	1	102,083	102,083	102,083	102,083	102,083	102,083
		2	58,763	60,842	64,462	68,286	72,325	76,45[illegible]
		3	43,320	41,241	37,621	33,797	29,758	25,[illegible]
		4	21.30	20.28	18.50	16.62	14.63	12.[illegible]
D	1,000	1	132,432	132,432	132,432	132,432	132,432	132,432
		2	58,763	60,842	64,462	68,286	72,325	76,451
		3	73,669	71,590	67,970	64,146	60,107	55,981
		4	36.22	35.20	33.42	31.54	29.56	27.53
E	30	1	109,091	109,091	109,091	109,091	109,091	109,091
		2	58,763	60,842	64,462	68,286	72,325	76,451
		3	50,328	48,249	44,629	40,805	36,766	32,640
		4	24.75	23.73	21.95	20.06	18.08	16.05
E	200	1	125,000	125,000	125,000	125,000	125,000	125,000
		2	58,763	60,842	64,462	68,286	72,325	76,451
		3	66,237	64,158	60,538	56,714	52,675	48,549
		4	32.57	31.55	29.77	27.89	25.90	23.87
E	1,000	1	162,162	162,162	162,162	162,162	162,162	162,162
		2	58,763	60,842	64,462	68,286	72,325	76,451
		3	103,399	101,320	97,700	93,876	89,837	85,711
		4	50.84	49.82	48.04	46.16	44.18	42.15

1/ Per Highway Capacity Manual.
2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.
3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.
4/ Growth rate interpolated from 1972 actual counts and 1995 KIPDA forecasts.

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MIAMI

INTERNATIONAL AIRPORT

CASE STUDY

CASE STUDY SUMMARY

Miami International Airport is located in the heart of Dade County, Florida about six miles west of the Miami CBD and nine miles west of Miami Beach and is operated by the Dade County Aviation Department. In 1976, MIA had 12.6 total passengers with a 37% transfer rate which is expected to increase to 40% by 1980 and 55% by 1995. There are over 24,000 people employed at the Airport, a figure expected to more than double by 1995. The Airport is now preparing a new Master Plan for development.

Significant traffic congestion occurs at intersections along LeJeune Road, the primary access route for passengers and employees using the Terminal area. This arterial serves not only as the primary access to the Airport, but as a major north-south route as well. Congestion along the East-West Expressway (S.R. 836) both east and west of LeJeune Road is also a major current problem. Other current congestion points include access routes to the cargo and employee areas along the northwestern and western boundaries of the Airport.

Highway construction projects have been proposed to alleviate these problems, including widening of the East-West Expressway and construction of a new arterial highway parallel to LeJeune Road. Implementation of these projects would provide significant relief to current and expected future traffic congestion. Plans to run the new Dade County Rapid Transit directly to the airport have been dropped, but may be reconsidered in the future. Shuttle service from the airport to the nearest transit station has been proposed.

Construction of a proposed parallel arterial east of LeJeune Road with a connector to the Terminal would provide significant relief. Relief to congestion on S.R. 836 would be provided by implementing current plans to widen that toll road. Capacity problems on the Airport Expressway should increase in frequency during the 1980's if the proposed highway widening does not take place.

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III. List of Tables

MIAMI INTERNATIONAL AIRPORT

A. BACKGROUND

1. General

Miami International Airport is located in Dade County, about six miles west of the Miami CBD and nine miles west of Miami Beach (Fig. 1) and is operated by the Dade County Aviation Department. In 1976, total enplaning and deplaning passengers were about 12.6 million (45% international), with a transfer rate of 37%, which is expected to increase in the next twenty years. Miami International handles 65% of all passenger traffic in Dade and Broward Counties, but its share is expected to decrease because of the growth of Fort Lauderdale-Hollywood International, located twenty miles to the north.

A new Airport Master Plan is currently being prepared by the Aviation Department. The selected concept calls for expansion of the terminal in its present location. To meet demand in the years 1995-2000, a new terminal may be built in the southwest corner of the Airport.

Miami International Airport is a major employment center in Dade County, with over 24,000 employees. There are five major employment areas including the passenger terminal, 20th Street (National Airlines, cargo and support facilities), cargo areas in the southwest and northwest, and 36th Street Maintenance Facilities which also houses the headquarters for Eastern Airlines. The headquarters for both Eastern and National Airlines account for over half of all employees (Eastern alone has 12,000). Employees are expected to reach 51,000 by 1995 (Ref. 2).

2. Transportation Planning Structure

Transportation planning for the entire Dade County area is conducted by the Metropolitan Dade County Government, which is unique in that it is also a municipal entity. The County's staff also serve as the MPO for Dade County. The MPO, in order to assist their staff in developing long-range transportation plans, formed an Interdisciplinary Team (IDT). The IDT, which is made up of citizen representatives and special interest groups, makes recommendations to the MPO for long-range plans and alternatives. Both the MPO and IDT meet monthly.

Transit planning is the responsibility of the Dade County Office of Transportation Administration as are highway, traffic and aviation planning. The Florida Department of Transportation has a regional office at the Fort Lauderdale-Hollywood Airport with a planning staff that is responsible for highway planning in southeast Florida. The State provides additional technical staff in Tallahassee. Local coordination is fairly good because of the single political entity.

An Intermodal Planning Group (IPG) exists at the Federal level in Atlanta but appears to have little influence on transportation planning in Dade County.

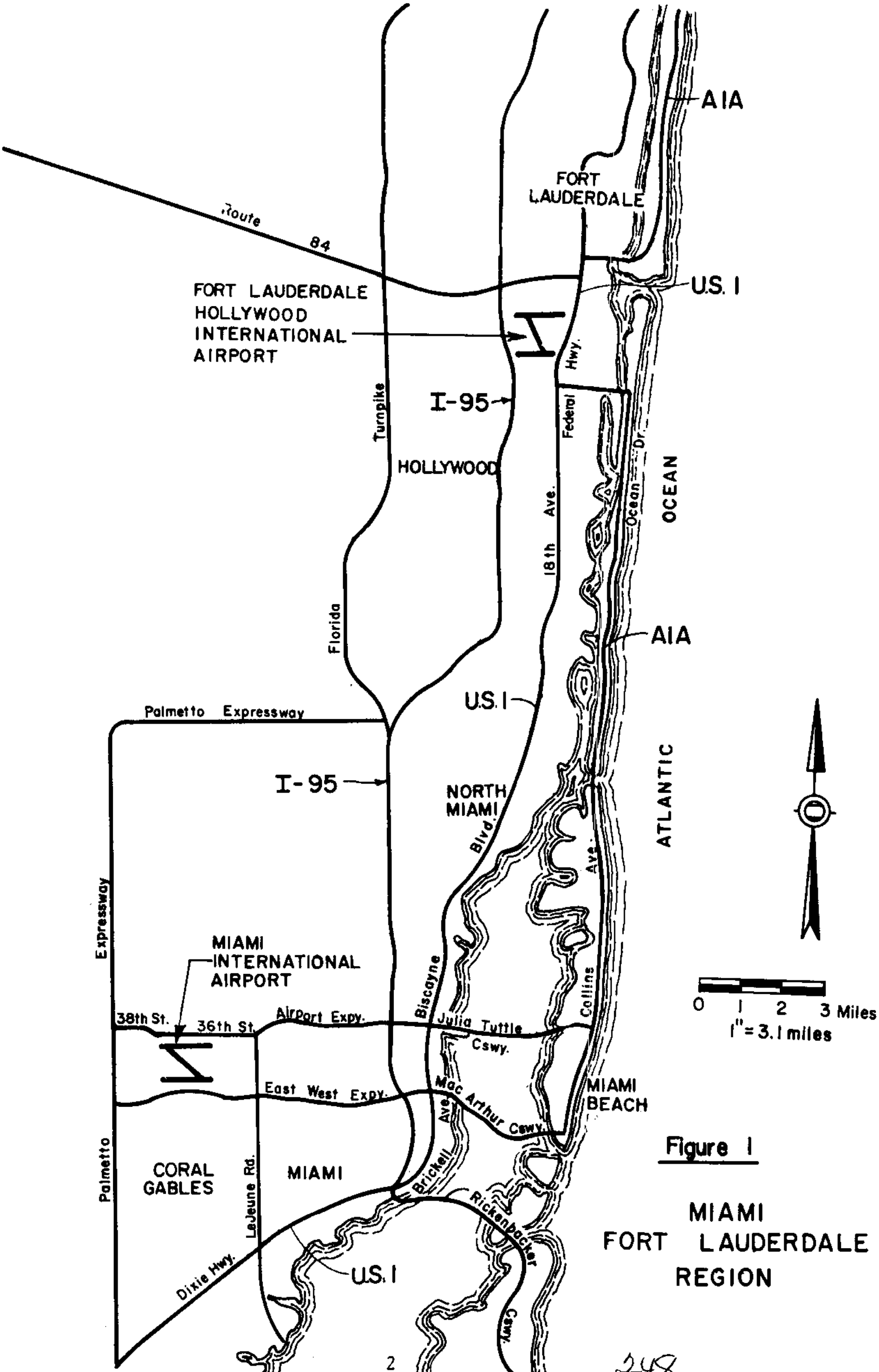

Figure 1

MIAMI
FORT LAUDERDALE
REGION

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3. Highway Access

Principal highway access is by LeJeune Road, Airport Expressway (State Route 112, a toll road), I-95, East-West Expressway (Route 836), Okeechobee Road (U.S. Route 27), and Palmetto Expressway (Figure 2). Traffic comes from the Miami CBD via I-95, East-West Expressway, LeJeune Road and the Airport Access Roadway. In a series of time runs conducted for the FHWA's continuing airport access analysis program, travel time was 14.6 minutes during the peak periods and 11.5 minutes during the off-peak hours.

Recent air traveler surveys have shown that only 7% of enplaning air passengers originated in the Miami CBD. The most significant concentration of non-transfer air travel trips is along Miami Beach and other oceanfront areas in Dade County, representing 35% of air passenger traffic generation. These passengers take I-195 (Julia Tuttle Expressway) to the Airport Expressway and LeJeune Road, or use the East-West Expressway from the Southern tip of the Beach to reach LeJeune Road.

Traffic from North or South Miami uses Palmetto Expressway to either Okeechobee Road or East-West Expressway. Travellers from Coral Gables and Hialeah arrive via LeJeune Road.

The major access congestion points listed below have been identified by the County as follows: (Reference 2)

1. LeJeune Road - Airport Expressway interchange

2. Route 836 - LeJeune Road interchange merge from three to two lanes

3. Toll collection on Route 836 (East-West Expressway)

4. Route 27 congestion

5. Excessive traffic along LeJeune Road in front of Airport

The County has a number of plans for relieving problems, including construction of a four-lane limited access highway parallel to and east of LeJeune Road, including connections to the terminal area; widening of the East-West Expressway and expansion of the interchange between NW 57th Avenue and the Airport's Perimeter Road.

4. Transit Access

Two thirds of all passengers use either a limousine, taxi, or rental car to travel to or from MIA. Less than one percent of all passengers use Metropolitan Transit Authority buses. Table 1 shows the modal split for deplaning passengers.

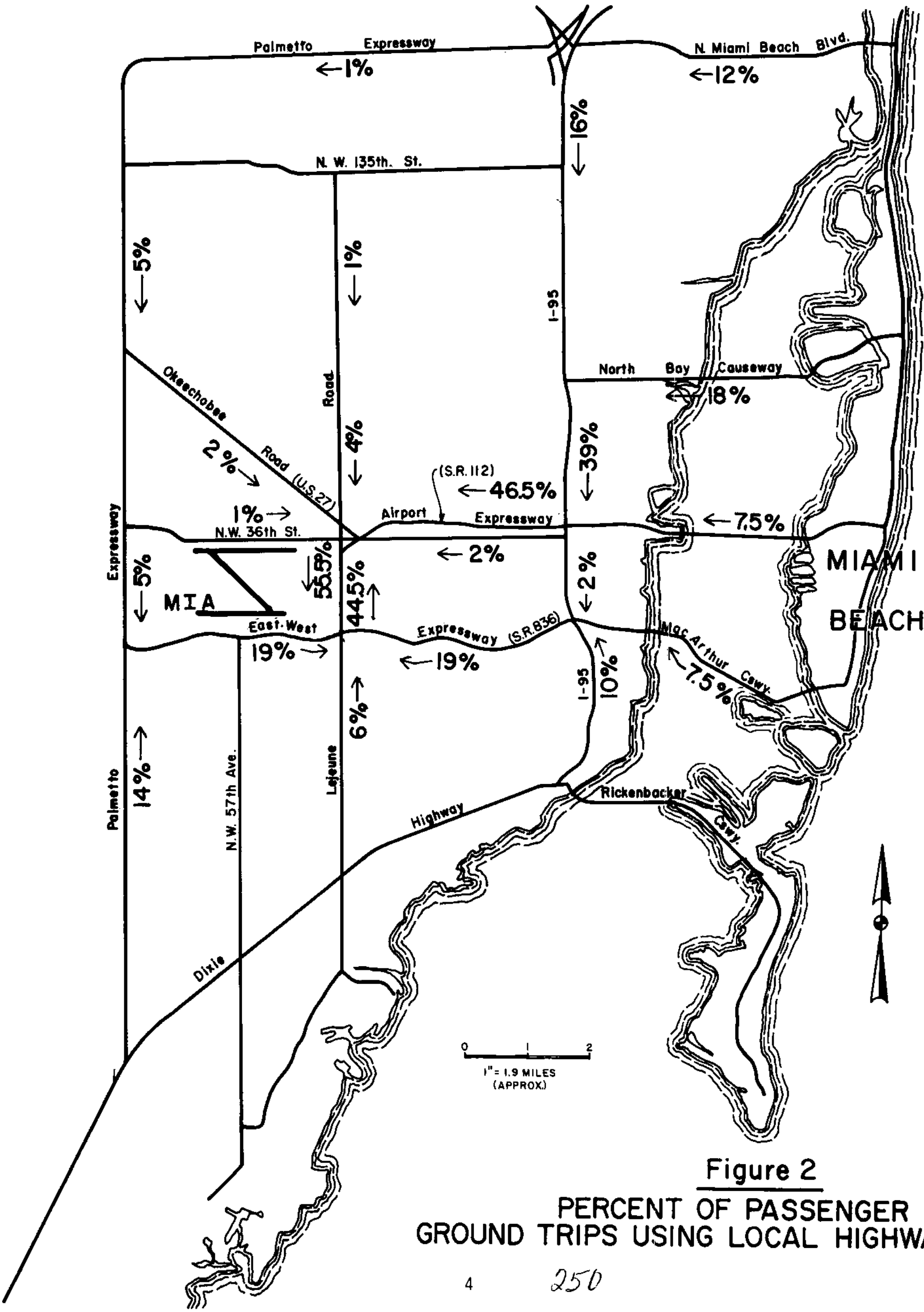

Figure 2

PERCENT OF PASSENGER GROUND TRIPS USING LOCAL HIGHWAYS

TABLE 1

MODAL CHOICE FOR

DEPLANING PASSENGERS

Peak Period - March 20-27, 1978

Mode of Ground Transportation	Percentage
Limousine	19.8
Taxi	24.2
Rental Car	16.1
Private Auto	39.1
Other (Bus, MTA, Charter Buses, Courtesy Cars, etc.)	.8
Total	100.0

Source: Ref. 4

Phase I plans for Dade County's new fixed rail Transit System do not serve the Airport. There are some sketchy future plans for fixed rail transit to a point just east of LeJeune Road with a transfer to a "people-mover" running to the terminal. At one time, plans were studied for a transit connection to Miami Beach (where 1/3 of the O&D passengers are going), but this appears highly unlikely because Miami Beach residents do not want fixed-rail transit.

5. Internal Access

The main entrance road runs from Northwest 37th Avenue to the passenger terminal with interchanges at LeJeune Road & Perimeter Road. This road is and will continue to be the primary access to the County's expressway system and major arterials. The passenger terminal is a two-level terminal, the upper level serving enplaning passengers & visitors and the lower level serving deplaning passengers. Access to the major employee areas are via U.S. Route 27, 36th Street, Milam Dairy Road, or Perimeter Road. Figure 3 shows the internal roadway and access system.

There are 4,984 public parking spaces in the Terminal area including long-term, short-term valet and special purpose spaces. It is estimated that the peak occupancy of the public parking facilities is 3,613 vehicles, 72% of the total supply. An additional 2,360 employee parking spaces are provided in close proximity to the terminal area with another 2,400 provided in the remote lot. These employees are served by a shuttle bus operating with 5 minute headways from 4 A.M. to midnight, and ten minute headways from midnight to 4 A.M. (Ref. 3).

B. CAPACITY ANALYSIS

1. Passenger Forecasts

The passenger forecast used in this report was derived from the MIA Master Plan Study (Ref. 1 and 2). Table 2 shows the number of passengers using the Airport in 1975 and 1977 and the number expected through 1995.

2. Airside Capacity

Airside Capacity forecasts were derived from information contained in the Master Plan Study forecast (Ref. 2). Peak hour airfield capacity (PHOCAP) was convered to an annual capacity (PANCAP) for the years 1977, 1980, 1985, 1990 and 1995.

The calculations for 1977 and 1980 were made on the basis of the airfield geometry existing in February 1976. Capacity calculations for 1985 and beyond are based on the improved airfield as described in the Master Plan Report (Ref. 2). Three separate capacity calculations were made in the Master Plan in order to analyze the effect of probable improvements in Air Traffic Control on airside capacity. The three cases were: 1) no improvement in capacity; 2) 10% improvement in capacity and 3) 20% improvement in capacity. The 10% figures are considered to be the most representative of probable conditions through the planning period and are used for this analysis.

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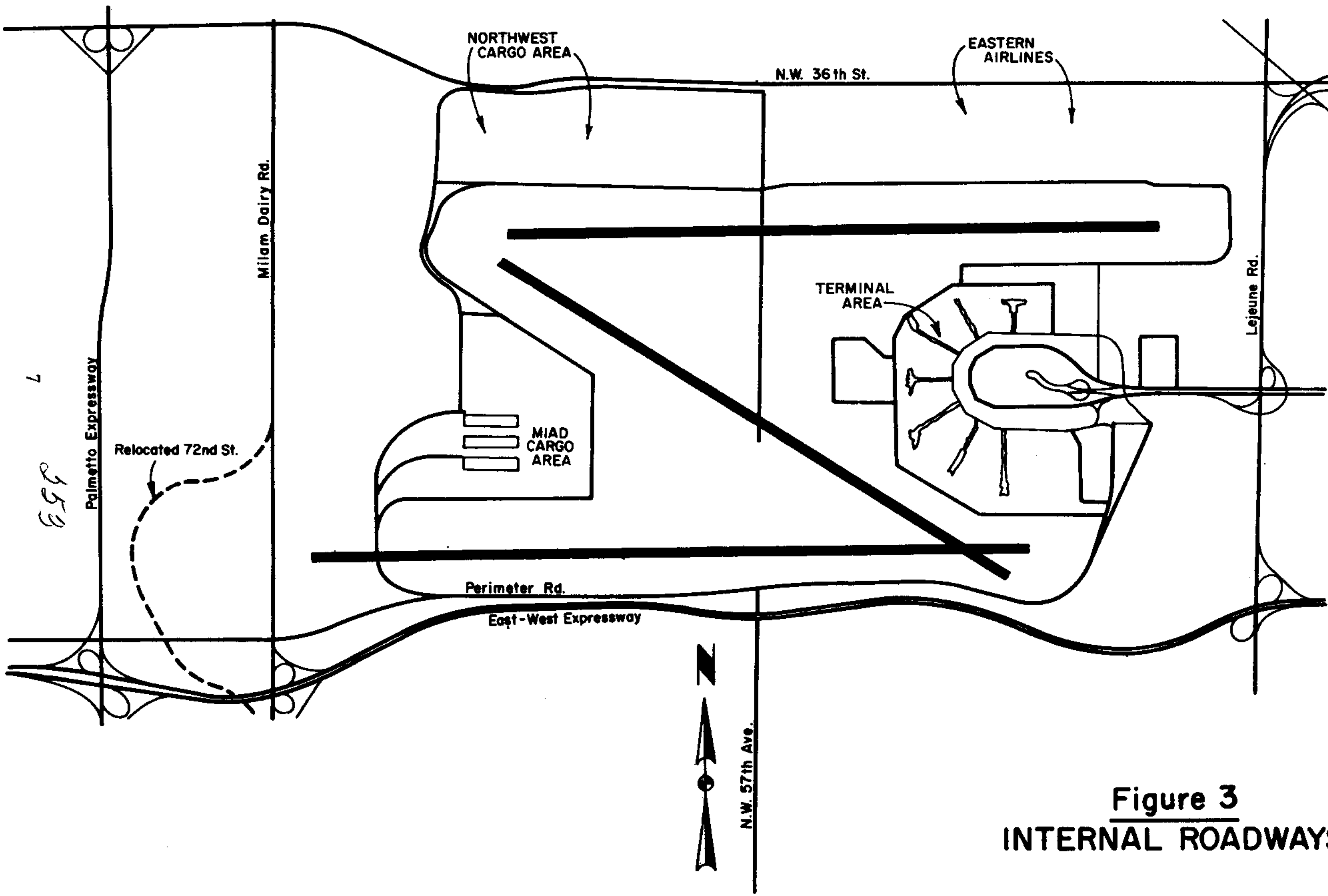

Figure 3
INTERNAL ROADWAYS

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Table 2

Air Passenger Forecast

Year	Millions of Passengers (enplaned and deplaned)
1975	12.1
1977	13.7
1980	16.7
1985	22.6
1990	29.9
1995	38.6

Sources: Ref. 1 and Ref. 2

PANCAP was converted to annual passengers by applying factors for percent air carrier operations, available seats per operation and the enplaning load factor (LF). Two factors were used: the current annual enplaned load factor of 49% and the current load factor plus 10%. The appropriate factors and results are shown in Table 3. Note that PANCAP increases are expected due to improved Air Traffic Control equipment after 1985.

3. Ground Access Capacity

Current airport ground trips for passengers were assigned to major highways and arterials as shown in Appendix A. For this analysis only vehichles using the main terminal roadway were considered, since reliable data for employees & passengers using Perimeter Road are not available. Employee access is via either the Main Entrance Roadway, Perimeter Road, 36th Street, or Milam Dairy Road.

For this analysis six locations carrying 19% or more of total Airport traffic were identified: Interstate 95 between the 79th Street Causeway and Airport Expressway, the Airport Expressway, East-West Expressway east of LeJeune Road, East-West Expressway west of LeJeune Road & LeJeune Road north of the Main Entrance Road. The growth rate of non-airport traffic was equal to 4% annually, based on projections developed for the MIA Master Plan. Vehicle capacity for airport trips were converted to air passengers by multiplying the ratio of 1976 annual passengers to 1976 Airport ADT (12,889,000/42,945 = 300) and dividing by the proportion of total airport traffic carrried by each access road. The current ratio was then increased through 1995 to show the projected growth in transfers as shown in Table 4. This rate is expected to increase primarily due to increased domestic international transfer activity.

The calculations for all six locations are given in Appendix B. The graphs which resulted for each location are found in Figures 4 through 9.

4. Interpretation

a. I-95: Figure 4 indicates that capacity on I-95 between 79th Street and the Airport Expressway will not reach level of service "D" in the 200th hour until the mid-1980's. Airport traffic accounts for only 7% of the total ADT. The growth of non-airport traffic will impact capacity when level of Service "E" conditions are met in the early 1990's.

TABLE 3

Calculation of Airside Capacity

Year	PANCAP	% Air Carrier	Average Seats/Oper.	Annual Pass. Capacity (Millions) L.F.=49%	L.F.=59%
1977	450,000	72	130	20.6	24.9
1980	408,800	80	161	25.8	31.1
1985	403,500	82	183	29.7	35.7
1990	429,400	83	209	36.5	43.9
1995	416,500	83	238	40.3	48.5

Source: Reference 2

Table 4

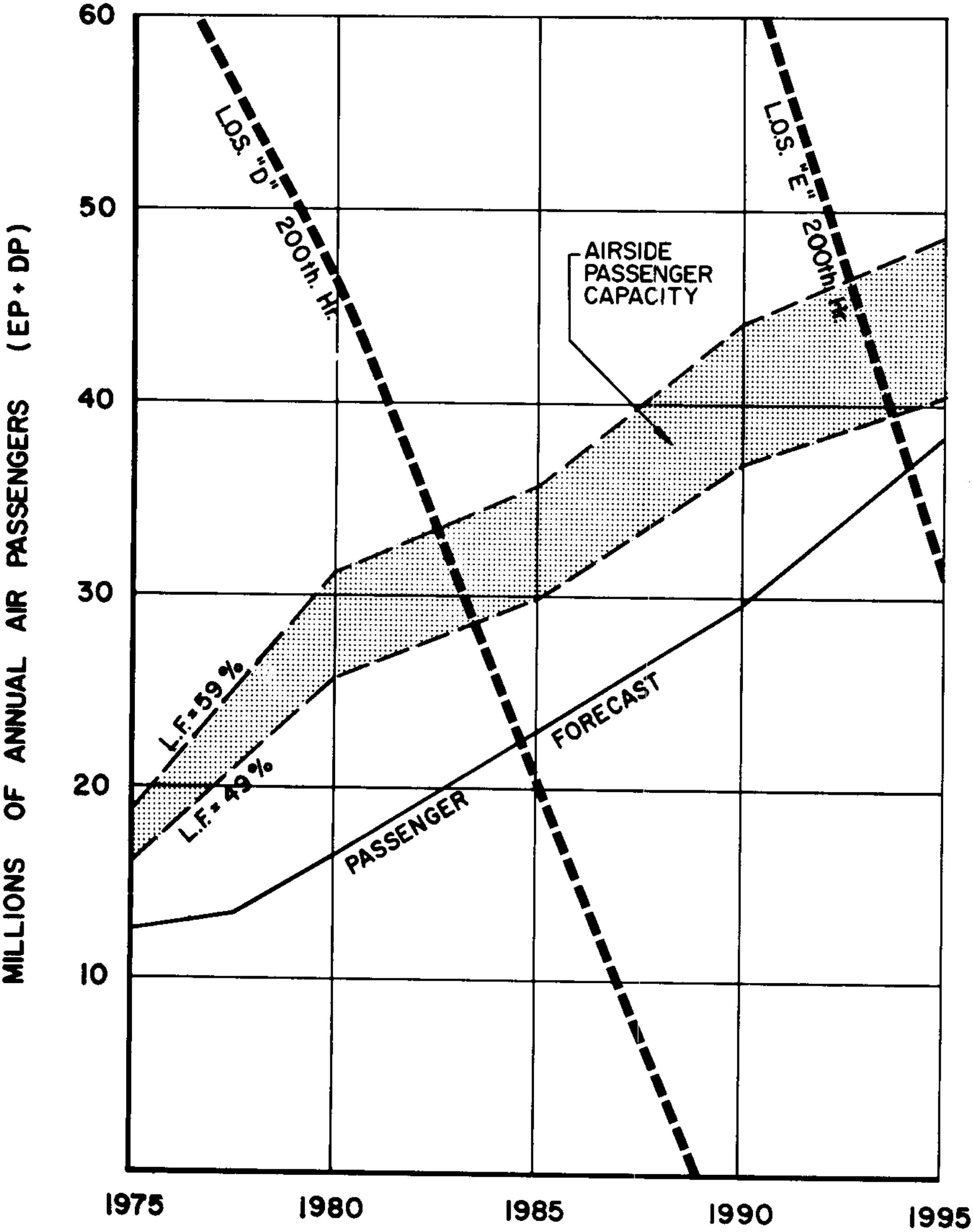
Projected Growth in Transfers

Year	% Transfers
1976	37%
1980	40%
1985	45%
1990	50%
1995	55%

Figure 4

DEMAND/CAPACITY RELATIONSHIP

INTERSTATE - 95



b. Airport Expressway: Like I-95, no capacity problems are seen on the Airport Expressway until the mid-1980's (Figure 5), when level of service "D" in the 200th hour will be reached. Serious capacity limitations will begin to take place in the late 1990's when level of service "E" is reached. Widening of this road as proposed by the County and State, would help to increase capacity in order to meet expected demand.

c. East-West Expressway (West of LeJeune Road): (Figure 6), Although traffic counts indicate a current level of service "D" for the East-West Expressway between Palmetto Expressway and LeJeune Road, observations indicate that the highway is now experiencing congestion equivalent to level of service "E" in the 200th hour. Like the Airport Expressway, there are plans to widen the East-West Expressway to 8 or 10 lanes. New interchanges are planned at both N.W. 57th St. and LeJeune Road.

d. East-West Expressway (east of LeJeune Road): This portion of the East-West Expressway has the same problems (Figure 7) as the western end. Plans for reconstructing the LeJeune Road interchange have been programmed and increasing the number of travel lanes has been proposed here also.

e. LeJeune Road South: Capacity analysis of non-intersection (mid-block) portions of LeJeune Road south of the Airport entrance (Figure 8) indicates that the road is already operating at level of service "D" in the 200th hour. Observation of current traffic, shows that the road is at level of Service "E" during peak hours at intersections and major access and egress points. Growth of both airport and non-airport traffic will cause this road to become severely strained for capacity unless a proposed parallel road is built (see Section C).

f. LeJeune Road North: Figure 9 shows that non-intersections of this roadway are nearly operating at level of service "D" in the 200th hour. Observations show that many intersections currently operate at level of Service "E" during peak hours.

C. PROPOSED SOLUTIONS

Table 5 indicates proposed solutions to airport access problems. Particularly important is the construction of a four-lane limited access highway parallel to and east of LeJeune Road with connections to the terminal area. This highway would allow airport destined traffic travelling from the east along either Airport Expressway or East-West Expressway to bypass LeJeune Road, thus relieving congestion during peak periods. As of this date, no commitment for funding has been made.

Some projects have already been programmed for construction. These include the reconstruction of the East-West Expressway/LeJeune Road interchange, and the widening of N.W. 57th Ave. from U.S. 1 to N.W. 7th Street. Less advanced projects include the widening of the Airport Expressway, East-West Expressway, and modifications at the East-West Expressway/N.W. 57th Ave. interchange. Other proposed solutions appear in the table.

Figure 5

DEMAND/CAPACITY RELATIONSHIP

AIRPORT EXPRESSWAY

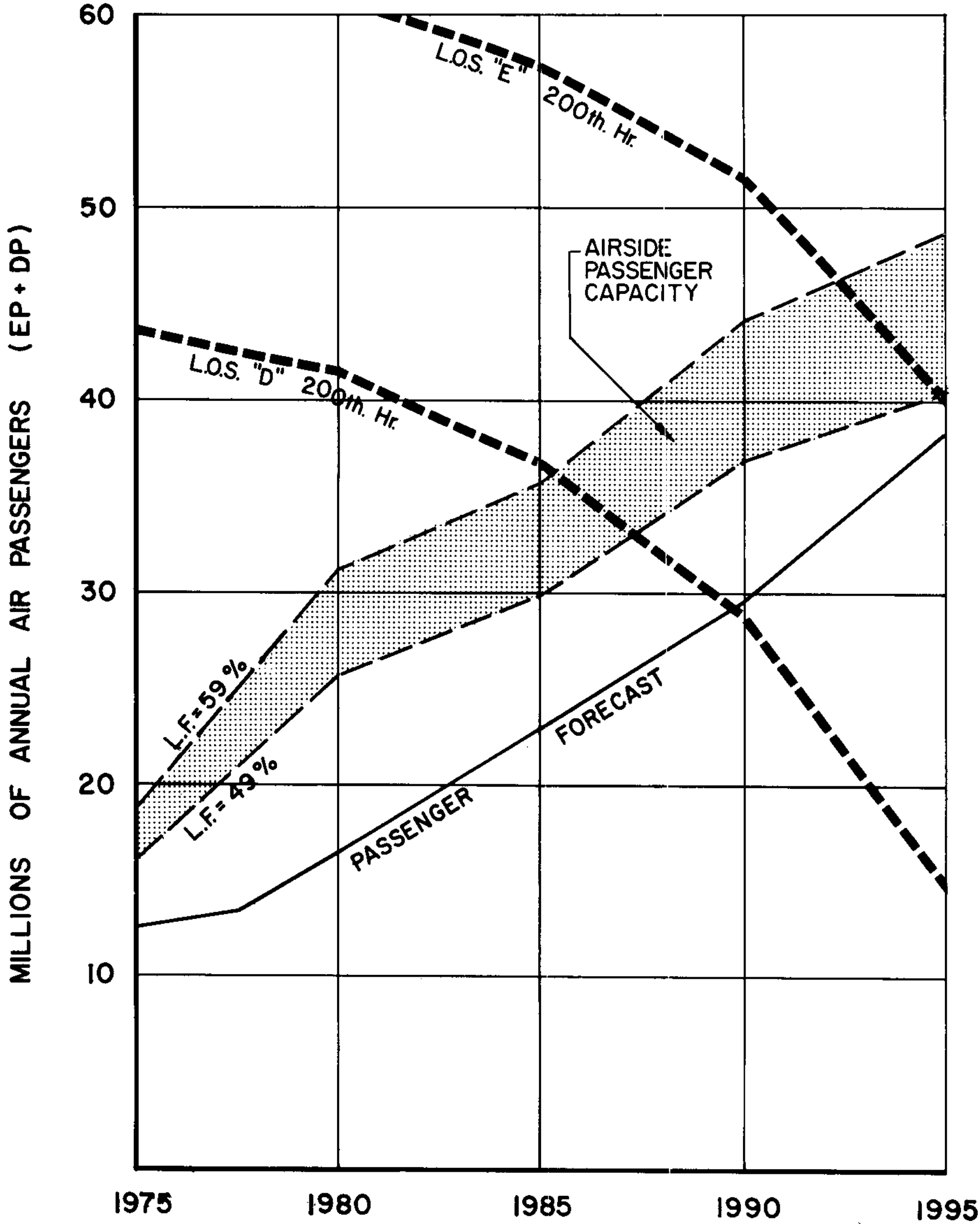


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Figure 6

DEMAND/CAPACITY RELATIONSHIP

EAST-WEST EXPRESSWAY (EAST OF AIRPORT)

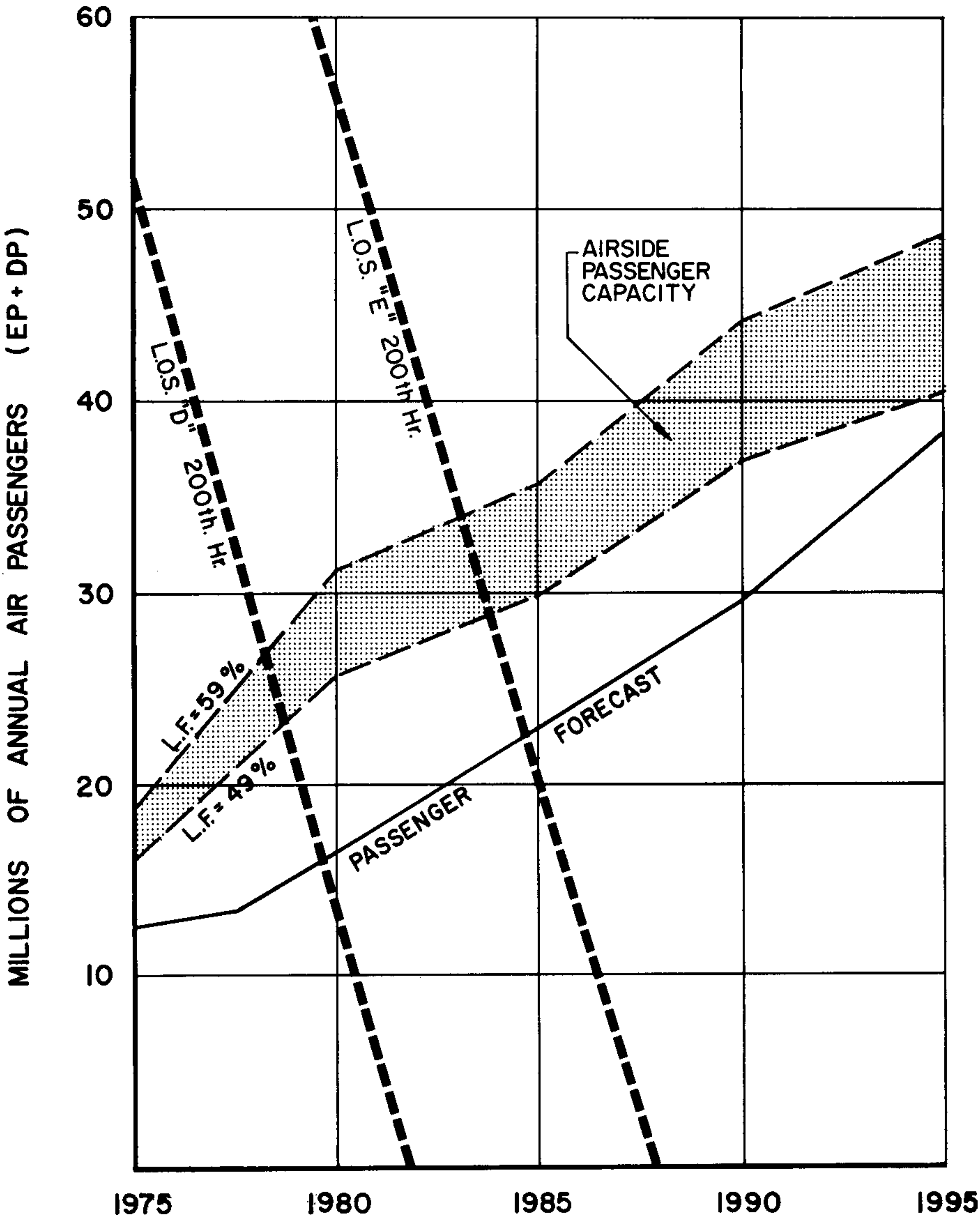

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Figure 7

DEMAND/CAPACITY RELATIONSHIP
EAST-WEST EXPRESSWAY (WEST OF AIRPORT)

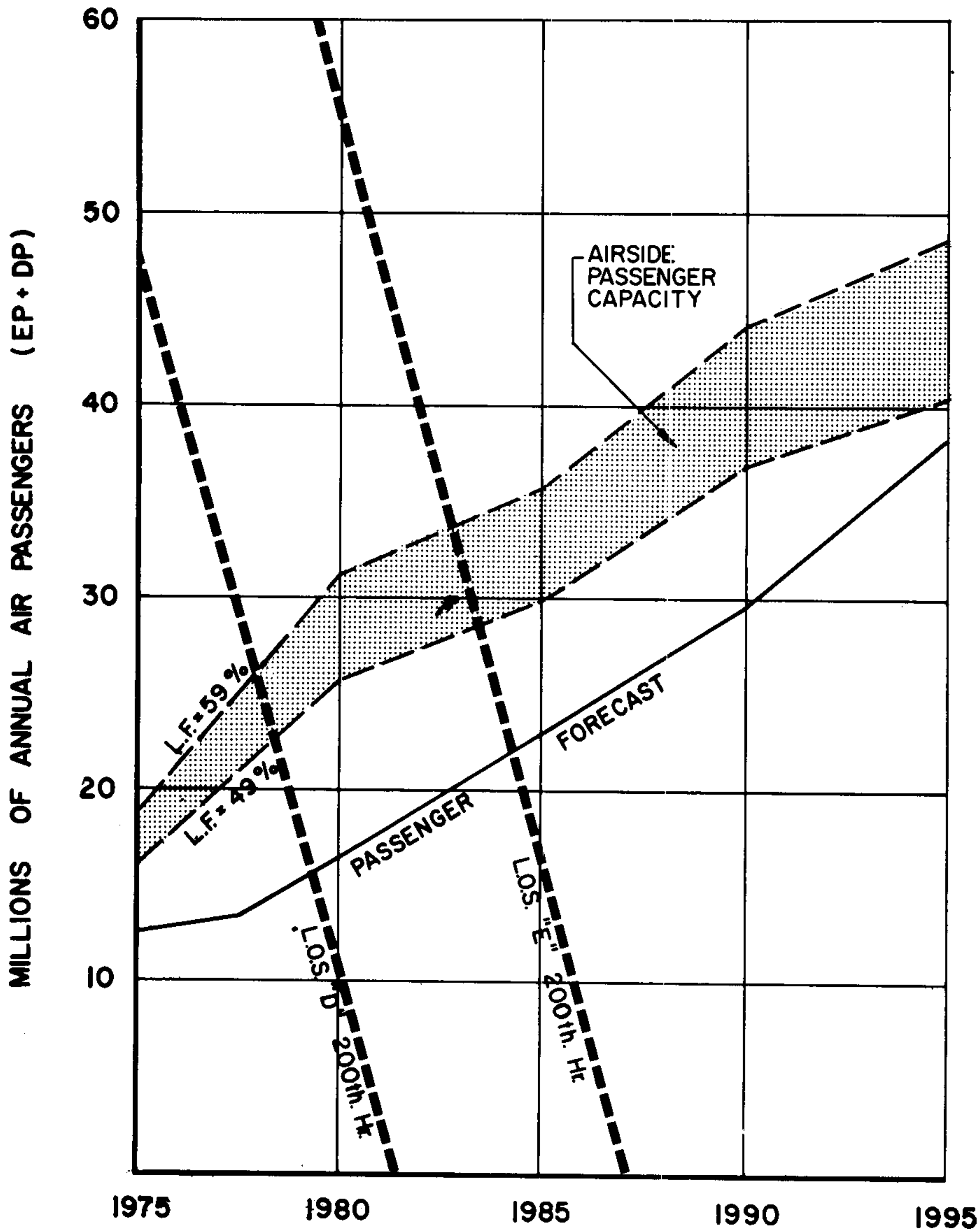

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Figure 8

DEMAND/CAPACITY RELATIONSHIP

LEJEUNE ROAD (SOUTH OF AIRPORT)

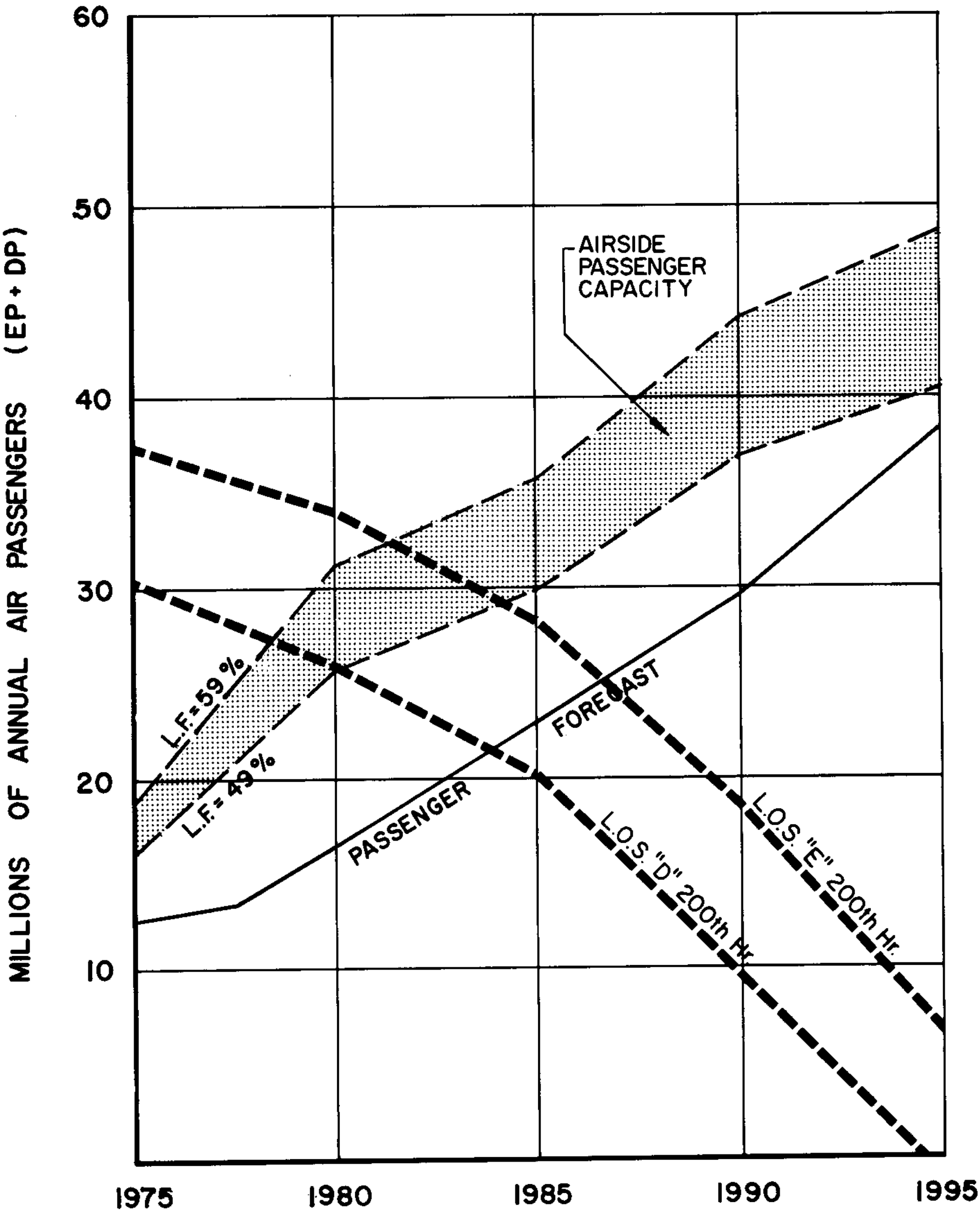

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Figure 9
DEMAND/CAPACITY RELATIONSHIP
LEJEUNE ROAD (NORTH OF AIRPORT)

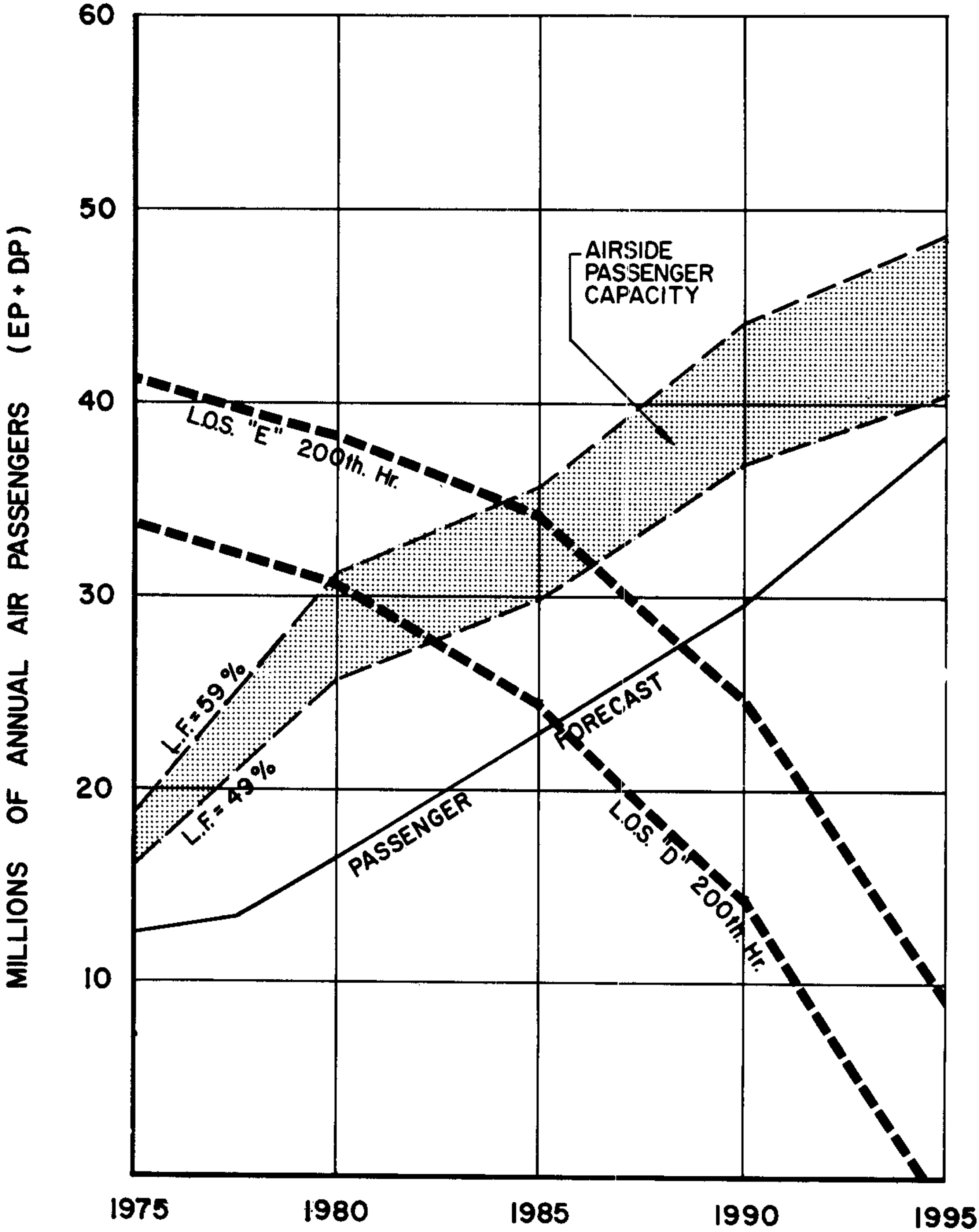

TABLE 5

PROPOSED SOLUTIONS

Proposed Solution	Initiator	Agency Respon. for Implement.	Funding Source	Est. Cost	Status
A. Construction					
1. North-South connector to Airport, East-West Exp. and Airport Exp.	Dade County Aviation Dept.	Florida Dept. of Transport.	*	*	Planning
2. East-West Expressway/ N.W. 57th St. Interchange	County	F.D.O.T.	Federal Primary	*	Programmed
3. Road crossing Miami River from N.W. 37th Ave. to N.W. 32nd.	County	County	*	*	Planning
4. Interchange on Palmetto Expressway at N.W. 25th.	County	F.D.O.T.	Federal	*	Planning
East-West Exp. Interchange.			Primary		
6. Widening Airport Exp.	County	F.D.O.T.	State/ Federal Prim.	*	Planning
7. Widening East-West Expressway	County	F.D.O.T.	State/ Federal Prim.	*	Planning
8. Widening N.W. 57th Ave.	County	County	County	*	Programmed

Proposed Solution	Initiator	Agency Respon. for Implement.	Funding Source	Est. Cost	Status
B. Transportation Systems Mgt.					
1. Rapid Transit Link		Dade County Rapid Transit	UMTA	*	Dropped
2. Local Street Signalization and Improvements	County	County	TOPICS	*	Construction & Completion
3. Shuttle Bus to Rapid Transit Station	County	Dade County Rapid Transit	UMTA	*	Planning
E. Relocation					
1. New Terminal	Airport Master Plan	County	F.A.A.	*	Master Plan
2. N.W. 72nd Street	County/ Master Plan	County	County	*	Planning

As previously mentioned, the new Dade County Rapid Transit System will not have a direct link to the Airport. At one time, the system was planned to have a direct connection to the Airport Terminal (Reference 7). However, due to high cost and low ridership projections, this alternative has been dropped, although it may be reevaluated in the future. There are plans for a shuttle service to run from the Terminal to the nearest transit station.

D. CONCLUSIONS

Significant traffic congestion occurs at intersections along LeJeune Road, the primary access route for passengers and employees using the Terminal area. This arterial serves not only as the primary access to the Airport, but as a major north-south route as well. Congestion along the East-West Expressway (S. R. 836) both east and west of LeJeune Road is also a major current problem. Other congestion points include access routes to the cargo and employee areas along the northwestern and western boundaries of the Airport.

The congestion along LeJeune Road has become more severe in recent years as a second peak period has developed at MIA. Previously, the peak travel period for passengers had been between noon & 2:00 P.M. However, with the increase in European and other international flights departing Miami, another peak has developed from 4:00 P.M. to 6:00 P.M. This means that airport related vehicles must share limited capacity along LeJeune Road with a high volume of non-airport related traffic. Since Miami plans to increase its international flights in the future, this peak period will continue to grow in importance. Construction of the proposed parallel arterial east of LeJeune Road with a connector to the Terminal would provide significant relief. Relief to congestion on S. R. 836 would be provided by implementing current plans to widen that toll road. Capacity problems on the Airport Expressway should increase in frequency during the 1980's, if the proposed highway widening does not take place.

The analysis has primarily been concerned with ground access for air passengers only. Although employees generate a large number of daily vehicle trips, their impact could not be quantified precisely because of a lack of data on employee ground transportation characteristics. Blue collar employee shifts generally run between 7:00 A.M. - 3:30 P.M., and 3:30 P.M. - midnight, and do not usually coincide with either passenger or local traffic peaks. However, a large number of white collar employees work day shifts and do incur problems. Most employees do not work within the central terminal area, but instead along the surrounding airport boundaries (this was shown graphically in Fig. 3 on Page 7). Thus, the impacted roads are Milam Diary, 36th Street, Perimeter Road, and Route 27.

In summary, the construction of a new roadway parallel to LeJeune Road with an Airport connection would solve the most immediate access problems at MIA. Planning for future growth should consider widening of the expressways flanking the Airport and possible connection to the new rail transit system.

APPENDIX A

TABLE A1

ROUTING OF AIRPORT ACCESS TRIPS BY DADE COUNTY ORIGIN/DESTINATION ZONES

The primary source for the assignment of airport ground trips was the Master Plan Study (Reference 4). The data is based on a 1973 survey using the 26 zones for the Dade County Limousine District. The percentage of passenger trips generated in the various areas are shown below.

ORIGIN/DESTINATION AREA	% OF TOTAL PASSENGER TRIPS
South of Kendall Drive	4.2
South of Tamiami Trail and West of Palmetto Expressway	2.1
Coral Gables	9.6
Miami Proper except C.B.D.	6.4
Miami C.B.D.	7.1
Doral, Medley, Hialeah Gardens	1.4
Miami Springs	7.4
Key Biscayne	1.9
Miami Beach	17.8
Bal Harbour, Surfside, Ocean Blvd.	29.8
Hialeah, North Miami, Carol City, North Miami Beach, Broward County Line	12.3
TOTAL	100.0%

These percentages were then assigned to the major highways as shown in Figure 2.

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

Expressways

The hourly capacities for I-95, Airport Expressway, and the East-West Expressway were read directly from the right hand side of Table 9.1 of the Highway Capacity Manual, assuming PHF = 0.91. To account for trucks - 5% on these highways - Table 9.3b of the HCM was used to get a T factor of .95. This was then converted to a daily VHC by dividing the hourly capacity by the peak hour percentage. Peak hour factors of 8 1/2% for the 30th highest hour, 8% for the 200th highest hour, and 7 1/2% for the 1,000th highest hour were used. These percentages are lower than normal experience because of heavy recreation travel in Southeast Florida.

Urban Arterials

The capacity for LeJeune Road, north and south were estimated by using a table previously developed in other traffic studies to estimate the midblock capacity of urban arterials. The hourly capacity for multi-lane-arterials was estimated to be 2/3 of ideal conditions found in Table 10.1 of the HCM. The resulting per lane capacity was multiplied by the number of lanes and then divided by the peak percentage. A more sophisticated calculation would require a detailed analysis of all access/egress points, intersections, traffic controls, truck traffic, and grades along all of these arterials.

Table B1

AIRPORT ACCESS CAPACITY

I - 95

L.O.S.[1]	Hrs./Yrs.[2]	Factor[3]	YEAR 1977	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	184,410	184,410	184,410	184,410	184,410
		2	125,050	140,680	171,190	208,210	253,350
		3	59,360	43,730	13,220	-	-
		4	45.6	36.4	12.4	-	-
D	200	1	195,940	195,940	195,940	195,940	195,940
		2	125,050	140,680	171,190	208,210	253,350
		3	70,890	55,260	24,750	-	-
		4	54.5	46.0	23.2	-	-
D	1000	1	209,000	209,000	209,000	209,000	209,000
		2	125,050	140,680	171,190	208,210	253,350
		3	83,950	68,320	37,810	790	-
		4	64.6	56.8	35.4	0.8	-
E	30	1	223,530	223,530	223,530	223,530	223,530
		2	125,050	140,680	171,190	208,210	253,350
		3	98,480	82,850	52,340	15,320	-
		4	75.8	68.9	49.0	15.9	-
E	200	1	237,500	237,500	237,500	237,500	237,500
		2	125,050	140,680	171,190	208,210	253,350
		3	112,450	96,820	66,310	29,290	-
		4	86.5	80.5	62.1	30.5	-
E	1000	1	253,330	253,330	253,330	253,330	253,330
		2	125,050	140,680	171,190	208,210	253,350
		3	128,280	112,650	82,140	45,120	-
		4	98.6	93.7	76.9	46.9	-

1] Per Highway Capacity Manual

2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

Table B2

AIRPORT ACCESS-CAPACITY

Airport Expressway

L.O.S.[1/]	Hrs./Yrs.[2/]	Factor[3/]	YEAR 1977	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	109,530	109,530	109,530	109,530	109,530
		2	49,730	55,950	68,080	82,800	100,750
		3	59,800	53,580	41,450	26,730	8,780
		4	38.6	37.4	32.5	23.3	8.4
D	200	1	116,380	116,380	116,380	116,380	116,380
		2	49,730	55,950	68,080	82,800	100,750
		3	66,650	60,430	48,300	33,580	15,630
		4	43.0	42.1	37.9	29.3	15.0
D	1000	1	124,130	124,130	124,130	124,130	124,130
		2	49,730	55,950	68,080	82,800	100,750
		3	74,400	68,180	56,050	41,330	23,380
		4	48.0	47.6	44.0	36.0	22.4
E	30	1	134,110	134,110	134,110	134,110	134,110
		2	49,730	55,950	68,080	82,800	100,750
		3	84,380	78,160	66,030	51,310	33,360
		4	54.4	54.5	51.8	44.7	32.0
E	200	1	142,500	142,500	142,500	142,500	142,500
		2	49,730	55,950	68,080	82,800	100,750
		3	92,770	86,550	74,420	59,700	41,750
		4	59.9	60.4	58.4	52.0	40.0
E	1000	1	152,000	152,000	152,000	152,000	152,000
		2	49,730	55,950	68,080	82,800	100,750
		3	102,270	96,050	83,920	69,200	51,250
		4	66.0	67.0	65.8	60.3	49.1

1] Per Highway Capacity Manual

2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

Table B3

AIRPORT ACCESS CAPACITY

East-West Expressway (East of LeJeune Road)

L.O.S.[1/]	Hrs./Yrs.[2/]	Factor[3/]	YEAR				
			1977	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	109,530	109,530	109,530	109,530	109,530
		2	95,620	107,570	130,900	159,200	193,730
		3	13,910	1,960	-	-	-
		4	21.4	3.3	-	-	-
D	200	1	116,380	116,380	116,380	116,380	116,380
		2	95,620	107,570	130,900	159,200	193,730
		3	20,760	8,810	-	-	-
		4	31.9	14.7	-	-	-
D	1000	1	124,130	124,130	124,130	124,130	124,130
		2	95,620	107,570	130,900	159,200	193,730
		3	28,510	16,560	-	-	-
		4	47.4	27.5	-	-	-
E	30	1	134,110	134,110	134,110	134,110	134,110
		2	95,620	107,570	130,900	159,200	193,730
		3	38,490	26,540	3,210	-	-
		4	59.2	44.1	6.0	-	-
E	200	1	142,500	142,500	142,500	142,500	142,500
		2	95,620	107,570	130,900	159,200	193,730
		3	46,880	34,930	11,600	-	-
		4	72.1	58.1	21.7	-	-
E	1000	1	152,000	152,000	152,000	152,000	152,000
		2	95,620	107,570	130,900	159,200	193,730
		3	56,380	44,430	21,100	-	-
		4	86.7	73.9	39.5	-	-

1] Per Highway Capacity Manual

2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

Table B4

AIRPORT ACCESS CAPACITY

East - West Expressway (West of LeJeune Road)

L.O.S.[1/]	Hrs./Yrs.[2/]	Factor[3/]	YEAR				
			1977	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	109,530	109,530	109,530	109,530	109,530
		2	98,040	110,300	134,220	163,240	198,630
		3	11,490	-	-	-	-
		4	18.1	-	-	-	-
D	200	1	116,380	116,380	116,380	116,380	116,380
		2	98,040	110,300	134,220	163,240	198,630
		3	18,340	6,080	-	-	-
		4	29.0	10.4	-	-	-
D	1000	1	124,130	124,130	124,130	124,130	124,130
		2	98,040	110,300	134,220	163,240	198,630
		3	26,090	13,830	-	-	-
		4	41.2	23.6	-	-	-
E	30	1	134,110	134,110	134,110	134,110	134,110
		2	98,040	110,300	134,220	163,240	198,630
		3	36,070	23,810	-	-	-
		4	57.0	40.6	-	-	-
E	200	1	142,500	142,500	142,500	142,500	142,500
		2	98,040	110,300	134,220	163,240	198,630
		3	44,460	32,200	8,280	-	-
		4	70.2	55.0	15.9	-	-
E	1000	1	152,000	152,000	152,000	152,000	152,000
		2	98,040	110,300	134,220	163,240	198,630
		3	53,960	41,700	17,780	-	-
		4	85.2	71.2	34.1	-	-

1] Per Highway Capacity Manual

2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

Table B5

AIRPORT ACCESS CAPACITY

Le Jeune Road (South of Airport)

L.O.S.[1] (1)	Hrs./Yrs.[2] (2)	Factor[3] (3)	YEAR 1977 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	84,710	84,710	84,710	84,710	84,710
		2	47,890	53,880	65,560	79,740	97,030
		3	36,820	30,830	19,150	4,970	-
		4	24.8	22.5	15.7	4.5	-
D	200	1	90,000	90,000	90,000	90,000	90,000
		2	47,890	53,880	65,560	79,740	97,030
		3	42,110	36,120	24,440	10,260	-
		4	28.4	26.4	20.0	9.3	-
D	1000	1	96,000	96,000	96,000	96,000	96,000
		2	47,890	53,880	65,560	79,740	97,030
		3	48,110	42,120	30,440	16,260	-
		4	32.4	30.7	25.0	14.8	-
E	30	1	94,590	94,590	94,590	94,590	94,590
		2	47,890	53,880	65,560	79,740	97,030
		3	46,700	40,710	29,030	14,850	-
		4	31.5	29.3	23.8	13.5	-
E	200	1	100,500	100,500	100,500	100,500	100,500
		2	47,890	53,880	65,560	79,740	97,030
		3	52,610	46,620	34,940	20,760	3,470
		4	35.5	34.0	28.7	18.9	3.5
E	1000	1	107,200	107,200	107,200	107,200	107,200
		2	47,890	53,880	65,560	79,740	97,030
		3	59,310	53,320	41,640	27,460	10,170
		4	40.0	38.9	34.1	25.0	10.2

1] Per Highway Capacity Manual

2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

Table B6

AIRPORT ACCESS CAPACITY

LeJeune Road (North of Airport)

L.O.S.[1]	Hrs./Yrs.[2]	Factor[3]	YEAR 1977	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	112,940	112,940	112,940	112,940	112,940
		2	60,460	68,020	82,770	100,670	122,490
		3	52,480	44,920	30,170	12,270	-
		4	28.4	26.3	19.8	9.0	-
D	200	1	120,000	120,000	120,000	120,000	120,000
		2	60,460	68,020	82,770	100,670	122,490
		3	59,540	51,980	37,230	19,330	-
		4	32:2	30.4	24.5	14.1	-
D	1000	1	128,000	128,000	128,000	128,000	128,000
		2	60,460	68,020	82,770	100,670	122,490
		3	67,540	59,980	45,230	27,330	5,510
		4	36.5	35.1	29.8	20.0	4.4
E	30	1	126,120	126,120	126,120	126,120	126,120
		2	60,460	68,020	82,770	100,670	122,490
		3	65,660	58,100	43,350	25,450	3,630
		4	35.5	34.0	28.5	18.6	2.9
E	200	1	134,000	134,000	134,000	134,000	134,000
		2	60,460	68,020	82,770	100,670	122,490
		3	73,540	65,980	51,230	33,330	11,510
		4	39.8	38.6	33.7	24.3	9.2
E	1000	1	142,930	142,930	142,930	142,930	142,930
		2	60,460	68,020	82,770	100,670	122,490
		3	82,470	74,910	60,160	42,260	20,440
		4	44.6	43.8	39.6	30.9	16.4

1] Per Highway Capacity Manual

2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

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FORT LAUDERDALE - HOLLYWOOD

INTERNATIONAL AIRPORT

CASE STUDY

CASE STUDY SUMMARY

Fort Lauderdale-Hollywood International Airport (FLL) has experienced extraordinary passenger growth (over 20% annually in the past 10 years) due to growth of Broward County, the Southeast Florida air passenger market and spillover from Miami International. Since the Airport was never planned to handle a high level of passenger volumes, many landside congestion problems have been experienced, thus prompting a plan to relocate the terminal complex from the eastern edge to the southwest corner of the Airport where room for expansion is available.

Major congestion is experienced at the internal roadways, which are unable to handle curb loading/unloading and adjacent traffic movement at a single level, and at the entrance to the terminal area which has a signalized intersection from U.S. 1 and an adjacent railroad grade crossing.

Capacity analyses indicate that FLL's airside components can handle forecast growth well into the future if some constraint is put on general aviation activities. However, ground access capacity may soon become a constraining factor, particularly on Interstate 95, the major north-south artery, due to expected growth in non-airport traffic. The I-95 problem is basically independent of the terminal area location. Airport planners have proposed an eventual tie-in with the Florida Turnpike, which is parallel to and west of I-95, to get additional North-South capacity. Currently, the terminal area relocation is being held up pending study of a proposed interchange between the relocated terminal and I-95.

These proposals and other highway improvements would go far toward improving FLL's access problem. However, the issues of terminal relocation and highway improvements are so unsettled at this time, that the future is difficult to predict. FLL's airport access problem is aggravated by the extraordinary growth of Broward County in general and air traffic in particular. The normal 8-10 year waiting period for study, design and construction of highways is an inconvenience in most other areas, but imposes a real hardship at FLL where air and highway traffic are growing so quickly.

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Case Study Summary

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FORT LAUDERDALE-HOLLYWOOD INTERNATIONAL AIRPORT

A. BACKGROUND

1. General

Fort Lauderdale-Hollywood International Airport (FLL) is located approximately four miles south of the Fort Lauderdale, Fla. CBD (See Figure 1) and is operated by Broward County. Broward County has a year-round resident population of 830,000 people which, according to the University of Florida's Bureau of Economic & Business Research, will reach nearly 1.6 million by 1995. Like other counties along Florida's Gold Coast, Broward County is heavily dependent upon the tourist and retirement industries.

Fort Lauderdale-Hollywood served 4 million enplaning plus deplaning passengers in 1976, and of this total only 8% were transfers from other flights. FLL expects to serve approximately 5.2 million total passengers during 1978. Passenger traffic has been growing at a rate of about 20% annually during the past ten years. Due to its close proximity to Miami International Airport and the similar market areas served, FLL has "co-terminal" status with Miami International Airport. By this designation, air carriers servicing the area can use either Fort Lauderdale-Hollywood and/or Miami International Airports. Since 1968, this has allowed FLL to double its number of carriers and increase its share of the South Florida region's O&D traffic to 35%. Presently, all U.S. domestic trunk carriers serve both airports.

In 1975, a Master Plan Study was initiated by the Broward County Commissioners (Reference 1). The study recommended that the terminal complex be relocated to the southwest corner of the Airport, primarily because of limited area for expansion at the current site on the east side. The 40 gate concept includes a three road access system, one of which can be converted to either an enplaning or deplaning drive, and a direct ramp to Interstate 95, which runs on the western edge of the airport. An Environmental Impact and Analysis Report (EIAR) for the relocation has been prepared but has not yet been accepted due to FAA and State uncertainty over the I-95 connection (see next section).

2. Transportation Planning Structure

Transportation planning and implementation are conducted at three levels: City, County and State. The City has a department of transportation which is primarily concerned with traffic engineering. Broward County has a department of transportation which is responsible for highway, transit and aviation planning. The State is responsible for highway planning, design and construction and also has a Department of Aviation.

In August, 1977, the Broward County Metropolitan Planning Organization (MPO) was formally established, replacing the Broward Area Transportation Study (BATS). Staff for the MPO is provided by the County through the Planning and Administrative Systems Division of the County Administrator's Office. In addition, the Florida Dept. of Transportation and Broward County D.O.T. staffs provide technical support to the MPO. The MPO is responsible for development,

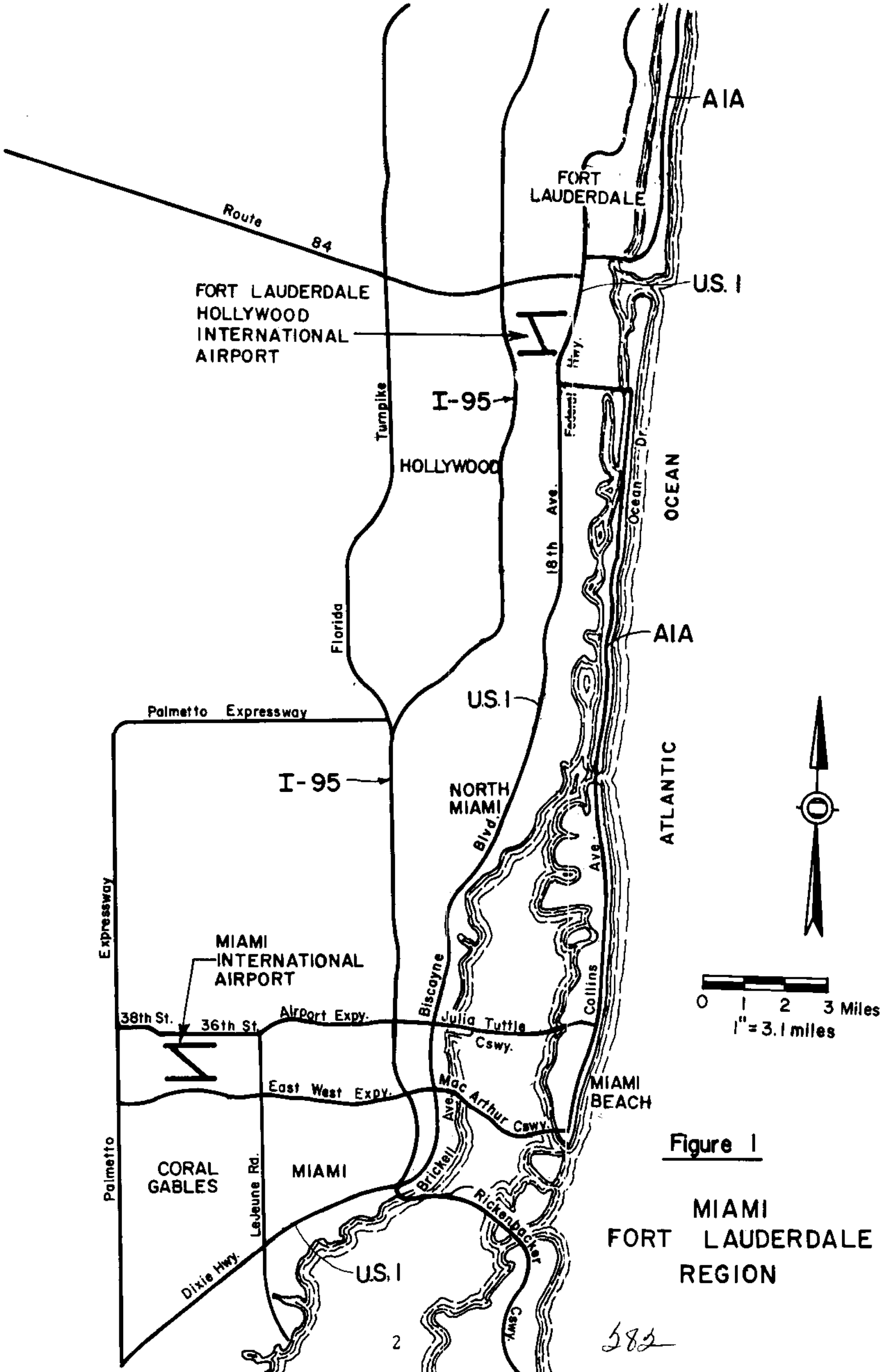

Figure 1

MIAMI
FORT LAUDERDALE
REGION

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adoption and revision, when necessary, of long-range transportation plans, the Short-Range Transportation Improvement Program and establishing procedures for the local transportation planning process and transportation program (Ref. 4).

Since highways are by far the most important means of airport access at FLL, the State role assumes particular importance. Unlike many states, Florida D.O.T. has a particularly large and well-staffed planning department at the District level. The District Office, which is responsible for southeast Florida is located on the Airport site. The D.O.T. is conducting, through a consultant, the preparation of the Year 2000 Transportation Plan for the MPO. Overall highway planning, including traffic forecasting, is done in Tallahassee, where the Aviation Department is also located. The District Office does no Aviation Planning.

An Intermodal Planning Group (IPG) exists at the Federal level in Atlanta, but appears to have little influence on transportation planning in Broward County.

3. Highway Access

Most trips to the airport are made in a north-south direction via either Interstate 95--a 6-lane limited access highway, or U.S. 1--a 4-lane undivided arterial. Traffic from the beach areas of Miami or Ft. Lauderdale can take S.R. A1A to U.S. 1.

The principal entrance to the airport is from U.S. 1 (Figure 2). The airport entrance at U.S. 1 has a signalized at-grade intersection and also an at-grade crossing of the Florida East Coast Railroad, which runs about 18-20 freight trains per day past the entrance. Both limit the capacity of traffic entering the Airport. Traffic coming from the north can utilize Perimeter Road to bypass this intersection, but Perimeter Road must be reached via low capacity residential streets.

The Florida Department of Transportation has plans to widen U.S. 1 to 6 lanes and to connect Miami and Ft. Lauderdale beachfront areas via Route A1A (Figure 2). The proposed construction of A1A calls for a 6 lane urban highway. Other plans include construction of I-75, parallel to and west of the Florida Turnpike in the 1980's along with a new Port Everglades Expressway paralleling S.R. 84 and running just north of the airport site.

As mentioned earlier, the Airport Master Plan recommends construction of a new terminal with direct ramps to I-95 (Figure 3). Future access would require connection to the Florida Turnpike. Broward County officials have asked the Florida Department of Transportation and the Federal Highway Administration for certification that the interchange project is feasible. The State, however, has not included the project in its latest 5-year planning program and won't until a detailed study and public hearings are held. The earliest date for completion of this step would be September, 1978.

4. Transit Access

The private automobile and rental car are by far the primary methods used by passengers and employees at FLL as shown in Table 1.

FIGURE 2

DISTRIBUTION OF APPROACH TRAFFIC ON SURFACE ACCESS SYSTEM

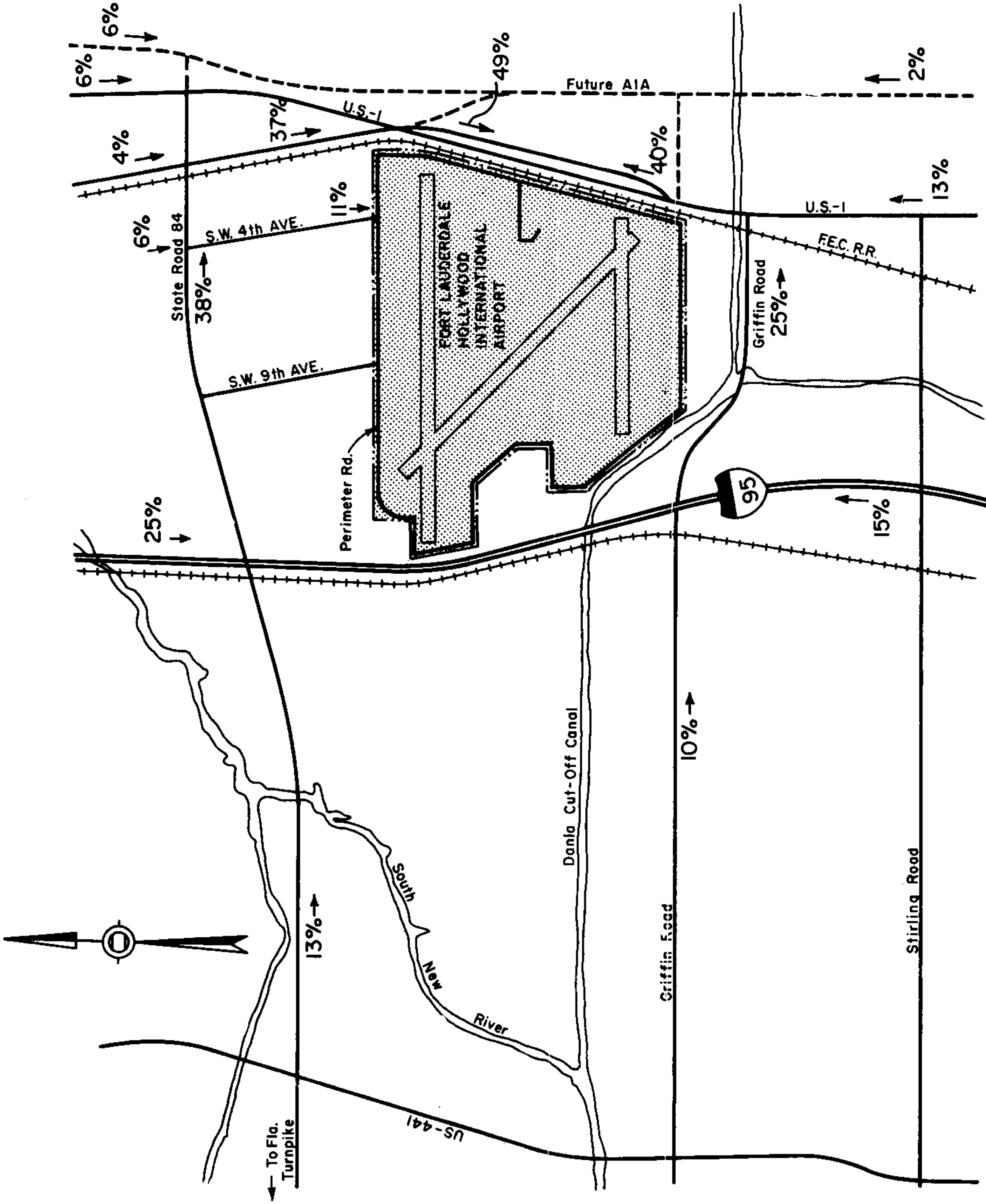
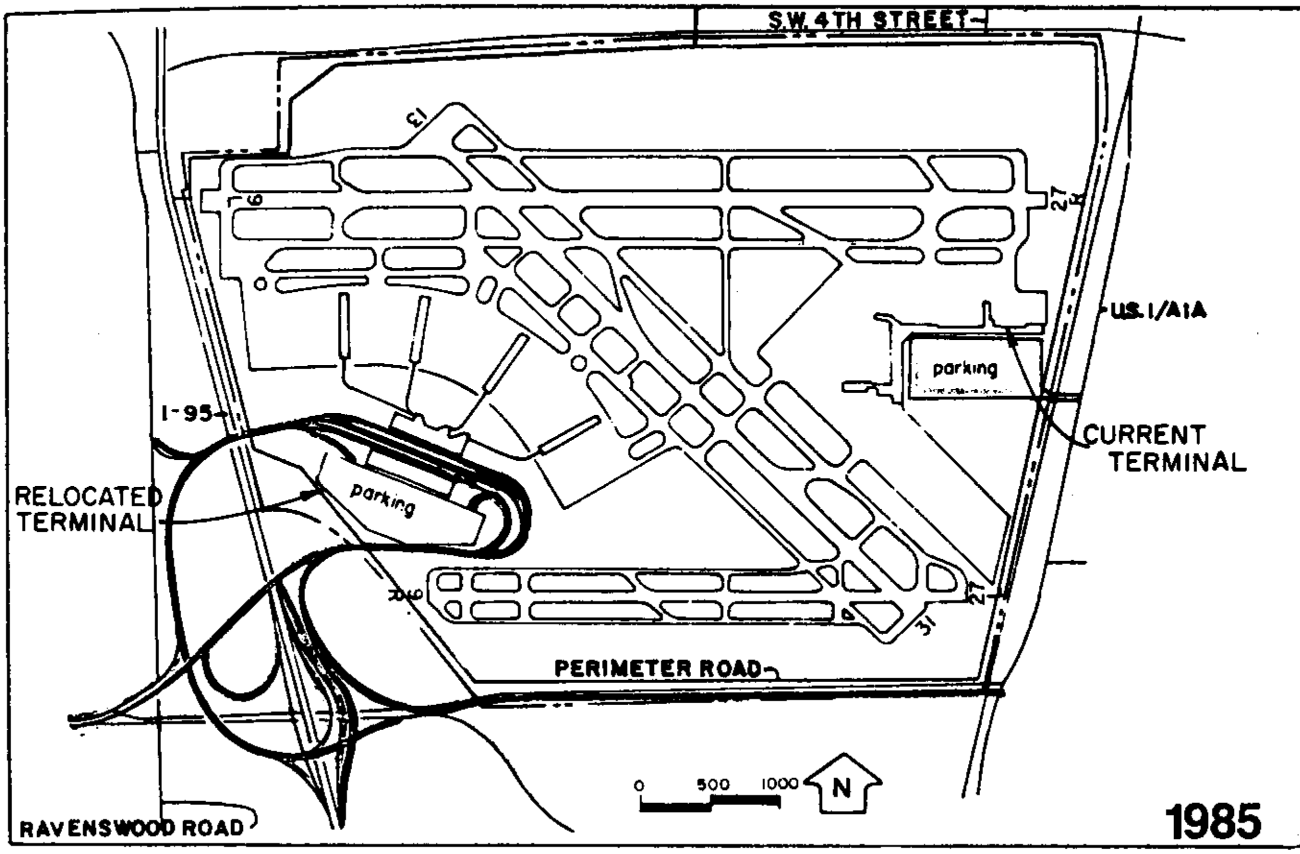


Figure 3
PROPOSED TERMINAL RELOCATION



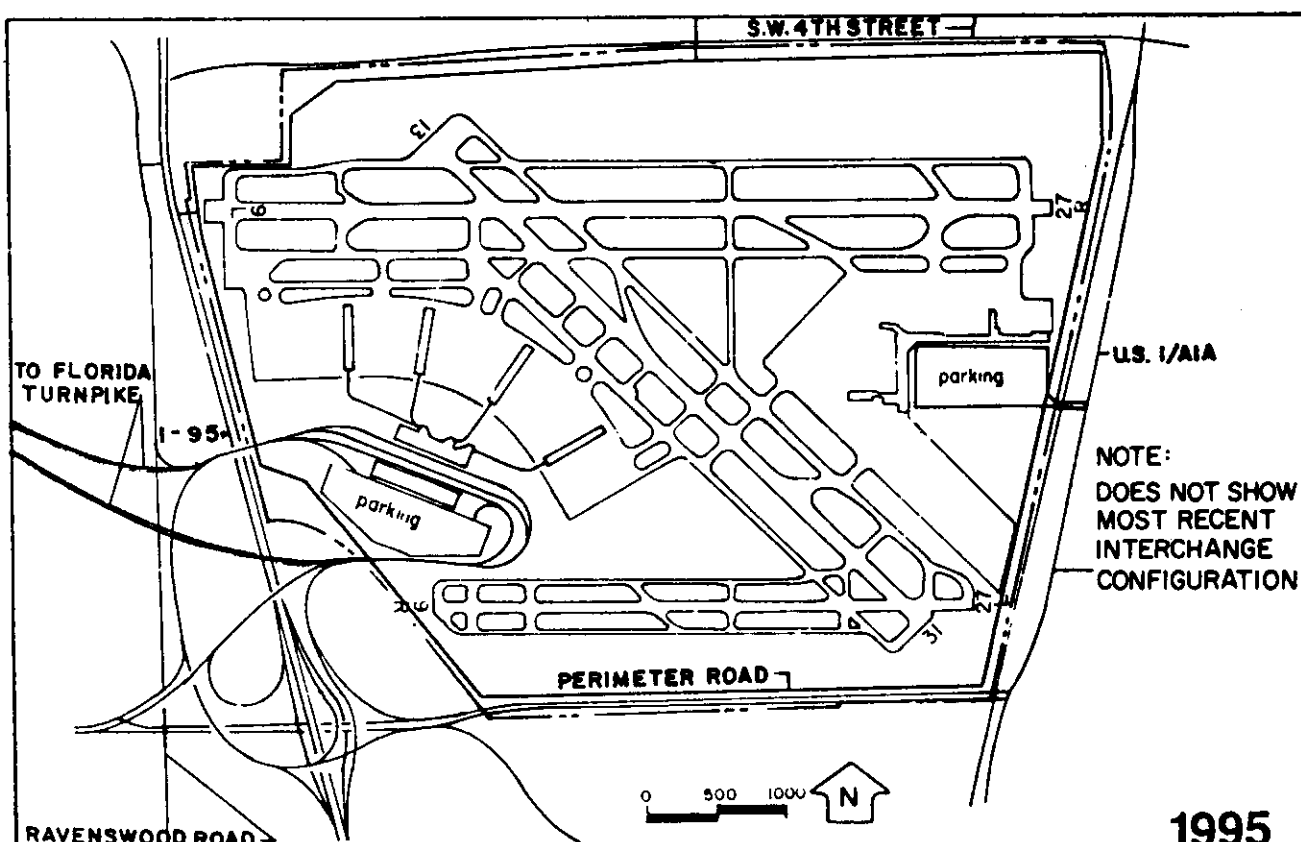


Table 1

Mode of Transportation for Air Passengers

Mode	Percent of Passengers
Private Auto	57%
Rental Car	19%
Taxi	8%
Limousine	11%
Courtesy Vehicle & Other	4%
Charter Bus	1%

Source: 1975 Inflight Survey of Deplaning Passengers

The Broward County Department of Transportation currently operates the local bus system. There is no bus service to the Airport proper and the nearest bus route stops on U.S. 1, 1/4 mile from the terminal. According to the County's Transit Authority, a taxi company has suggested development of park-and-ride lots for shuttle bus service in the Western suburbs, and such service will begin in late 1978.

5. Internal Access

All terminal-destined traffic funnels into a single-level loop roadway. The roadway has four lanes adjacent to the curb, with the right lane reserved for loading/unloading and the left lane for metered parking. An additional express roadway is located outside the area adjacent to the terminal. During peak periods, inadequate curb frontage leads to double and even triple parking on the interior roadway, thereby blocking traffic movement. This presents a clear constraint to internal vehicle movement.

Presently, there are 3,300 parking spaces available at FLL, which are divided as follows:

Public	1,750
Employee	850
General Aviation	700
	3,300 (Source Ref. 2)

B. CAPACITY ANALYSIS

1. Passenger Forecasts

The passenger forecast used in this analysis was developed for the FLL Master Plan Study (Ref. 2). Table 2 shows the number of passengers expected.

2. Airside Capacity

Airside capacity forecasts were derived from information contained in the Master Plan Report (Ref. 2). Peak hour airfield capacity (PHOCAP) was converted to an annual capacity (PANCAP) for 1974, 1985, and 1995. By constraining general aviation activity, adequate annual airfield capacity appears available to accommodate air carrier and military operations plus a portion of general aviation to at least the 1990's.

PANCAP was converted to annual passengers by applying factors for percent air carrier operations, available seats per operation and the enplaning load factor (LF). Two load factors were used: the current annual enplaned load factor of 42% and the current load factor plus 10%. The appropriate factors and results are shown in Table 3. The PANCAP was interpolated for the years 1980 and 1990. Note that substantial capacity increases are possible by constraining some of the general aviation activity.

Table 2

Air Passenger Forecasts

Year	Millions of Air Passengers (enplaned & deplaned)
1974	3.4
1976	4.2
1978	5.2
1980	6.5
1985	8.9
1990	11.8
1995	15.3

Source: Reference 2

Table 3

Calculation of Airside Capacity

Year	PANCAP	% Air Carrier	Average Seats/Oper	Annual Pass.Capacity (Millions) LF=42%	LF=52%
1974	456,000	25	124	5.9	7.4
1980	446,800*	24	135	6.1	7.5
1985	437,500	29	146	7.8	9.6
1990	423,500*	37	157	10.3	12.8
1995	409,000	46	168	13.3	16.4

*Data interpolated

Source: Reference 2

3. Ground Access Capacity

Current airport ground trips were assigned to major highways and arterials as explained in Appendix A. For this analysis, the current terminal location off U.S. 1 was retained. Seven locations carrying over 25% of airport traffic were identified: Interstate 95 north of the Airport, State Route 84 east of I-95, Andrews Avenue south of S.R. 84, U.S. Route 1 north of the Airport, U.S. 1 south of the Airport and the intersection of U.S. 1 and the Airport Entrance intersection. The growth rate for non-airport traffic was based on the projected population growth rate for Broward County from 1974-1990 which also conformed closely to computer-generated traffic forecasts. This equaled a 4 1/2% annual growth to 1980, and 3% beyond. Vehicle capacity available for airport trips were converted to air passengers by multiplying the ratio of 1976 annual passengers to 1976 airport ADT (4,200,000/24,970=168) and dividing by the proportion of total airport traffic carried by each access road. The calculations for these locations are given in Appendix B. The graphs which resulted for each location are found in Figures 4 through 9. Final design for expansion of Route 1 to six lanes in the early 1980's is underway, and this improvement has been included in the calculations.

4. Interpretation

a. Interstate 95: Figure 4 indicates that I-95 in the area of FLL is currently operating at level of service "D" in the 30th highest hour of the year. The expected growth of non-airport traffic on I-95 will begin to limit capacity for airport traffic severely in the mid-1980's when level of service "E" conditions are reached. Since airport traffic accounts for only about 6-7% of I-95's traffic, the volume/capacity relationship is primarily dependent on non-airport traffic growth.

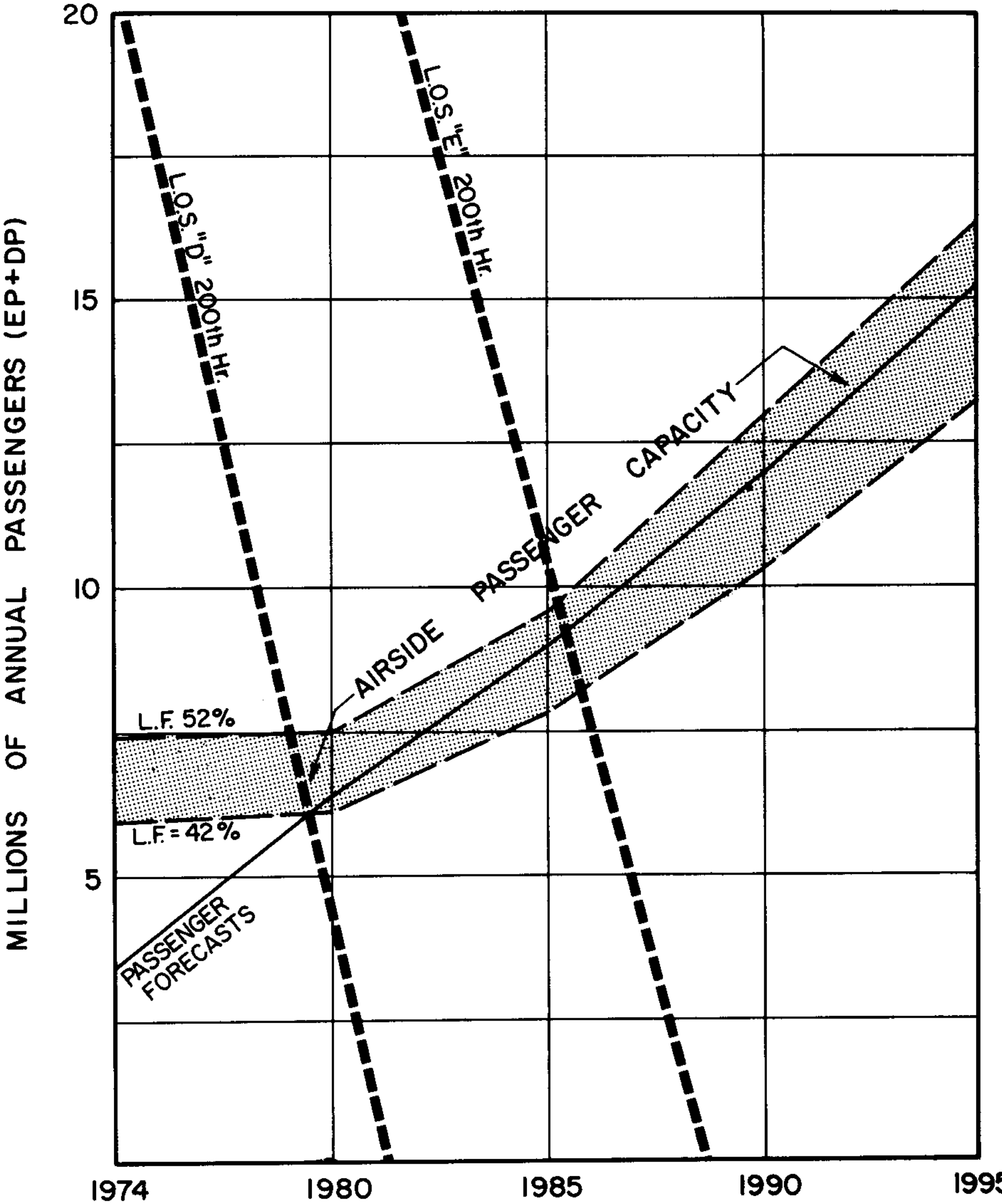
b. Griffin Road: The capacity of this 2-lane road is limited and severe congestion problems are likely to occur in the early 1980's (see Figure 5) if this connection is not upgraded. However, Griffin Road will become less critical if the terminal is relocated since it will not be used by traffic coming from I-95. It could again become an important factor in the long run when I-95 becomes congested and more airport traffic filters back onto U.S. 1.

c. U.S. 1 South: The analysis shows that midblock capacity on U.S. 1 is substantially more than required (Figure 6).

d. U.S. 1 North: Same as U.S. 1 South (Figure 7).

e. Airport Entrance Intersection: Figure 8 shows that this critical intersection actually has sufficient capacity overall to handle current traffic volumes at better than level of service "D". However, current traffic signal timing appears to favor thru traffic on U.S. 1 and penalizes traffic turning in and out of the airport. In addition, while the railroad traffic does not reduce capacity significantly on a daily basis, it does impose frustrating delays on traffic using the entrance when a train is crossing.

Figure 4
DEMAND/CAPACITY RELATIONSHIP
I-95



I-95

Figure 5
DEMAND/CAPACITY RELATIONSHIP
GRIFFIN ROAD

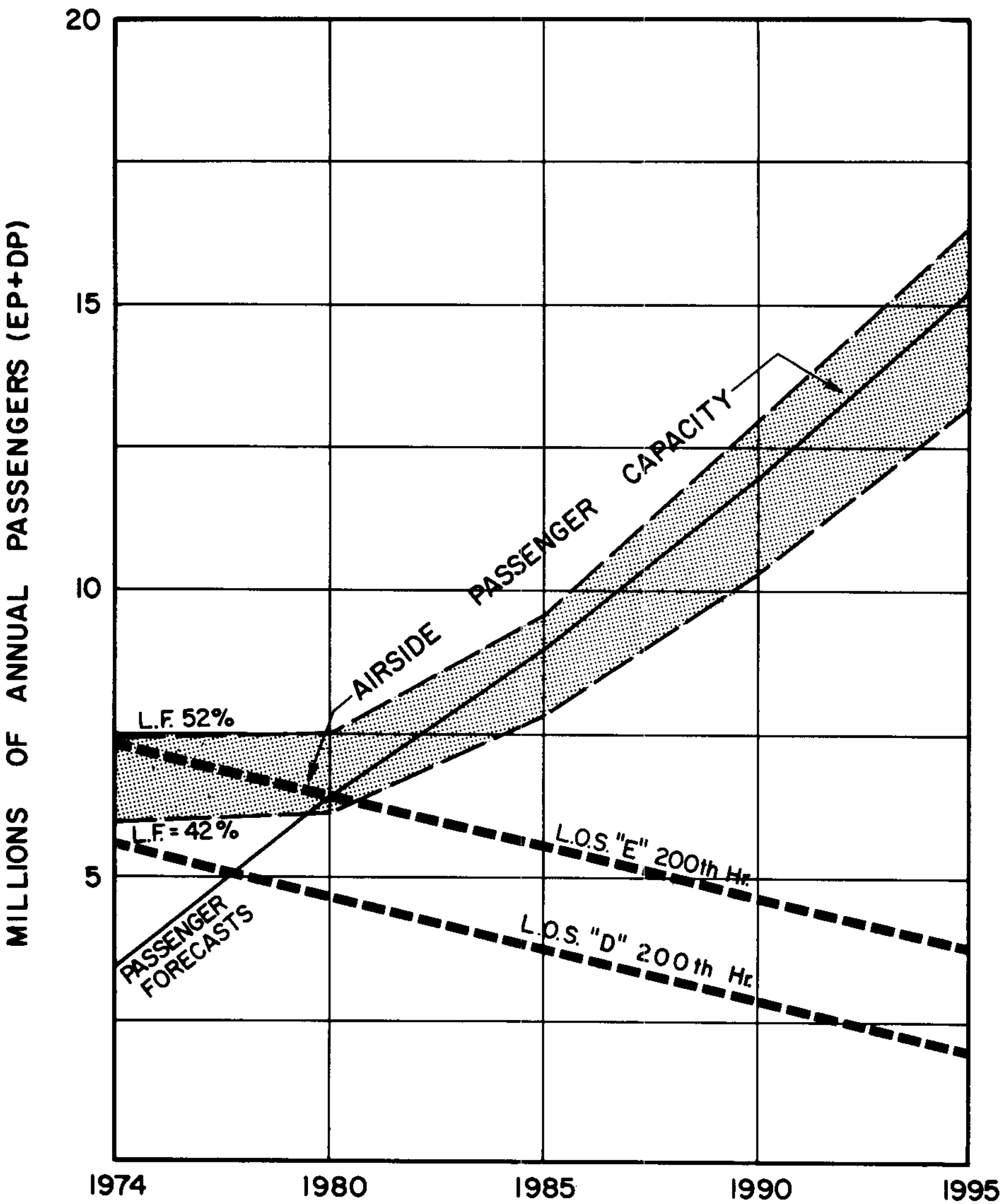


Figure 6
DEMAND/CAPACITY RELATIONSHIP
U.S. 1 SOUTH

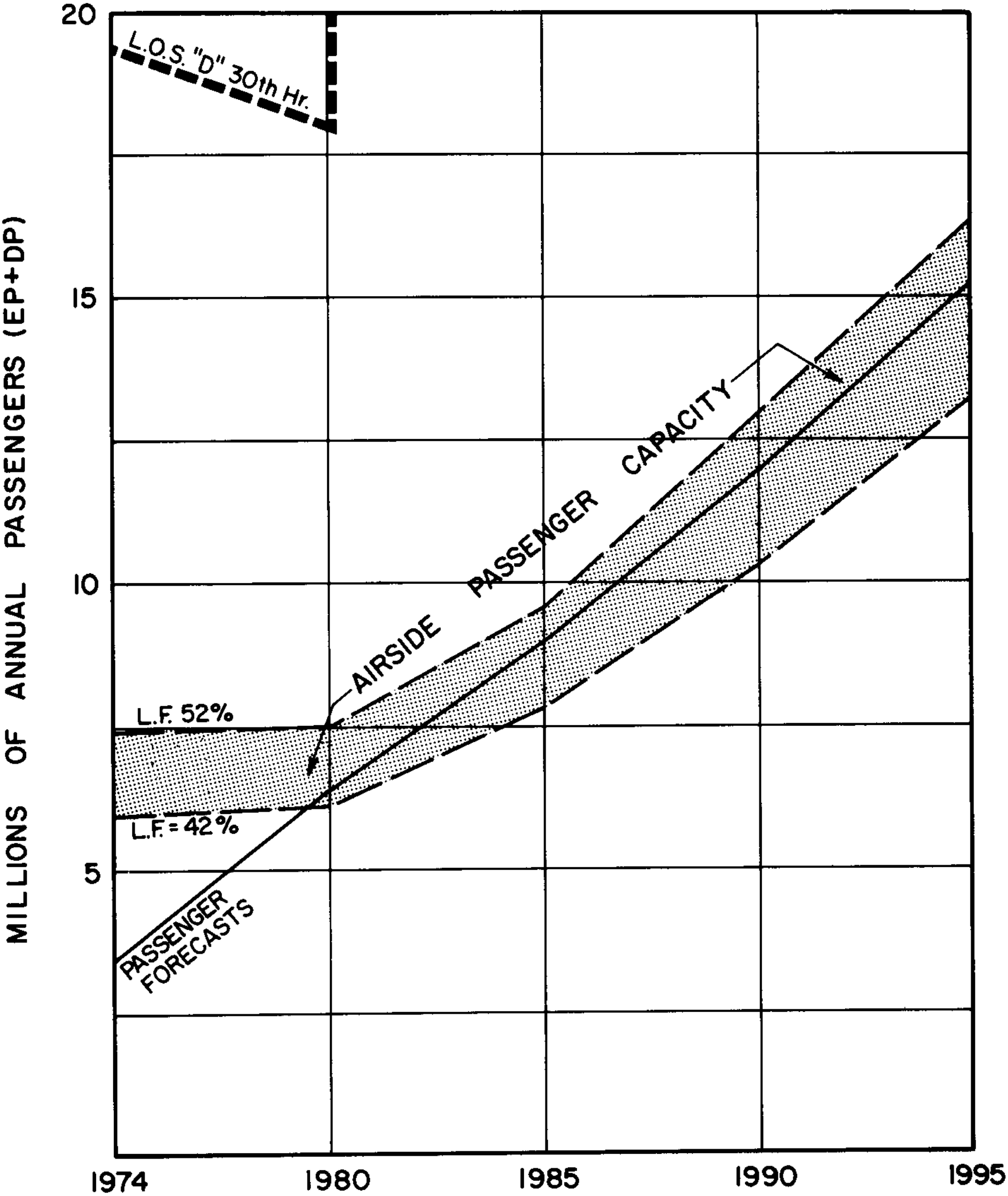


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Figure 7
DEMAND/CAPACITY RELATIONSHIP
U.S. 1 NORTH

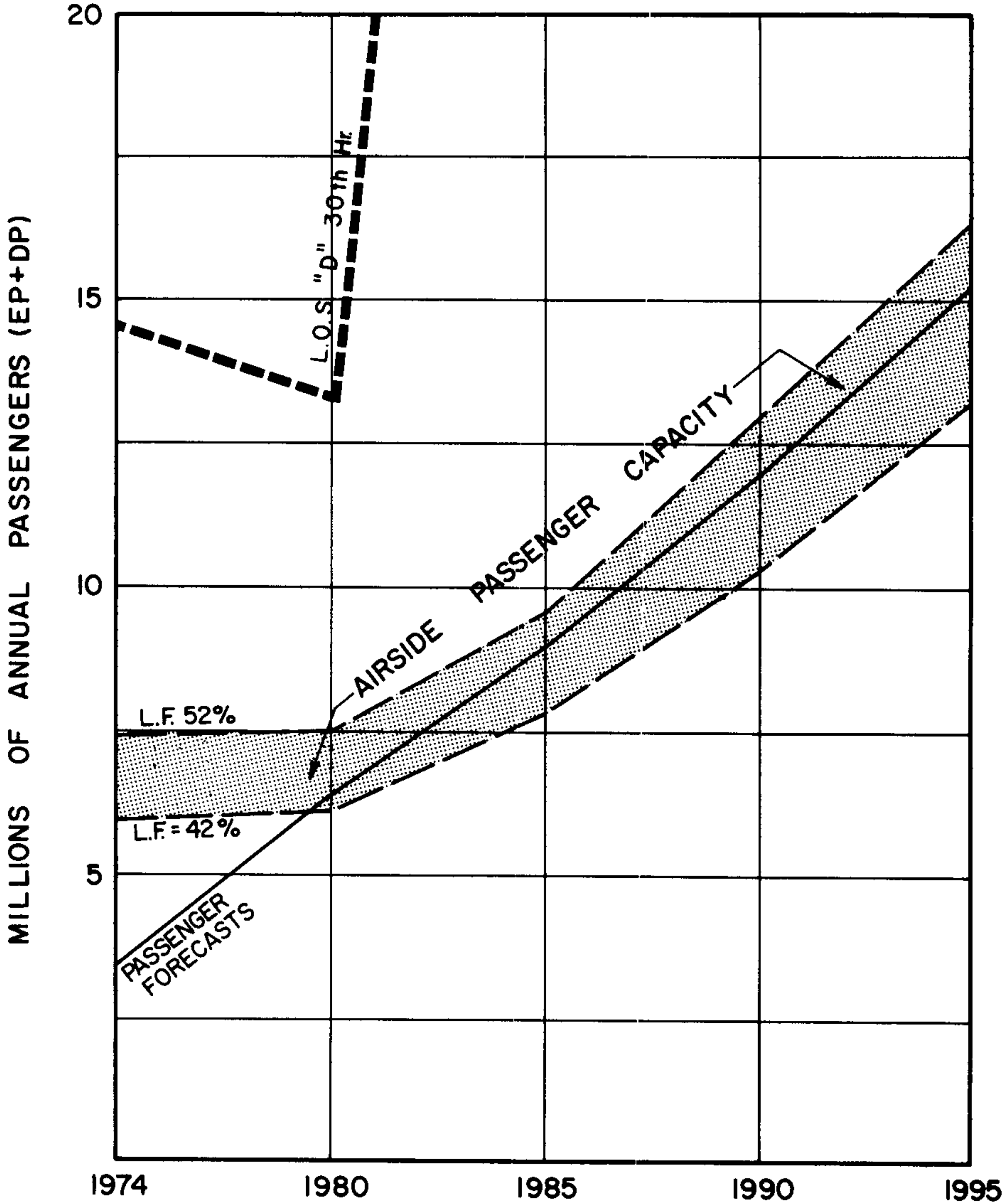

Figure 8
DEMAND/CAPACITY RELATIONSHIP
INTERSECTION OF U.S. 1 AND AIRPORT ENTRANCE ROAD

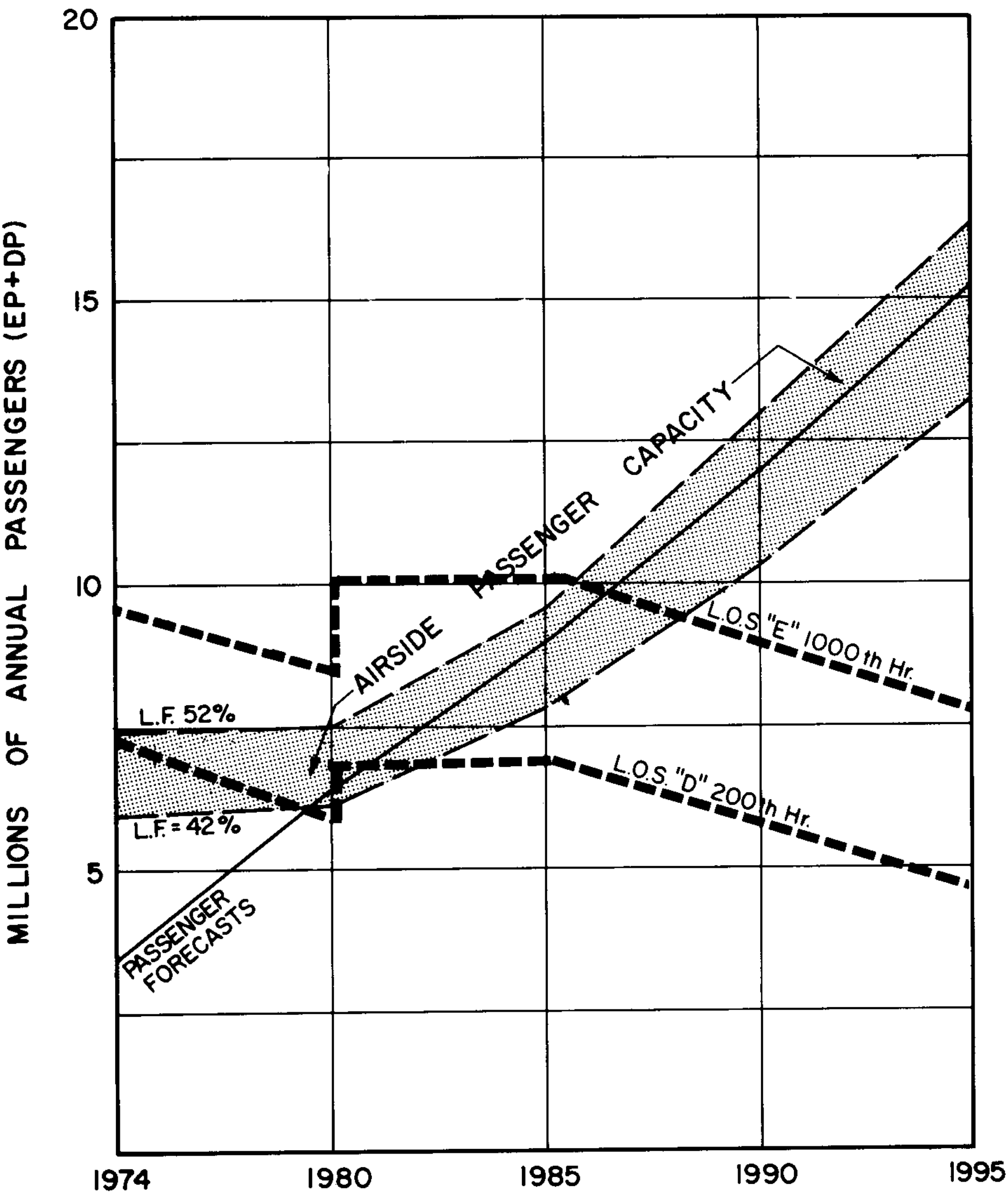

Figure 9
DEMAND/CAPACITY RELATIONSHIP
ROUTE 84

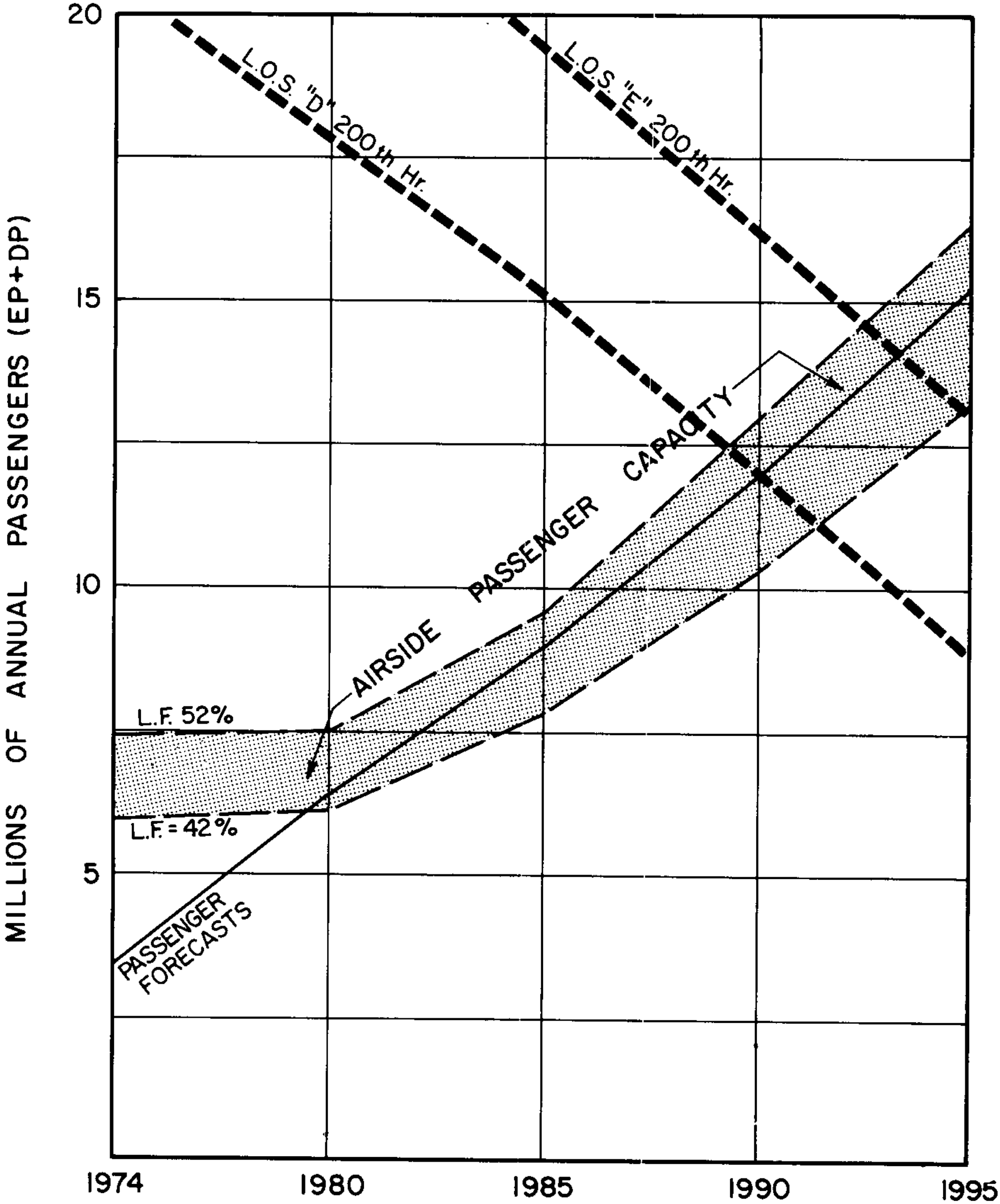

Figure 8 indicates that if signal timing were improved and U.S. 1 widened to 6 lanes, the intersection could operate at better than level of service "E" into the early 1980's. By 1985, however, the intersection could no longer function effectively without grade separation.

f. State Route 84: Figure 9 indicates that capacity limitations on State Route 84 should not prove to be a problem for airport traffic until 1990. It appears likely that the Port Expressway would be built and the terminal relocated prior to that date so that S.R. 84 should present no problems for airport access.

g. Andrews Avenue: Capacity on Andrews Avenue was much higher than demand and fell outside the limits of the graph.

C. PROPOSED SOLUTIONS

Table 4 indicates proposed solutions to airport access problems. The most visible solution is relocation of the Airport Terminal to the southwest corner of the Airport where internal roadways would interchange with Interstate 95. It is anticipated that terminal relocation would be financed primarily by revenue bonds with increased revenue generated by airlines, concessions and general aviation. It has been assumed that the I-95 interchange would be provided through federal highway funds, possibly as part of the Port Everglades Expressway. Consideration has also been given to operating the Port Expressway as a toll road if Federal funding was not made available.

Most other solutions involve construction or improvement of highways. Projects to extend State Route A1A and widen U.S. 1 in the vicinity of the Airport appear likely to be implemented (and are considered in the capacity analysis). Improvements to Griffin Road are not as far advanced. It appears likely that some traffic engineering improvements will be made at the Airport Entrance intersection to provide interim capacity increases.

The only transit proposal identified is the previously mentioned Airport shuttle bus service from various parts of the County which is scheduled to begin in late 1978.

Because of internal expansion constraints and the RR crossing, it has been proposed that the terminal be relocated to the southwest corner of the airport.

Relocating the terminal and providing the terminal roadways with a ramp to I-95 will alleviate the internal roadway problems and the grade-crossing problem. The I-95 interchange is important in the sense that grade-separated access from a freeway is a very desirable element of airport terminal planning. However, I-95 will soon become congested and relief for north-south traffic through use of the Florida Turnpike and U.S 1 will be important. The Florida Turnpike currently operates at less than 1/4 of its level of service "D" capacity because of tolls, infrequent interchanges, and a location west of major population areas. Providing a connection between the Turnpike and the Airport

Table 4

Proposed Solutions To Airport Access Problems

PROPOSED SOLUTION	INITIATOR	AGENCY RESP. FOR IMPLEM.	FUNDING SOURCES	EST. COST (MILLIONS)	STATUS
A. CONSTRUCTION					May 1978
1. Port Everglades Expwy.	Fla.D.O.T.	Fla.D.O.T.	Toll/ Inter-state	360	Planning
2. U.S. 1 Widening	Fla.D.O.T.	Fla.D.O.T.	Fed. Aid Primary	6	Final Design
3. S.R. A1A Extension	Fla.D.O.T.	Fla.D.O.T.	Fed. Aid Primary	11	Final Design
4. I-95 Interchange at Griffin Rd.	FLL Master Plan	Fla.D.O.T.	Fed. Hwy.	**	Study
5. Widening of Griffin Rd.	County	County	County	11	Planning
B. TRANSP. SYSTEMS MGMT					
1. Shuttle Buses From Park-Ride Lots	Local Taxi Co.	Broward County	*	*	To begin in late 1978
2. Traffic Engin. Improvements to Airport Entrance Intersection	City	Fla.D.O.T.	State	.24	Proposal
C. RELOCATION					
1. Relocation of Terminal Complex to Southwest Corner of Airport	FLL Master Plan	Broward County	Revenue Bonds Fla.D.O.T. funds ADAP	245	Completed Study

*Not Available or Unknown

**Included in Estimated Cost for Port Everglades Expressway is important (which is recognized in the FLL Master Plan) and could be accomplished via the proposed Port Everglades Expressway, which also serves to relieve S.R. 84.

Improvements to U.S. 1 and A1A on the east side of the Airport will significantly increase capacity on U.S. 1 and help to relieve I-95. Connecting U.S. 1 and A1A with a relocated terminal will require improvements to Griffin Road which have been planned.

Note that most proposed solutions have been heavily highway-oriented. Transit proposals probably would not have major impact because of the probable dispersal of trip origins and limited use of transit in Broward County. However, an increase in transit usage would be desirable and may be possible through shuttle bus service to destination points such as Port Everglades.

D. CONCLUSIONS

FLL currently has a generally perceived ground access problem that is aggravated considerably by the rapid growth of airport passenger traffic. The immediate problems are insufficient curbspace which congests the internal roadways, and the at-grade intersection with railroad grade crossings which backs up traffic at the Airport's entrance.

The capacity analysis indicates that traffic engineering improvements to the intersection can provide significant capacity increases and help alleviate the short-term problem. These improvements will not, however, relieve the frustration of air travelers who must wait for a passing or even stopped freight train at the grade crossing.

In summary, implementation of the high cost highway construction solutions proposed would greatly improve FLL's long-term access problems. Relocating the terminal does more to solve internal rather than external access problems. Such problems are aggravated by the extraordinary growth of Broward County in general and air traffic in particular. The normal 8-10 year waiting period for study, design and construction of highways is an inconvenience in most other areas, but imposes a real hardship at FLL where air and highway traffic are growing so quickly.

APPENDIX A

ASSIGNMENT OF CURRENT AIRPORT GROUND TRIPS

Assignment of access trips was taken directly from data supplied by Landrum & Brown (L&B), the Airport's Consultants. L&B used two sources for the data: a 1975 inflight survey and the Broward Area Transportation Study (BATS).

L&B's assignment assumed construction of the proposed Port Everglades Expressway and relocation of the Airport terminal, two elements not assumed for this analysis. Therefore, the L&B data were adjusted as shown below.

Location		Percent of Airport-Vehicles	
		Case Study Data	L&B Data
I-95 north of Rte. 84	=	25%	30%
I-95 south of Griffin Road	=	15%	20%
U.S. 1 south of Griffin Road	=	13%	8%
U.S. 1 north of S.R. 84	=	6%	3%
Port Expressway	=	0%	12%
Route 84 west of I-95	=	13%	1%
Andrews Ave. north of 84	=	4%	2%
Rte. A1A south of Griffin Road	=	2%	2%
Rte. A1A north of S.R.84	=	6%	6%
4th Ave. north of S.R.84	=	6%	6%
Griffin Road, West of I-95	=	10%	10%
TOTAL		100%	100%

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

I-95

The hourly capacity for I-95 was read directly from the right hand side of Table 9.1 of the Highway Capacity Manual, assuming PHF = 0.91. To account for trucks - 3% on this highway - Table 9.3b of the HCM was used to get a T factor of .97. This was then converted to a daily VHC by dividing the hourly capacity by the peak hour percentage. Peak hour factors of 8 1/2% for the 30th highest hour, 8% for the 200th highest hour, and 7 1/2% for the 1,000th highest hour were used. These percentages are lower than normal experience because of heavy recreation travel in Southeast Florida.

Urban Arterials

The capacity for Rte. 1, Rte. 84, Griffin Road and Andrews Avenue were estimated by using a table previously developed in other traffic studies to estimate the midblock capacity of urban arterials. For two lane arterials (e.g. Griffin Road) the estimated per lane hourly capacity was 2/3 of ideal capacity as based on HCM Table 10.7, assuming up to 5% trucks. The resulting hourly capacity was multiplied by two and then divided by the peak percentage. The hourly capacity for multi-lane arterials was estimated to be 2/3 of ideal conditions found in Table 10.1 of the HCM. A more sophisticated calculation would require a detailed analysis of all access/egress points, intersections, traffic controls, truck traffic, and grades along all of these arterials.

Airport Entrance Intersection

The capacity of the intersection at U.S. 1 and the Airport Entrance Road was calculated irrespective of current signal timing. Figure 6.8 of the Manual was used to determine the approach volume per hour of green time (V.P.H.G.). Lane width was assumed to be 12 feet with no parking. Appropriate adjustments were made for turns, trucks and metropolitan area size. The resulting service volume was then multiplied by the ratio of available green time to total signal phasing time, which provided the hourly capacity. Each segment was then added to show the hourly capacity for the entire approach.

The basic capacity was reduced by a factor of .12 to account for amber time and by an additional .10 for freight trains crossing the tracks on the Entrance Road. Currently, 11 freight trains are scheduled between 8 A.M. and 6 P.M. Assuming 5 minutes delay per train, a total of 55/600 or 9.2% delay was calculated and rounded up to 10%.

Tables B1 and B7 show the capacity calculations for all seven locations.

Table B1

AIRPORT ACCESS CAPACITY

I-95 North

L.O.S.[1] (1)	Hrs/Yrs[2] (2)	Factor[3] (3)	YEAR 1977 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	110,500	110,500	110,500	110,500	110,500
		2	98,330	112,190	130,030	150,780	174,790
		3	12,170	-	-	-	-
		4	8.2	-	-	-	-
D	200	1	118,800	118,800	118,800	118,800	118,800
		2	98,330	112,190	130,030	150,780	174,790
		3	20,470	6,610	-	-	-
		4	13.8	4.4	-	-	-
D	1,000	1	125,100	125,100	125,100	125,100	125,100
		2	98,330	112,190	130,030	150,780	174,790
		3	26,770	12,910	-	-	-
		4	18.0	8.7	-	-	-
E	30	1	135,300	135,300	135,300	135,300	135,300
		2	98,330	112,190	130,030	150,780	174,790
		3	36,970	23,110	5,270	-	-
		4	24.9	15.5	3.5	-	-
E	200	1	145,500	145,500	145,500	145,500	145,500
		2	98,330	112,190	130,030	150,780	174,790
		3	47,170	33,310	15,470	-	-
		4	31.7	22.4	10.4	-	-
E	1,000	1	153,200	153,200	153,200	153,200	153,200
		2	98,330	112,190	130,030	150,780	174,790
		3	54,870	41,010	23,170	2,420	-
		4	36.9	27.6	15.6	1.6	-

1] Per <u>Highway Capacity Manual</u>

2] Number of hours/years during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway capacity; 2) = nonairport related traffic; 3)= capacity for airport related vehicles; 4) = million annual passenger associated with 3

Table B2

AIRPORT ACCESS CAPACITY

- Griffin Road - 25%

L.O.S.[1/]	Hrs/Yrs[2/]	Factor[3/]	YEAR 1977	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	13,410	13,410	13,410	13,410	13,410
		2	6,330	7,220	8,370	9,700	11,250
		3	7,080	6,190	5,040	3,710	2,160
		4	4.8	4.0	3.4	2.5	1.5
D	200	1	14,250	14,250	14,250	14,250	14,250
		2	6,330	7,220	8,370	9,700	11,250
		3	7,920	7,030	5,880	4,550	3,000
		4	5.3	4.7	4.0	3.1	2.0
D	1,000	1	15,200	15,200	15,200	15,200	15,200
		2	6,330	7,220	8,370	9,700	11,250
		3	8,880	7,980	6,830	5,500	3,950
		4	6.0	5.4	4.6	3.7	2.7
E	30	1	15,760	15,760	15,760	15,760	15,760
		2	6,330	7,220	8,370	9,700	11,250
		3	9,430	8,540	7,390	6,060	4,510
		4	6.3	5.7	5.0	4.1	3.0
E	200	1	16,750	16,750	16,750	16,750	16,750
		2	6,330	7,220	8,370	9,700	11,250
		3	10,420	9,530	8,380	7,050	5,500
		4	7.0	6.4	5.6	4.7	3.7
E	1,000	1	17,870	17,870	17,870	17,870	17,870
		2	6,330	7,220	8,370	9,700	11,250
		3	11,540	10,650	9,500	8,170	6,620
		4	7.8	7.2	6.4	5.5	4.5

1] Per Highway Capacity Manual

2] Number of hours/years during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway capacity; 2) = nonairport related traffic; 3)= capacity for airport related vehicles; 4) = million annual passenger associated with 3

Table B3

AIRPORT ACCESS CAPACITY

U.S. 1 South (40%)

L.O.S.	Hrs/Yrs	Factor	YEAR 1977	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	56,470	56,470	84,700	84,700	84,700
		2	11,900	13,580	15,740	18,250	21,160
		3	44,570	42,890	68,960	66,450	63,540
		4	18.7	18.0	29.0	27.9	26.7
D	200	1	60,000	60,000	90,000	90,000	90,000
		2	11,900	13,580	15,740	18,250	21,160
		3	48,100	46,420	74,260	71,750	68,840
		4	20.2	19.5	31.2	30.2	28.9
D	1,000	1	64,000	64,000	96,000	96,000	96,000
		2	11,900	13,580	15,740	18,250	21,160
		3	52,100	50,420	80,260	77,750	74,840
		4	21.9	21.2	33.7	32.7	31.5
E	30	1	63,060	63,060	94,590	94,590	94,590
		2	11,900	13,580	15,740	18,250	21,160
		3	51,160	49,480	78,850	76,340	73,430
		4	21.5	20.8	33.2	32.1	30.9
E	200	1	67,000	67,000	100,500	100,500	100,500
		2	11,900	13,580	15.740	18,250	21,160
		3	55,100	53,420	84,760	82,250	79,340
		4	23.2	22.5	35.6	34.6	33.4
E	1,000	1	71,470	71,470	107,200	107,200	107,200
		2	11,900	13,580	15,740	18,250	21,160
		3	59,570	57,890	91,460	88,950	86,040
		4	25.0	24.3	38.5	37.4	36.2

1] Per Highway Capacity Manual

2] Number of hours/years during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway capacity; 2) = nonairport related traffic; 3)= capacity for airport related vehicles; 4) = million annual passenger associated with 3

Table B4

AIRPORT ACCESS CAPACITY

U.S. 1 North (49%)

L.O.S. (1)	Hrs/Yrs (2)	Factor (3)	YEAR 1977 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	56,470	56,470	84,700	84,700	84,700
		2	15,320	17,480	20,260	23,490	27,230
		3	41,150	38,990	64,440	61,210	57,470
		4	14.1	13.4	22.1	21.0	19.7
D	200	1	60,000	60,000	90,000	90,000	90,000
		2	15,320	17,480	20,260	23,490	27,230
		3	44,680	42,520	69,740	66,510	62,770
		4	15.3	14.7	23.9	22.8	21.5
D	1,000	1	64,000	64,000	96,000	96,000	96,000
		2	15,320	17,480	20,260	23,490	27,230
		3	48,680	46,520	75,740	72,510	68,770
		4	16.7	16.0	26.0	24.9	23.6
E	30	1	63,060	63,060	94,590	94,590	94,590
		2	15,320	17,480	20,260	23,490	27,230
		3	47,740	45,580	74,330	71,100	67,360
		4	16.4	15.6	25.5	24.4	23.1
E	200	1	67,000	67,000	100,500	100,500	100,500
		2	15,320	17,480	20,260	23,490	27,230
		3	51,680	49,520	80,240	77,010	73,270
		4	17.8	16.9	27.5	26.4	25.2
E	1,000	1	71,470	71,470	107,200	107,200	107,200
		2	15,320	17,480	20,260	23,490	27,230
		3	56,150	53,990	86,940	83,710	79,970
		4	19.3	18.5	29.8	28.7	27.5

1] Per <u>Highway Capacity Manual</u>

2] Number of hours/years during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway capacity; 2) = nonairport related traffic; 3)= capacity for airport related vehicles; 4) = million annual passenger associated with 3

Table B5

AIRPORT ACCESS CAPACITY

Intersection of Airport Entrance Road & U.S. 1

L.O.S. 1/	Hrs/Yrs 2/	Factor 3/	YEAR 1977	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	58,780 4/	58,780	67,350	67,350	67,350
		2	27,230	31,070	36,010	41,760	48,410
		3	31,550	27,710	32,370	25,590	18,940
		4	6.0	5.2	6.1	4.8	3.6
D	200	1	62,460	62,460	72,640	72,640	72,640
		2	27,230	31,070	36,010	41,760	48,410
		3	35,230	31,390	36,630	30,880	24,230
		4	6.7	5.9	6.9	5.8	4.6
D	1,000	1	66,630	66,630	77,480	77,480	77,480
		2	27,230	31,070	36,010	41,760	48,410
		3	39,400	35,560	41,470	35,720	29,070
		4	7.4	6.7	7.8	6.8	5.5
E	30	1	66,890	66,890	78,168	78,168	78,168
		2	27,230	31,070	36,010	41,760	48,410
		3	39,660	35,820	42,158	36,408	29,758
		4	7.5	6.8	8.0	6.9	5.6
E	200	1	71,069	71,069	83,150	83,150	83,150
		2	27,230	31,070	36,010	41,760	48,410
		3	43,839	39,999	47,140	41,390	34,740
		4	8.3	7.6	8.9	7.8	6.6
E	1,000	1	75,810	75,810	88,700	88,700	88,700
		2	27,230	31,070	36,010	41,760	48,410
		3	48,580	44,740	52,690	46,940	40,290
		4	9.2	8.5	10.1	8.9	7.6

1] Per Highway Capacity Manual

2] Number of hours/years during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway capacity; 2) = nonairport related traffic; 3)= capacity for airport related vehicles; 4) = million annual passenger associated with 3

4] Capacity adjusted to account for 12% amber time and 10% time for railroad crossings.

Table B6

AIRPORT ACCESS CAPACITY

Route 84

L.O.S.[1]	Hrs/Yrs[2]	Factor[3]	YEAR 1977	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	72,000	72,000	72,000	72,000	72,000
		2	31,850	36,340	42,1 20	48,840	56,620
		3	40,150	35,660	29,880	23,160	15,380
		4	17.8	15.8	13.2	10.3	6.8
D	200	1	76,500	76,500	76,500	76,500	76,500
		2	31,850	36,340	42,120	48,840	56,620
		3	44,650	40,160	34,380	27,660	19,880
		4	19.8	17.8	15.2	12.2	8.8
D	1,000	1	81,600	81,600	81,600	81,600	81,600
		2	31,850	36,340	42,120	48,840	56,620
		3	49,750	45,260	39,480	32,760	24,980
		4	22.0	20.0	17.5	14.5	11.1
E	30	1	80,400	80,400	80,400	80,400	80,400
		2	31,850	36,340	42,120	48,840	56,620
		3	48,550	44,060	38,280	31,560	23,780
		4	21.5	19.5	16.9	14.0	10.5
E	200	1	85,425	85,425	85,425	85,425	85,425
		2	31,850	36,340	42,120	48,840	56,620
		3	53,605	49,085	43,305	36,585	28,805
		4	23.7	21.7	19.2	16.2	12.8
E	1,000	1	91,120	91,120	91,120	91,120	91,120
		2	31,850	36,340	42,120	48,840	56,620
		3	59.270	54.780	49,000	42,280	34,500
		4	26.2	24.2	21.7	18.7	15.3

1] Per Highway Capacity Manual

2] Number of hours/years during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway capacity; 2) = nonairport related traffic; 3)= capacity for airport related vehicles; 4) = million annual passenger associated with 3

Table B7

AIRPORT ACCESS CAPACITY

Andrews Avenue

L.O.S.1/ (1)	Hrs/Yrs2/ (2)	Factor3/ (3)	YEAR 1977 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	56,470	56,470	56,470	56,470	56,470
		2	2,530	2,890	3,350	3,880	4,500
		3	53,940	53,580	53,120	52,590	51,970
		4	24.5	24.4	24.1	23.9	23.6
D	200	1	60,000	60,000	60,000	60,000	60,000
		2	2,530	2,890	3,350	3,880	4,500
		3	57,470	57,110	56,650	56,120	55,500
		4	26.2	25.9	25.7	25.2	25.0
D	1,000	1	64,000	64,000	64,000	64,000	64,000
		2	2,530	2,890	3,350	3,880	4,500
		3	61,470	61,110	60,650	60,120	59,500
		4	27.9	27.8	27.6	27.3	27.0
E	30	1	63,060	63,060	63,060	63,060	63,060
		2	2,530	2,890	3,350	3,880	4,500
		3	60,530	60,170	59,710	59,180	58,560
		4	27.5	27.4	27.1	26.9	26.6
E	200	1	67,000	67,000	67,000	67,000	67,000
		2	2,530	2,890	3,350	3,880	4,500
		3	64,470	64,110	63,650	63,120	62,500
		4	29.5	29.2	28.9	28.6	28.4
E	1,000	1	71,470	71,470	71,470	71,470	71,470
		2	2,530	2,890	3,350	3,880	4,500
		3	68,940	68,580	68,120	67,590	66,970
		4	31.3	31.2	31.0	30.7	30.4

1] Per Highway Capacity Manual

2] Number of hours/yrs. in which level of service is equal to or worse than that shown in Column (1)

3] Key: 1) = Highway capacity; 2) = nonairport related traffice; 3) = capacity for airport related vehicles; 4) = million annual passengers associated with 3

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LAGUARDIA AIRPORT

CASE STUDY

CASE STUDY SUMMARY

LaGuardia Airport is one of three major air carrier airports serving the New York Metropolitan region. Although it is the most conveniently located of the three airports, airside limitations have restricted it to short-haul air services. Nevertheless, in 1976, it served 14.1 million passengers, and this number is expected to increase, if unconstrained, to over 25 million by 1995.

The airport is located on the Grand Central Parkway, a major highway connecting to several east-west and north-south highways serving the region. Several routes exist to the Manhattan central business district (CBD) which is itself rather disbursed. New York generates a high percentage of its travel (about 30%) from the CBD. At LaGuardia, almost one-half of local trips are CBD oriented. Of these, more than half use the taxi mode, thus generating a relatively high requirement for ground access capacity.

LaGuardia is currently operating at its ground access capacity due to traffic congestion on the Grand Central Parkway on the way to Manhattan. This situation is expected to worsen only slowly, due to the slow growth in non-airport traffic and to the availability of alternate routes for most travelers. The airport is also currently operating at its airside capacity, and it is unclear whether the airside or the ground access system most constrains airport capacity and air travel.

Solutions to the access problem have been proposed recently, but no action has been taken. Capital programs proposed to increase capacity include a highway connector from the Brooklyn-Queens Expressway to the airport and a people-mover system connecting the airport to existing public rail transport serving the New York region.

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A. BACKGROUND

1. General

LaGuardia Airport (LGA) is located on the East River, in the northern section of Queens County, New York City. It is generally considered to be the most popular of the three major air carrier airports in the area, due to its proximity to high population and employment centers. LaGuardia is only 8 miles from mid-Manhattan, the primary generator (nearly 35%) of air passenger trips in the area. Because of its proximity to Manhattan, and to other locations generating large volumes of air traffic, a high level of future passenger demand is assured. In 1976, commercial airlines at LGA enplaned and deplaned approximately 14.1 million annual passengers on some 750 average daily commercial flights.

LaGuardia is limited in the scope and volume of its operations by its small area, only about 650 acres. The relatively limited airport area necessitates prohibiting nonstop Transcontinental and overseas flights out of LGA on a regular basis. Thus, LGA is primarily a short- and medium-haul airport with long-haul and overseas flights being handled at Kennedy and Newark Airports. This division of services at the airports in the New York region is consistent with the general principle that the short-haul airport (LGA) should be the most easily accessible of all commercial airports in a region.

LaGuardia is conveniently located on the Grand Central Parkway, a divided, limited-access highway with connections to several other major north-south and east-west highways. Ground access to LGA is also available directly from the local surface street system in the Flushing area of Queens.

2. Transportation Planning Structure

The three major airports in the New York region, LaGuardia, Kennedy, and Newark, are operated by the Port Authority of New York and New Jersey. The Port Authority, as an agency of both states, is composed of 12 commissioners which are appointed--six each by the governors of the two states--for overlapping six-year terms. Both governors hold veto power over the minutes of the meetings of the commissioners, and although this power is rarely used, it has been used on occasion. The Port Authority is self-supporting, receiving funds from user fees and revenue bonds.

Regional transporation planning is the responsibility of the Tri-State Regional Planning Commission (TSRPC), the designated MPO for an area covering 21 counties (located in New York, New Jersey, and Connecticut) in the New York metropolitain area. The Port Authority is a non-voting member of the TSRPC, and works closely with the agency in developing and coordinating aviation and airport-access plans.

At the state level, the Port Authority interfaces with the New York State Department of Transporation and the Metropolitan Transporation Authority in developing access plans for LaGuardia. The three agencies are each members of the Aviation Technical Committee of the TSRPC; and, in addition, work closely with one another outside the framework of the TSRPC.

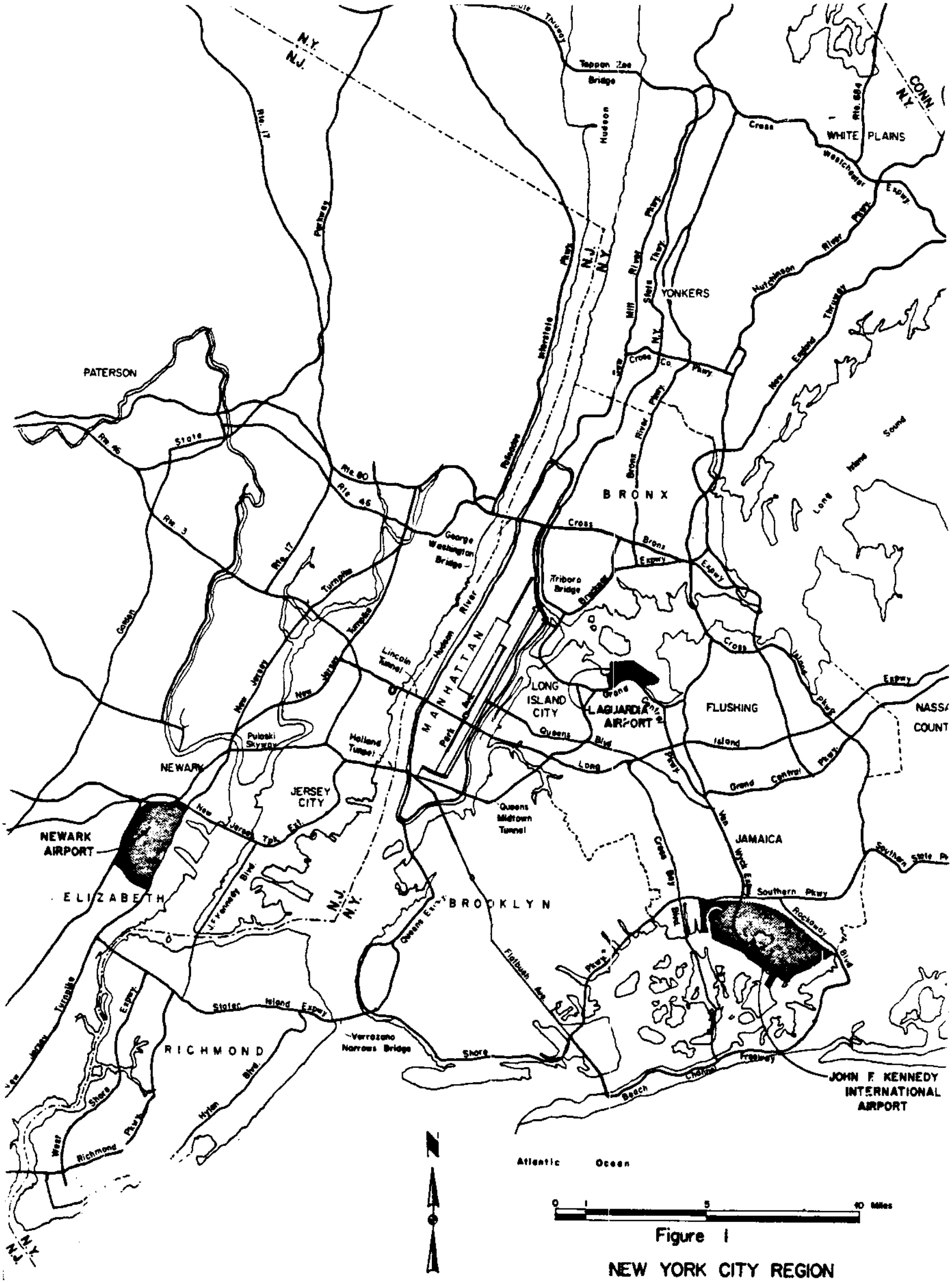

Figure 1

NEW YORK CITY REGION

3. Highway Access

Figure 2 shows the highway access system serving LaGuardia. LaGuardia is located in the Grand Central Parkway (GCP), a limited-access highway connecting to other major north-south and east-west highways in the region. Access to New York City is via the GCP directly to the Triborough Bridge, or via the GCP and the Brooklyn-Queens Expressway (BQE) to the Queens-Midtown Tunnel (by way of I495), the Williamsburg Bridge, the Manhattan Bridge, the Brooklyn Bridge, or the Brooklyn-Battery Tunnel. Alternate routes are available via the GCP west to I495 to the Queens-Midtown Tunnel or the GCP west to I495 to the BQE to any of the other tunnels or bridges. Because Manhattan is itself ringed by a highway system, travelers destined for lower Manhattan may generally use any of the river crossings north of their final destination.

As a measure of the extent of the access systems congestion problem, a recent update of the Federal Highway Administration's continuing airport access analysis program indicated that travel time from Manhattan (at Queens-Midtown Tunnel) to the airport was 32 minutes during peak periods, but only 19.5 minutes in off-peak periods.

Access between LGA and the growing Long Island suburbs of New York is via the GCP west to I495, the Long Island Expressway (LIE). Access between LGA and the affluent Westchester County and Connecticut suburbs is via the GCP and the Whitestone Bridge.

Access to the airport is also directly available from local city streets in North Queens. This entrance provides an excellent alternative to the GCP when the GCP is congested in the vicinity of the airport. However, since local routes are not signed from the major highways, they are used only by a few frequent travelers familiar with the area and by residents in the vicinity.

4. Transit Access 1/

The Carey Transportation Company provides frequent express type bus service between LaGuardia and the East Side Airlines Terminal in Manhattan. The running time varies between 30 minutes to an hour depending upon traffic conditions. The fare at $3.00 per passenger is about one half the normal taxi fare between the same two points.

The taxi mode to or from Manhattan is particularly attractive given its direct door-to-door service characteristic and the relative cost. The average taxi fare to midtown Manhattan at $6.00 is competitive with the Carey Bus service which is slower and, in most cases, requires a transfer to another vehicle to complete the trip. The per passenger taxi cost, which is reduced proportionately by the number of vehicle occupants, is an economical way to access LaGuardia Airport when two or more persons are sharing the same taxi.

1/ First four paragraphs are quoted from Reference 6.

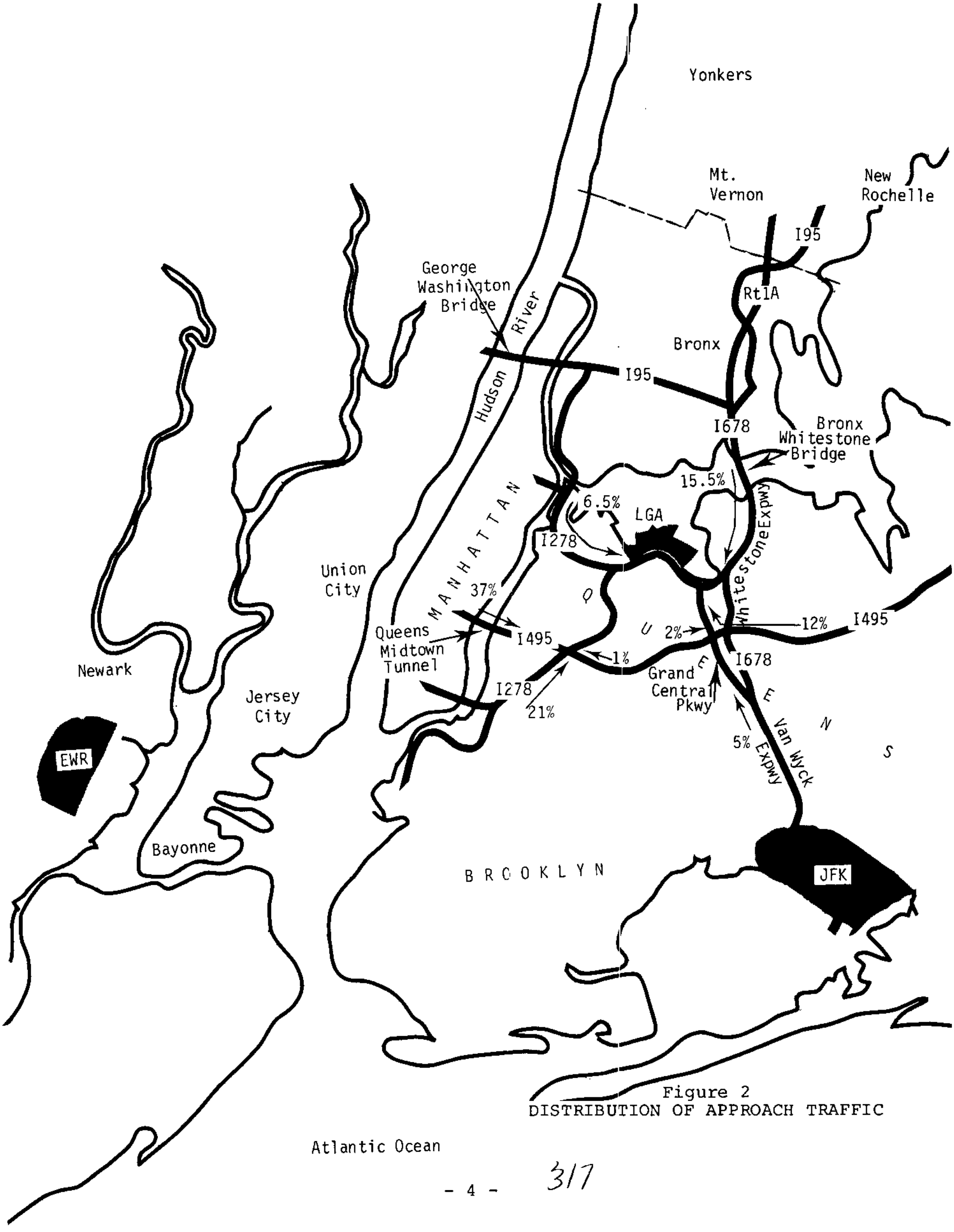

Figure 2
DISTRIBUTION OF APPROACH TRAFFIC

LaGuardia is easily accessible by local public transportation. The Q-33 bus operated by Triboro Coach provides frequent service between the terminal area and the IRT-IND station at Broadway and Roosevelt and thus provides subway access to all parts of New York City. The bus ride to the subway station takes 15-20 minutes depending upon the prevailing conditions and a typical subway ride to Grand Central via the IRT #7 line takes another 15-20 minutes. The entire trip between LaGuardia and Grand Central can be made in about 40-50 minutes.

The bus-subway modes, while relatively speedy and inexpensive, requires an extra transfer and does not provide for the convenient transport of personal baggage. Seats may be difficult to obtain during peak periods which represents a major disincentive for many air passengers.

The 1972 split of airport ground access modes is shown in Table 1. Taxi, limousine, and bus modes account for over one-half of all trips made, and account for almost 85% of those made from Manahttan. The taxi mode is more than twice as popular as bus and limousine modes combined.

5. Internal Access

Figure 3 shows the internal access system at LGA. Entry to the airport is from the Grand Central Parkway or from Ditmars Boulevard, which parallels the Parkway and provides local access. There is parking for some 8,600 cars including a parking garage for 3,000 completed in 1976. The Marine Air Terminal, originally the main terminal building, is now used by Air New England, small non-scheduled airlines, and general aviation. The Eastern Airlines Shuttle Terminal, soon to be replaced, handles the hourly shuttle to Boston and Washington.

B. CAPACITY ANALYSIS

1. Passenger Forecast

The two passenger forecasts used in the study were taken from the most recent FAA report, Terminal Area Forecasts, 1978-1988, and a forecast prepared by the Tri State Regional Planning Commission. The FAA forecast extends only until 1988 and is projected to 1995 at the 1983-1988 growth rate. The Tri-State Commission's forecast extends to 1995 and is interpolated for 1990. The TSRPC forecast is adjusted for anticipated ground access congestion assuming planned roadway and transit improvements are implemented. The forecasts are presented in Table 2.

2. Airside Capacity

Table 3 presents the calculations that were made to determine airside capacity at LaGuardia. Interpolation between the existing practical annual

TABLE 1

MODE SPLIT OF ACCESS TO LAGUARDIA

County of Origin	Percentage by Mode: Auto	Taxi	Limo/Bus	Average Day Departing Passengers
(1)	(2)	(3)	(4)	(5)
Connecticut	63%	3%	34%	949
New Jersey	70	8	11	1022
New York City				
Manhattan	16	63	20	8244
Queens	50	25	21	2083
Other	66	27	6	1456
Other New York State				
Nassau	77	14	9	1384
Westchester	74	12	14	1140
Other	84	6	10	824
Total	43	38	18	17102

* Percentage may not add to one hundred because of unreported access modes.

Note: Departing air passengers originating outside of the Tri-State region are not included in this tabulation.

Source: The Port Authority of New York and New Jersey.

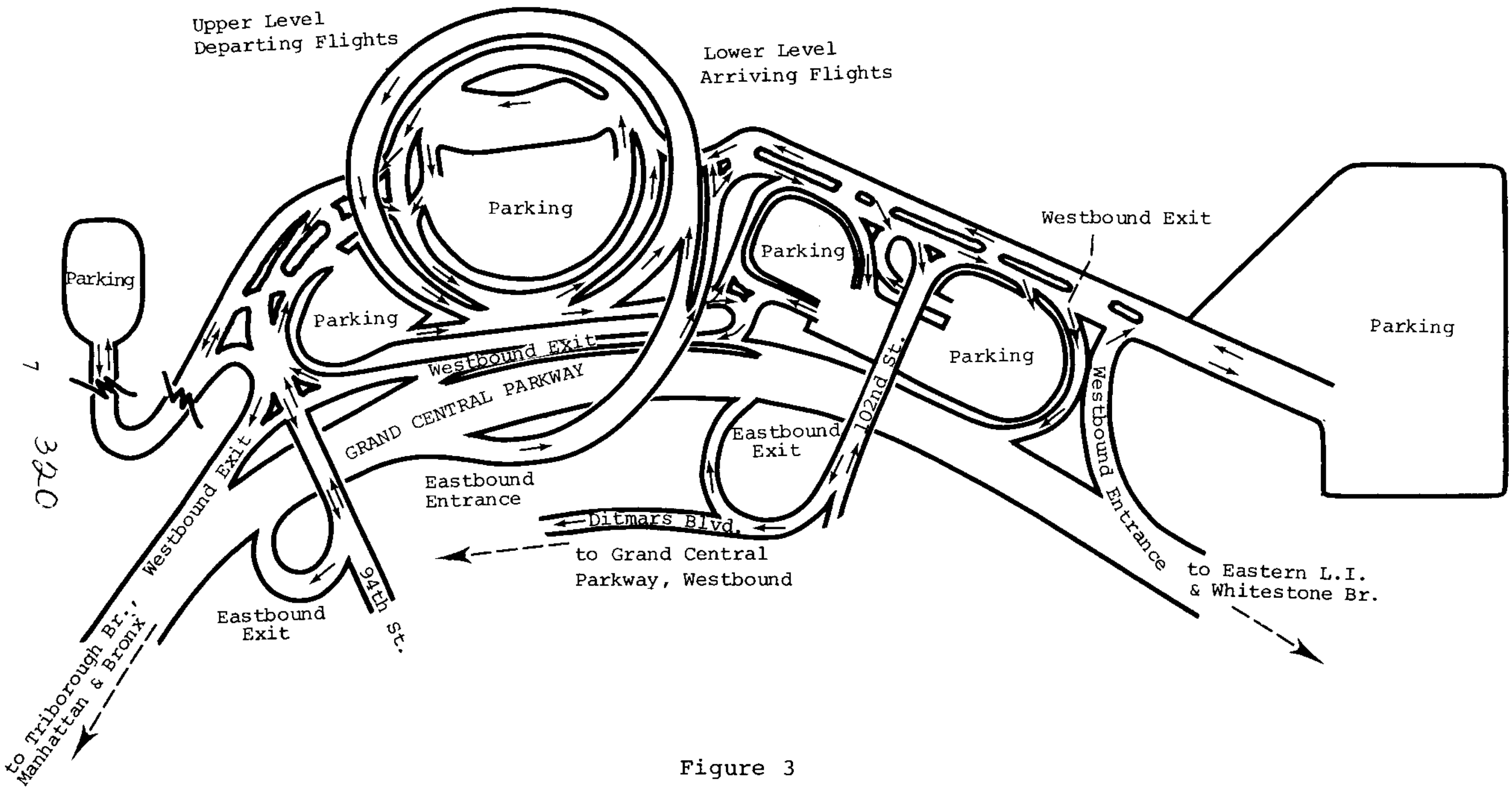

Figure 3

INTERNAL ACCESS ROADWAY SYSTEM

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TABLE 2

FORECAST OF DEMAND
(Million Annual Passengers)

Year	Tri-State Regional	FAA
(1)	(2)	(3)
1975-76	14.1 1/	14.1 1/
1980	16.2	14.9
1985	18.5	18.1 2/
1990	20.3 2/	21.4 3/
1995	22.3	25.3 3/

1/ Actual.

2/ Interpolated.

3/ Extended.

TABLE 3

CALCULATION OF AIRSIDE CAPACITY

Year	PANCAP 1/	% Air Carrier 2/	Passenger per Operation 3/	Passenger Capacity
(1)	(2)	(3)	(4)	(5)
Conservative				
1975	294,000	77	44.1	10.0
1980	289,563	77	48.7	10.9
1985	285,062	77	53.8	11.8
1990	280,491	77	59.4	12.8
1995	277,000	77	65.5	14.0
Optimistic				
1975	294,000	77	52.9	12.0
1980	289,563	77	64.4	14.4
1985	285,062	77	78.3	17.2
1990	280,491	77	95.3	20.6
1995	277,000	77	115.9	24.7

1/ PANCAP interpolated between 1975 and 1995.

2/ Source: FAA Air Traffic Activity, Calendar Year 1975.

3/ Conservative uses existing value (Source: Port Authority Monthly Airport Traffic Reports) and assumes 2% annual growth in aircraft capacity. Optimistic assumes 20% increase (Approximately 10 point load factor increase) on top of 4% annual growth in aircraft capacity.

capacity (PANCAP) and the PANCAP projected for 1995 by the TSRPC, 1/ provided the base for our calculations. The percentage of air carrier operations were derived from FAA information on air traffic activity and was assumed to remain constant through 1995. Conservative projections for passengers per operation were based on existing figures assuming a two percent annual increase in aircraft capacity. 2/ Optimistic figures assumed a 20% increase over a 4% annual increase in aircraft capacity. PANCAP was then converted to annual passenger capacities by applying the factors for percent of air carrier and passengers per operation.

3. Ground Access Capacity

Current airport ground trips were assigned to major highways as described in Appendix A. The following three critical highway locations were identified:

(1) Grand Central Parkway east of airport;

(2) Grand Central Parkway west of airport; and

(3) Brooklyn-Queens Expressway between the Grand Central Parkway and I495.

The bridges and tunnels between Manhattan and the Brooklyn-Queens Expressway, in aggregate, form a critical highway location. However, because of the large variety of possible routings for each destination within Manhattan, it was impossible to perform a capacity analysis on this aggregate highway link.

Non-airport traffic on the roadway access system serving LaGuardia was projected to grow at an unconstrained annual rate of 1% per year. Support for this assumption and others, and documentation of the access capacity calculations is presented in Appendix B. The resulting graphs for the critical highway locations are shown in Figures 4 through 6.

4. Interpretation

4.1 Grand Central Parkway

The Grand Central Parkway (GCP) is the route virtually all air passengers use on the final segment of their trips to LaGuardia. The Western

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1/ Source: TSRPC, Airspace Inventory, Airspace Analysis Airport Capacity: An Airport Systems Planning Report, September, 1977.
The PANCAP figure is adjusted to reflect airspace capacity and prevailing noise-avoidance procedures.

2/ The low growth rate in aircraft size reflects the short-haul nature of LGA traffic and the assumption that wide-body equipment will be used predominantly on longer-haul routes.

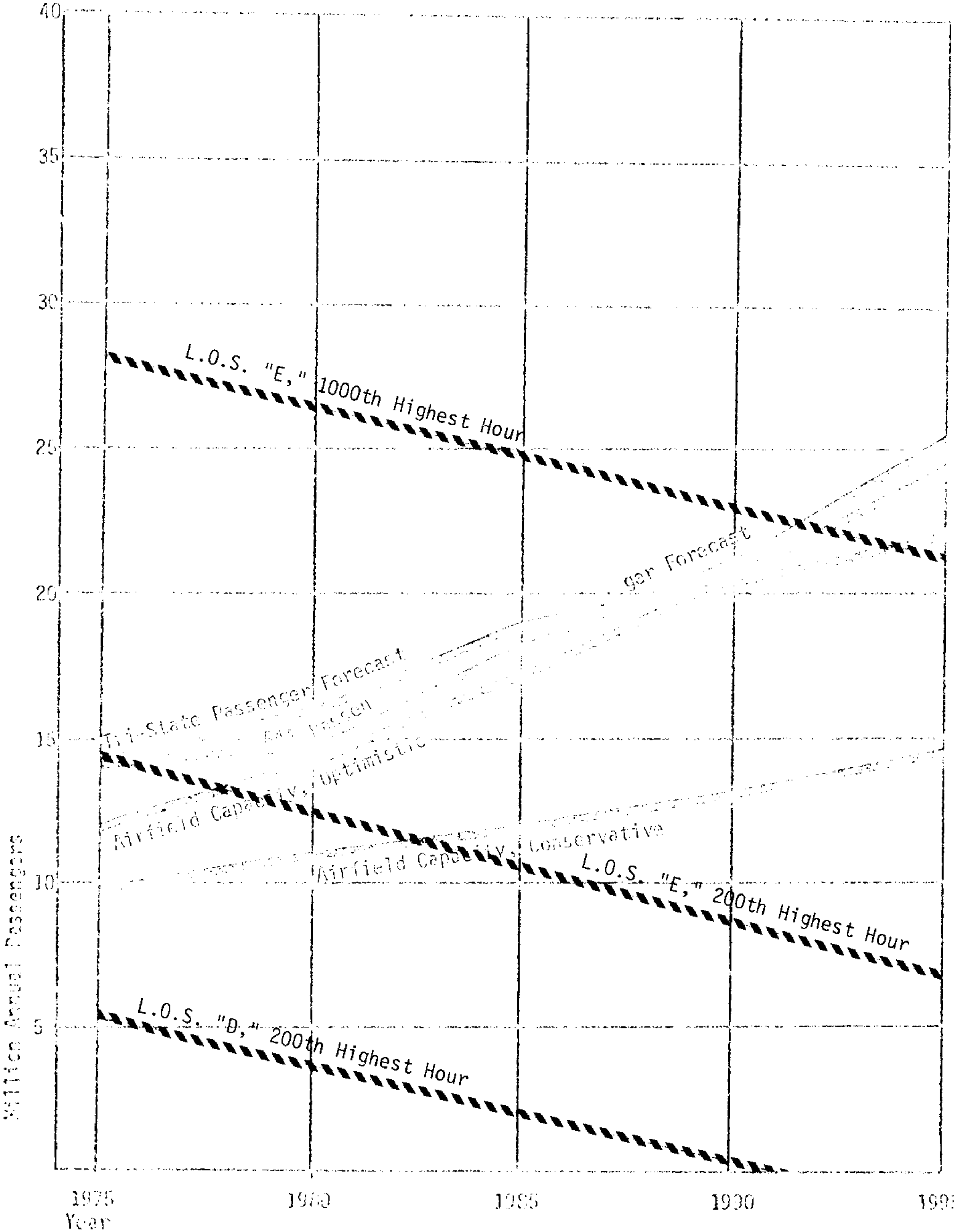

Figure 4

DEMAND/CAPACITY RELATIONSHIPS

Grand Central Parkway West of Airport 324

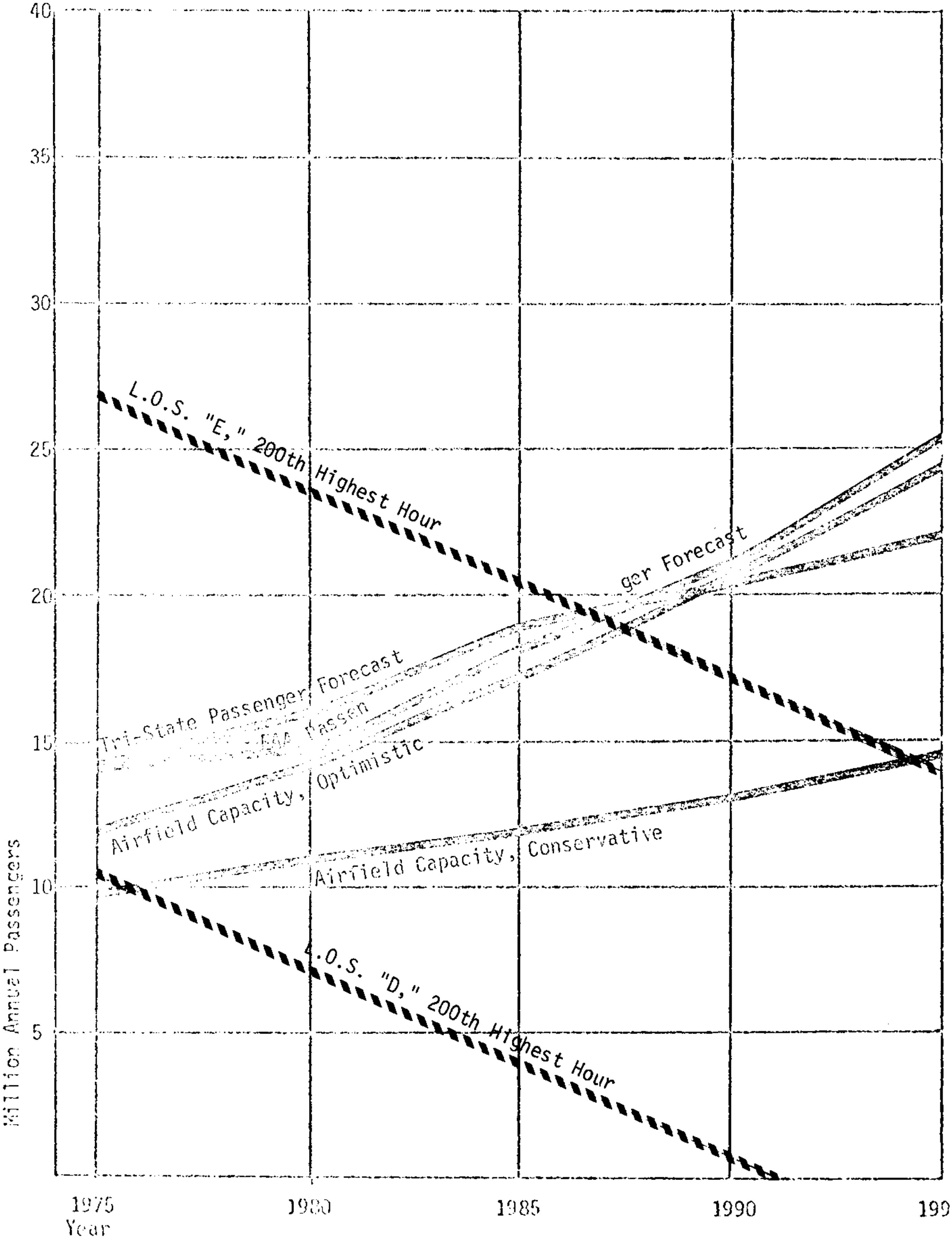

Figure 5

DEMAND/CAPACITY RELATIONSHIPS

Grand Central Parkway East of Airport

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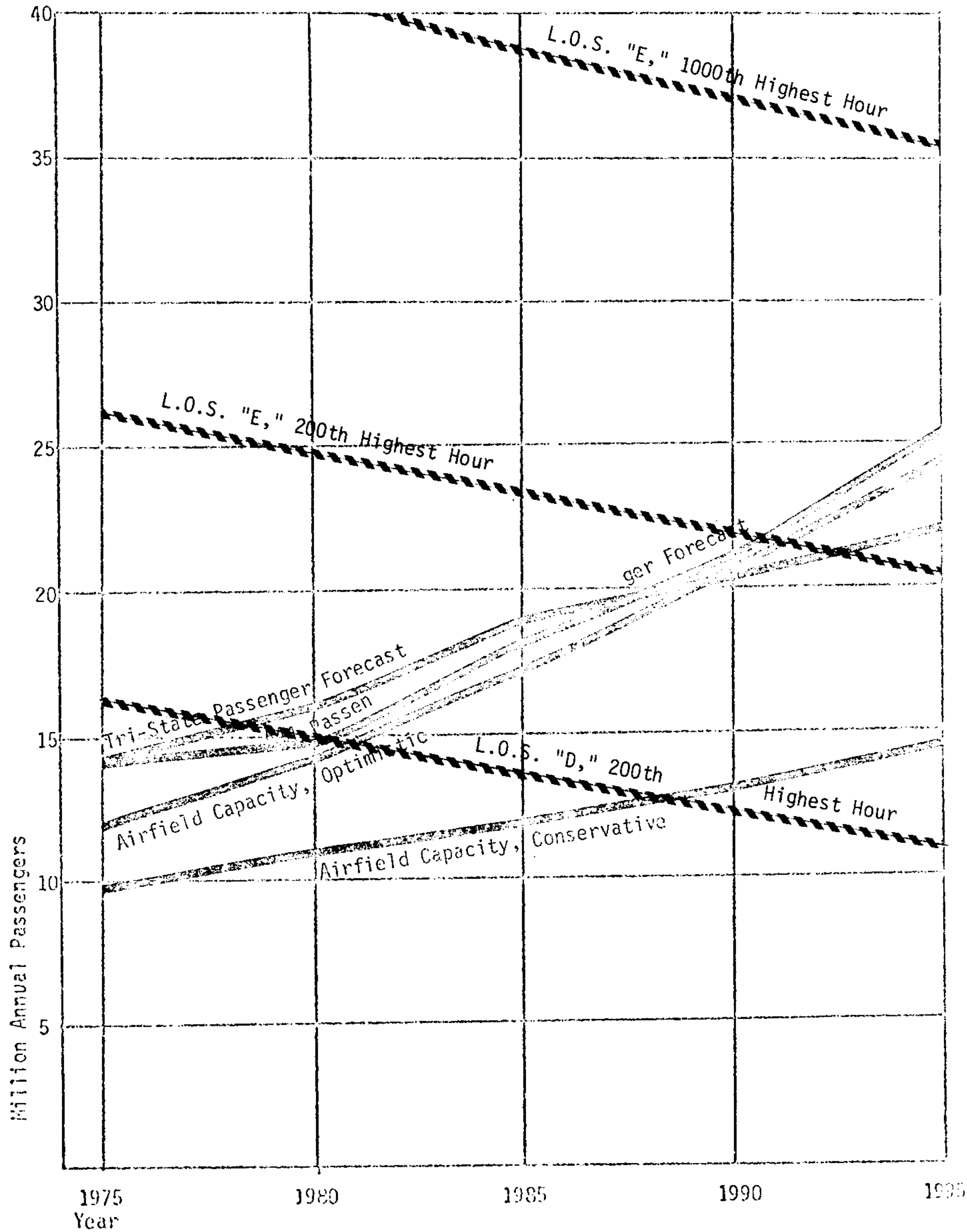

Figure 6

DEMAND/CAPACITY RELATIONSHIPS
Brooklyn-Queens Expressway Between the Grand Central Parkway and the Long Island Expressway

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segment of the GCP carries approximately two-thirds of this traffic (including most of the traffic from Manhattan). Because the segments of the GCP east and west of the airport have the same capacity for air-relative vehicles, the western segment reaches capacity before the eastern segment as air traffic grows. Currently the western segment operates at level of service "E" for some 200 hrs./year (see Figure 4) while the eastern segment operates at level of service "D" (see Figure 5). Congestion is expected to increase slowly, with level of service "E" for 1,000 hrs./year not reached on the western segment until the 1990's and level of service "E" for 200 hrs./year not reached until the late 1980's on the eastern segment.

The capacity analysis may over-estimate access roadway capacity in trips toward the airport. Both from the east and west, the GCP merges with other major highways not far from the airport boundary. These merges tend to reduce capacity at the point of intersection, because of vehicle maneuvering and weaving. On trips away from the airport, capacity is probably insignificantly affected by the diversion of traffic, although some weaving may occur. The effect of the highway merger is not included in Figures 4 and 5.

It should be noted that whenever congestion exists in one direction and not in the other, most passengers may use the less congested route without a great penalty in circuity. The alternative to the GCP west followed by BQE is the GCP east followed by the LIE. The alternative to the GCP east followed by the LIE east is the GCP west followed by the BQE and the LIE.

Note also that the segments of highway between the merge and the airport, those segments most likely to experience congestion, are less than two miles long. This, however, does not necessarily reduce the impact of congestion since traffic will back up on the merging highways when congestion on these segments exist.

4.2 Brooklyn-Queens Expressway

The Brooklyn-Queens Expressway (I278) is the major connector for Manhattan's airport related traffic to the Grand Central Parkway. This highway is a particularly important access route to LaGuardia, since a large percentage of airport related vehicles employ this route for the major portion of their trip. The Brooklyn-Queens Expressway is currently operating at level of service "D" for nearly 200 hours per year, and is projected to be operating at level of service "E" for 200 hours per year by the early 1990's (Figure 6). The congestion experienced on this highway will affect close to 60% of airport related traffic. The only viable access highway providing an alternative route to LaGuardia from Manhattan is the Long Island Expressway (LIE). However, the LIE routing is more circuitous and unless major changes take place, the LIE is expected to experience greater congestion than I278.

4.3 Airside Capacity

It should be pointed out that airside capacity for LaGuardia is generally lower than the projected passenger demand. Indeed, currently the airport is operating above its practical annual capacity. This is accomplished by accepting longer delays, by using pricing and reservations schemes to ration capacity in peak periods, and by restricting the normal peaking characteristics of demand.

C. PROPOSED SOLUTIONS

Proposed solutions to the access problems observed at LGA are listed in Table 4. The connector from the BQE to the airport is recommended for the 1981-1985 period, and the people-mover connector is recommended for the 1986-1995 period. Both projects are currently at the proposal stage.

Internal airport improvements are also deemed necessary by the TSRPC to meet the projected demand. Such improvements include terminal development, employee parking lot expansion, and the improvement of the internal access roadway.

In addition, if all interested parties -- the Port Authority State and carriers -- continue to try to influence passengers to use Newark, and if they are successful, it is possible that Newark's excess capacity at present could be better utilized until the mid to late 1980's when Newark itself is expected to approach capacity conditions.

D. CONCLUSIONS

LaGuardia is currently operating at its ground access capacity (L.O.S. "E") due to traffic congestion on the Grand Central Parkway west of the airport. This route is generally used by about two-thirds of the air passengers. The situation is expected to worsen slowly because of the slow growth in non-airport traffic, and because of the availability of alternate routes.

The airport is currently also operating at its airside capacity. This situation is expected to improve slightly in the future due to the use of larger aircraft and higher load factors. Because of the impracticality of comparing the airside and access measures of capacity (PANCAP and level of service "E", respectively), there is no saying whether the airport capacity is constrained more by ground access or whether it is constrained more by the airside. These conclusions differ somewhat from those of the TSRPC which finds that airport access is the constraining factor. The reasons for this difference are primarily the TSRPC's use of level of service "D" versus this study's use of level of service "E" as the constraining capacity of the access system and the TSRPC's assumption that non-airport traffic will grow at the same rate as airport traffic versus this study's more conservative assumption of 1% annual growth in non-airport traffic.

Solutions to the access problems have been proposed, but no action has been taken. Capital programs proposed to increase capacity include a highway connector from the BQE to the airport in the Grand Central Parkway right of way, and a people-mover system from existing transit facilities on the Long Island Railroad and New York City rapid transit system.

TABLE 4

PROPOSED SOLUTIONS TO AIRPORT ACCESS PROBLEMS

Proposed Solutions	Initiator	Agency Respon. for Implemta.	Funding Sources	Est. Cost (1976 Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
A. CONSTRUCTION					
1. Eastbound connection from intersection of Brooklyn-Queens Expressway and Grand Central Parkway extending to 102nd St. inside the right of way of Grand Central Parkway.	TSRPC	*	*	$13,000,000	Proposed by TSRPC. No other action taken.
2. People-mover rail link from Shea Stadium station of Long Island Railroad (Port Washington Branch) via Willets Point subway station of the Flushing IRT line to 3 points in airport terminal area.	TSRPC	MTA	UMTA	$86,000,000	Proposed by TSRPC. No other action taken.
3. Realignment and expansion of internal access system.	TSRPC	Port Authority	User Fees Revenue Bonds	$22,000,000	*

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Proposed Solutions	Initiator	Agency Respon. for Implemta.	Funding Sources	Est. Cost (1976 Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
D. SERVICE IMPROVEMENTS					
1. Coordinated bus/rail service via Long Island Railroad and ITR subway stations at Woodside and the IWD and IRT subway stations at 74th Street.	TSRPC	*	*	*	*

*Not Available or Unknown.

Key of Abbreviations:

MTA = Metropolitan Transportation Authority

TSRPC = Tri-State Regional Planning Commission

UMTA = Urban Mass Transportation Administration

APPENDIX A

ROUTING OF AIRPORT ACCESS TRIPS

BY LOCAL ORIGIN/DESTINATION ZONE

Data compiled from a passenger survey taken in 1972 at LaGuardia International Airport by the Port Authority (see Reference 2) was used to determine passenger originations and destinations. Table A1 shows how survey percentages were distributed to account for 100% percent of the passengers utilizing the ground access system and the assumed routings of these passengers to and from the airport.

TABLE A1

ROUTING OF AIRPORT ACCESS TRIPS

BY LOCAL ORIGIN/DESTINATION ZONE

Zone	Percent Per Survey	Percent as Distributed	Routing	Percent by Route
(1)	(2)	(3)	(4)	(5)
Manhattan, N.Y.	43	48	MTB, LE, I278, GC	48
Bronx, N.Y.	3	3	CB, WB, I678, GC	1.5
			I87, I278, GC	.75
			CB, I87, I287, GC	.75
Brooklyn, N.Y.	4	4	I278, GC	3
			IP, GC	1
Queens, N.Y.	11	12	LE, GC	5
			GC	2
			I278, GC	2
			LE, I278, GC	2
			I678, GC	1
Nassau, N.Y.	7	8	LE, GC	6
			SS, BP, VW, GC	2
Suffolk, N.Y.	3	3	LE, GC	3
Westchester, N.Y.	6	7	I95, WB, I678, GC	3.5
			HP, WB, I678, GC	3.5
Orange/Rockland, N.Y.	1	1	I95, I278, GC	1
Richmond, N.Y.	1	1	I278, GC	1
Connecticut	5	6	I95, WB, I678, GC	6

Zone	Percent Per Survey	Percent as Distributed	Routing	Percent by Route
(1)	(2)	(3)	(4)	(5)
New Jersey/ Pennsylvania	6	7	GB, I87, I278, GC	2
			GB, I87, I278, GC	5

Key:

BP	Belt Parkway
CB	Cross Bronx Expressway
GC	Grand Central Parkway
HP	Hutchinson Parkway
IP	Interborough Parkway
LE	Long Island Expressway
MTB	Manhattan Tunnels and Bridges
WB	Whitestone Bridge
SS	Southern State Parkway
VW	Van Wyck Expressway

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

The capacities of the GCP and the BQE were obtained from the Highway Capacity Manual, Table 9.1, assuming a PHF of .91 and assuming each highway has six lanes. The GCP has eight lanes in the vicinity of the airport, however, the capacity of these lanes is assumed to be significantly reduced by the frequent on-off ramps, seriously reducing the capacity of the outer lanes for through travel and somewhat reducing the capacity of the inner lanes due to weaving. Merges with the Whitestone and Brooklyn-Queens Expressway also reduced capacity. In light of these factors, the simplifying assumption of three through lanes may be optimistic for the GCP.

Airport-related traffic on the access routes was estimated by using Port Authority 1977 traffic counts at the CTA for a Friday, 4 to 5 P.M. in August (5375 vehicles). The peak period traffic was converted to average daily by division by .096 and the daily traffic routed on the access system in accordance with Appendix A.

Non-airport traffic was assumed to grow at an annual rate of 1%. This assumption is based on the following forecasts:

- BEA 1/ SMSA population annual growth rate between 1980 and 1990 of 0.8%;
- BEA 1/ SMSA employment annual growth rate between 1980 and 1990 of 0.9%;

1/ U.S. Department of Commerce, Bureau of Economic Analysis. Area Economic Projections 1990, 1976.

MAP for 1975-75 of 14.1 was obtained from the Tri-State Regional Planning Commission.

- BEA 1/ SMSA earnings in constant dollars in the motor vehicle and equipment industries, annual growth rate between 1980 and 1990 of 2.0%;

- SMM 2/ SMSA population, annual growth rate between 1976 and 1981 of -0.3%;

- SMM 2/ SMSA growth in families between 1976 and 1981 of 1.0%.

The calculations are presented in Tables B1 through B3.

1/ Ibid.

2/ Sales and Marketing Management. 1977 Survey of Buying Power, Part II, October, 1977.

Table B1

AIRPORT ACCESS CAPACITY

GRAND CENTRAL PARKWAY WEST OF AIRPORT

Level of Service 1/ (1)	Hrs./Year 2/ (2)	Factor 3/ (3)	Year 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	89,091	89,091	89,091	89,091	89,091
		2	87,423	91,882	96,569	101,495	106,673
		3	1,668	NA	NA	NA	NA
		4	.64	NA	NA	NA	NA
D	200	1	102,083	102,083	102,083	102,083	102,083
		2	87,423	91,882	96,569	101,495	106,673
		3	14,660	10,201	5,514	588	NA
		4	5.64	3.92	2.12	.23	NA
D	1,000	1	132,432	132,432	132,432	132,432	132,432
		2	87,423	91,882	96,569	101,495	106,673
		3	45,009	40,550	35,863	30,937	25,759
		4	17.30	15.59	13.79	11.89	9.9
E	30	1	109,091	109,091	109,091	109,091	109,091
		2	87,423	91,882	96,569	101,495	106,673
		3	21,668	17,209	12,522	7,596	2,418
		4	8.33	6.62	4.81	2.92	.93
E	200	1	125,000	125,000	125,000	125,000	125,000
		2	87,423	91,882	96,569	101,495	106,673
		3	37,577	33,118	28,431	23,505	18,327
		4	14.45	12.73	10.93	9.04	7.05
E	1,000	1	162,162	162,162	162,162	162,162	162,162
		2	87,423	91,882	96,569	101,495	106,673
		3	74,739	70,280	65,593	60,667	55,489
		4	28.73	27.02	25.22	23.32	21.33

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B2

AIRPORT ACCESS CAPACITY

Grand Central Parkway East of Airport

Level of Service 1/	Hrs./Year 2/	Factor 3/	Year 1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	89,091	89,091	89,091	89,091	89,091
		2	87,423	91,882	96,569	101,495	106,673
		3	1,668	NA	NA	NA	NA
		4	1.22	NA	NA	NA	NA
D	200	1	102,083	102,083	102,083	102,083	102,083
		2	87,423	91,882	96,569	101,495	106,673
		3	14,660	10,201	5,514	588	NA
		4	10.70	7.45	4.02	.43	NA
D	1,000	1	132,432	132,432	132,432	132,432	132,432
		2	87,423	91,882	96,569	101,495	106,673
		3	45,009	40,550	35,863	30,937	25,759
		4	32.85	29.60	26.18	22.58	18.80
E	30	1	109,091	109,091	109,091	109,091	109,091
		2	87,423	91,882	96,569	101,495	106,673
		3	21,668	17,209	12,522	7,596	2,418
		4	15.82	12.56	9.14	5.54	1.76
E	200	1	125,000	125,000	125,000	125,000	125,000
		2	87,423	91,882	96,569	101,495	106,673
		3	37,577	33,118	28,431	23,505	18,327
		4	27.43	24.17	20.75	17.16	13.38
E	1,000	1	162,162	162,162	162,162	162,162	162,162
		2	87,423	91,882	96,569	101,495	106,673
		3	74,739	70,280	65,593	60,667	55,489
		4	54.55	51.30	47.89	44.28	40.50

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B3

AIRPORT ACCESS CAPACITY

Brooklyn-Queens Expressway Between the Grand Central Parkway and the Long Island Expressway

Level of Service 1/	Hrs./Year 2/	Factor 3/	Year 1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	89,091	89,091	89,091	89,091	89,091
		2	62,716	65,915	69,277	72,811	76,525
		3	26,375	23,176	19,814	16,280	12,566
		4	11.26	9.89	8.46	6.95	5.36
D	200	1	102,083	102,083	102,083	102,083	102,083
		2	62,716	65,915	69,277	72,811	76,525
		3	39,367	36,168	32,806	29,272	25,558
		4	16.80	15.44	14.00	12.49	10.91
D	1,000	1	132,432	132,432	132,432	132,432	132,432
		2	62,716	65,915	69,277	72,811	76,525
		3	69,716	66,517	63,155	59,621	55,907
		4	29.76	28.39	26.95	25.45	23.86
E	30	1	109,091	109,091	109,091	109,091	109,091
		2	67,716	65,915	69,277	72,811	76,525
		3	46,375	43,176	39,814	36,280	32,566
		4	19.79	18.43	16.99	15.48	13.90
E	200	1	125,000	125,000	125,000	125,000	125,000
		2	62,716	65,915	69,277	72,811	76,525
		3	62,284	59,085	55,723	52,189	48,475
		4	26.58	25.22	23.78	22.27	20.69
E	1,000	1	162,162	162,162	162,162	162,162	162,162
		2	62,716	65,915	69,277	72,811	76,525
		3	99,446	96,247	92,885	89,351	85,637
		4	42.44	41.08	39.64	38.14	36.55

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

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JOHN F. KENNEDY

INTERNATIONAL AIRPORT

CASE STUDY

CASE STUDY SUMMARY

The John F. Kennedy International Airport (JFK) is the largest of the three major air carrier airports serving the New York metropolitan area. It is by far the most active U.S. port of entry and exit for international travel and international air cargo. In 1976, it handled some 21 million passengers and employed some 40 thousand ground and flight personnel.

The airport is located in the southern section of Queens County, New York, on Jamaica Bay. Primary access to the airport is via the Van Wyck Expressway, a north-south highway which connects to most of the east-west highways in the New York region. Just north of the airport is the Southern Parkway, part of the "Belt System" of highways which surrounds Queens and Brooklyn. Access to the airport is also available directly from local streets in the vicinity.

The case study analysis identified ground access constraints on the capacity of JFK due to traffic congestion on the Van Wyck and Long Island Expressways. Both of these expressways are on the primary route to Manhattan, and the Van Wyck is on the primary route to the Bronx and the Westchester County and Connecticut suburbs. The Southern Parkway, handling the traffic to eastern Long Island is also congested, but it was not analyzed because it carries less than 25% of the air passengers (although it carries a considerably higher percentage of the employees working at the airport).

Solutions proposed to deal with the access constraints include the completion of the Nassau Expressway, widening of the Southern and Laurelton Parkways, and the construction of a rail link to JFK plus a passenger distribution system within the CTA. The highway improvements are expected to cost about $85 million, and the rail system is expected to cost about $470 million. Although the impact of these alternatives on ground access has not been quantified in this case study, the Tri-State Commission believes that their implementation would relieve the access constraint through 1995.

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A. BACKGROUND

1. General

John F. Kennedy International Airport (JFK) is located in the southern section of Queens County, New York, on Jamaica Bay (see Figure 1). It is unquestionably the largest airport in terms of physical size and commercial air traffic in the New York, Tri-State region. Operated by the Port Authority of New York and New Jersey (PANYNJ), Kennedy handles more traffic (especially overseas) than the New York metropolitan population might indicate. The reason for this proportionately high demand for air travel is twofold. First, New York's predominant role as a business capital influences particularly the demand for domestic flights in the area. Second, the economic advantages of having a centralized location for transfers from domestic to overseas flights supports Kennedy's position as a major international terminal. This function as an international gateway also accounts for the high percentage of transfer passengers at Kennedy (approximately 30%) versus LaGuardia or Newark.

Approximately 32% of all air passenger traffic at Kennedy can be attributed to Manhattan, 15 miles away. Other significant numbers of airport-related vehicles originate in the heavily populated areas surrounding the airport (i.e., Queens, Brooklyn, and Nassau Counties). In 1976, Kennedy Airport handled approximately 21 million passengers.

2. Transportation Planning Structure

The three major airports in the New York region, LaGuardia, Kennedy, and Newark, are operated by the Port Authority of New York and New Jersey. The Port Authority, as an agency of both states, is composed of 12 commissioners which are appointed--six each by th governors of the two states--for overlapping six-year terms. Both governors hold veto power over the minutes of the meetings of the commissioners. The Port Authority is self-supporting, receiving funds from user fees and revenue bonds.

Regional transportation planning is the responsibility of the Tri-State Regional Planning Commission (TSRPC), the designated MPO for an area covering 21 counties (located in New York, New Jersey, and Connecticut) in the New York metropolitan area. The Port Authority is a non-voting member of the TSRPC, and works closely with the agency in developing and coordinating aviation and airport access plans.

At the state level, the Port Authority interfaces with the New York State Department of Transportation and the Metropolitan Transportation Authority in developing access plans for Kennedy. The three agencies are each members of the Aviation Technical Committee of the TSRPC, and, in addition, work closely with one another outside the framework of the TSRPC.

3. Highway Access

Figure 2 shows the highway access system serving JFK and the assumed distribution of airport traffic upon it. The airport is located directly on the Van Wyck Expressway. The Van Wyck is a major north-south highway connecting to

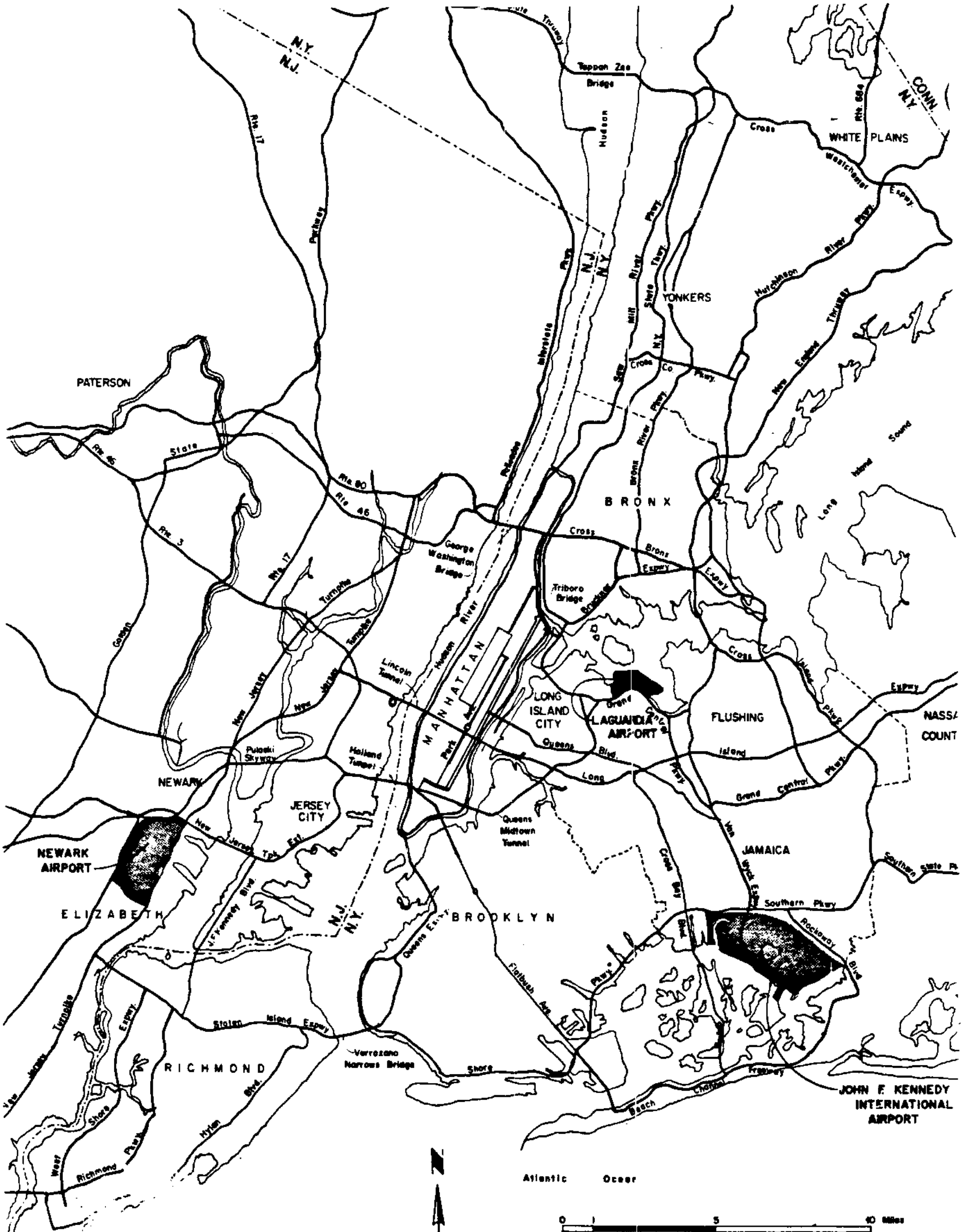

Figure 1

NEW YORK CITY REGION

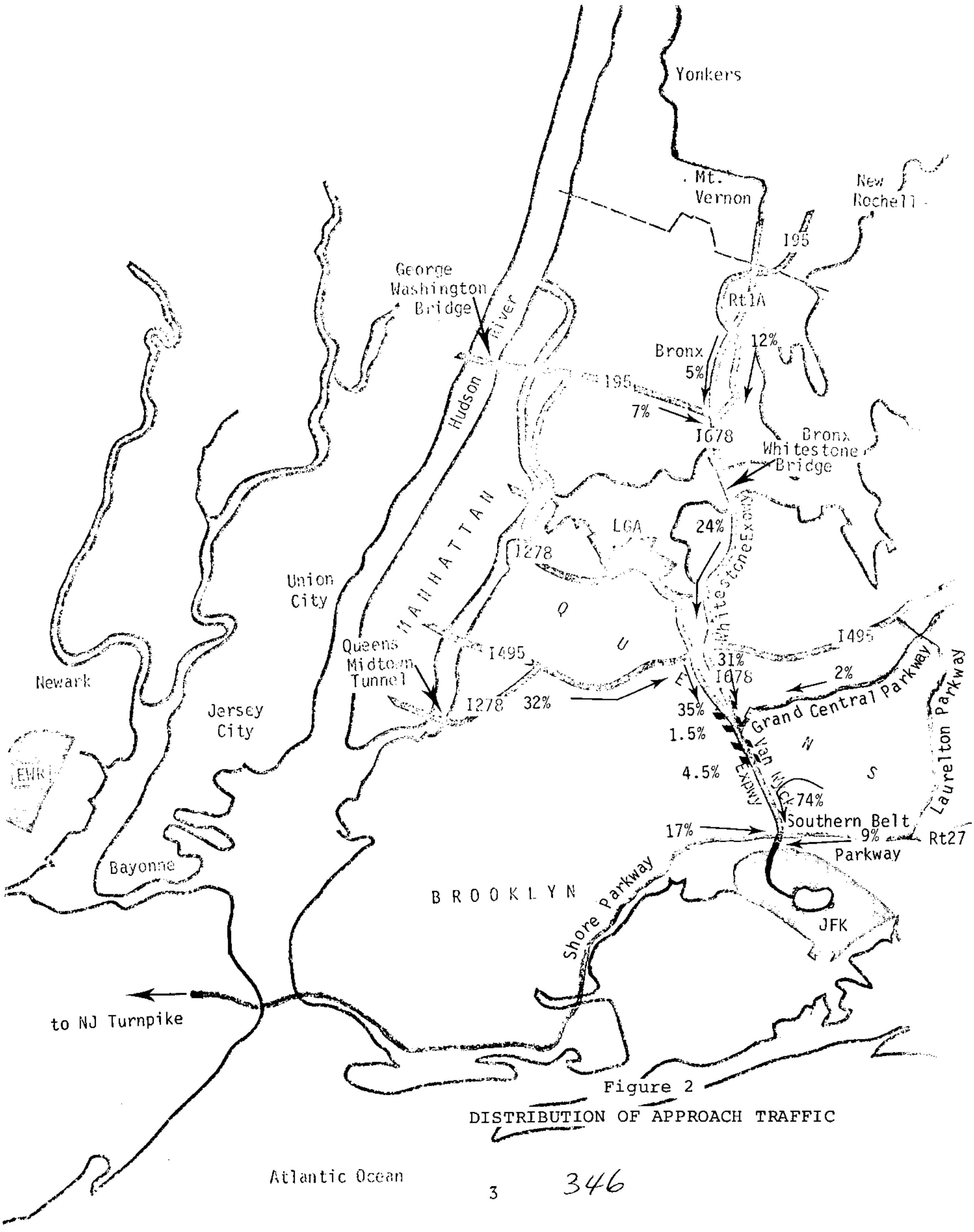

Figure 2
DISTRIBUTION OF APPROACH TRAFFIC

east-west highways serving Long Island and New York City and to I678 which accesses highways in the Bronx, Westchester County and Connecticut. The major routing to Manhattan is via the Van Wyck and Long Island Expressways. The Southern Parkway, just north of the airport boundary, runs east-west serving southern Queens and Brooklyn (where it becomes the Shore, or Belt Parkway) and southern Nassau County (as the Southern State), and connects to the major north-south expressways in Long Island.

Access to the airport is available to knowledgable travelers and employees from the Southern Parkway and local streets via 150th Street. This route bypasses the Van Wyck/Southern Parkway interchange, a frequent source of congestion.

As a measure of the extent of the access systems congestion problem, a recent update of the Federal Highway Administration's continuing airport access analysis program indicated that travel time from Manhattan (at the Queens-Midtown Tunnel) to the airport was 40 minutes during peak periods, but only 22 minutes in off-peak periods.

4. Transit Access 1/

The Carey Transporation Company provides frequent express type bus service between JFK and the East Side Airlines Terminal in Manhattan. The running times are variable depending upon traffic conditions, but generally can be expected to be between 40 and 75 minutes. The present fare of $4.00 per passenger is much less than the $12.00 taxi fare between the same two points. The Manhattan terminus of this service, located at First Avenue and 36th Street interfaces poorly with other public transporation facilities, particularly subways, resulting in additional travel time and out-of-pocket costs.

Carey also provides an inter-airport shuttle between JFK and LaGuardia airports at half hour and hourly headways, depending on the time of day, for passengers desiring to make connecting flights. The fare is $2.50 per passenger and the running time is about 30 minutes.

The Q-10 local bus operated by Green Bus provides frequent service between JFK and points in Queens including the IND subway stations at Lefferts Boulevard and Kew Gardens. The fare at 50¢ is comparable to other local New York City transit service.

The LIRR Jamaica Station is a bit less than four miles from JFK. There is no direct bus service available at present between these two points, although it is possible to take a taxi for about $4.00. Frequent rail service is available to Penn Station, Flatbush Avenue in Brooklyn as well as points east in Nassua and Suffolk Counties.

Limousine service to and from Nassau, Suffolk and Westchester is readily available. Limited limousine service between JFK and points in Connecticut and New Jersey is also available.

1/ First five paragraphs are quoted from Reference 6.

The 1972 mode split is shown in Table 1. Auto is the predominant mode of travel to JFK, accounting for over 55% of the passenger access trips. The remaining trips are split almost evenly between taxi service on the one hand, and limousine/bus on the other. The mode split varies substantially by local zone, with Manhattan being most different from the others. Only for the Manhattan zone does the auto share fall below 45%, and in this zone it falls to 25%.

5. Internal Access

Figure 3 shows the internal access system at JFK. The airport has nine separate passenger terminals and five different parking lots accessed via a complex three-ring roadway. The system is designed so that it is unnecessary for every vehicle using the curbside to pass by every terminal (as is the case with a single roadway loop). This feature is essential since most JFK passengers, being on long-haul, medium-haul, and international trips, carry a great deal of luggage, and consequently stop at the terminal curbside, instead of going directly to parking areas. There are disadvantages, however, since the complex signing required to direct passengers to the appropriate terminal, parking, or exit roadways, can confuse vehicles and tends to slow down or even to halt traffic.

The terminal roadway system is accessed via either the Van Wyck extension (the signed approach from the highway system) or the 150th Street/Farmers Boulevard extension. The latter entry can be reached from local streets or from the Southern Parkway, and passes through the main cargo complex before reaching the terminals. Cargo and maintenance buildings also line the Van Wyck extension, and may be reached via separate service roads having limited access to the extension.

B. CAPACITY ANALYSIS

1. Passenger Forecast

The two passenger forecasts used in the study were taken from the most recent FAA report, Terminal Area Forecasts, 1978-1988, and a forecast prepared by the Tri-State Regional Planning Commission. The FAA forecast extends only until 1988 and is projected to 1995 at the 1983-1988 growth rate. The Tri-State Commission's forecast extends to 1995 and is interpolated for 1990. The TSRPC forecast is adjusted for anticipated ground access congestion and assumes that planned roadway and transit improvements are implemented. These forecasts are presented in Table 2.

2. Airside Capacity

Table 3 presents the calculations that were made to determine airside capacity at Kennedy. Interpolation between the existing practical annual

TABLE 1

MODE SPLIT OF ACCESS TO JFK

County of Origin	Percentage by Mode: Auto	Percentage by Mode: Taxi	Percentage by Mode: Limo/Bus	Average Day Departing Passengers
(1)	(2)	(3)	(4)	(5)
Connecticut	62%	1%	37%	951
New Jersey	70	4	19	1,527
New York City				
Bronx	70	28	2	949
Kings	72	21	6	1,897
Manhattan	25	39	35	5,799
Queens	61	22	15	2,340
Richmond	84	6	3	182
Other New York State				
Nassau	82	10	8	1,530
Suffolk	83	8	8	708
Westchester	69	15	15	936
Other	73	5	17	384
TOTAL	55	22	21	17,203

* Percentages may not add to 100 because of unreported access modes.

Note: Departing air passengers originating outside of the Tri-State region are not included in this tabulation.

Source: Reference 6.

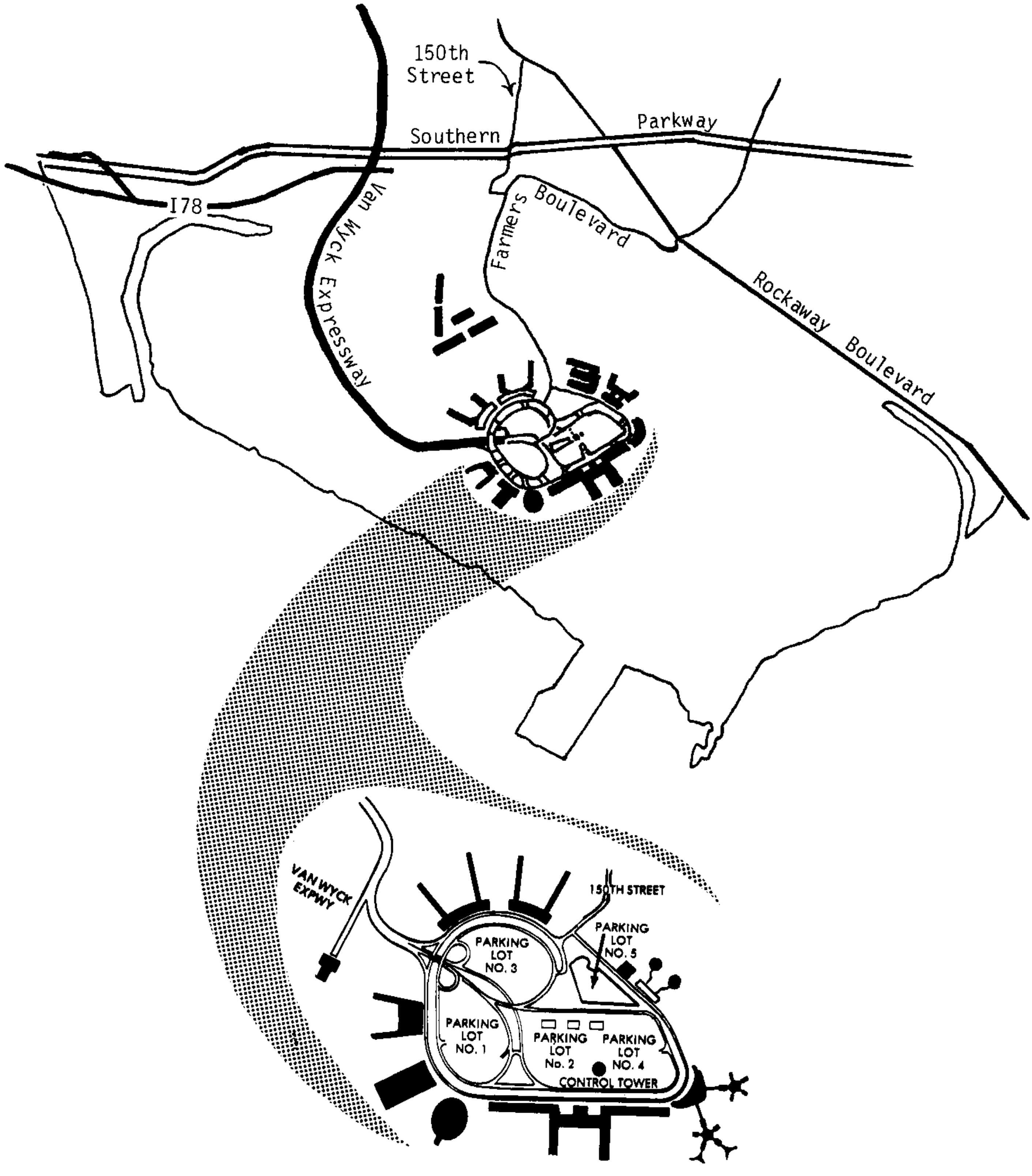

Figure 3

INTERNAL ACCESS ROADWAY SYSTEM

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TABLE 2

FORECAST OF DEMAND

(Million Annual Passengers)

Year	Tri-State Regional Planning Commission	FAA
(1)	(2)	(3)
1975-76	21.0 1/	21.0 1/
1980	26.1	26.3
1985	31.0	34.0 2/
1990	33.6 2/	43.6 3/
1995	36.3	55.9 3/

1/ Actual.

2/ Interpolated.

3/ Extended.

TABLE 3

CALCULATION OF AIRSIDE CAPACITY

Year	PANCAP 1/	% Air Carrier 2/	Passenger/ Operations 3/	Passenger Capacity
(1)	(2)	(3)	(4)	(5)
Conservative				
1975	319,000	84	64.7	17.3
1980	310,945	84	71.4	18.6
1985	302,689	84	78.9	20.1
1990	294,223	84	87.1	21.5
1995	290,000	84	96.1	23.4
Optimistic				
1975	319,000	84	77.6	20.8
1980	310,945	84	94.4	24.7
1985	302,689	84	114.9	29.2
1990	294,223	84	139.8	34.6
1995	290,000	84	170.0	41.4

1/ PANCAP interpolated between 1975 and 1995.

2/ Source: FAA Air Traffic Activity, Calendar Year 1975.

3/ Conservative uses existing value (Source: Port Authority Monthly Airport Traffic Reports) and assumes 2% annual growth in aircraft capacity. Optimistic assumes 20% increase (Approximately 10 point load factor increase) on top of 4% annual growth in aircraft capacity.

capacity (PANCAP) and the PANCAP projected for 1995 by the TSRPC, 1/ provided the base for our calculations. The percentage of air carrier operations were derived from FAA information on air traffic activity and was assumed to remain constant through 1995. Conservative projections for passengers per operation were based on existing figures assuming a two percent annual increase in aircraft capacity. 2/ Optimistic figures assumed a 20% increase over a 4% annual increase in aircraft capacity. PANCAP was then converted to annual passenger capacities by applying the factors for percent of air carrier and passengers per operation.

3. Ground Access Capacity

Current airport ground trips were assigned to major highways as described in Appendix A. The following three critical highway locations were identified:

(1) The Van Wyck Expressway just north of the Southern Parkway;

(2) The Long Island Expressway west of the Grand Central Parkway and east of the Brooklyn-Queens Expressway; and

(3) The Whitestone Bridge.

The bridges and tunnels between Manhattan and the Brooklyn-Queens Expressway, in aggregate, form a critical highway location. However, because of the large variety of possible routings for each destination within Manhattan, it was impossible to perform a capacity analysis on this aggregate highway link.

Non-airport traffic on the roadway access system serving JFK was projected to grow at 1% per year. Support for this assumption and others, and documentation of the access capacity calculations, is presented in Appendix B. The resulting graphs for the critical highway locations are shown in Figures 4 through 6.

4. Interpretation

4.1 Van Wyck Expressway

The Van Wyck Expressway is the primary access highway to Kennedy International Airport. Approximately three quarters of all passenger traffic use the Van Wyck for some portion of their trip to the airport. The Van Wyck is

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1/ Source: TSRPC, Airspace Inventory, Airspace Analysis Airport Capacity: An Airport Systems Planning Report, September, 1977.

The PANCAP figure is adjusted to reflect airspace capacity and prevailing noise-avoidance procedures.

2/ The low growth rate in aircraft size reflects the fact that a large percentage of current JFK operations are performed by widebodied aircraft, leaving relatively little opportunity to expand aircraft size much further.

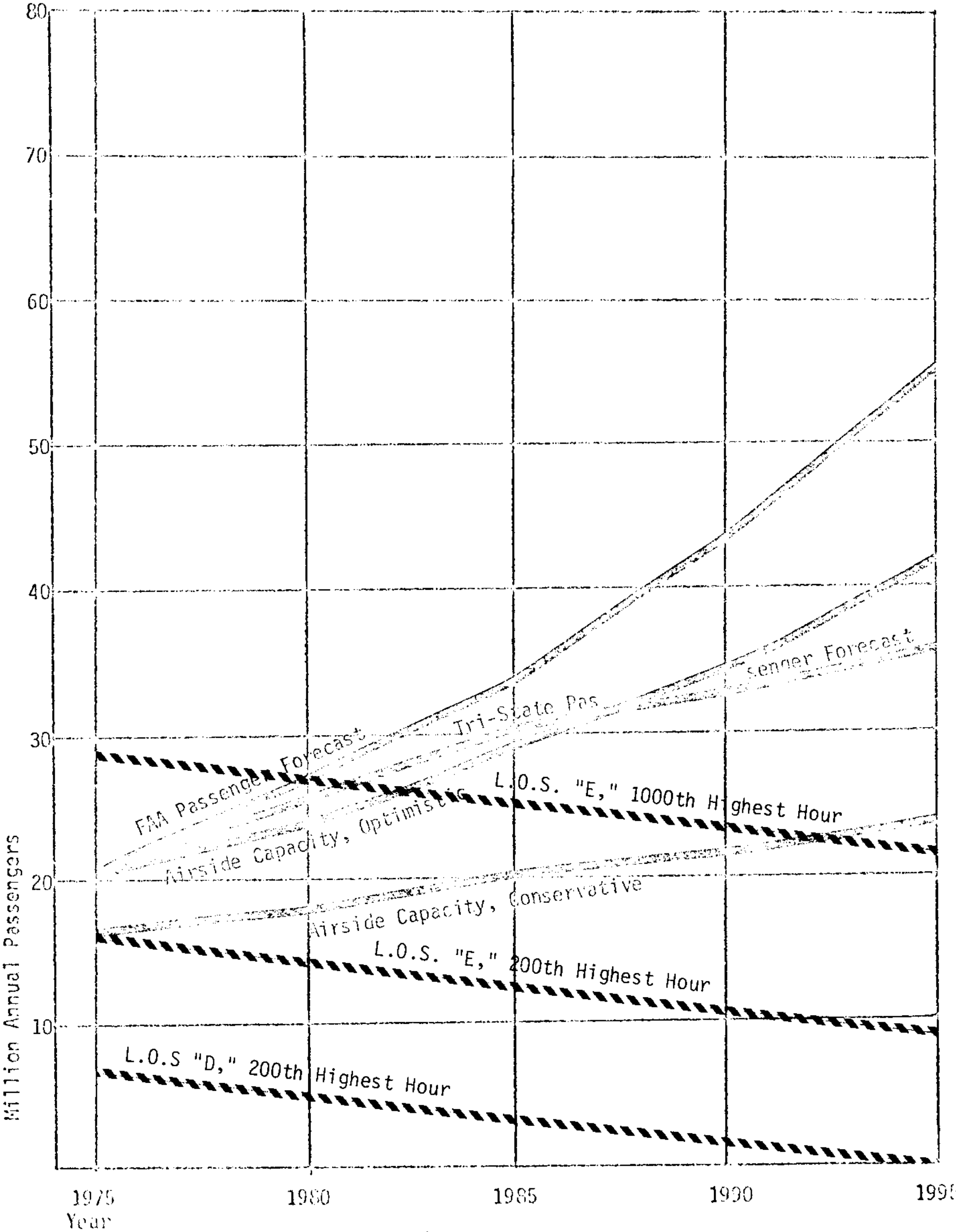

Figure 4

DEMAND/CAPACITY RELATIONSHIPS

Van Wyck Expressway

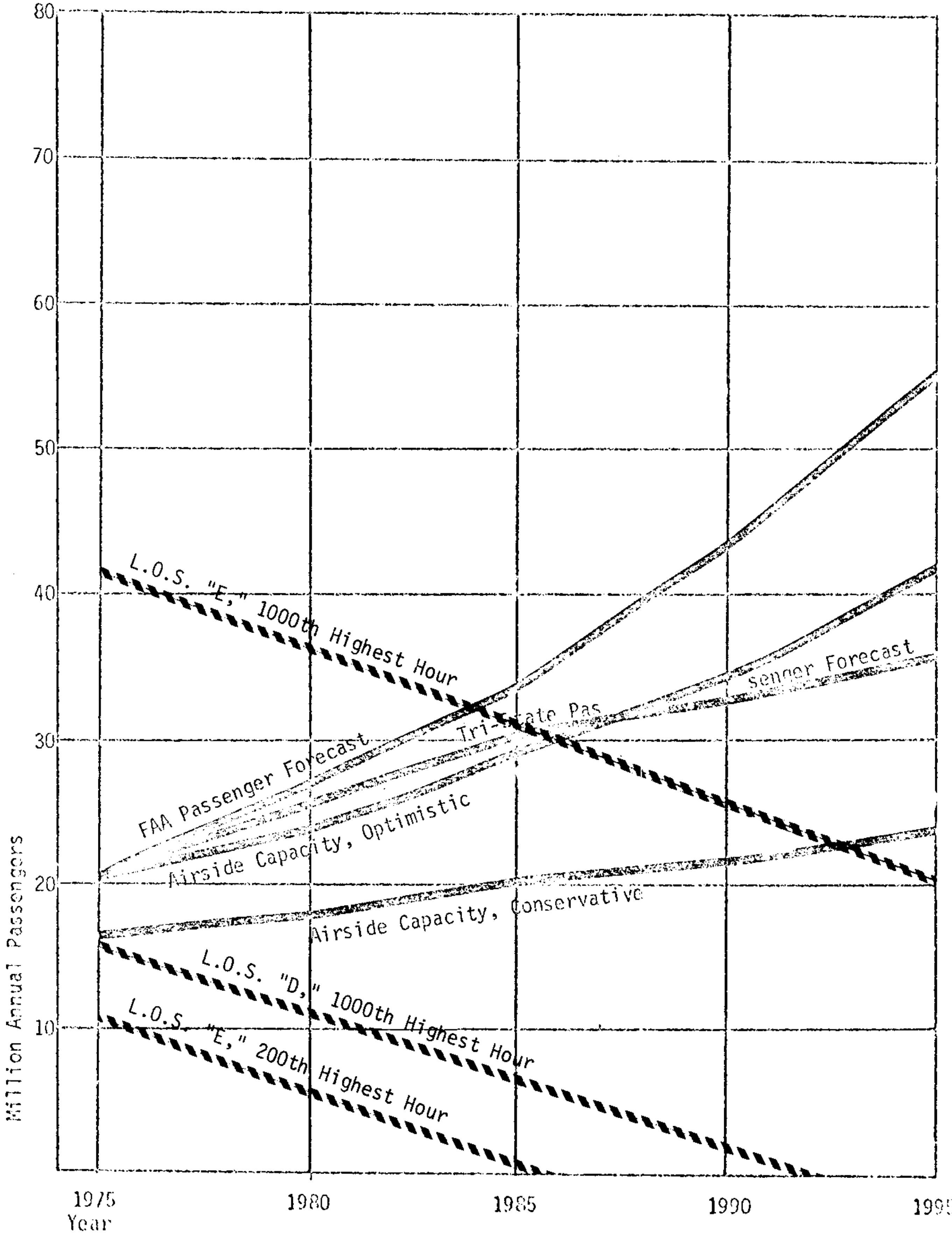

Figure 5

DEMAND/CAPACITY RELATIONSHIPS

Long Island Expressway West of Grand Central
and East of Brooklyn-Queens Expressway

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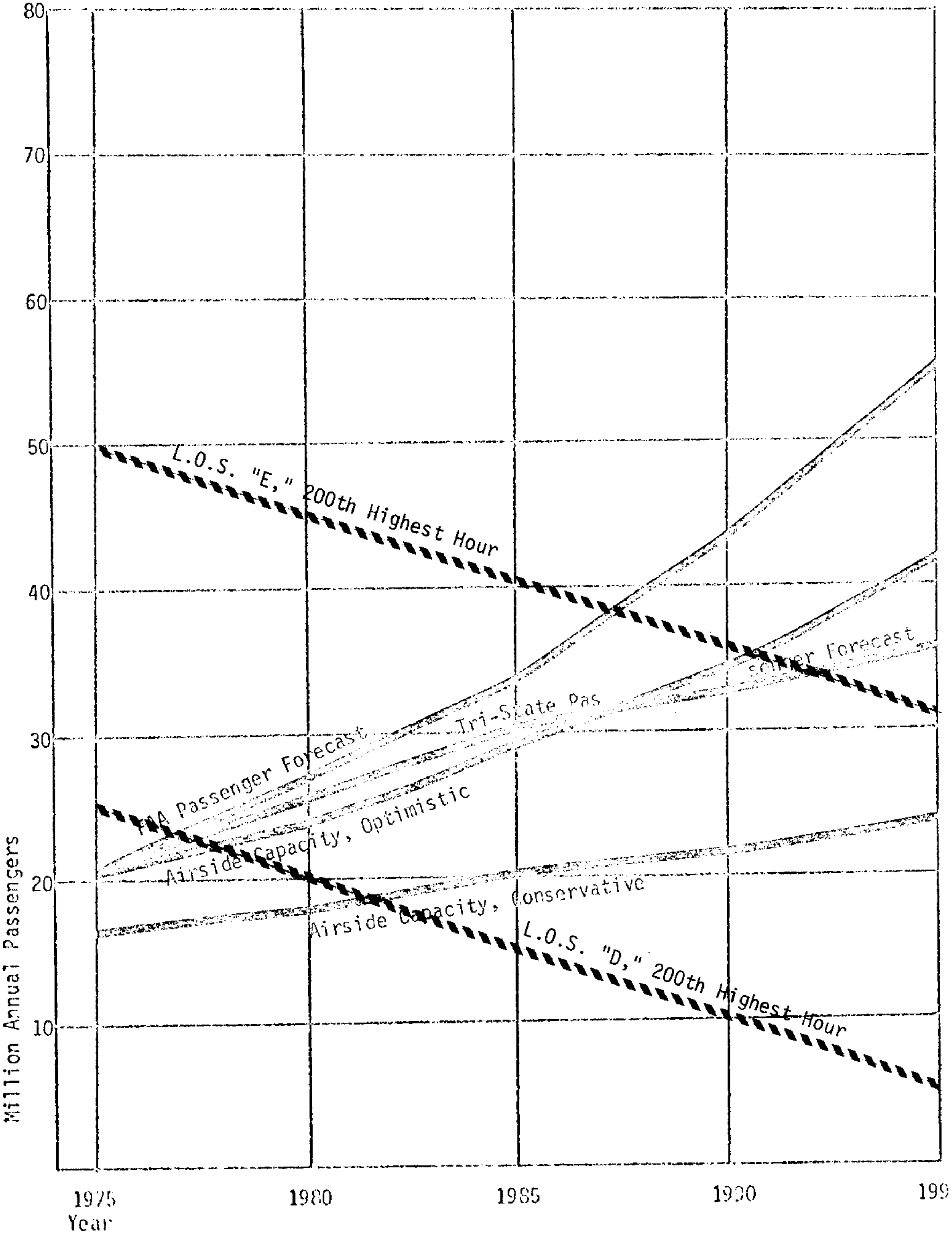

Figure 6
DEMAND/CAPACITY RELATIONSHIPS
Whitestone Bridge 13

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currently operating at level of service "E" for over 200 hours per year. By 1981 or 1982, our analysis shows that this highway will be operating at level of service "E" for 1,000 hours per year (see Figure 4). Large percentages of airport related vehicles originating in Manhattan and north of the Whitestone Bridge, generally use the Van Wyck for a large segment of their trips to Kennedy. There are no convenient alternate routings for these passengers, thereby placing additional importance on the need for a solution to the Van Wyck congestion problem.

4.2 Long Island Expressway

Figure 5 graphically depicts the congestion problem on the Long Island Expressway (LIE) and its impact on air passenger demand. Currently the LIE, at the point of observation in this study, is operating at level of service "D" for more than 1,000 hours per year, and level of service "E" is expected for approximately 1,000 hours per year by 1985. The LIE is a segment of the most direct routing from midtown Manhattan, thereby accounting for approximately one-third of all airport related vehicles.

4.3 Whitestone Bridge

Congestion on the Whitestone Bridge is not expected to reach the proportions of the Van Wyck and Long Island Expressways. The present level of service on the Whitestone Bridge is "D" for approximately 200 hours per year. The bridge is part of the major route serving air passengers from several New York counties to the north, as well as travelers from Connecticut and New Jersey.

4.4 Airside Capacity

Airside capacity is generally expected to be lower than the passenger demand at Kennedy International. Indeed, currently the airport is operating above its practical capacity. This is accomplished by accepting longer delays, by using pricing and reservations schemes to ration capacity in peak periods, and by restricting the normal peaking of demand.

4.5 Employees

About 40,000 people are employed at JFK, which because of its maintenance and cargo centers has one of the highest ratios of employees to passengers in the country. Over 75 percent of residential origins of airport employees are in Queens and Nassau Counties. This is in marked contrast to the dispersed characteristics of passenger origins-destinations. The large number and local nature of employee access trips could lead to certain inaccuracies in the conclusions for JFK. Because at other case study airports data on employee local origins were generally unavailable and employee access was less of a problem, the methodology developed makes certain inherent assumptions, explained in Section I.B of the Airport Ground Access Addendum, that may not be accurate for JFK. As a result, employees using the central terminal area have been assumed to be distributed on the highway network and to grow in proprortion to airport traffic. Both of these assumptions tend to overestimate the congestion problem on the route to Manhattan, although congestion on the Van Wyck is probably estimated accurately. Also, congestion on routes heavily used by employees, specifically the Southern, 150th Street and Farmers Blvd., is not considered because these routes are used by less than 25% of air travellers. Thus, it is conceivable that airport growth is constrained by insufficient capacity in the access systems to handle employee growth and that this constraint has been ignored by the analysis. However, this possibility is unlikely because some of the employee activity (specifically FAA and other office personnel) could be moved to off-airport locations and because the employee access trip is more amendable (than the passenger access trip) to vehicle-reducing alternatives such as carpooling and mini-bus demand-responsive or fixed-route systems.

C. PROPOSED SOLUTIONS

Proposed solutions to the access problems observed at JFK are listed in Table 4. In addition, many aspects of the regional rail plan, such as the Long Island Railroad's planned East Midtown facility and 63rd Street Line would enhance transit access if the JFK airport rail line is built.

In addition, if all interested parties -- the Port Authority State and carriers -- continue to try to influence passengers to use Newark, and if they are successful, it is possible that Newark's access capacity at present could be better utilized until the mid to late 1980's when Newark itself is expected to approach capacity conditions.

D. CONCLUSIONS

The John F. Kennedy International Airport is currently operating at its ground access capacity (L.O.S. "E") due to traffic congestion on the Van Wyck and Long Island Expressways. About three-quarters of the air passengers generally use one or both of these highways.

The airport is currently also operating at its airside capacity. This situation is expected to improve slightly in the future due to the use of larger aircraft and higher load factors. Because of the impracticality of comparing the airside and access measures of capacity without reference to level of service (PANCAP and level of service "E", respectively), there is no saying whether the airport capacity is constrained more by ground access or whether it is constrained more by the airside. These conclusions differ somewhat from those of the TSRPC, which finds that airport access is the constraining factor. The reasons for this difference are primarily the TSRPC's use of level of service "D" versus this study's use of level of service "E" as the constraining capacity of the access system and the TSRPC's assumption that non-airport traffic will grow at the same rate as airport traffic versus this study's more conservative assumption of 1% annual growth in non-airport traffic.

TABLE 4

PROPOSED SOLUTIONS TO AIRPORT ACCESS PROBLEMS

Proposed Solutions	Initiator	Agency Resp. for Implem.	Funding Source	Est. Cost (1976 Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
A. CONSTRUCTION					
1. Completion of Nassau Expressway along northern edge of airport and related extension of service roads of Van Wyck Expressway to the Southern Parkway.	*	NYDOT	FHWA	$30,000,000 (only for portions that will increase access capacity to JFK)	Completion expected by 1985.
2. Completion of two Eastbound and two Westbound lanes on Southern Parkway between 150th St. and Laurelton Parkway.	TSRPC	NYDOT	FHWA	$25,000,000 (includes cost of item 3 below)	Study proposed.
3. Addition of one Northbound lane on Laurelton Parkway for lane balancing purposes from Southern to Cross Island Parkway.	TSRPC	NYDOT	FHWA	See Item 2	Study proposed.

Proposed Solutions	Initiator	Agency Resp. for Implem.	Funding Source	Est. Cost (1976 Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
4. Direct rail link from Manhattan and Jamaica via the Long Island Railroad along abandoned Rego Park-Ozane Park line and extension into the terminal area with connection to an internal transit system.	TSRPC	MTA PANYNJ	UMTA, ADAP Use- fees, Revenue Bonds	$400,000,000 off airport; $70,000,000 on airport	Part of regional rail plan (see Reference 5) Off-airport funds are programmed. Project is undergoing reevaluation and other alternatives are being considered.
5. Improve internal roadways, parking	TSRPC	PANYNJ	ADAP, User fees, Revenue Bonds	$188,000,000	*

*Not available or unknown.

ADAP Airport Development Aid Program

FHWA Federal Highway Administration

MTA New York State Mass Transit Authority

NYDOT N.Y. Dept. of Transportation

PANYNJ Port Authority of New York and New Jersey

TSRPC Tri-State Regional Planning Commission

UMTA Urban Mass Transportation Administration

Several solutions to these access problems have been proposed. Highway development proposals include the completion of the Nassau Expressway, a project which has been on the books since the 1920's and which is now expected to be completed by 1985, and the widening of the Southern and Laurelton Expressways in order to relieve Van Wyck corridor congestion and add to overall access capacity. Transit development proposals include direct rail access from Manhattan via the (abandoned) Rego Park-Ozone Park Line, a new extension into the terminal area, and a passenger distribution system within the CTA. The TSRPC has analyzed this transit development under the assumption that it will operate on 15 minute or better headways, with running times of 22 minutes to Penn Station and 21 minutes to the East Side (plus an additional 10 minutes on the inter-terminal system) and at a fare of $2.00.

Of the proposed solutions, the transit system offers the most relief to the Manhattan passenger, and will help to reduce congestion on the LIE and the Van Wyck. The widening of the Laurelton and Southern Parkways will improve access from Eastern Long Island, and should divert many non-airport users of the Van Wyck. Completion of the Nassau Expressway is expected to relieve congestion in the Van Wyck/Southern Parkway interchange by providing additional and alternate access routes to and from the airport at 150th Street. The majority of the more than 40,000 employees working at the airport will also benefit by this improved routing, thus enhancing the passenger access to the Central Terminal Area. In summary, it appears that the proposed solutions, if they are implemented, will help relieve the ground access constraint. The TSRPC has concluded that the implementation of these plans would, in fact, completely remove the access constraint, but this issue has not been addressed in this case study.

APPENDIX A

ROUTING OF AIRPORT ACCESS TRIPS BY LOCAL ORIGIN/DESTINATION ZONE

Data compiled from a passenger survey taken in 1972 at Kennedy International Airport by the Port Authority (see Reference 2) was used to determine passenger originations and destinations. Table A1 shows how survey percentages were distributed to account for 100% of the passengers utilizing the ground access system and the assumed routings of these passengers to and from the airport.

TABLE A1

ROUTING OF AIRPORT ACCESS TRIPS

BY LOCAL ORIGIN/DESTINATION ZONE

Zone	Percent Per Survey	Percent as Distributed	Routing	Percent by Route
(1)	(2)	(3)	(4)	(5)
Manhattan, N.Y.	23	32	MT, LE, VW	32
Bronx, N.Y.	4	6	CB, WB, VW	4
			I95, WB, VW	2
Brooklyn, N.Y.	8	11	SP	8
			AA, VW	1.5
			RB, VW	1.5
Queens, N.Y.	9	12	BP	3
			GC, VW	3
			LE, VW	3
			VW	3
Nassau, N.Y.	6	8	SS, LP, BP	2
			GC, LP, BP	2
			GC, VW	2
			LE, LP, BP	2
Suffolk, N.Y.	3	4	LE, VW	2
			LE, LP, VW	2
Westchester, N.Y.	4	6	I95, WB, VW	3
			HP, WB, VW	3
Putnam/Duchess, N.Y.	1	1	HP, WB, VW	1
Richmond, N.Y.	1	1	I278, SP	1
Orange/Rockland, N.Y.	1	1	I87, CC, HP, WB, VW	1
Connecticut	5	7	I95, WB, VW	7

Zone	Percent Per Survey	Percent as Distributed	Routing	Percent by Route
(1)	(2)	(3)	(4)	(5)
New Jersey/ Pennsylvania	8	11	I95, I278, SP	8
			GB, CB, WB, VW	3

KEY:

AA Atlantic Avenue

BP Belt Parkway (Southern Parkway)

CB Cross Bronx Expressway

CC Cross County Parkway

GB George Washington Bridge

GC Grand Central Parkway

HP Hutchinson Parkway

LE Long Island Expressway

LP Laurelton and Cross Island Parkways

MT Queens Midtown Tunnel or Brooklyn-Queens Expressway and other tunnels and bridges

RB Rockaway Boulevard

SP Shore Parkway

SS Southern State Parkway

VW Van Wyck Expressway

WB Whitestone Bridge

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

The capacities of the Van Wyck Expressway, the LIE, and the Whitestone Bridge were obtained from the Highway Capacity Manual, Table 9.1, assuming a PHF of .91. The toll plaza at the Whitestone Bridge was not assumed to impose any constraint since there is room for expansion of the plaza at its current site, if necessary.

Total traffic entering the airport (75,875 ADT) was calculated from information provided by the Port Authority of N.Y. and N.J. The 1975 MAP (21 million) was obtained from the Tri-State Regional Planning Commission.

Non-airport traffic was assumed to grow at an annual rate of 1%. this assumption is based on the following forecasts:

- BEA 1/ SMSA population annual growth rate between 1980 and 1990 of 0.8%;
- BEA 1/ SMSA employment annual growth rate between 1980 and 1990 of 0.9%;
- BEA 1/ SMSA earnings in constant dollars in the motor vehicle and equipment industries, annual growth rate between 1980 and 1990 of 2.0%;
- SMM 2/ SMSA population, annual growth rate between 1976 and 1981 of -0.3%;
- SMM 2/ SMSA growth in families between 1976 and 1981 of 1.0%.

The calculations are presented in Tables B1 through B3.

1/ U.S. Department of Commerce, Bureau of Economic Analysis. Area Economic Projections 1990, 1976.

2/ Sales and Marketing Management. 1977 Survey of Buying Power, Part II, October, 1977.

Table B1

AIRPORT ACCESS CAPACITY

Van Wyck Expressway

Level of Service[1/] (1)	Hrs./Year[2/] (2)	Factor[3/] (3)	Year 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	89,090	89,090	89,090	89,090	89,090
		2	83,852	88,129	92,625	97,349	102,315
		3	5,238	961	NA	NA	NA
		4	1.96	.36	NA	NA	NA
D	200	1	102,083	102,083	102,083	102,083	102,083
		2	83,852	88,129	92,625	97,349	102,315
		3	18,231	13,954	9,458	4,734	NA
		4	6.82	5.22	3.54	1.77	NA
D	1,000	1	132,432	132,432	132,432	132,432	132,432
		2	83,852	88,129	92,625	97,349	102,315
		3	48,580	44,303	39,807	35,083	30,117
		4	18.17	16.57	14.89	13.12	11.26
E	30	1	109,091	109,091	109,091	109,091	109,091
		2	83,852	88,129	92,625	97,349	102,315
		3	25,239	20,962	16,466	11,742	6,776
		4	9.44	7.84	6.16	4.39	2.53
E	200	1	125,000	125,000	125,000	125,000	125,000
		2	83,852	88,129	92,625	97,349	102,315
		3	41,148	36,871	32,375	27,651	22,685
		3	15.39	13.79	12.11	10.34	8.48
E	1,000	1	162,162	162,162	162,162	162,162	162,162
		2	83,852	88,129	92,625	97,349	102,315
		3	78,310	74,033	69,537	64,813	59,847
		4	29.29	27.69	26.00	24.24	22.38

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B2

AIRPORT ACCESS CAPACITY

.g Island Expressway West of Grand Central
and East of Brooklyn-Queens Expressway

Level of Service 1/	Hrs./Year 2/	Factor 3/	Year 1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	89,091	89,091	89,091	89,091	89,091
		2	113,020	118,785	124,844	131,212	137,905
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	200	1	102,083	102,083	102,083	102,083	102,083
		2	113,020	118,785	124,844	131,212	137,905
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	1,000	1	132,432	132,432	132,432	132,432	132,432
		2	113,020	118,785	124,844	131,212	137,905
		3	19,412	13,647	7,588	1,220	NA
		4	16.79	11.80	6.56	1.06	NA
E	30	1	109,091	109,091	109,091	109,091	109,091
		2	113,020	118,785	124,844	131,212	137,905
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
E	200	1	125,000	125,000	125,000	125,000	125,000
		2	113,020	118,785	124,844	131,212	137,905
		3	11,980	6,215	156	NA	NA
		4	10.36	5.38	.13	NA	NA
E	1,000	1	162,162	162,162	162,162	162,162	162,162
		2	113,020	118,785	124,844	131,212	137,905
		3	49,142	43,377	37,318	30,950	24,257
		4	42.51	37.52	32.28	26.77	20.98

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B3

AIRPORT ACCESS CAPACITY

Whitestone Bridge

Level of Service[1/]	Hrs./Year[2/]	Factor[3/]	Year 1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	89,091	89,091	89,091	89,091	89,091
		2	80,290	84,386	88,690	93,213	97,968
		3	8,801	4,705	401	NA	NA
		4	10.15	5.43	.46	NA	NA
D	200	1	102,083	102,083	102,083	102,083	102,083
		2	80,290	84,386	88,690	93,213	97,968
		3	21,793	17,697	13,393	8,870	4,115
		4	25.14	20.41	15.45	10.23	4.75
D	1,000	1	132,432	132,432	132,432	132,432	132,432
		2	80,290	84,386	88,690	93,213	97,968
		3	52,142	48,046	43,742	39,219	34,464
		4	60.14	55.42	50.45	45.24	39.75
E	30	1	109,091	109,091	109,091	109,091	109,091
		2	80,290	84,386	88,690	93,213	97,968
		3	28,801	24,705	20,401	15,878	11,123
		4	33.22	28.49	23.53	18.31	12.83
E	200	1	125,000	125,000	125,000	125,000	125,000
		2	80,290	84,386	88,690	93,213	97,968
		3	44,710	40,614	36,310	31,787	27,032
		4	51.57	46.84	41.88	36.66	31.18
E	1,000	1	162,162	162,162	162,162	162,162	162,162
		2	80,290	84,386	88,690	93,213	97,968
		3	81,872	77,776	73,472	68,949	64,194
		4	94.43	89.71	84.74	79.53	74.04

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

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NEWARK

INTERNATIONAL AIRPORT

CASE STUDY

CASE STUDY SUMMARY

Newark International Airport is one of three major air carrier airports serving the New York Metropolitan area. In 1976 it served 6.8 million passengers, of which less than 6% connected to other flights.

Located in New Jersey, less than fifteen miles southwest of Manhattan, Newark International attracts only about 8% of the passengers originating in Manhattan, and derives over 75% of its passengers from points in New Jersey. The Tri-State Regional Planning Commission, the MPO for the New York Metropolitan Area, has proposed the increased utilization of Newark as a means to offset and reverse growing ground access problems at LaGuardia and Kennedy Airports. However, in order to increase the utilization of Newark, more passengers will have to be attracted from Manhattan.

The primary access route to Newark International is the New Jersey Turnpike, a north-south toll highway used by about 54% of originating passengers. The Turnpike serves New York City via several bridges and tunnels, and directly serves the fast-growing suburbs to the south of the airport. Capacity analyses show that the turnpike will not be a problem until the 1990's.

U.S. Route 21, serving about one-quarter of the originating air passengers, is expected to reach level of service "E" for over 200 hours per year in the early 1980's; however, it is expected that level of service "E" will not reach 1000 hours per year until after 1995.

If Newark International succeeds in attracting more passengers from Manhattan, the Lincoln and Holland Tunnels will operate at level of service "E" for more than 200 hours per year until the late 1980's and for more than 1000 hours per year thereafter. This makes it unlikely that Newark can significantly reduce the loads on the access highway systems of the other New York airports. Proposals to resolve the problem of inadequate ground access between New York and Newark International have centered around improved transit and taxi access. One solution that received a lot of attention was proposed construction of a passenger distribution system connecting the terminal with a proposed PATH station near the airport. However, it now appears unlikely that the PATH system will be extended. Consequently, the best active proposals are now the improvement of shuttle bus service between the airport and Penn Station Newark and the reduction of taxi fees between New York City and the airport.

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A. BACKGROUND

1. General

Newark International Airport (EWR) is one of three major air carrier airports serving the New York metropolitan area. It is located in northeastern New Jersey, partially in the City of Newark and partially in the City of Elizabeth, less than fifteen miles southwest of Manhattan (see Figure 1). It is operated by the Port Authority of New York and New Jersey (PANYNJ).

In 1976, EWR served 6.8 million passengers, of which less than 6% connected to other flights. Of the originating passengers, over 75% come from points in New Jersey, points which are inconvenient to LaGuardia and JFK Airports. However, Newark attracts less than 8% of passengers originating in Manhattan, a low percentage considering that the airport is closer than JFK International is to Manhattan.

The primary access route to EWR is the New Jersey Turnpike, a north-south toll highway used by about 54% of originating passengers. The Turnpike connects to the Holland and Lincoln Tunnels to Manhattan, the Verrazano Bridge to Brooklyn, and the George Washington Bridge to upper Manhattan, the Bronx, Queens and Westchester. To the south of the airport, the Turnpike serves the rapidly growing suburban areas of New Jersey.

2. Transportation Planning Structure

The three major airports in the New York region, LaGuardia, Kennedy, and Newark, are operated by the Port Authority of New York and New Jersey. The Port Authority, as an agency of both states, is composed of twelve commissioners which are appointed--six each by the governors of the two states--for overlapping six-year terms. Both governors hold veto power over the minutes of the meetings of the commissioners, and although this power is rarely used, it has been used on occasion. The Port Authority is self-supporting, receiving funds from user fees and revenue bonds.

Regional transportation planning is the responsibility of the Tri-State Regional Planning Commission (TSRPC), the designated MPO for an area covering 21 counties (located in New York, New Jersey, and Connecticut) in the New York metropolitan area. The Port Authority is a non-voting member of the TSRPC, and works closely with the agency in developing and coordinating aviation and airport-access plans.

At the state level, the Port Authority interfaces with the New Jersey Department of Transportation and the New Jersey Turnpike Authority in developing access plans for Newark.

3. Highway Access

Figure 2 shows the highway access system serving Newark and the distribution of airport-related traffic upon it. The airport is located at the

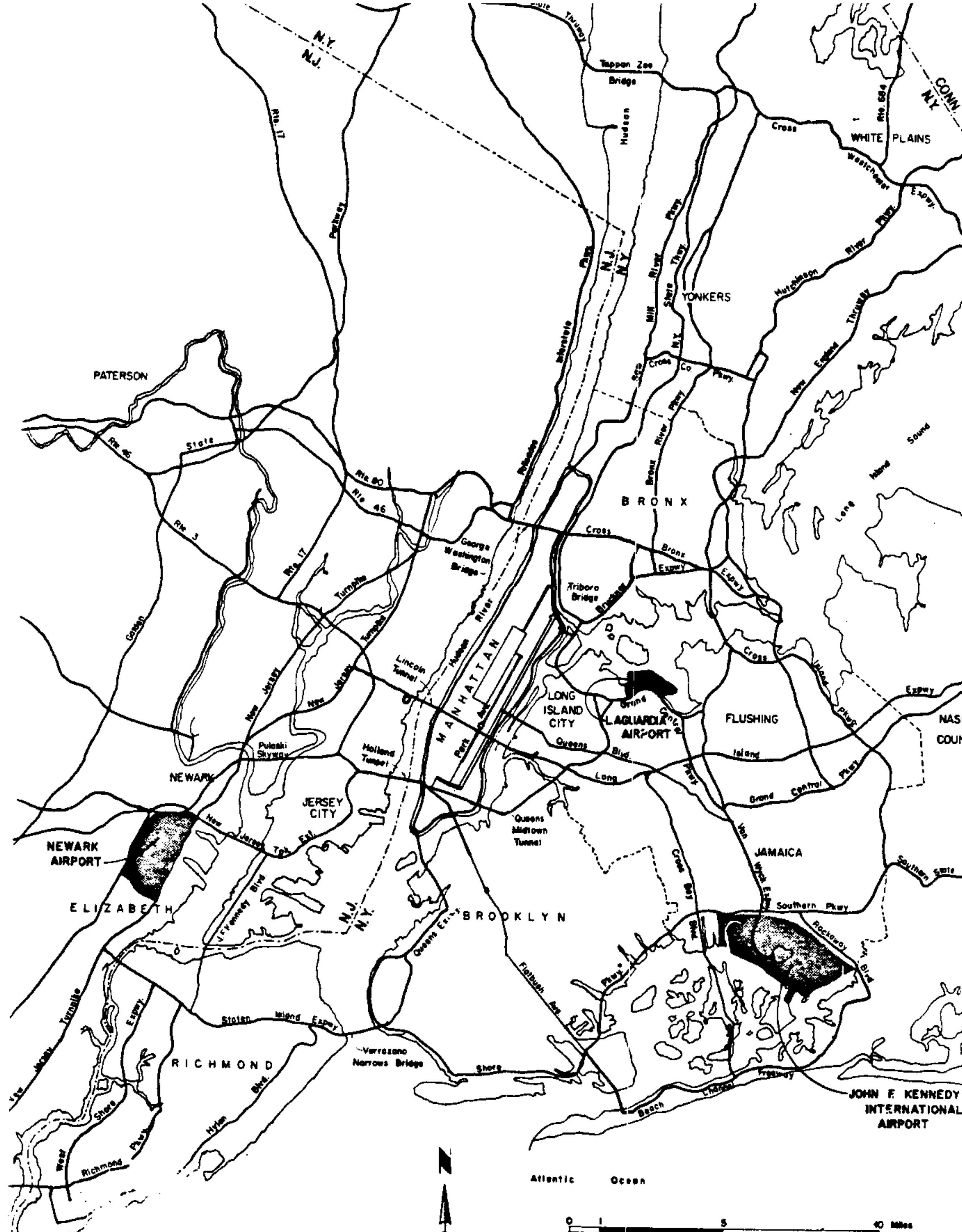

Figure 1

NEW YORK CITY REGION

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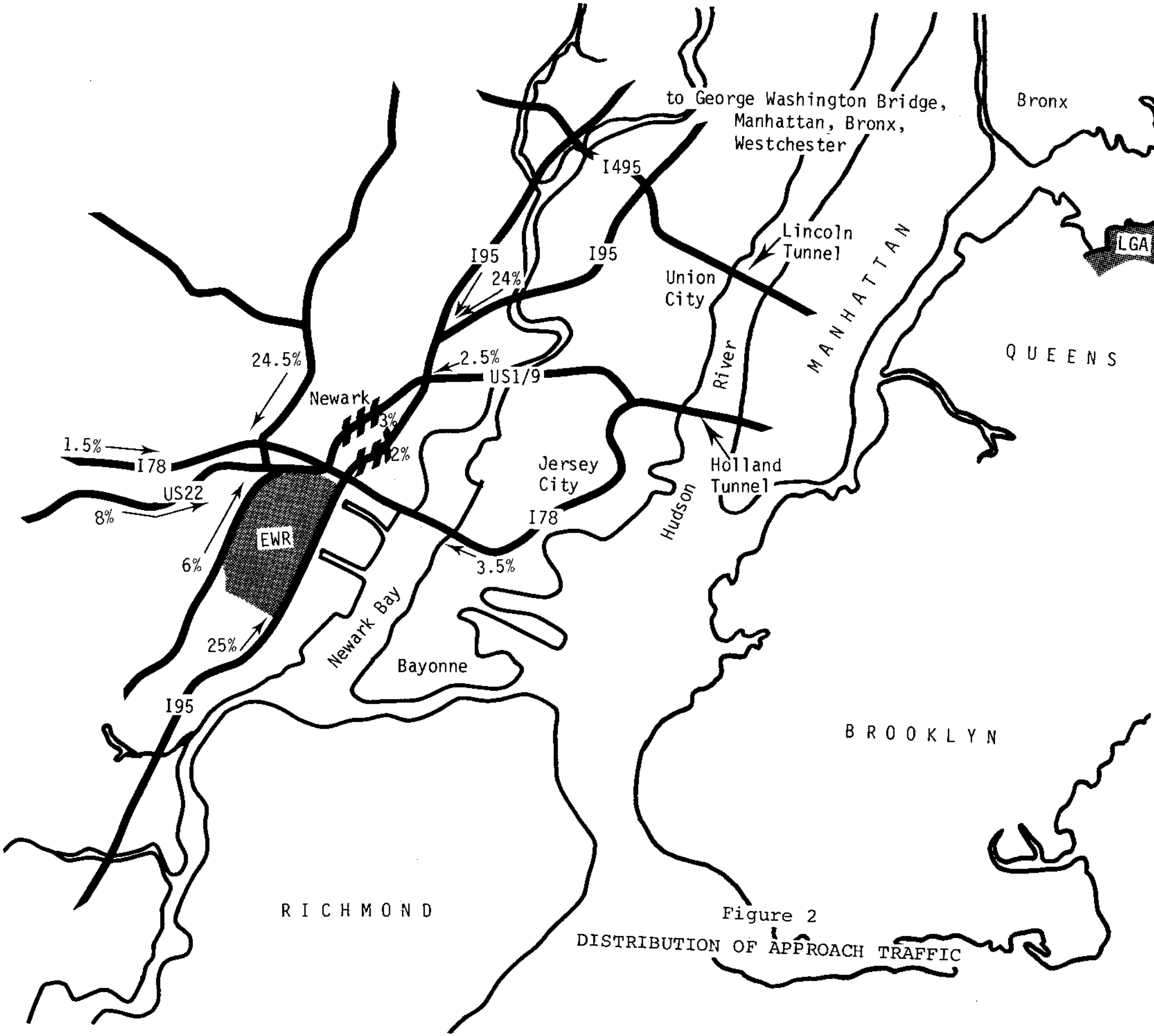

Figure 2
DISTRIBUTION OF APPROACH TRAFFIC

intersection of five major thoroughfares, the New Jersey Turnpike, Interstate 78, U.S. Routes 1 and 9, U.S. Route 22, and New Jersey Route 21. The Turnpike handles about 54% of the originating passenger traffic, directly serving the fast growing suburbs south of the airport, and also serving New York City via the Lincoln and Holland Tunnels and the Verrazano and George Washington Bridges. Route 21, the McCarter Highway, is a signaled four-lane arterial north of the airport to Interstate 280, and a limited access highway just north of the Interstate.

As a measure of the extent of the access systems congestion problem, a recent update of the Federal Highway Administration's continuing airport access analysis program indicated that travel time from Manhattan (Holland Tunnel entrance) to airport was 32 minutes during peak periods, but only 23 minutes in off-peak periods.

4. Transit Access 1/

The TNJ 107A bus provides frequent and quick service between the new terminal buildings and midtown Manhattan (Port Authority Bus Terminal). The scheduled running time is 26 minutes via the New Jersey Turnpike. The present fare is $1.75 per passenger. Regular 107 buses also provide service to the old terminal area at a fare of $1.25.

A number of rail services are available at Penn Station-Newark, which is only about three miles from Newark Airport. Penn Central, Central Rail Road of New Jersey, and PATH trains all stop here as well as at the Newark city subway.

Local bus service between the airport and Penn Station-Newark is provided by "Airlink" and the TNJ #21 bus, which meanders through local streets. The #21 service is generally frequent, but not all buses terminate at the airport, the result of which is an effective headway of about 45 minutes during most of the day.

Taxi service is available to Newark, but the fare at $4.00 - $7.00 is rather high considering the length of the trip. As an alterative, scheduled limousine service at $1.50 per passenger is also available at approximately

1/ First five paragraphs quoted from Reference 6.

hourly headways between the airport and various center city locations including Penn Station-Newark. 1/

Taxi service from New York City to Newark Airport is readily available, but at twice the meter rate (about $25 from Manhattan) for New York City medallioned cabs. The double rate is applied because these cabs are not permitted to pick up passengers at Newark Airport (or any other point outside of New York City) and must return empty. Passengers are charged tolls for the entire round trip of the vehicle

The 1972 split of airport ground access modes is shown in Table 1. The auto mode accounts for approximately 73% of passenger trips. Over one-half of the limousine/bus patronage to the airport originates in Manhattan, and the limosine/bus mode accounts for over 55% of the EWR passengers originating in Manhattan.

5. Internal Access

Figure 3 shows the internal access system at EWR. Access to the terminal area is available directly from Routes 1-9, Route I78, and the New Jersey Turnpike. The three main terminals (one of which remains uncompleted due to lack of demand) are connected with a two-tiered (arrival and departure) circular roadway. Parking for 8,200 cars is provided in six at-grade lots--two short-term, three long-term--and one reduced-rate (extra long-term). Access to the North Terminal--the main terminal until 1973--is available also from Routes I-9, Interstate 78 and the Turnpike, as well as from the main terminal area via Brewster Road.

B. CAPACITY ANALYSIS

1. Passenger Forecast

The two passenger forecasts used in the study were taken from the most recent FAA report, Terminal Area Forecasts, 1978-1988, and a forecast prepared by the Tri-State Regional Planning Commission. The FAA forecast extends only until 1988 and is projected to 1995 at the 1983-1988 growth rate. The Tri-State Commission's forecast extends to 1995 and is interpolated for 1990. These forecasts are presented in Table 2.

1/ Not reported in Reference 6 is the "Air Link" mini-bus service operating at 20 minute headways between the airport and several locations in downtown Newark, including Penn Station-Newark, and priced at $1.25 per passenger.

TABLE 1

MODE SPLIT OF ACCESS TO EWR

County of Origin	Percentage by Mode Auto	Taxi	Limo/Bus	Average Day Departing Passengers
(1)	(2)	(3)	(4)	(5)
Connecticut	87	0	13	53
New Jersey				
Essex	77	14	8	1521
Other	85	7	7	4449
New York City				
Manhattan	23	21	55	1140
Other	61	11	18	329
Other New York State	80	4	14	195
Total	74	11	15	7687

*Percentages may not add to 100 because of unreported access modes

Note: Departing air passengers originating outside of the Tri-State region are not included in the tabulation.

Source: The Port Authority of New York and New Jersey.

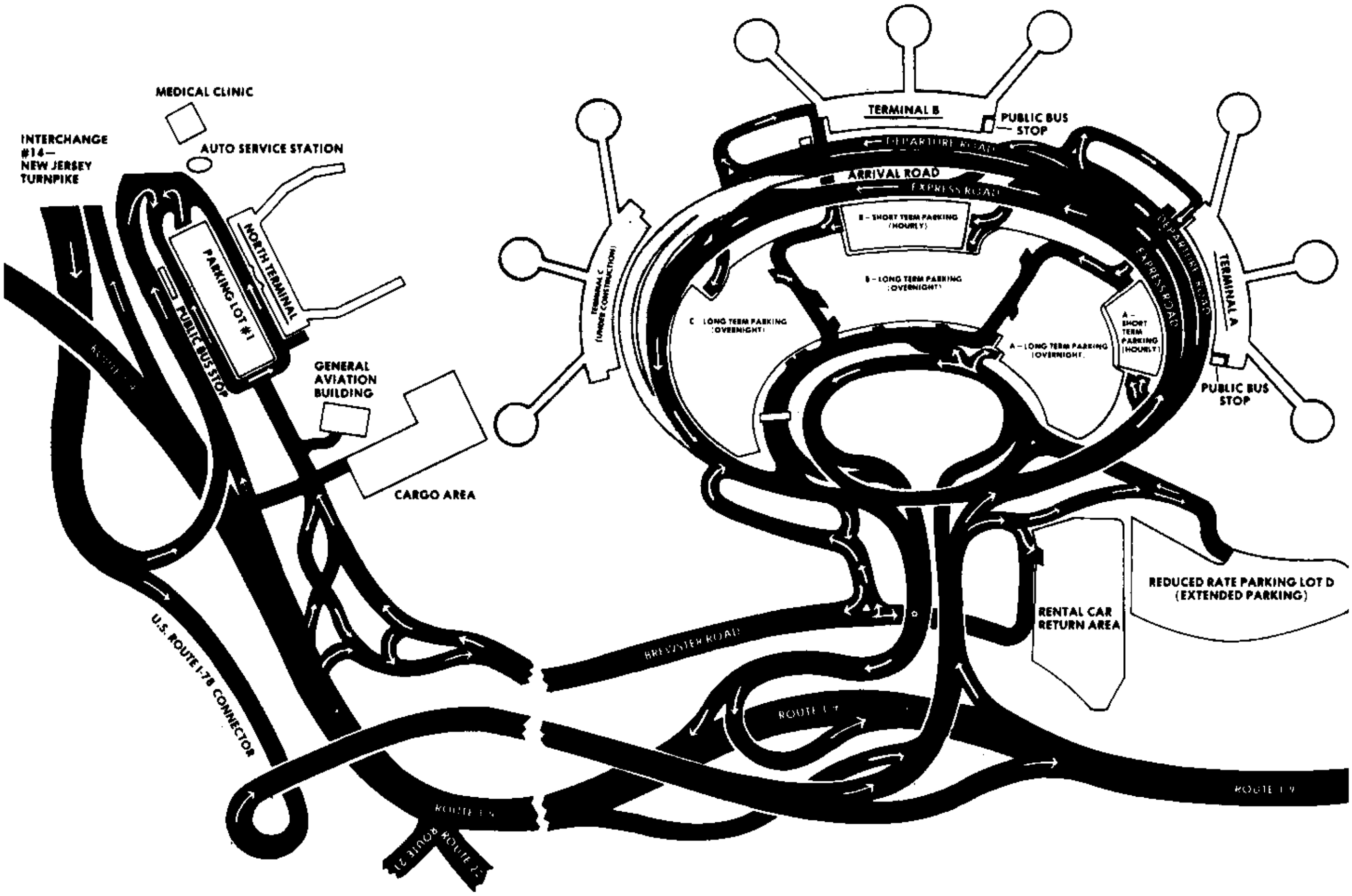

Figure 3
INTERNAL ACCESS ROADWAY SYSTEM

TABLE 2

FORECAST OF DEMAND

(Million Annual Passengers)

Year	Tri-State Regional Planning Commission	FAA
(1)	(2)	(3)
1975-76	6.8 1/	6.8 1/
1980	8.7	8.2
1985	12.0	10.8 2/
1990	15.6 2/	14.0 3/
1995	20.2	18.2 3/

1/ Actual.

2/ Interpolated.

3/ Extended.

2. Airside Capacity

Table 3 presents the calculations that were made to determine airside capacity at Newark. Interpolation between the existing practical annual capacity (PANCAP) and the PANCAP projected for 1995 by the TSRPC 1/ provided the base for our calculations. The percentage of air carrier operations were derived from FAA information on air traffic activity and was assumed to remain constant through 1995. Conservative projections for passengers per operation were based on existing figures assuming a four percent annual increase in aircraft capacity. Optimistic figures assumed a 20% increase over the conservative forecast, representing an increase of about 10 points in the enplaned load factor. PANCAP was then converted to annual passenger capacities by applying the factors for percent of air carrier and passengers per operation.

3. Ground Access Capacity

Current airport ground trips were assigned to major highways as described in Appendix A. The following three critical highway locations were identified:

(1) New Jersey Turnpike north of the airport;

(2) New Jersey Turnpike south of the airport; and

(3) Route 21 north of the airport.

Since currently, only 12 to 13 percent of Newark's originations are from Manhattan, the Lincoln and Holland Tunnels were not considered to be part of Newark's access system for purposes of the case study analysis. However, because the increased utilization of Newark Airport could help reduce ground access congestion at LaGuardia and Kennedy Airports, the case study looks at an alternative scenario in which EWR captures one-third of the passengers from Manhattan. In this scenario, the tunnels are part of the access system to EWR and their capacity to handle the airport traffic is evaluated.

The assumptions inherent in the ground access capacity analyses and the calculations supporting the analyses are presented in Appendix B. The resulting graphs for the critical highway segments and the combined Lincoln/Holland Tunnels are shown in Figures 4 through 7.

1/ Source: TSRPC, Airspace Inventory, Airspace Analysis Airport Capacity: An Airport Systems Planning Report, September, 1977.

The PANCAP figure is adjusted to reflect airspace capacity and prevailing noise-avoidance procedures.

TABLE 3

CALCULATION OF AIRSIDE CAPACITY

Year (1)	PANCAP 1/ (2)	% Air Carrier 2/ (3)	Passengers/ Operations 3/ (4)	Passenger Capacity (5)
Conservative				
1975	280,000	68	37.7	7.2
1980	272,930	68	45.9	8.5
1985	265,684	68	55.8	10.1
1990	258,252	68	67.9	11.9
1995	255,000	68	82.6	14.3
Optimistic				
1975	280,000	68	45.2	8.6
1980	272,930	68	55.1	10.2
1985	265,684	68	67.0	12.1
1990	258,252	68	81.5	14.3
1995	255,000	68	99.1	17.2

1/ PANCAP interpolated between 1975 and 1995.

2/ Source: FAA Air Traffic Activity, Calendar year 1975.

3/ Conservative uses existing value, Source: Port Authority Monthly Airport Traffic Reports.

Assumes 4% annual increase in aircraft capacity.

Optimistic assumes 20% increase (approximately 10 point load factor increase).

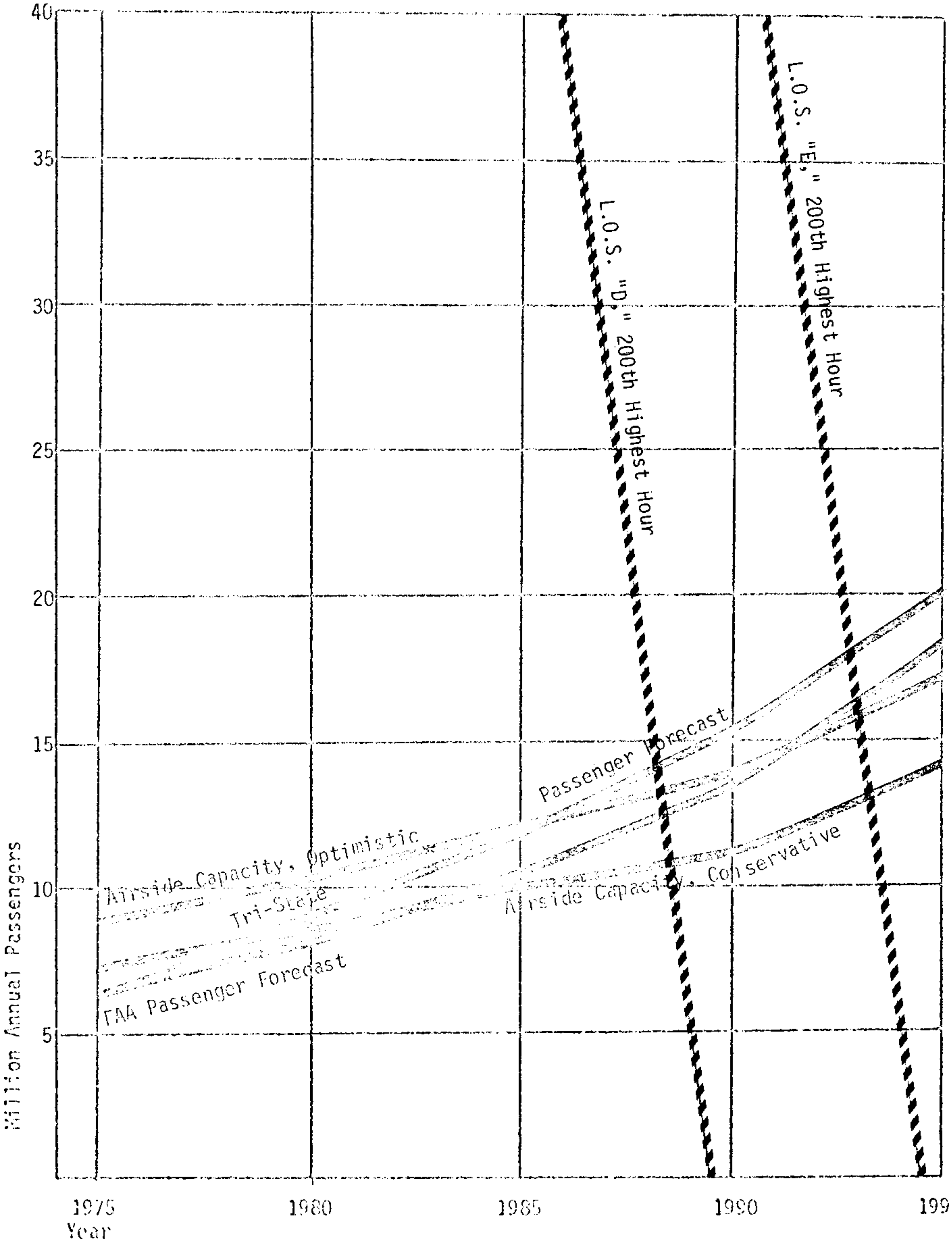

Figure 4

DEMAND/CAPACITY RELATIONSHIPS

N. J. Turnpike North of Airport 384

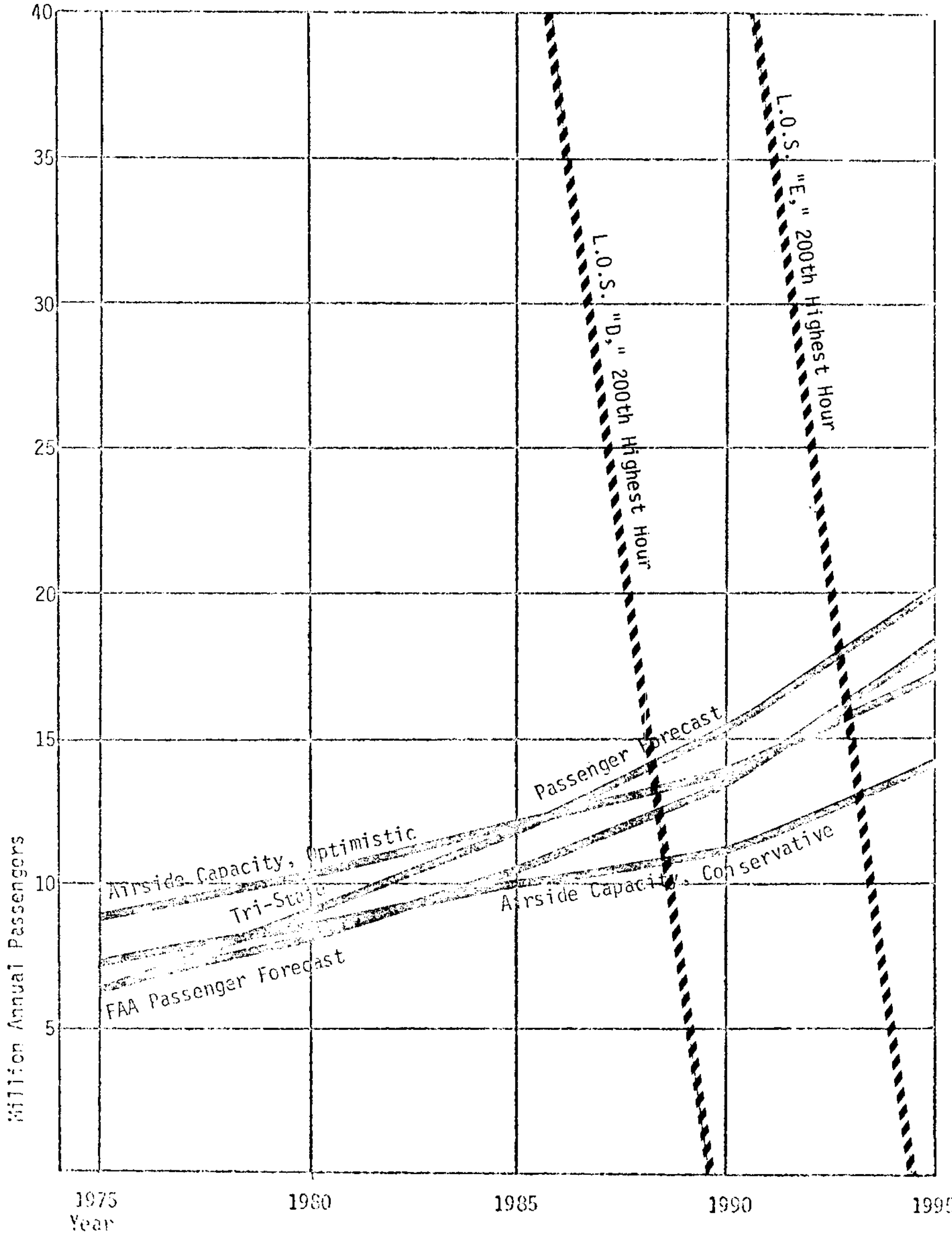

Figure 5

DEMAND/CAPACITY RELATIONSHIPS

N. J. Turnpike South of Airport

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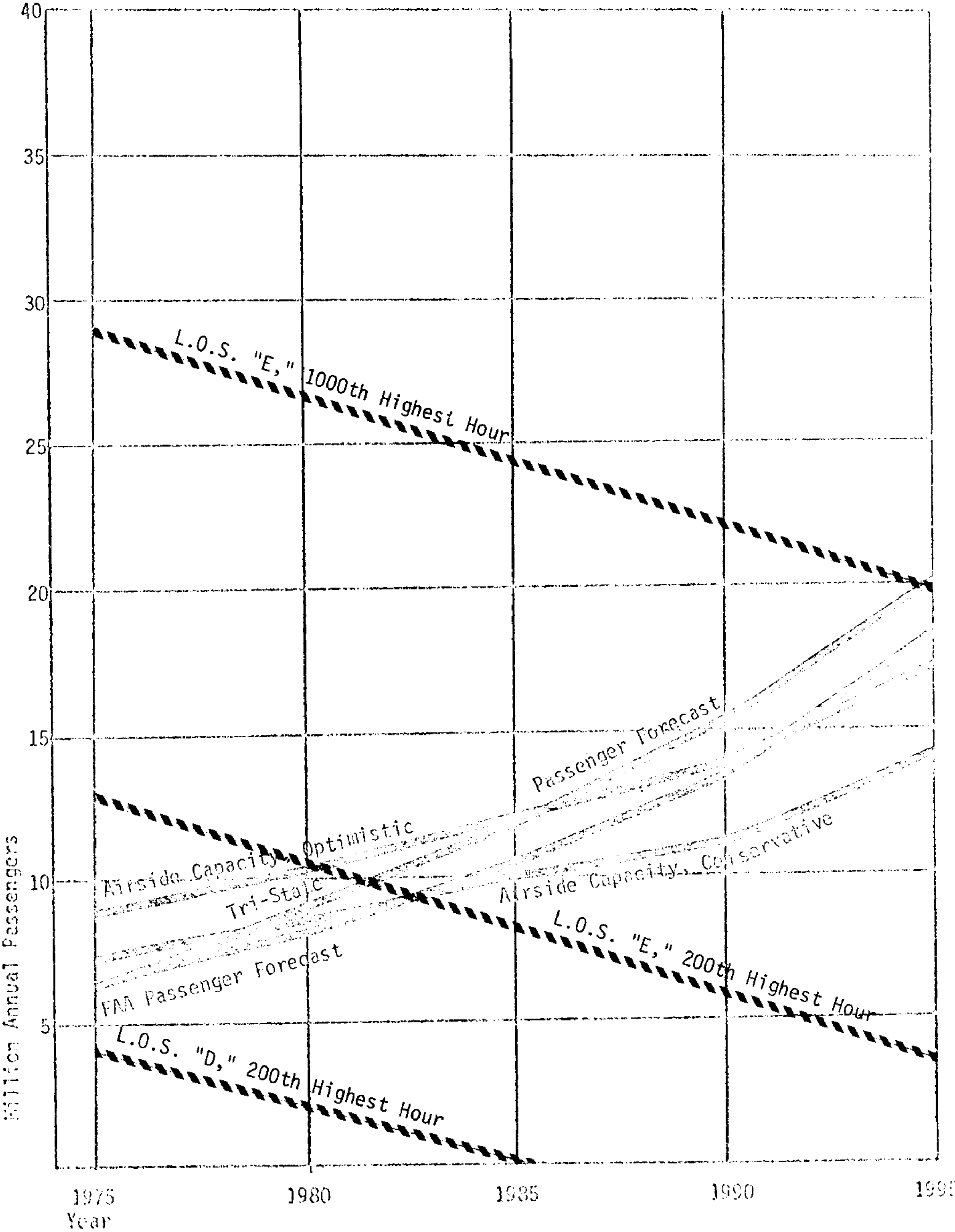

Figure 6

DEMAND/CAPACITY RELATIONSHIPS

Rt. 21 (McCarter Highway)

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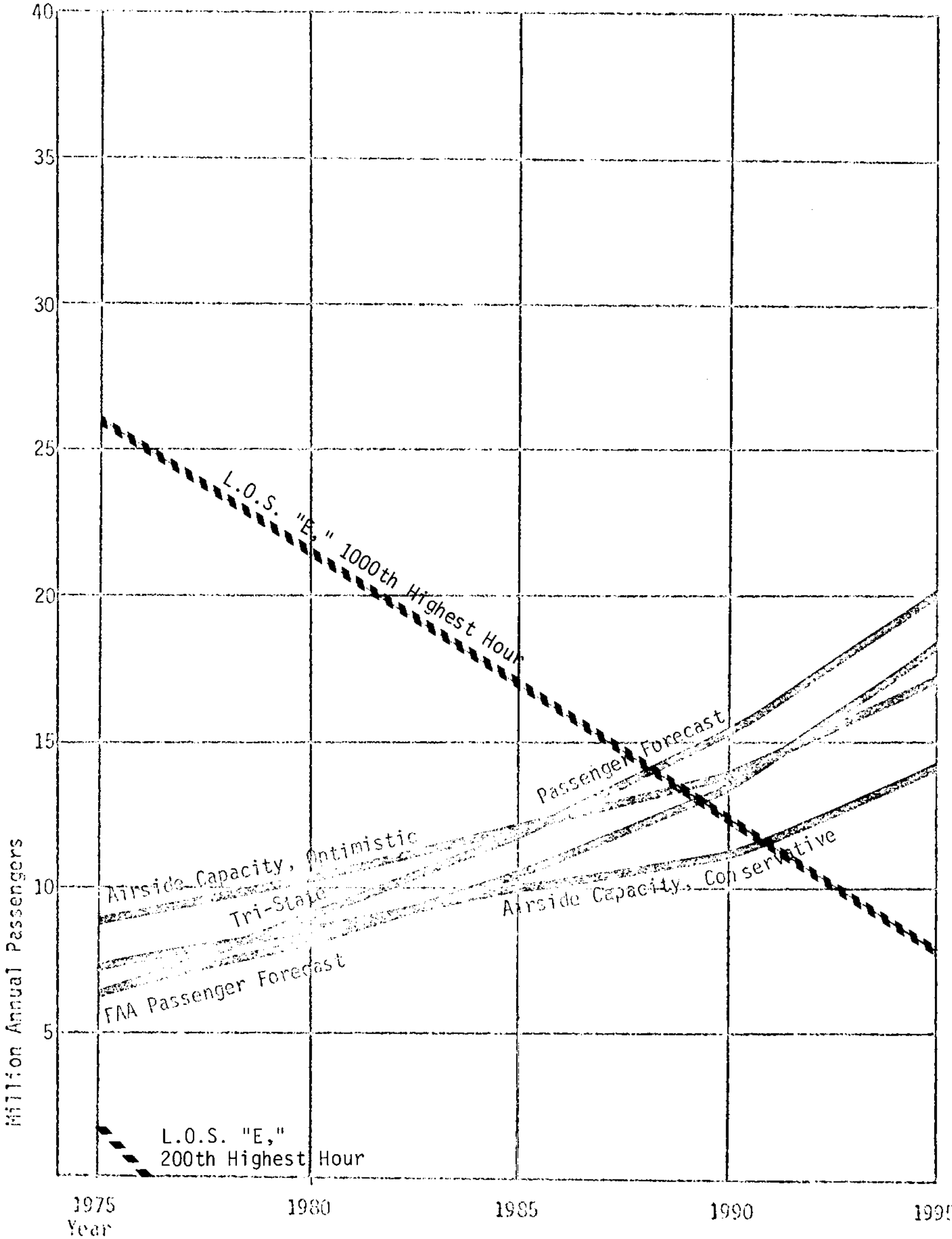

Figure 7

DEMAND/CAPACITY RELATIONSHIPS

Holland and Lincoln Tunnels

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4. Interpretation

4.1 New Jersey Turnpike

The New Jersey Turnpike is the principal north to south ground access route to Newark International Airport. Over fifty percent of all locally originating airport related traffic utilize the New Jersey Turnpike for some segment of their trip to the airport. Currently, the New Jersey Turnpike does not have a congestion problem, and capacity for the future is expected to besufficient through 1995. By 1990, our analysis indicates that this highway will experience level of service "D" for over two hundred hours per year (see Figures 4 and 5). This is a relatively low level of congestion in comparison with other highways in this heavily developed area.

The steepness of the capacity curves indicates airport related traffic is a small percentage of total traffic on the N.J. Turnpike, and therefore, capacity for airport related traffic has a high degree of elasticity with respect to increase in non-airport traffic.

4.2 McCarter Highway

The McCarter Highway (Route 21) provides access for air passengers arriving at the airport from the north and northwest. Most of these passengers originate in the heavily populated Northern New Jersey area. Figure 6 presents the demand/capacity relationships for the critical segment of Route 21 just north of I78. It is expected that by the early 1980's, Route 21 will operate at level of service "E" for over 200 hours per year.

4.3 Holland and Lincoln Tunnels

Air passengers traveling from Manhattan to Newark International generally use either the Holland or Lincoln Tunnels. Although approximately thirteen percent of Newarks air passengers are currently originating in Manhattan, EWR captures a relatively small fraction (about .075) of the total Manhattan air traffic. If this fraction were to increase to one-third, perhaps as a result of ground access congestion at LaGuardia and Kennedy Airports and improved air services at Newark, it is quite likely that the Holland and Lincoln Tunnels would then become a constraint to the growth of EWR.

Figure 7 shows the results of a capacity analysis performed under the assumption that one-third of Manhattan's air travelers choose EWR. In this scenario, the tunnels operate at level of service "E" for more than 200 hours per year in 1975, and would be expected to reach level of service "E" for 1000 hours per year by the late 1980's.

C. SOLUTIONS

Table 4 describes some proposals for improving ground access to EWR. The new exit 13A on the New Jersey Turnpike, connecting the Turnpike with U.S. Route 1 at the southern edge of the airport is designed to route traffic originating south of the airport directly to the terminal area rather than requiring the more circuitous routing north to I78, then south again along U.S. Routes 1 and 9. This proposal has the additional benefits of reducing the concentration of traffic approaching the terminal area from the north and of increasing the number of lanes entering the terminal area. The highway connector from the proposed interchange at U.S. Route 21 and Interstate 78 would provide additional lanes to the terminal area from the North.

Until recently, the PATH rapid transit line between lower Manhattan and Newark was programmed for a 17-mile extension to Plainfield according to the TSRPC regional rail plan. This extension was to have a station at McClellan Street just west of the airport boundary. The TSRPC had proposed a passenger distribution system connecting this station to the airport terminal building. However, New Jersey has recently cancelled plans to extend PATH, opting instead for a $600,000,000 plan to upgrade the State's mass transit. Consequently, plans for the proposed passenger distribution system are at least temporarily moot.

D. CONCLUSIONS

Compared to the other New York airports, Newark International is relatively free of ground access congestion if current access patterns persist. Only Route 21 (which is used by about one-quarter of the airport passengers) shows any signs of becoming a serious problem before 1990. However, if Newark is to successfully compete with the other New York airports for traffic from Manhattan, inadequate capacity of the combined Holland and Lincoln Tunnels will have to be overcome. To date, the only active proposal to address problems faced by the Manhattan passenger is the proposal to improve bus shuttle service from Penn Station Newark.

TABLE 4

PROPOSED SOLUTIONS TO AIRPORT ACCESS PROBLEMS

Proposed Solutions	Initiator	Agency Resp. for Implem.	Funding Sources	Est. Cost (1976 Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
A. CONSTRUCTION					
1. New Exit 13A on New Jersey Turnpike	*	New Jersey Turnpike Authority	FHWA-- Revenue Bonds	$50,000,000	Under design.
2. Highway Connector Airport and Proposed Interstate 78/Route 21 Intersection	TSRPC	*	*	$77,000,000	Under study
3. New PATH Station at McClellan Street West of Airport	*	*	UMTA	$355,000,000	Inactive
4. People-mover Rail Link and Distribution System to Terminals A, B, & C	TSRPC	Port Authority	ADAP, User Fees, Revenue Bonds	$120,000,000	Inactive
5. Added Terminal Frontage and Roadways and Parking	TSRPC	Port Authority	ADAP, User Fees, Revenue Bonds	$21,000,000	Under study
D. SERVICE					
1. Eliminate double taxi fare between Manhattan and airport	*	New York City Port Authority, Private Companies	*	None	No progress

Proposed Solutions	Initiator	Agency Resp. for Implem.	Funding Sources	Est. Cost (1976 Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
2. Continuation and expansion. "Air Link" Shuttle Bus from Penn Station, Newark, until New Rail Distribution is functional	TSRPC	*	*	*	*
3. Continuation of "Air Link" to Old North Terminal. Use of Rail Bus System for employees	TSRPC	*	*	*	*
4. Other mass transit alternatives, i.e., satellite terminals, group taxi rides, better limousine service	TSRPC	*	*	*	*

*Not available or unknown.

Key of Abbreviations:

ADAP	Airport Development Aid Program
TSRPC	Tri-State Regional Planning Commission
UMTA	Urban Mass Transportation Administration

APPENDIX A

ROUTING OF AIRPORT ACCESS TRIPS

BY LOCAL ORIGIN/DESTINATION ZONE

Data compiled from a passenger survey taken in 1972 at Newark International Airport by the Port Authority (see Reference 2) was used to determine passenger originations and destinations. Table A1 shows how survey percentages were distributed to account for 100 percent of the passengers utilizing the ground access system and the assumed routings of these passengers to and from the airport.

TABLE A1

ROUTING OF AIRPORT ACCESS TRIPS

BY LOCAL ORIGIN/DESTINATION ZONE

Zone	Percent Per Survey	Percent as Distributed	Routing	Percent by Route
(1)	(2)	(3)	(4)	(5)
Manhattan, N.Y.	12	13	LT, I95	8
			HT, RT1-9	2.5
			HT, I78	2.5
Bronx, N.Y.	1	1	GB, I95	1
Brooklyn, N.Y.	1	1	VB, I278, I95	1
Queens, N.Y.	1	1	HT, I78	1
Orange, N.Y.	1	1	GS, RT17, I80, I95	1
Rockland, N.Y.	1	1	PP, I95	1
Richmond, N.Y.	2	2	I280, I95	2
Westchester, N.Y./ Connecticut	2	2	PP, I95	2
Bergen, N.J.	10	11	PP, I95	11
Passaic, N.J.	3	3	RT21	1.5
			GS, I78	1.5
Essex, N.J.	16	17	I280, RT21	12
			RT21	2
			RT1-9	1
			RT22	2
Hudson, N.J.	4	4	I95	2
			RT1-9	2
Union, N.J.	9	10	RT1-9	6
			RT95	2
			RT22	2

Zone	Percent Per Survey	Percent as Distributed	Routing	Percent by Route
(1)	(2)	(3)	(4)	(5)
Morris, N.J.	8	9	I80, I280, RT21	7
			RT22	1
			RT21	1
Sommerset, N.J.	2	2	RT22	2
Middlesex, N.J.	6	7	I95	5
			GS, I95	2
Monmouth, N.J.	7	8	GS, I95	5
			I95	3
Mercer, N.J.	4	4	I95	4
Hunterdon, N.J.	1	1	I78, RT22	.5
			RT22	.5
Sussex, N.J.	1	1	I80, I280, RT21	1
Ocean, N.J.	1	1	GS, I95	1

Key:

GB	George Washington Bridge
GS	Garden State Parkway
HT	Holland Tunnel
In	Interstate n
LT	Lincoln Tunnel
PP	Palisades Parkway
RTn	US or NJ Route n
VB	Verrazano Narrows Bridge

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

The capacity of the New Jersey Turnpike was obtained from the Highway Capacity Manual (HCM), Table 9.1, assuming a PHF of .91. The capacity of the McCarter Highway was obtained from the HCM, Figure 6.8, assuming 40 minutes/hour green time for stop lights, curb-to-division-line approach width of 30 ft., SMSA population over one million, and PHF of .95.

The capacity of the Lincoln/Holland Tunnels was obtained from Table 9.1 of the HCM using adjustments for lane width and restricted speeds. The number of lanes, N, equals 10. The width adjustment factor, W = .66, was found from Table 9.2a of the manual assuming 9 ft. lanes and no distance from traffic lane edge to obstruction. The PHF factor was assumed to be .91 and the working value at level of service "D" for restricted highway speed of 50 miles per hour was used. Level of Service "D" hourly capacity is then

$$2000 \times 10 \times .66 \times (.45 \times .91) = 5405.4$$

Level of service "E" hourly capacity is

$$2000 \times 10 \times .66 = 13,200$$

The annual growth of non-airport traffic on the New Jersey Turnpike in the vicinity of EWR was assumed to be 5%, per Turnpike Authority planning figures. Non-airport traffic on other roads analyzed was assumed to grow at an annual rate of 1%. This assumption is based on the following forecasts:

- BEA 1/ SMSA population annual growth rate between 1980 and 1990 of 0.8%;
- BEA 1/ SMSA employment annual growth rate between 1980 and 1990 of 0.9;

1/ U.S. Department of Commerce, Bureau of Ecomomic Analysis. Area Economic Projections 1990, 1976.

- BEA 1/ SMSA earnings in constant dollars in the motor vehicle and equipment industries, annual growth rate between 1980 and 1990 of 2.0%;

- SMM 2/ SMSA population, annual growth rate between 1976 and 1981 of -0.3%;

- SMM 2/ SMSA growth in families between 1976 and 1981 of 1.0%.

Airport-related traffic in the access routes was estimated for 1974 by using Port Authority traffic counts at the CTA for a Friday, 4:00 to 5:00 P.M. in August (2335 vehicles/hour). The peak period traffic was converted to average daily by division by .096, 3/ and the daily traffic was routed on the access system in accordance with Appendix A. Vehicle trips available for airport use were converted to air passengers by multiplying by the ratio of annual passengers (6.8 million, per Reference 3) to average daily airport traffic on each access route, computed as explained above. In the scenario assuming one-third of Manhattan passengers use Newark (Table B4), the airport-related traffic was inflated in proportion to the increase in enplanements caused by the influx of Manhattan passengers.

The calculations are presented in Table B1 through B4.

1/ Ibid.

2/ Sales and Marketing Management. 1977 Survey of Buying Power, Part II, October, 1977.

3/ Conversion factor obtained from Highway Capacity Manual, assuming hourly traffic count is 200th highest in year.

Table B1

AIRPORT ACCESS CAPACITY

N. J. Turnpike North of Airport

Level of Service[1/] (1)	Hrs./Year[2/] (2)	Factor[3/] (3)	Year 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	180,000	180,000	180,000	180,000	180,000
		2	99,560	127,066	162,172	206,977	264,161
		3	80,440	52,934	17,828	NA	NA
		4	93.64	61.62	20.75	NA	NA
D	200	1	206,250	206,250	206,250	206,250	206,250
		2	99,560	127,066	162,172	206,977	264,161
		3	106,690	79,184	44,078	NA	NA
		4	124.20	92.18	51.31	NA	NA
D	1,000	1	267,568	267,568	267,568	267,568	267,568
		2	99,560	127,066	162,172	206,977	264,161
		3	168,008	140,502	105,396	60,591	3,407
		4	195.58	163.56	122.70	70.54	3.97
E	30	1	218,182	218,182	218,182	218,182	218,182
		2	99,560	127,066	162,172	206,977	264,161
		3	118,622	91,116	56,010	11,205	NA
		4	138.09	106.07	65.20	13.04	NA
E	200	1	250,000	250,000	250,000	250,000	250,000
		2	99,560	127,066	162,172	206,977	264,161
		3	150,440	122,934	87,828	43,023	NA
		4	175.13	143.11	102.24	50.08	NA
E	1,000	1	324,324	324,324	324,324	324,324	324,324
		2	99,560	127,066	162,172	206,977	264,161
		3	224,764	197,258	162,152	117,347	60,163
		4	261.66	229.64	188.77	136.61	70.04

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B2

AIRPORT ACCESS CAPACITY

N. J. Turnpike South of Airport

Level of Service[1/] (1)	Hrs./Year[2/] (2)	Factor[3/] (3)	Year 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	180,000	180,000	180,000	180,000	180,000
		2	99,560	127,066	162,172	206,977	264,161
		3	80,440	52,934	17,828	NA	NA
		4	89.98	59.21	19.94	NA	NA
D	200	1	206,250	206,250	206,250	206,250	206,250
		2	99,560	127,066	162,172	206,977	264,161
		3	106,690	79,184	44,078	NA	NA
		4	119.34	88.57	49.30	NA	NA
D	1,000	1	267,568	267,568	267,568	267,568	267,568
		2	99,560	127,066	162,172	206,977	264,161
		3	168,008	140,502	105,396	60,591	3,407
		4	187.93	157.16	117.89	67.78	3.81
E	30	1	218,182	218,182	218,182	218,182	218,182
		2	99,560	127,066	162,172	206,977	264,161
		3	118,622	91,116	56,010	11,205	NA
		4	132.69	101.92	62.65	12.53	NA
E	200	1	250,000	250,000	250,000	250,000	250,000
		2	99,560	127,066	162,172	206,977	264,161
		3	150,440	122,934	87,828	43,023	NA
		4	168.28	137.51	98.24	48.12	NA
E	1,000	1	324,324	324,324	324,324	324,324	324,324
		2	99,560	127,066	162,172	206,977	264,161
		3	224,764	197,258	162,152	117,347	60,163
		4	251.41	220.65	181.38	131.26	67.30

1/ Per *Highway Capacity Manual*.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B3

AIRPORT ACCESS CAPACITY

Rt. 21 (McCarter Highway)

Level of Service 1/	Hrs./Year 2/	Factor 3/	Year 1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	35,200	35,200	35,200	35,200	35,200
		2	36,441	38,300	40,254	42,307	44,465
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	200	1	40,333	40,333	40,333	40,333	40,333
		2	36,441	38,300	40,254	42,307	44,465
		3	3,892	2,033	79	NA	NA
		4	4.44	2.32	.09	NA	NA
D	1,000	1	52,324	52,324	52,324	52,324	52,324
		2	36,441	38,300	40,254	42,307	44,465
		3	15,883	14,024	12,070	10,017	7,859
		4	18.13	16.01	13.78	11.43	8.97
E	30	1	41,800	41,800	41,800	41,800	41,800
		2	36,441	38,300	40,254	42,307	44,465
		3	5,359	3,500	1,546	NA	NA
		4	6.12	4.00	1.76	NA	NA
E	200	1	47,896	47,896	47,896	47,896	47,896
		2	36,441	38,300	40,254	42,307	44,465
		3	11,455	9,596	7,642	5,589	3,431
		3	13.08	10.95	8.72	6.38	3.92
E	1,000	1	62,135	62,135	62,135	62,135	62,135
		2	36,441	38,300	40,254	42,307	44,465
		3	25,694	23,835	21,881	19,828	17,670
		4	29.33	27.21	24.98	22.63	20.17

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B4

AIRPORT ACCESS CAPACITY

Holland and Lincoln Tunnels

Level of Service 1/ (1)	Hrs./Year 2/ (2)	Factor 3/ (3)	Year 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	49,140	49,140	49,140	49,140	49,140
		2	136,670	143,642	150,968	158,668	166,762
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	200	1	56,306	56,306	56,306	56,306	56,306
		2	136,670	143,642	150,968	158,668	166,762
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	1,000	1	73,046	73,046	73,046	73,046	73,046
		2	136,670	143,642	150,968	158,668	166,762
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
E	30	1	120,000	120,000	120,000	120,000	120,000
		2	136,670	143,642	150,968	158,668	166,762
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
E	200	1	137,500	137,500	137,500	137,500	137,500
		2	136,670	143,642	150,968	158,668	166,762
		3	830	NA	NA	NA	NA
		3	.53	NA	NA	NA	NA
E	1,000	1	178,378	178,378	178,378	178,378	178,378
		2	136,670	143,642	150,968	158,668	166,762
		3	41,708	34,736	27,410	19,710	11,616
		4	26.82	22.34	17.63	12.68	7.47

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

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GREATER PITTSBURGH

INTERNATIONAL AIRPORT

CASE STUDY

402

CASE STUDY SUMMARY

Greater Pittsburgh International Airport is located 16 miles west of downtown Pittsburgh and operated by the Allegheny County Department of Aviation. The Airport serves a metropolitan population of 2.4 million.

In 1976, the Airport served approximately 8 million enplaning plus deplaning passengers, and of this total approximately 43% were transfers from other flights. Passenger traffic is projected to grow at a rate of 5% annually during the next twenty years. General aviation activity comprises about 29% of total operations at the Airport.

Capacity analyses indicate that the Airport's airside components can handle forecasted passenger growth well into the future. However, ground access capacity from some directions may become a constraining factor, particularly in the Fort Pitt Tunnel near downtown Pittsburgh and the Airport Parkway - the major Airport access roadway. The Fort Pitt Tunnel provides inadequate carrying capacity which results in traffic bottlenecks and airport access delays during peak travel periods. The Airport Parkway, a four-lane divided arterial near the Airport, is required to carry all east-west traffic in the Airport area. The location of two at-grade intersections, located at the Airport Entrance and Carnot and Beers School Road will begin to constrain both airport and non-airport traffic in the early 1980's.

Plans to implement new and expanded highways which would have facilitated improved airport access have been dropped due to limited State-Federal funding. Plans to improve the existing transit system will have a minimal airport access impact. The County Department of Aviation has initiated the development of a new Master Plan to analyze proposed alternative airport improvements including the possibility of relocating the terminal. However, the possibilities for terminal relocation and roadway improvements are very uncertain at this time.

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GREATER PITTSBURGH INTERNATIONAL AIRPORT

A. BACKGROUND

1. General

Greater Pittsburgh International Airport is located in Moon Township 16 miles west of Pittsburgh (See Figure 1). The Airport was originally built by the War Department as a World War II airfield and was subsequently transferred to the Allegheny County Board of Commissioners. Greater Pittsburgh International Airport is presently operated by the Allegheny County Department of Aviation. The airport serves a metropolitan population of 2.4 million (1970 census).

Greater Pittsburgh International served approximately 8 million enplaning plus deplaning passengers in 1976 and of this total 43% were transfers from other flights. Passenger traffic is projected to grow at a rate of about 5% annually during the next twenty years. The vast majority of existing and projected operations at the airport are scheduled domestic air carrier flights. General aviation activity comprises about 29% of operations at the Airport.

In 1972, a Master Plan Study was initiated by the Allegheny County Board of Commissioners (Reference 1). The study recommended that the terminal complex be relocated to the west of the existing terminal facilities, primarily because of limited area for expansion at the current site on the east side of airport property. However, limited finances and reduced airport activity growth have resulted in a reevaluation of this plan. In 1977, Allegheny County initiated a new Master Plan Study for Greater Pittsburgh International Airport.

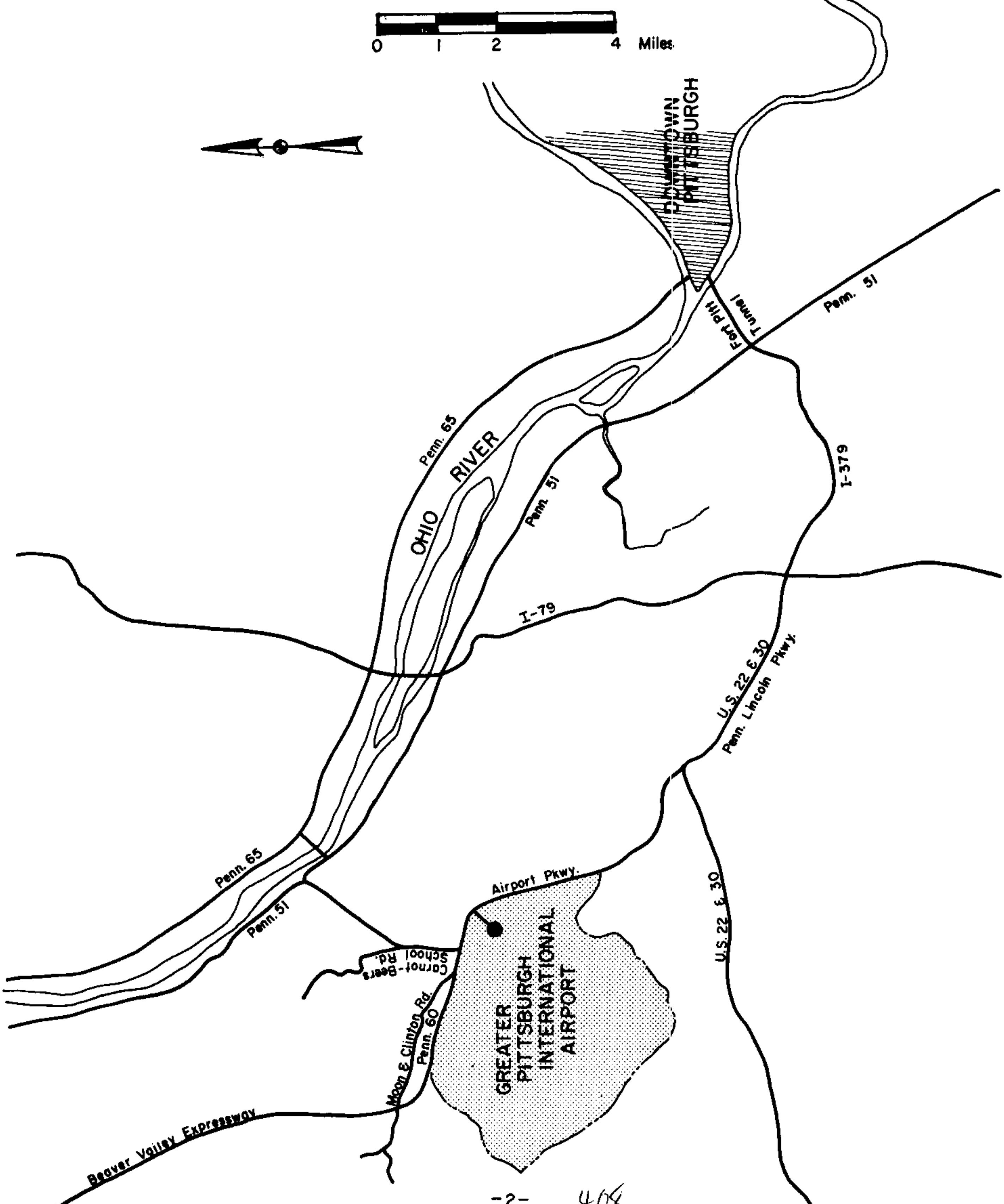
2. Transportation Planning Structure

Transportation planning and implementation are conducted at four levels: City, County, Region and State. The City has a Department of Public Works which is primarily concerned with traffic engineering. Allegheny County has several transportation related departments: Planning and Development, Aviation, Engineering and Maintenance. The Department of Planning and Development is responsible for coordinating transportation planning for the County and develops capital project plans for the other County transportation departments.

The Southwestern Pennsylvania Regional Planning Commission (SPRPC) is the designated Metropolitan Planning Organization (MPO) for the six county region comprising Allegheny, Armstrong, Beaver, Butler, Washington, and Westmoreland Counties. The SPRPC is responsible for development, adoption, and revision, when necessary, of long-range transportation plans, the Short-Range Transportation Improvement Program, and establishing procedures and policies for the transportation planning process and programs for the region. The SPRPC provides its own staff and receives the major portion of its funds from PennDOT, the FHWA, and UMTA. The Allegheny County Department of Planning and Development acts as the Department of Aviation liaison to the SPRPC. All pertinent airport

Figure 1

PITTSBURGH REGION



plans and programs are channeled through Planning and Development for incorporation in the SPRPC's long range planning function.

The State (PennDOT) is responsible for transportation planning, design and construction and also has a Department of Aviation.

In 1974, the SPRPC adopted a long-range transportation plan for the region. Included in this plan were several highway and transit related projects programmed to improve access capacity to the airport. However, since the adoption of this plan, the availability of Federal and State transportation monies for major project implementation has seriously declined. This situation has resulted in dropping the 1974 SPRPC long-range plan. Therefore, for the foreseeable future, all transportation planning within the region will involve minor capital projects, primarily focusing on rehabilitation of existing facilities (bridges and highway surfaces). Projects to improve airport access capacity are not expected for some time (Reference 2).

3. Highway Access

Most trips to the airport are made from the east via the Penn. Lincoln Parkway - U.S. 22/30 (4-lane limited access highway), which becomes the Airport Parkway - State Route 60 (4-lane limited access highway east of the Airport; 4-lane divided arterial near the airport). Access from the west and northwest is provided by the Beaver Valley Expressway-State Route 60 (4-lane limited access highway) which becomes the Airport Parkway approximately two miles west of the airport. Access from the north is provided by the Carnot and Beers School Road - State Route 51 (4-lane undivided arterial) which intersects the Airport Parkway about 1/4 miles west of the principal airport entrance.

The principal passenger entrance to the airport is from the Airport Parkway - State Route 60 (Figure 2). The airport entrance at the Airport Parkway has a signalized (fully actuated) at-grade intersection with an airport entrance road turnout to facilitate traffic movements into the airport from the east (Figure 2). Traffic from the west and north can utilize an airport entrance to the west parking lot located at the intersection of Airport Parkway and the Carnot and Beers School Road. A fully actuated signal controls traffic through this intersection. Recent traffic studies show that approximately 10% of airport traffic utilizes this entrance. The major employee hangar and cargo entrance is Cargo Road #1 located 1/4th mile west of Carnot and Beers School Road (Figure 2).

As mentioned earlier, the present status of transportation planning within the region precludes any significant changes to the existing airport access system.

4. Transit Access

The private automobile is by far the primary method used by passengers and employees at Greater Pittsburgh International Airport as shown in Table 1.

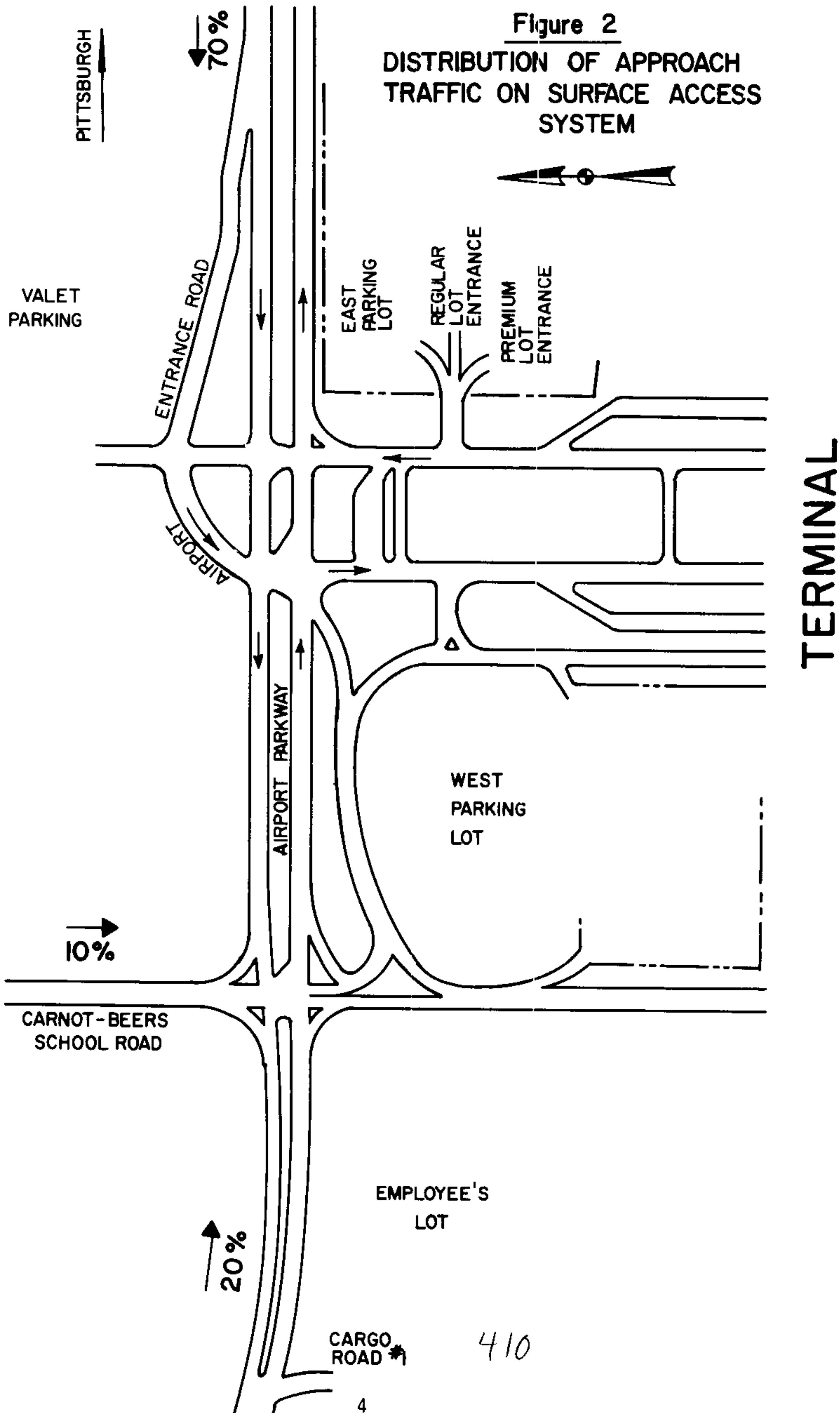


Figure 2
DISTRIBUTION OF APPROACH TRAFFIC ON SURFACE ACCESS SYSTEM
PITTSBURGH
70%
VALET PARKING
ENTRANCE ROAD
EAST PARKING LOT
REGULAR LOT ENTRANCE
PREMIUM LOT ENTRANCE
TERMINAL
AIRPORT
AIRPORT PARKWAY
WEST PARKING LOT
10%
CARNOT-BEERS SCHOOL ROAD
EMPLOYEE'S LOT
20%
CARGO ROAD #1
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TABLE 1

Mode of Transportation for Air Passengers

Mode	Percent of Passengers
Private Auto	64%
Airport Bus/Limousine	16%
Rental Car	10%
Taxis	10%

Source: RGA-TAMS, Nov. 1969 "Analysis of Parking Vehicular Access Requirements - Future Terminal".

The Port Authority Transit (PAT) operates buses between the CBD and the Airport during weekdays only. A total of five runs are made in the morning between 6:50 andd 9:40 A.M. and four in the afternoon between 3:00 and 5:40 P.M. The one-way fare is $.95 and passengers are picked up and discharged at the Airport Parkway entrance only.

The taxi service is provided seven days a week by the Yellow Cab Co. The one-way fare ranges between $11 and $13.

The Airlines Transportation Co. provides limousine service between the CBD and the airport seven days a week for a fare of $3.00.

5. Internal Access

All terminal-destined traffic funnels into a single-level loop roadway. The roadway has a curb-to-curb width of 40' with the right lane reserved for loading/unloading by the terminal building and metered parking along other right lane segments. During many periods, inadequate curb frontage leads to double and triple parking on the interior roadway, thereby constraining internal vehicle movement.

B. CAPACITY ANALYSIS

1. Passenger Forecasts

The passenger forecast used in this analysis was developed for the new Greater Pittsburgh International Airport Master Plan Study (Reference 3). Table 2 shows the number of passengers expected.

2. Airside Capacity

Airside capacity forecasts were derived from information contained in the new Master Plan Study (Reference 3). Annual Capacity (PANCAP) for 1976 to 2000 for air carrier and Allegheny Airlines commuter operations only are shown in Table 3. General aviation and military operations have been factored out of these capacity forecasts and are assumed to be constrained in the future. PANCAP was converted to annual passengers by applying factors for average seats per operation and a load factor (LF). Two load factors were used: the current annual enplaned load factor of 45% and the current load factor plus 10%. The appropriate factors and results are shown in Table 3.

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TABLE 2

Air Passenger Forecasts

Year	Millions of Air Passengers (enplaned & deplaned)
1976	8.1 (actual)
1980	9.8
1985	12.3
1990	15.3
1995	19.2
2000	23.7

TABLE 3

Calculation of Airside Capacity

Year	PANCAP (Air Carrier and Commuter Only)	Average Seats/Operation	Annaul Pass. Capacity (millions) Load Factor=45%	Load Factor=55%
1976	205,300	100	9.2	11.3
1980	240,100	109	11.8	14.4
1985	276,600	121	15.1	18.4
1990	309,000	132	18.4	22.4
1995	356,800	143	23.0	28.1
2000	405,500	154	28.1	34.3

Source: Reference 3

From results shown on Table 3, adequate annual airfield capacity appears available to accommodate air carrier and commuter operations to at least the turn of the century.

3. Ground Access Capacity

Current airport ground trips were assigned to major highways and arterials as explained in Appendix A. Eight locations carrying substantial airport traffic were identified: Airport Parkway east of the Airport, Airport Parkway west of State Route 51, Beaver Valley Expressway east of Moon Road, Carnot and Beers School Road north of Airport Parkway, the intersection of Airport Parkway and the primary Airport entrance, the intersection of Airport Parkway and Carnot and Beers School Road, the Fort Pitt Tunnel, and I-379 east of I-79. An annual growth rate of 2% for non-airport traffic was based on recent PennDOT traffic projections for Allegheny County from 1975-2000.

Vehicle capacity available for airport trips were converted to air passengers by multiplying the ratio of 1976 annual passengers to airport ADT (8,100,000/33,510=242) and dividing by the proportion of total airport-bound ground traffic carried by each access road. Traffic was assigned to these highways based on an analysis contained in Appendix B. The capacity analyses for each location are shown graphically in Figures 3 through 10.

4. Interpretation

Airport Parkway (east of Airport): Figure 3 indicates that the Airport Parkway to the east of the Airport Entrance Road is currently operating at better than level of service "D" at the 200th highest hour of the year. A moderate growth of non-airport traffic on the Airport Parkway will not limit capacity for airport traffic until at least the late 1980's. In addition, since airport traffic accounts for over half of the Airport Parkway traffic, the volume/capacity relationship will be particularly sensitive to airport traffic growth.

b. Beaver Valley Expressway: Capacity on the Beaver Valley Expressway was much higher than demand and fell outside the limits of the graph (Figure 4).

c. Carnot & Beers School Road: Figure 5 indicates that midblock capacity limitations on Carnot and Beers School Road should not prove to be a problem for airport traffic at least until the 1990's.

d. Airport Parkway (west of Airport): The analysis shows that midblock capacity on the Airport Parkway west of the Airport entrance will remain adequate until well into the 1990's when level of service "D" at the 200th highest hour is approached (Figure 6).

e. Airport Entrance Intersection: Figure 7 shows that this critical intersection is currently operating at better than level of service "D" for the 200th highest hour of the year. The figure further indicates that severe congestion problems are likely to occur in the early to mid-1980's upon the growth of airport or non-airport related traffic.

Figure 3

DEMAND/CAPACITY RELATIONSHIP

AIRPORT PARKWAY (EAST OF AIRPORT)

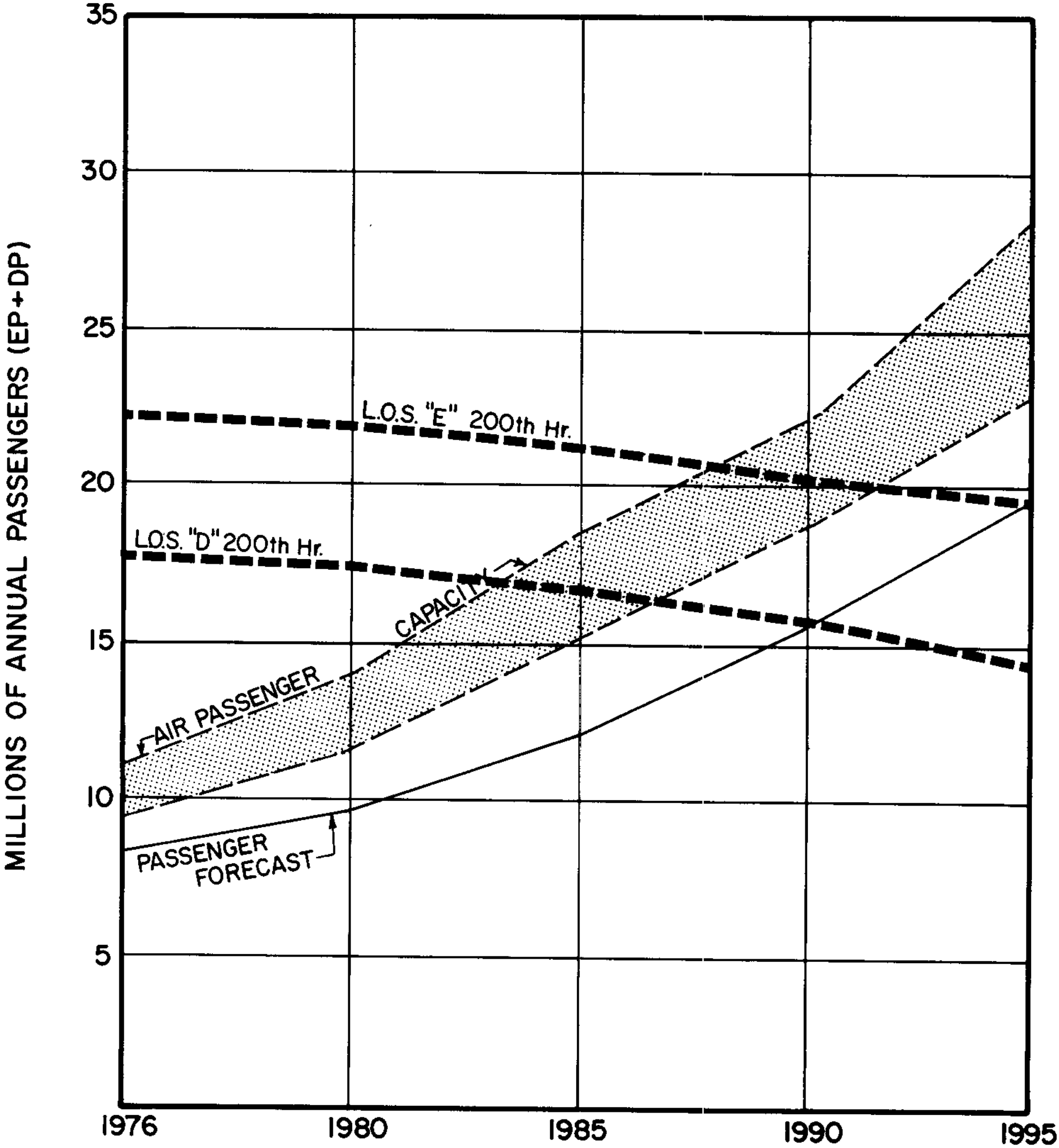

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Figure 4

DEMAND/CAPACITY RELATIONSHIP

BEAVER VALLEY EXPRESSWAY

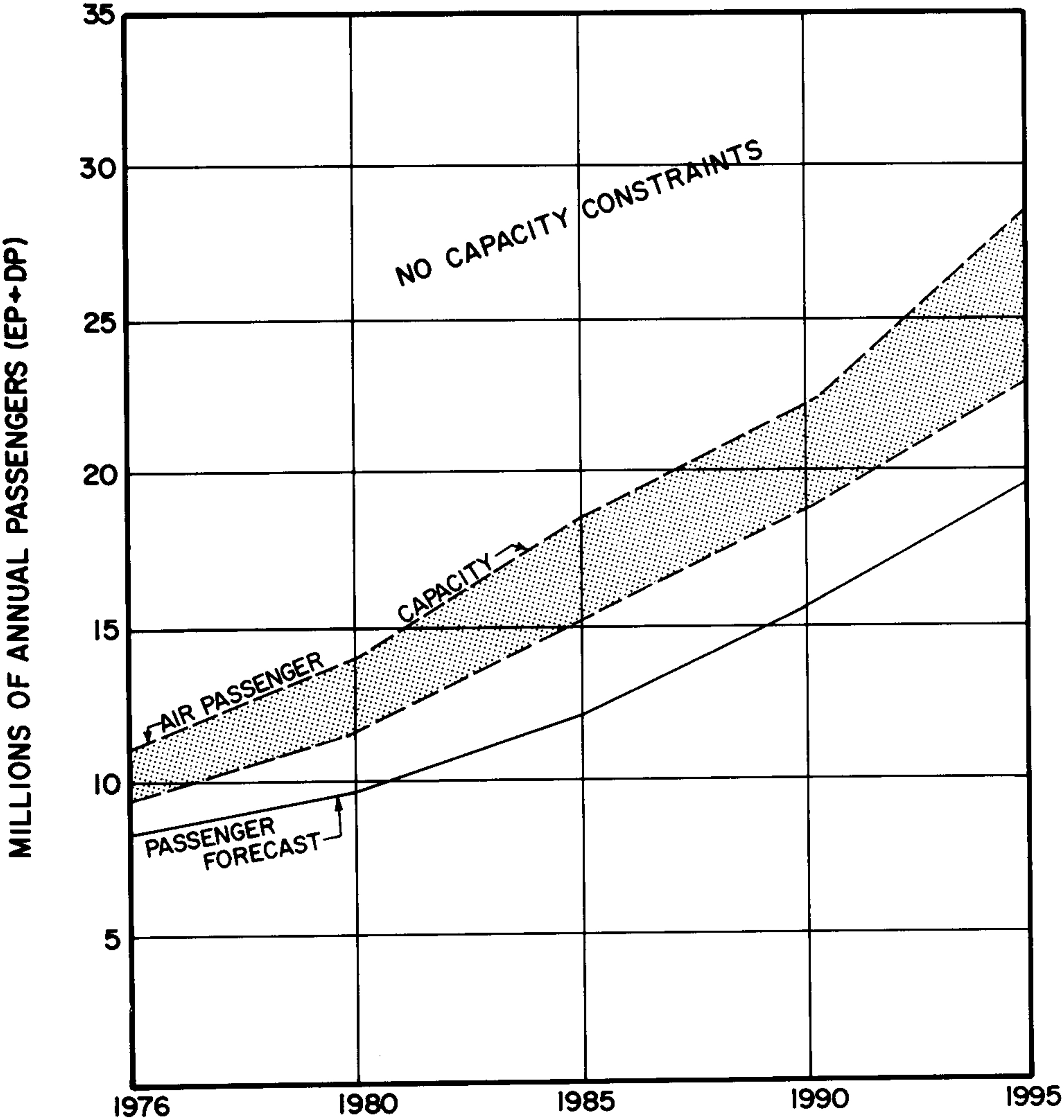

Figure 5

DEMAND/CAPACITY RELATIONSHIP

CARNOT + BEERS SCHOOL ROAD

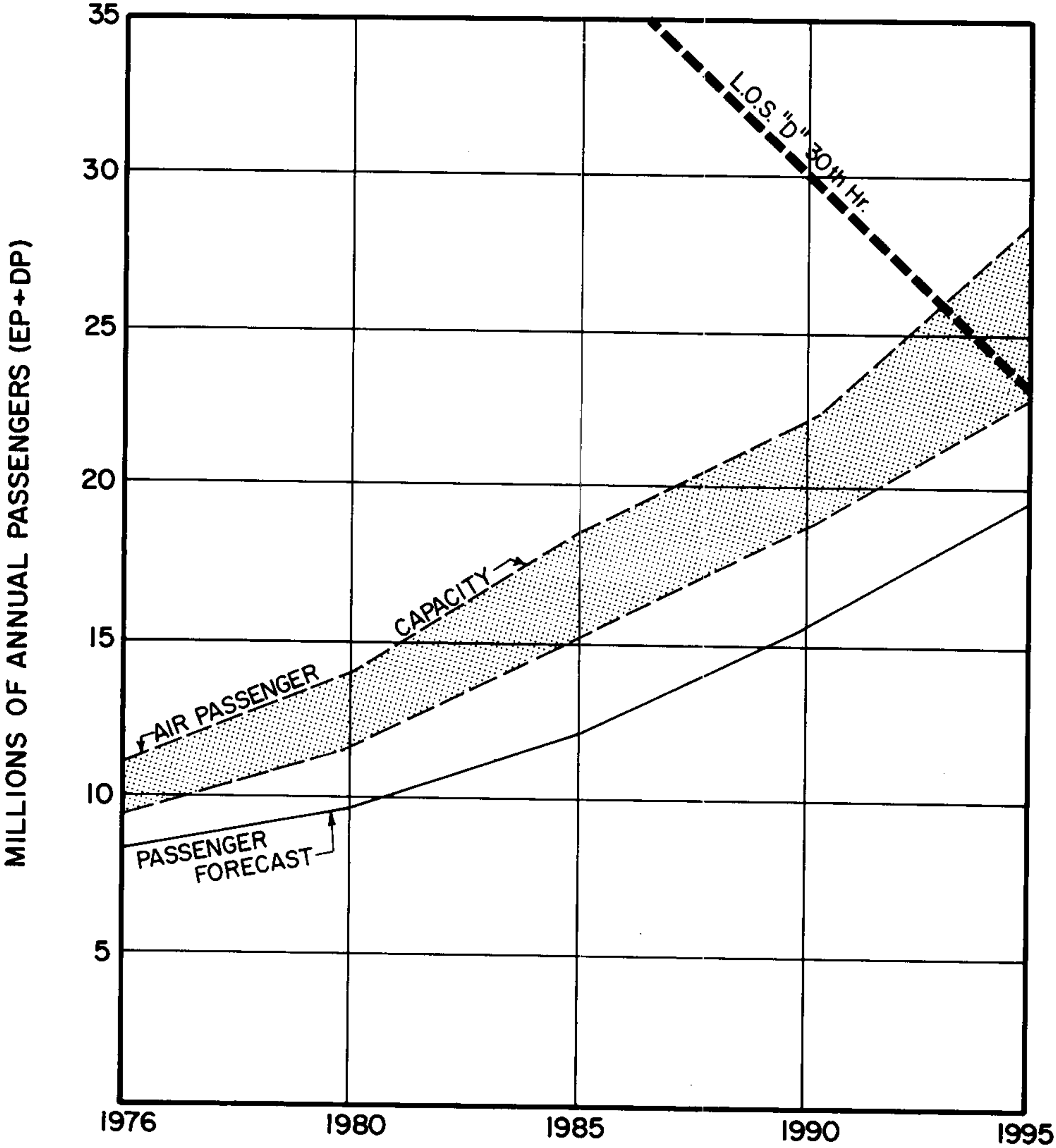

Figure 6

DEMAND/CAPACITY RELATIONSHIP

AIRPORT PARKWAY (WEST OF AIRPORT)

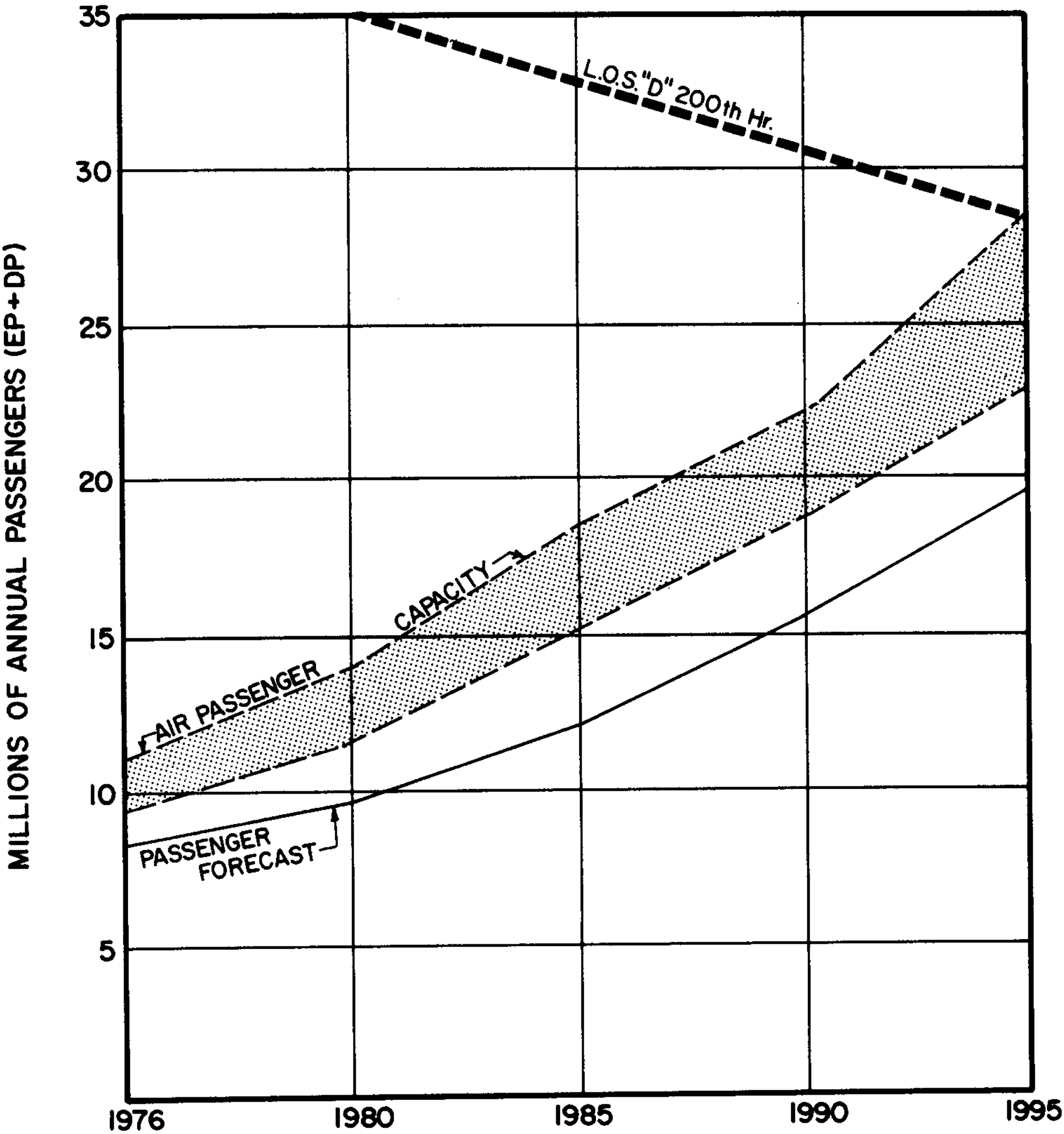

Figure 7

DEMAND/CAPACITY RELATIONSHIP

INTERSECTION OF AIRPORT PARKWAY AND AIRPORT ENTRANCE ROAD

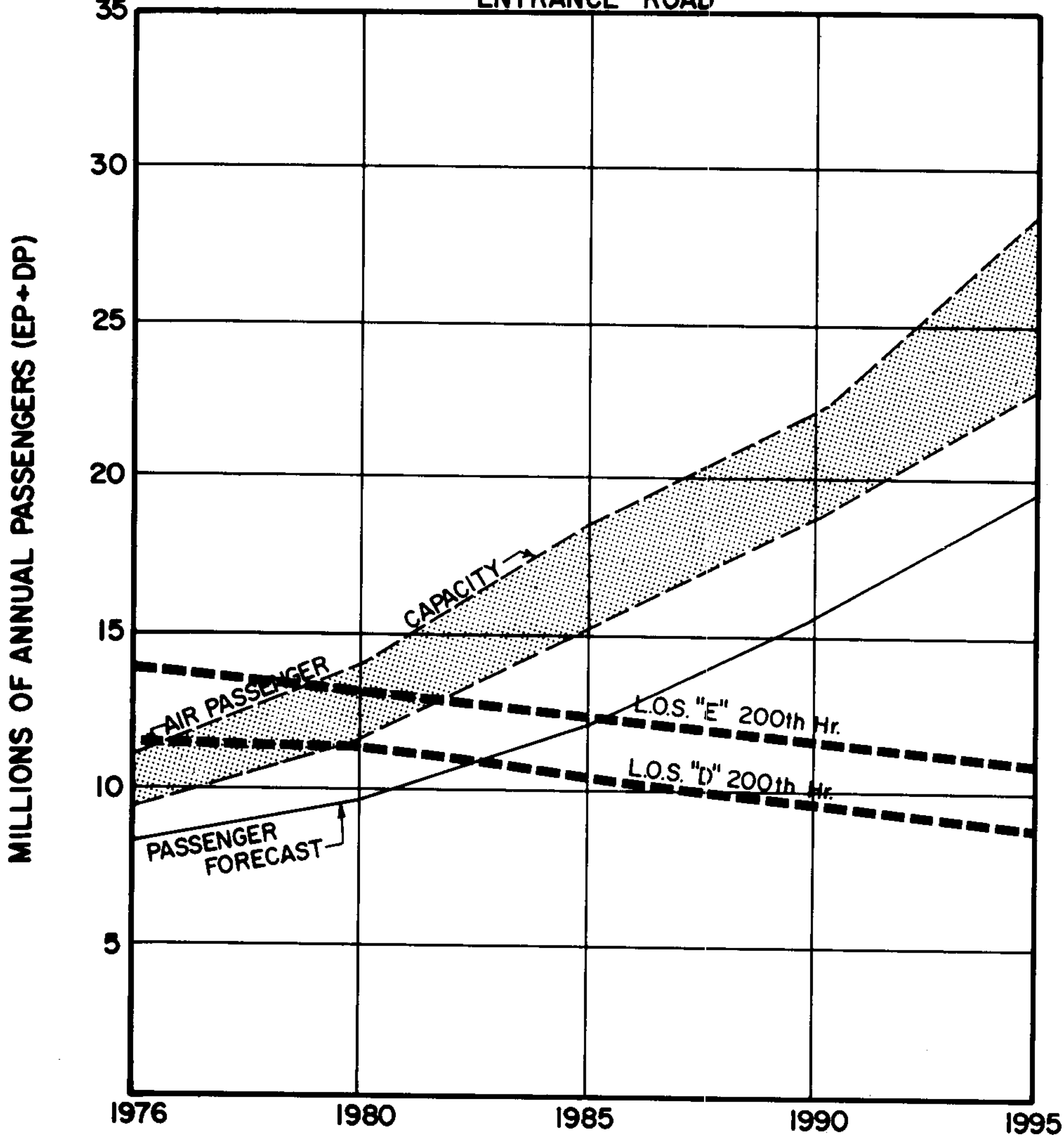

Figure 8

DEMAND/CAPACITY RELATIONSHIP

INTERSECTION OF AIRPORT PARKWAY AND

CARNOT & BEERS SCHOOL ROAD

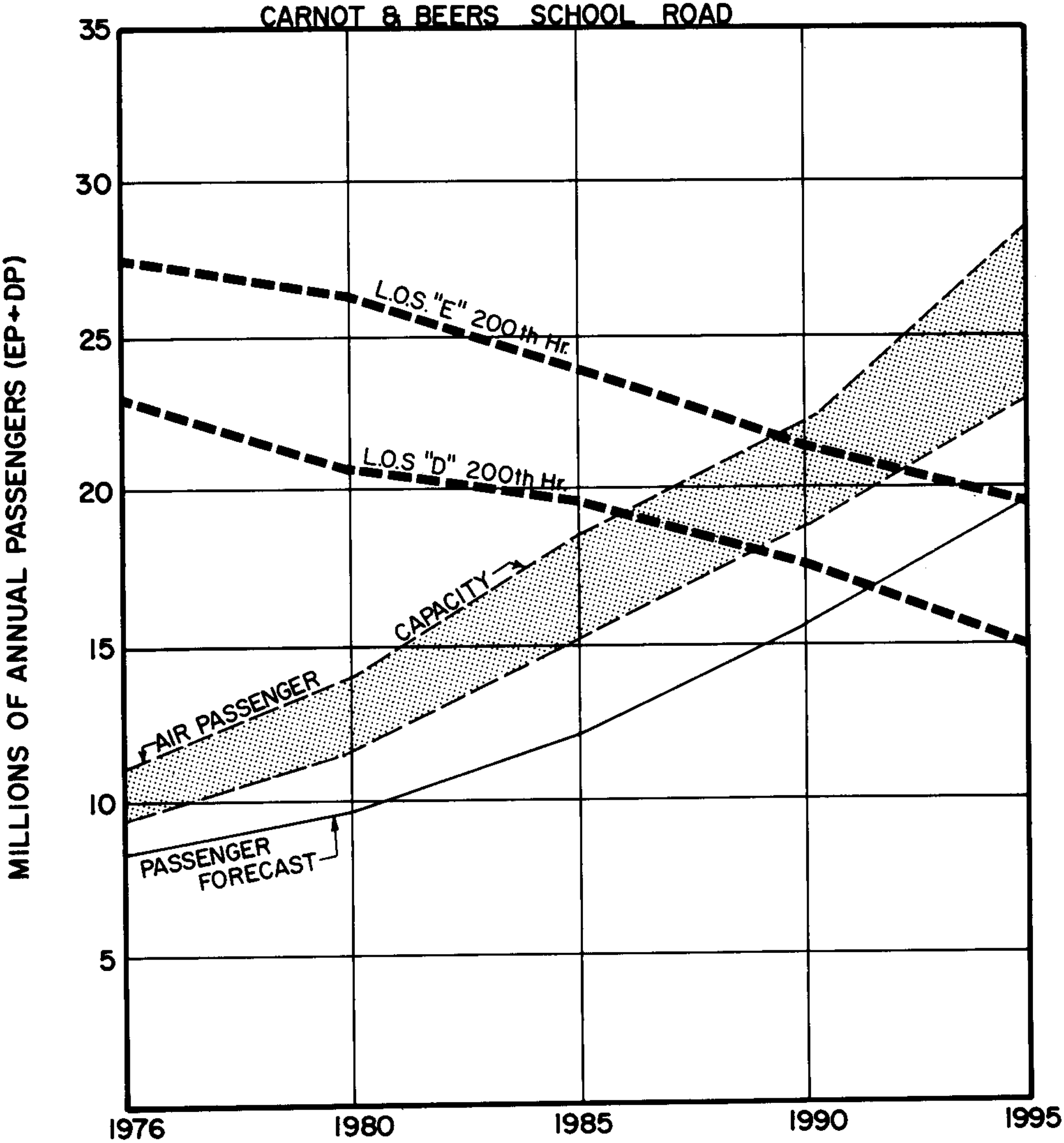

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Figure 9

DEMAND/CAPACITY RELATIONSHIP

FORT PITT TUNNEL

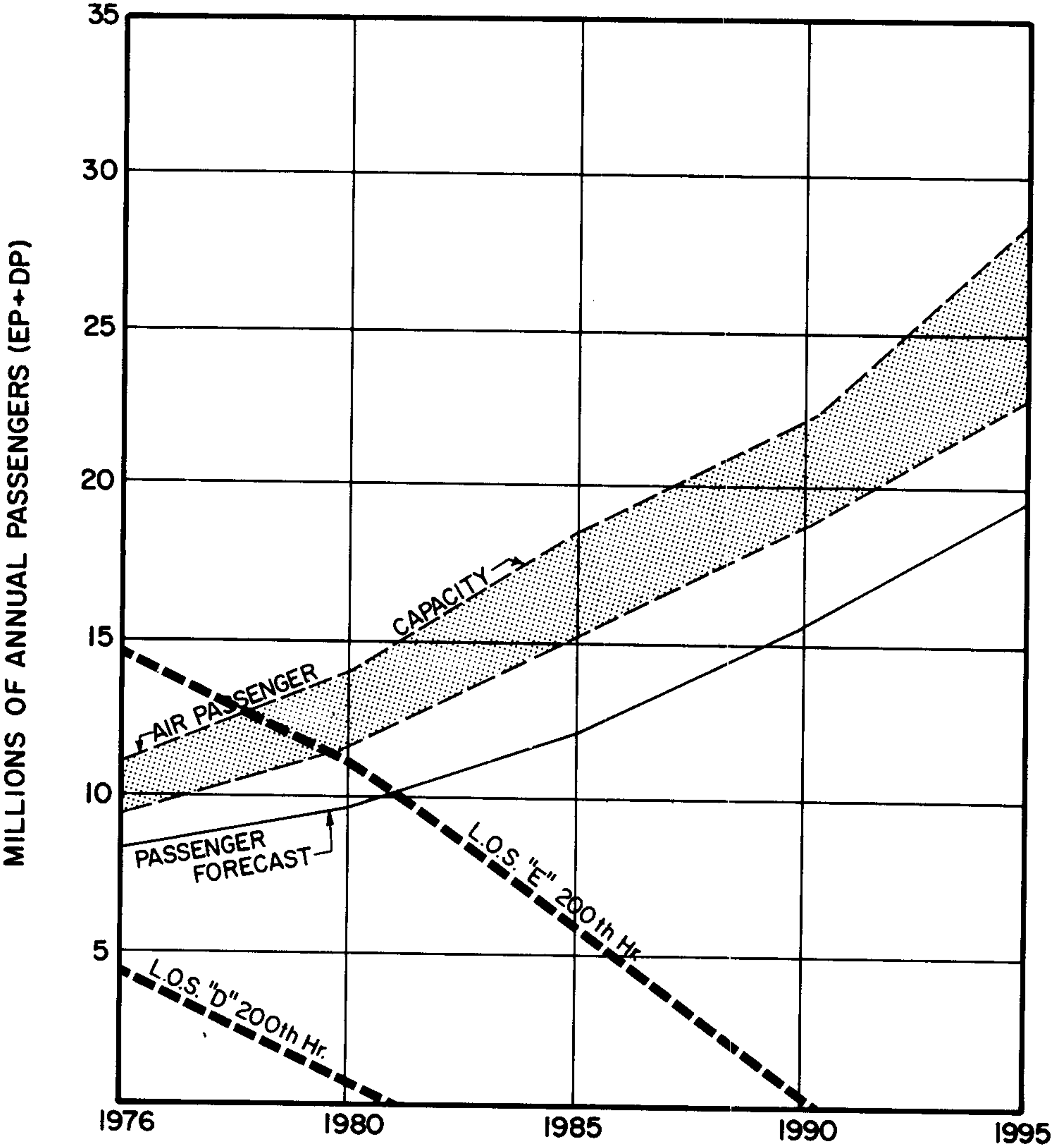
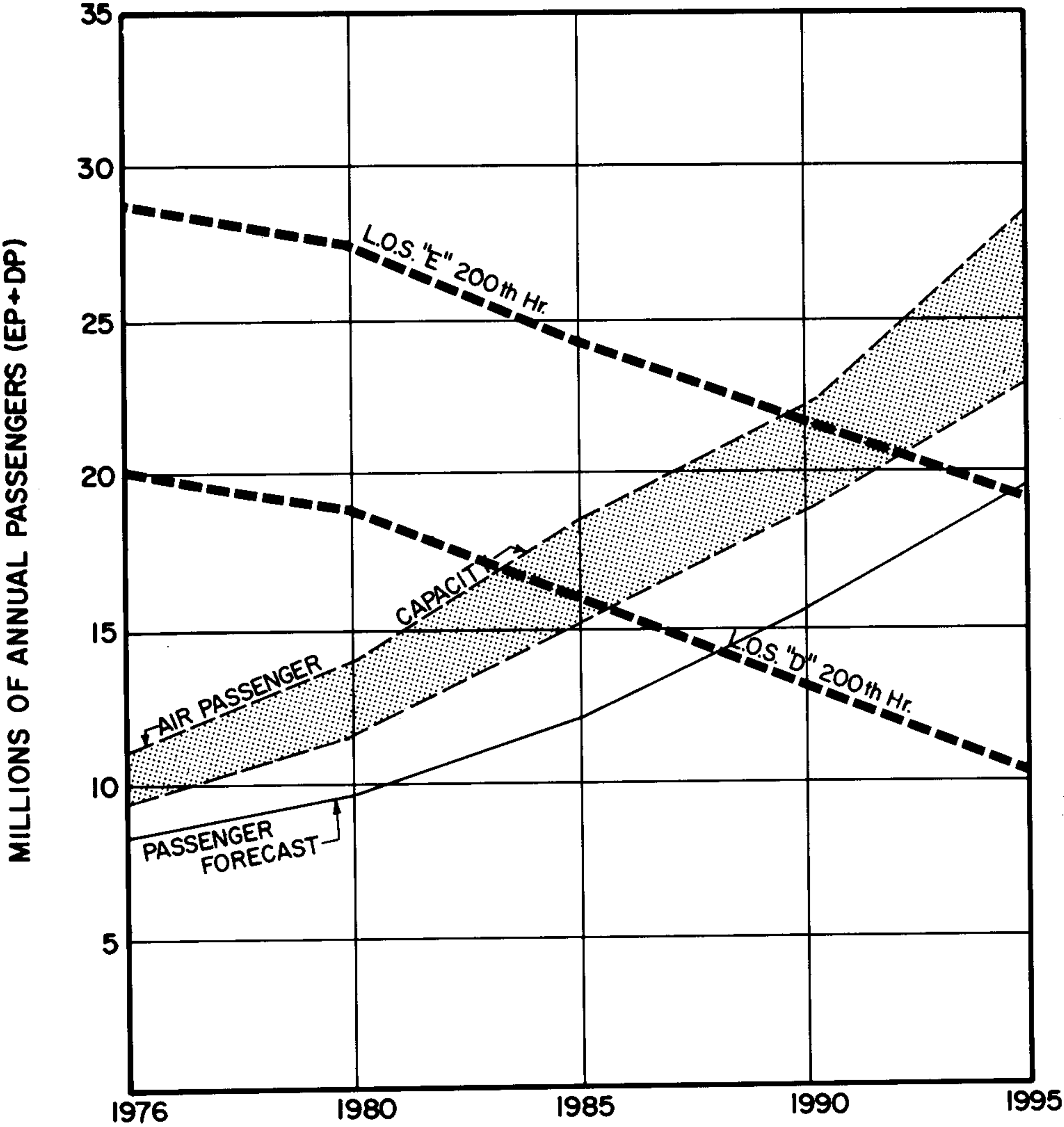


Figure 10

DEMAND/CAPACITY RELATIONSHIP

I-379 (EAST OF I-79)



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An analysis of signal timing for all intersection approaches revealed adequate green time for traffic turning in and out of the Airport. However, the Airport Parkway approach from the east is operating at capacity at peak hours with the existing "green time" allocated. Further traffic growth on this approach will limit the effectiveness of the intersection for airport related trips without grade separation.

f. Airport Parkway and Carnot & Beers School Road: Figure 8 indicates that this intersection is operating better than level of service "D" at the 200th highest hour. The figure further shows that the intersection will not pose a problem to forecasted passenger volumes until the early 1990's.

Analysis of all intersection approaches revealed many traffic movements through the intersection requiring separate signal phases. This resulted in particularly long signal cycles during heavy traffic periods causing long traffic queues. Continued traffic growth on these roadway approaches will require grade separation.

g. Fort Pitt Tunnel: The capacity of this roadway is limited, with operating conditions exceeding level of service "E" for the 200th highest hour of the year in the early 1980's. The figure indicates that traffic congestion is already serious with traffic bottlenecks apparent for this roadway section.

h. Interstate 379 - Penn. Lincoln Parkway East of I-79: Figure 10 indicates that Interstate 379 - Penn. Lincoln Parkway is currently operating at better than level of service "D" at the 200th highest hour of the year. The figure indicates that a moderate access problem will appear during the late-1980's with continued traffic growth. This access problem would become severe by the mid-1990's.

C. PROPOSED SOLUTIONS

As stated earlier, limited State and Federal transportation funds, along with the need to improve the deteriorated condition of many existing facilities, have caused the elimination of plans for new and expanded highway facilities (See Table 4). The overall effect of these funding reductions is a loss to the region of 63 percent over the amount previously expected during the present programming period.

TABLE 4

Proposed Solutions to Airport Access Problems

PROPOSED SOLUTION	INITATOR	AGENCY RESP. FOR IMPLEM.	FUNDING SOURCES	EST. COST (MILLIONS)	STATUS
A. CONSTRUCTION					June, 1978
1. Beaver Valley Expwy. Exten.	SPRPC	PennDOT	Fed. Aid Primary	31.0	Dropped
2. Airport Pkwy. Upgrading	SPRPC	PennDOT	Fed. Aid Primary	24.0	Dropped
3. Carnot & Beers Sch. Road Upgrading	County	PennDOT	Topics	0.5	Proposed
4. Airport Busway	SPRPC	PAT	UMTA	36.0	Dropped
5. Airport Terminal Freeway	SPRPC	PennDOT	Fed. Aid Primary	38.0	Dropped (Cycle 1 Planning)
B. RELOCATION					
1. Relocation of Terminal Complex to West of Airport Property	Pittsburgh International Airport Master Plan (1972)	Allegheny County	Revenue Bonds ADAP	*	New Master Plan Update Underway

*Not Available

With the dropping of plans to extend the Beaver Valley Expressway and to upgrade the Airport Parkway (so as to by-pass the existing Airport Parkway configuration to the Airport Entrance Road) the external roadway system presently serving the Airport is projected to remain essentially unmodified.

D. CONCLUSIONS

Greater Pittsburgh International Airport currently has a moderate ground access problem that is primarily caused by traffic congestion at the Fort Pitt Tunnel near downtown Pittsburgh and the need for the Airport Parkway (the major Airport access route) to function as the sole east-west travel facility in the Airport area.

With the dropping of plans to construct by-pass routes north and south of the Airport, the Airport Parkway (4-lane divided arterial) is scheduled to handle all airport and substantial amounts of non-airport related traffic for the forseeable future.

Traffic congestion is increasing at two Airport Parkway intersections located at the Airport Entrance Road and the Carnot and Beers School Road. Capacity analyses in this report indicate that low-cost traffic engineering improvements to these intersections (such as modified signal phasing) may not prove feasible as a method to alleviate the problem. The extended length of the signal cycles and maximum "green time" required to handle existing roadway approach service volumes will limit the effectiveness of any short-term improvements. The need to grade-separate these intersections may become necessary in the early 1980's to avoid a serious constraint to airport access.

The problem at the Fort Pitt Tunnel involves inadequate carrrying capacity for existing traffic volumes. Although traffic conditions improve substantially west of the Banksville Road - U.S. 19 interchange, the traffic bottlenecks created along the tunnel segment (approximately one mile in length) cause extended travel times to the Airport, particularly during peak travel periods.

Plans have been developed to completely overhaul and rebuild the City's existing trolley system within the South Hills Corridor. However, the number of automobile diversions projected for the Fort Pitt tunnel as a result of these transit improvements is expected to be minimal (Reference 5).

The immediate problems within the Airport property include insufficient parking and curbspace which congests the internal roadway. In addition, the present location of the Airport Terminal precludes major expansion opportunities due to surrounding land development. The County Department of Aviation has initiated the development of a new Airport Master Plan to seek solutions to these conditions, including the possibility of relocating the terminal facilities to airport-owned land to the west of the existing terminal.

Relocating the terminal to the west would essentially eliminate the forecasted access congestion problem at the two Airport Parkway intersections. However, a new terminal site would still have to contend with the congestion problem at the Fort Pitt Tunnel and the existing "no-build" highway policy when considering external airport access needs.

APPENDIX A

ASSIGNMENT OF CURRENT AIRPORT GROUND TRIPS

Assignment of access trips was based on a 1969 parking and vehicular access study (Reference 4) and data supplied by the Department of Aviation. The originating airport passenger and employee volumes generated by zone within the City of Pittsburgh and by county were assigned to existing major access highways or arterials. The data were assigned as shown below.

Location	Percent of Airport Vehicles
Beaver Valley Expressway - Rt. 60 (east of Moon Road)	20%
Interstate 79 (north of Rt. 60)	16%
Interstate 79 (south of U.S. 22/30)	14%
Interstate 379 (east of I-79)	40%
Fort Pitt Tunnel	34%
Carnot & Beers School Road (north of Airport Parkway)	10%
Saw Mill Run Blvd. - Rt. 51 (south of I-279)	10%
Ohio River Blvd. - Rt. 65 (west of I-79)	8%
Airport Parkway - Rt. 60 (west of Rt. 51)	20%
Airport Parkway - Rt. 60 (east of Airport entrance)	70%
Intersection of Airport Parkway and Airport Entrance Road	86%
Intersection of Airport Parkway and Carnot and Beers School Road	37%

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

ROADWAY CAPACITY

Airport Parkway (east of Airport); Beaver Valley Expressway; Fort Pitt Tunnel; I-379 (east of I-79)

The hourly capacity for these roadways was read directly from the right hand side of Table 9.1 of the Highway Capacity Manual, assuming PHF = 0.91. This was then converted to an average daily capacity (ADT) by dividing the hourly capacity by the peak hour percentage. Peak hour percentages of 11% for the 30th highest hour, 9.6% for the 200th highest hour, and 7.4% for the 1,000 highest hour were used from typical urban freeway data given in the HCM.

Airport Parkway (west of State Route 51); Carnot & Beers School Road

The capacity for these arterial roadways were estimated by using a table previously developed in other traffic studies to estimate the midblock capacity of urban arterials. For two lane arterials the estimated per lane hourly capacity was 2/3 of ideal capacity as based on HCM Table 10.7, assuming up to 5% trucks. The resulting hourly capacity was multiplied by two and then divided by the peak percentage. The hourly capacity for multi-lane arterials was estimated to be 2/3 of ideal conditions found in Table 10.1 of the HCM. A more sophisticated calculation would require a detailed analysis of all access/egress points, intersections, traffic controls, truck traffic, and grades along all of these arterials.

Primary Airport Entrance and Carnot & Beers School Road Intersections with Airport Parkway

The capacities of these two intersections were initially calculated for all roadway approaches irrespective of signal timing. Figure 6.8 of the Highway Capacity Manual was used to determine the approach volume per hour of green time (V.P.H.G.). Appropriate adjustments were made for turning lanes, traffic movements, trucks, metropolitan area size. The resulting service volume for each approach was then multiplied by the ratio of available green time to total signal phasing time, which provided the hourly capacity. The maximum green time (existing phasing) allocated for each approach by the fully actuated signals at these intersections was used. Each roadway approach was then added to show the hourly capacity for the intersection.

Available Airport Traffic Capacity and Passenger Volumes

Traffic not destined for the airport was subtracted from roadway capacity at levels of service "D" and "E" to obtain highway capacity available for airport traffic. Non-airport traffic was calculated by subtracting current airport-destined traffic from current daily traffic count data. Current airport destined traffic was identified in Pittsburgh through traffic counts at entrances leading to the Airport. These volumes were then assigned to access roadways based on origin and destination data and summarized by Appendix A. Current non-airport traffic was projected into the future by using an annual growth factor of 2%.

Vehicle capacity available for airport trips were converted to air passengers by utilizing procedures outlined in Section B.3 (Ground Access Capacity). Tables B1 through B8 show the capacity calculations for all six locations.

Table B1

AIRPORT ACCESS CAPACITY

Airport Parkway (East of Airport)

L.O.S.[1/]	Hrs./Yrs.[2/]	Factor[3/]	YEAR 1976	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	60,000	60,000	60,000	60,000	60,000
		2	17,900	19,370	21,390	23,610	26,080
		3	42,100	40,630	38,610	36,390	33,920
		4	14.5	14.0	13.3	12.6	11.7
D	200	1	68,800	68,800	68,800	68,800	68,800
		2	17,900	19,370	21,390	23,610	26,080
		3	50,900	49,430	47,410	45,190	42,720
		4	17.6	17.1	16.4	15.6	14.7
D	1000	1	89,200	89,200	89,200	89,200	89,200
		2	17,900	19,370	21,390	23,610	26,080
		3	71,300	69,830	67,810	65,590	63,120
		4	24.6	24.1	23.4	22.6	21.8
E	30	1	72,730	72,730	72,730	72,730	72,730
		2	17,900	19,370	21,390	23,610	26,080
		3	54,830	53,360	51,340	49,120	46,650
		4	18.9	18.4	17.7	16.9	16.1
E	200	1	83,300	83,300	83,300	83,300	83,300
		2	17,900	19,370	21,390	23,610	26,080
		3	65,400	63,930	61,910	59,690	57,220
		4	22.6	22.1	21.4	20.6	19.7
E	1000	1	108,100	108,100	108,100	108,100	108,100
		2	17,900	19,370	21,390	23,610	26,080
		3	90,200	88,730	86,710	84,490	82,020
		4	31.1	30.6	29.9	29.1	28.3

1] Per Highway Capacity Manual
2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.
3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

Table B2

AIRPORT ACCESS CAPACITY

Beaver Valley Expressway

L.O.S.[1]	Hrs./Yrs.[2]	Factor[3]	YEAR 1976	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	60,000	60,000	60,000	60,000	60,000
		2	13,800	14,930	16,490	18,200	20,110
		3	46,200	45,070	43,510	41,800	39,890
		4	55.9	54.5	52.6	50.5	48.2
D	200	1	68,800	68,800	68,800	68,800	68,800
		2	13,800	14,930	16,490	18,200	20,110
		3	55,000	53,870	52,310	50,600	48,690
		4	66.5	65.1	63.2	61.2	58.9
D	1000	1	89,200	89,200	89,200	89,200	89,200
		2	13,800	14,930	16,490	18,200	20,110
		3	75,400	74,270	72,710	71,000	69,090
		4	91.1	89.8	87.9	85.8	83.5
E	30	1	72,730	72,730	72,730	72,730	72,730
		2	13,800	14,930	16,490	18,200	20,110
		3	58,930	57,800	56,240	54,530	52,620
		4	71.2	69.9	68.0	65.9	63.6
E	200	1	83,300	83,300	83,300	83,300	83,300
		2	13,800	14,930	16,490	18,200	20,110
		3	69,500	68,370	66,810	65,100	63,190
		4	84.0	82.7	80.8	78.7	76.4
E	1000	1	108,100	108,100	108,100	108,100	108,100
		2	13,800	14,930	16,490	18,200	20,110
		3	94,300	93,170	91,610	89,900	87,990
		4	114.0	112.6	110.8	108.7	106.4

1] Per <u>Highway Capacity Manual</u>

2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

Table B3

AIRPORT ACCESS CAPACITY

Carnot & Beers School Road

L.O.S.[1/]	Hrs./Yrs.[2/]	Factor[3/]	YEAR 1976	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	37,900	37,900	37,900	37,900	37,900
		2	19,250	20,830	23,000	25,390	28,050
		3	18,650	17,070	14,900	12,510	9,850
		4	45.1	41.3	36.0	30.2	23.8
D	200	1	45,800	45,800	45,800	45,800	45,800
		2	19,250	20,830	23,000	25,390	28,050
		3	26,550	24,970	22,800	20,410	17,750
		4	64.2	60.4	55.1	49.3	42.9
D	1000	1	59,500	59,500	59,500	59,500	59,500
		2	19,250	20,830	23,000	25,390	28,050
		3	40,250	38,670	36,500	34,110	31,450
		4	97.3	93.5	88.2	82.4	76.0
E	30	1	48,500	48,500	48,500	48,500	48,500
		2	19,250	20,830	23,000	25,390	28,050
		3	29,250	27,670	25,500	23,110	20,450
		4	70.7	66.9	61.6	55.9	49.4
E	200	1	55,600	55,600	55,600	55,600	55,600
		2	19,250	20,830	23,000	25,390	28,050
		3	36,350	34,770	32,600	30,210	27,550
		4	87.9	84.0	78.8	73.0	66.6
E	1000	1	72,100	72,100	72,100	72,100	72,100
		2	19,250	20,830	23,000	25,390	28,050
		3	52,850	51,270	49,100	46,710	44,050
		4	127.7	123.9	118.7	112.9	106.5

1] Per Highway Capacity Manual
2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.
3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

TABLE B4

AIRPORT ACCESS CAPACITY

Airport Parkway (West of Rt. 51)

L.O.S.[1/]	Hrs./Yrs.[2/]	Factor[3/]	YEAR 1976	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	37,900	37,900	37,900	37,900	37,900
		2	15,400	16,660	18,400	20,310	22,440
		3	22,500	21,240	19,500	17,590	15,460
		4	27.2	25.7	23.6	21.3	18.7
D	200	1	45,800	45,800	45,800	45,800	45,800
		2	15,400	16,660	18,400	20,310	22,440
		3	30,400	29,140	27,400	25,490	23,360
		4	36.7	35.2	33.1	30.8	28.2
D	1000	1	59,500	59,500	59,500	59,500	59,500
		2	15,400	16,660	18,400	20,310	22,440
		3	44,100	42,840	41,100	39,190	37,060
		4	53.3	51.8	49.7	47.4	44.8
E	30	1	48,500	48,500	48,500	48,500	48,500
		2	15,400	16,660	18,400	20,310	22,440
		3	33,100	31,840	30,100	28,190	26,060
		4	40.0	38.5	36.4	34.1	31.5
E	200	1	55,600	55,600	55,600	55,600	55,600
		2	15,400	16,660	18,400	20,310	22,440
		3	40,200	38,940	37,200	35,290	33,160
		4	48.6	47.1	45.0	42.6	40.1
E	1000	1	72,100	72,100	72,100	72,100	72,100
		2	15,400	16,660	18,400	20,310	22,440
		3	56,700	55,440	53,700	51,790	49,660
		4	68.5	67.0	64.9	62.6	60.0

1] Per Highway Capacity Manual

2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

Table B5

AIRPORT ACCESS CAPACITY

Intersection of Airport Parkway and Airport Entrance Road

L.O.S.[1/] (1)	Hrs./Yrs.[2/] (2)	Factor[3/] (3)	YEAR 1976 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	54,800	54,800	54,800	54,800	54,800
		2	24,100	26,080	28,800	31,790	35,110
		3	30,700	28,720	26,000	23,010	19,690
		4	8.6	8.1	7.3	6.5	5.5
D	200	1	66,250	66,250	66,250	66,250	66,250
		2	24,100	26,080	28,800	31,790	35,110
		3	42,150	40,170	37,450	34,460	31,140
		4	11.8	11.3	10.5	9.7	8.8
D	1000	1	85,950	85,950	85,950	85,950	85,950
		2	24,100	26,080	28,800	31,790	35,110
		3	61,850	59,870	57,150	54,160	50,840
		4	17.4	16.8	16.1	15.2	14.3
E	30	1	61,370	61,370	61,370	61,370	61,370
		2	24,100	26,080	28,800	31,790	35,110
		3	37,270	35,290	32,570	29,580	26,260
		4	10.5	9.9	9.2	8.3	7.4
E	200	1	74,160	74,160	74,160	74,160	74,160
		2	24,100	26,080	28,800	31,790	35,110
		3	50,060	48,080	45,360	42,370	39,050
		4	14.1	13.5	12.7	11.9	11.0
E	1000	1	96,200	96,200	96,200	96,200	96,200
		2	24,100	26,080	28,800	31,790	35,110
		3	72,100	70,120	67,400	64,410	61,090
		4	20.3	19.7	18.9	18.1	17.2

1] Per <u>Highway Capacity Manual</u>
2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.
3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

Table B6

AIRPORT ACCESS CAPACITY

Intersection of Airport Parkway and Carnot & Beers School Road

L.O.S.[1/]	Hrs./Yrs.[2/]	Factor[3/]	YEAR 1976	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	52,300	52,300	52,300	52,300	52,300
		2	27,600	29,860	32,980	36,400	40,210
		3	24,700	22,440	19,320	15,900	12,090
		4	16.1	14.7	12.6	10.4	7.9
D	200	1	63,200	63,200	63,200	63,200	63,200
		2	27,600	29,860	32,980	36,400	40,210
		3	35,600	33,340	30,220	26,800	22,990
		4	23.3	21.8	19.7	17.5	15.0
D	1000	1	82,000	82,000	82,000	82,000	82,000
		2	27,600	29,860	32,980	36,400	40,210
		3	54,400	52,140	49,020	45,600	41,790
		4	35.5	34.1	32.0	29.8	27.3
E	30	1	57,700	57,700	57,700	57,700	57,700
		2	27,600	29,860	32,980	36,400	40,210
		3	30,100	17,840	24,420	21,300	17,490
		4	19.7	11.7	16.1	13.9	11.4
E	200	1	69,800	69,800	69,800	69,800	69,800
		2	27,600	29,860	32,980	36,400	40,210
		3	42,200	39,940	36,820	33,400	29,590
		4	27.6	26.1	24.0	21.8	19.3
E	1000	1	90,500	90,500	90,500	90,500	90,500
		2	27,600	29,860	32,980	36,400	40,210
		3	62,900	60,640	57,520	54,100	50,290
		4	41.1	39.6	37.6	35.3	32.8

1] Per Highway Capacity Manual

2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

Table B7

AIRPORT ACCESS CAPACITY

Fort Pitt Tunnel

L.O.S.[1/]	Hrs./Yrs.[2/]	Factor[3/]	YEAR 1976	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	60,000	60,000	60,000	60,000	60,000
		2	62,540	67,670	74,740	82,490	91,120
		3	-	-	-	-	-
		4	-	-	-	-	-
D	200	1	68,800	68,800	68,800	68,800	68,800
		2	62,540	67,670	74,740	82,490	91,120
		3	6,260	1,130	-	-	-
		4	4.5	0.8	-	-	-
D	1000	1	89,200	89,200	89,200	89,200	89,200
		2	62,540	67,670	74,740	82,490	91,120
		3	26,660	21,530	14,460	6,710	-
		4	19.0	15.3	10.3	4.8	-
E	30	1	72,730	72,730	72,730	72,730	72,730
		2	62,540	67,670	74,740	82,490	91,120
		3	10,190	5,060	-	-	-
		4	7.2	3.6	-	-	-
E	200	1	83,300	83,300	83,300	83,300	83,300
		2	62,540	67,670	74,740	82,490	91,120
		3	20,760	15,630	8,560	810	-
		4	14.8	11.1	6.1	0.6	-
E	1000	1	108,100	108,100	108,100	108,100	108,100
		2	62,540	67,670	74,740	82,490	91,120
		3	45,560	40,430	33,360	25,610	16,980
		4	32.4	28.7	23.7	18.2	12.1

1] Per Highway Capacity Manual
2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.
3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

Table B8

AIRPORT ACCESS CAPACITY

I-379 (East of I-79)

L.O.S.[1/]	Hrs./Yrs.[2/]	Factor[3/]	YEAR 1976	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	60,000	60,000	60,000	60,000	60,000
		2	35,600	38,520	42,540	46,960	51,870
		3	24,400	21,480	17,460	13,040	8,130
		4	14.7	13.0	10.6	7.9	4.9
D	200	1	68,800	68,800	68,800	68,800	68,800
		2	35,600	38,520	42,540	46,960	51,870
		3	33,200	30,280	26,260	21,840	16,930
		4	20.1	18.3	15.9	13.2	10.2
D	1000	1	89,200	89,200	89,200	89,200	89,200
		2	35,600	38,520	42,540	46,960	51,870
		3	53,600	50,680	46,660	42,240	37,330
		4	32.4	30.6	28.2	25.5	22.6
E	30	1	72,730	72,730	72,730	72,730	72,730
		2	35,600	38,520	42,540	46,960	51,870
		3	37,130	34,210	30,190	25,770	20,860
		4	22.4	20.7	18.2	15.6	12.6
E	200	1	83,300	83,300	83,300	83,300	83,300
		2	35,600	38,520	42,540	46,960	51,870
		3	47,700	44,780	40,760	36,340	31,430
		4	28.8	27.1	24.6	22.0	19.0
E	1000	1	108,100	108,100	108,100	108,100	108,100
		2	35,600	38,520	42,540	46,960	51,870
		3	72,500	69,580	65,560	61,140	56,230
		4	43.8	42.0	39.6	36.9	34.0

1] Per Highway Capacity Manual

2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

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PORTLAND

INTERNATIONAL AIRPORT

CASE STUDY

CASE STUDY SUMMARY

Portland International Airport (PIA), owned and operated by the Port of Portland, is located approximately six miles northeast of the Portland central business district. The airport, classified by the FAA as a "medium hub," serves over three million passengers annually, of which about 75% originate or terminate their trips in Portland.

The airport is accessed via city streets (primarily 82nd Avenue) which connect it to the interstate system. The Banfield Freeway, I80, runs east-west about three miles south of the airport and I5 runs north-south about four miles west of the airport. An eastern by-pass to the city of Portland, I205, is being constructed, and will offer direct access to the airport from the interstate system via the extension of a major access road (Airport Way). The expected completion data for I205 is 1982.

Currently, access to the airport is impeded by level of service "E" bottlenecks on the Banfield Freeway and on 82nd Avenue. The completion of I205 is expected to resolve the problem of access between the Banfield Freeway and the airport, thus removing the bottleneck at 82nd Avenue and offering an alternative to 82nd Avenue. Plans are also under consideration to widen the Banfield Freeway which would eliminate or reduce congestion in the short-term.

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A. BACKGROUND

1. General

Portland International Airport (PIA), owned and operated by the Port of Portland, is located in Multnomah County, in northwestern Oregon. Approximately six miles northeast of the Portland Central Business District (CBD) and separated from Vancouver, Washington, by the Columbia River, PIA serves both the northern Oregon and southern Washington regions.

In 1975, approximately three million passengers were enplaned and deplaned, thereby placing Portland International in the FAA's medium hub classification. Of these three million passengers, 75% originated or terminated their trips at PIA, thus requiring utilization of the ground access system.

The ground access system consists of two major interstate highways, the Banfield Freeway (East to West) and I5 (North to South), which carry a large portion of airport related traffic from the surrounding areas. The final approach to the airport is made on surface streets, with 82nd Avenue, the primary connector to Airport Way, handling almost 85% of all traffic entering the airport. The map presented in Figure 1 shows PIA in relation to the major access roadway system.

2. Transportation Planning Structure

Although PIA is physically located within the City of Portland, it is operated by the Port of Portland, a state agency whose commissioners are appointed by the Governor.

The planning structure at Portland is in a state of flux. Currently, the Metropolitan Planning Organization (MPO) for the Portland area is the Columbia Region Association of Governments (CRAG), of which the Port is a member. The implementing agency for regional plans is the Metro Service District (MSD). Per a recent popular referendum, CRAG will be subsumed under the MSD starting December 1978. Commissioners of the MSD will be elected from local districts with equal populations.

Under the present structure, the Port works closely with CRAG in formulating regional airport access plans and in evaluating the impact on the airport of other regional plans. The Port participates in the development of the Unified Work Program and in the long-range planning for the Portland/Vancouver region. The long range transportation plan is documented in the Interim Transporation Plan, which is presently being updated. Aviation plans are coordinated with the State, which has responsibility for the state aviation systems plan. Off-airport roadway improvements in the vicinity of the airport may be planned with the aid of the State Department of Transportation, which also provides assistance to local jurisdictions in implementing approved programs.

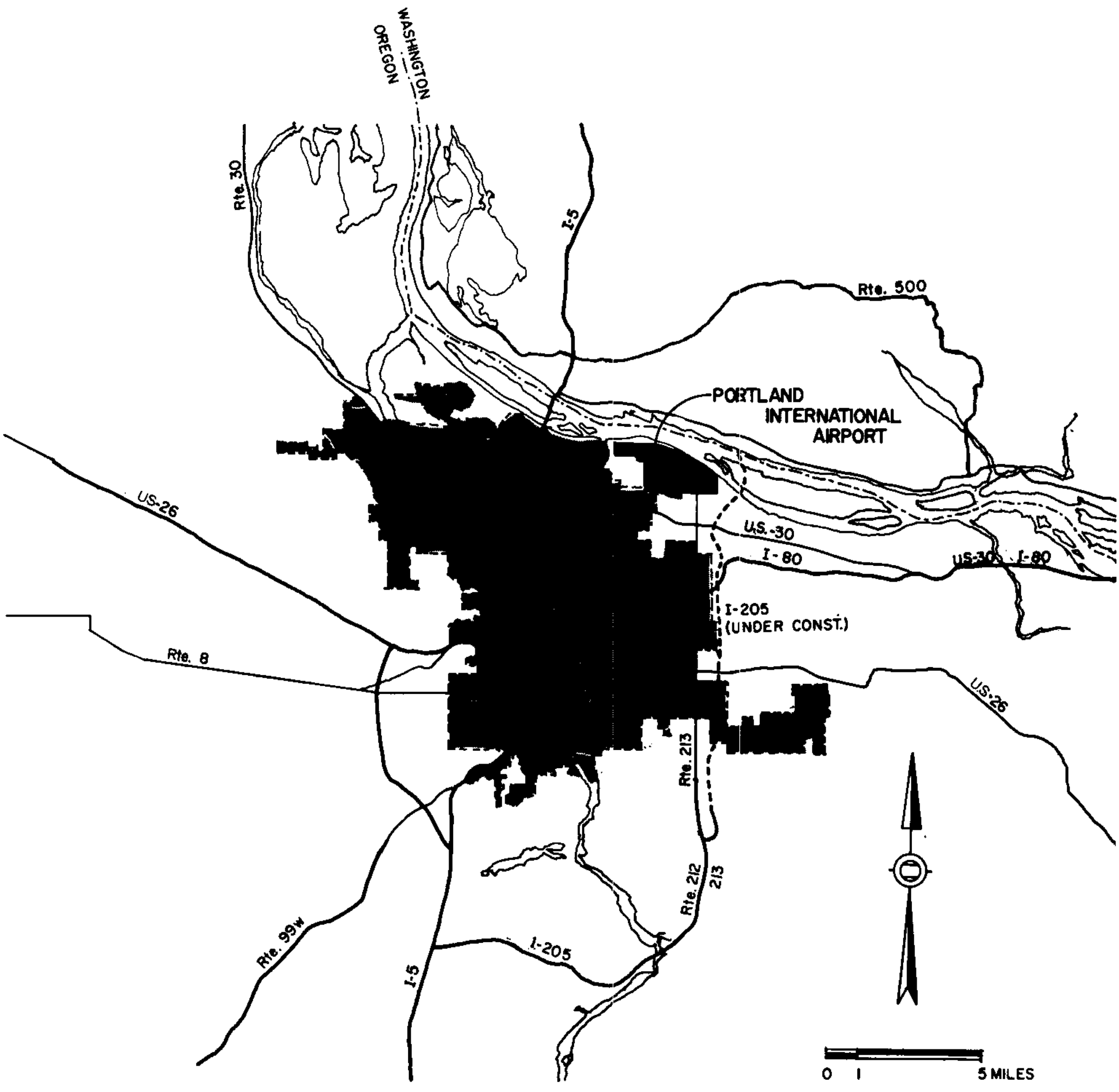

Figure 1
PORTLAND REGION

3. Highway Access

Airport-related vehicles utilize the access routing system depicted in Figure 2 1/. Although some air travelers use the interstate highway system on the initial stages of their trip to the airport, the final segment of the trip is made on either 82nd Avenue or Lombard Street via Marine Drive. Of these two possible routes 82nd Avenue is by far the most heavily employed, accounting for nearly 85% of all vehicles entering PIA.

The Portland CBD accounts for only 5% of all air passenger vehicle trips going to the airport. However, an additional 30% of all air passenger trips originate in areas to the south or west of the CBD and for the most part employ the same routes to the airport as the CBD originating traffic. As a measure of extent of access delays, a recent update of the Federal Highway Administration's continuing airport access analysis program indicated that travel time from the CBD to the airport was 23.7 minutes during peak periods, compared to 18.3 minutes in off-peak periods.

Other routes in the airport vicinity are also experiencing increasing congestion as development of the area increases. The completion of I205, scheduled for 1982, should bring significant short-term reductions in the traffic volumes on the existing roadway serving the airport and its environs.

4. Transit Access

Results of the June 1977 access survey conducted for Portland International Airport showed that approximately 6% of all originating passengers use some form of transit. The major transit options are Tri-Met, DART, limousines, and taxis. The 82nd Avenue line, a north-south crosstown line, is the only Tri-Met line serving the airport. There is no direct Tri-Met service to the airport from the downtown area or other major regional centers. DART services are provided between the airport and the central business district. DART, a private business which contracts with the Port, offers direct trips to the airport and employs sixteen-seat vehicles. Limousine service is provided between the airport and Beaverton, Vancouver, Salem, and Woodburn.

1/ Passenger vehicles only, to remain consistent with other case studies for which employee data were unavailable; Figure 2 differs from PIA modes presented in PIA Master Plan working paper 4.3, page 18, which includes both passenger and employee vehicles.

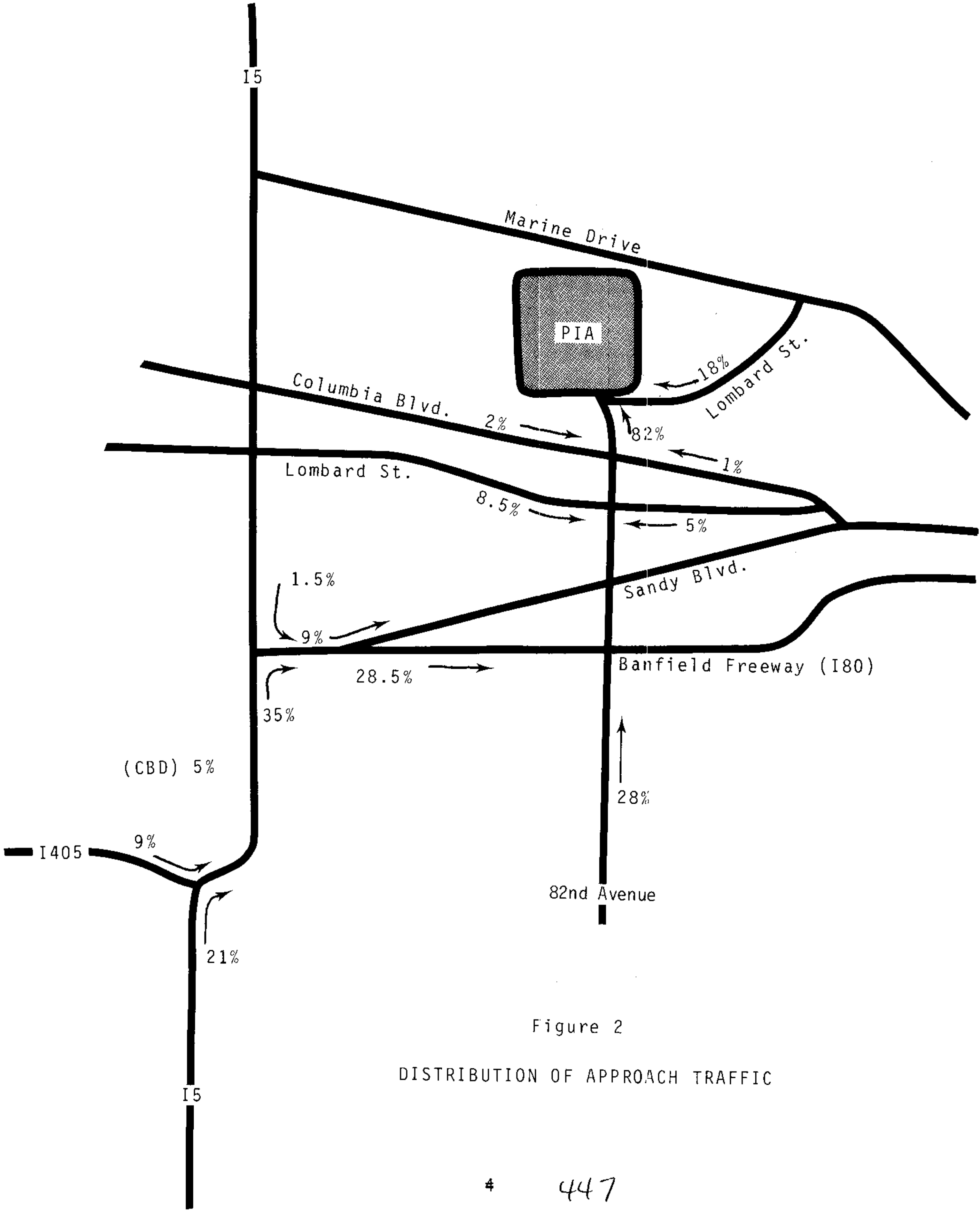

Figure 2

DISTRIBUTION OF APPROACH TRAFFIC

5. Internal Access

The internal access system at Portland International Airport consists of a four-lane divided roadway that provides routing from 82nd Avenue to the central terminal area. The access road widens, becoming one directional approaching the terminal and splits into upper (enplaning) and lower (deplaning) levels to facilitate traffic flow in front of the terminal. Access to the terminal building from the parking lots is provided by a tunnel system. Substantial efforts have been made recently to provide an efficient internal access system. Most notably, a 17 million dollar construction project for internal improvement was completed in 1977. Figure 3 shows the internal access system at PIA.

B. CAPACITY ANALYSIS

1. Passenger Forecast

The two passenger forecasts used in this study were taken from the most recent FAA forecast and a forecast prepared by Peat, Marwick, Mitchell & Co. for the Port of Portland. The FAA forecast extends only until 1988 and is projected to 1995 at the 1983-1988 growth rate. The Peat, Marwick, Mitchell & Co. forecast extends to the year 2000 and is interpolated for 1995. Table 1 presents these passenger forecasts.

2. Airside Capacity

The 1978 Draft Master Plan for Portland International Airport and vicinity presents the most recent projections for airfield capacity and suggests possible alternatives to increase this capacity. Using projected volumes of the demand for aircraft operations through the year 2000, there appears to be sufficient airfield capacity to accommodate air passenger traffic. Table 2 shows projected capacity under the conservative assumption that no new airfield facilities (runways, taxiways, etc.) will be built.

3. Ground Access Capacity

Current airport ground trips were assigned to major access routes as shown in Appendix A. Four critical highway locations were identified:

(1) 82nd Avenue north of Columbia Boulevard;

(2) 82nd Avenue south of I80;

(3) I80 between I5 and 82nd Avenue; and

(4) I5 just south of I80.

Since for I80 the demand/capacity ratios were much greater where the highway has four lanes rather than six, the demand/capacity analysis focuses only on the four-lane section of I80.

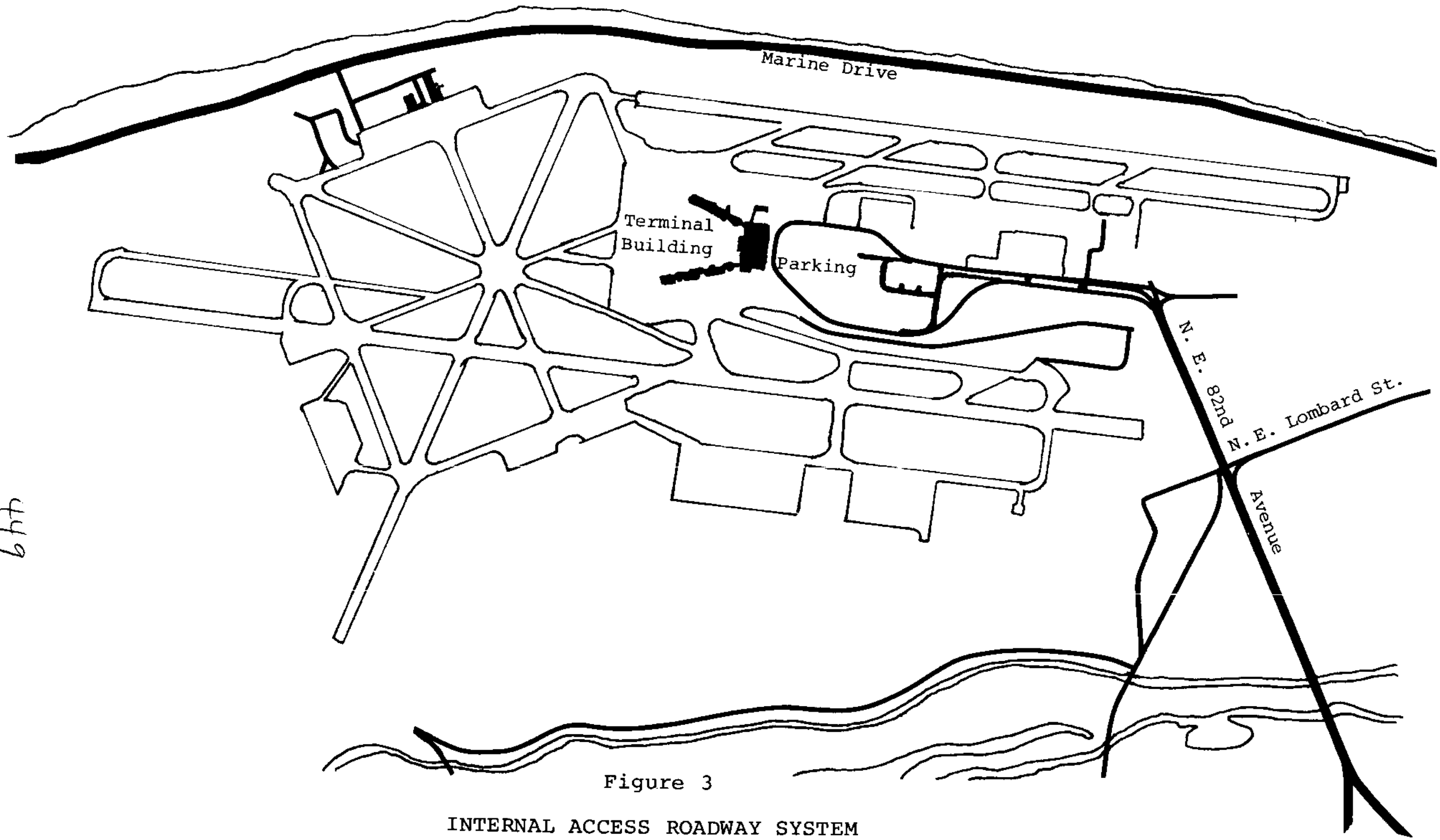

Figure 3

INTERNAL ACCESS ROADWAY SYSTEM

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TABLE 1

FORECAST OF DEMAND

(MILLION ANNUAL PASSENGERS)

Year	Portland	FAA
(1)	(2)	(3)
1975	3.0 1/	3.0 1/
1980	3.9	3.9
1985	4.8	5.1 2/
1990	5.8	6.7 3/
1995	7.1 2/	8.7 3/

1/ Actual.

2/ Interpolated.

3/ Extended.

TABLE 2

FORECAST OF AIRSIDE CAPACITY

(MILLION ANNUAL PASSENGERS)

Year	Capacity
(1)	(2)
1975	4.95
1980	6.10
1985	6.54
1990	7.74
1995	9.01 1/

1/ Interpolated.

Source: Peat, Marwick, Mitchell & Co. Draft PIA Masterplan, Technical Memorandum No. V-7. Enplanements per Departure found in Table A-1; Capacity for Departures found in Table 7.

When I205 is completed (expected date is 1982), the total capacity of roadway between I80 and the airport will increase significantly. Not only will I205 be available to airport traffic, but also the existing access routes (82nd Avenue and Sandy Blvd. to 82nd Ave.) will remain viable approach routes. In addition, non-airport traffic on 82nd Avenue should decrease significantly in the short term. Information currently being compiled for the PIA Master Plan seems to indicate that although opening I205 will provide short term relief, increased airport vicinity traffic will present capacity problems along 82nd Avenue by 1990. This updated roadway traffic forecast could change the demand capacity relationship presented in this case study and should be acknowledged as a further possible constraint to airport access. Accordingly, due to the lack of traffic forecast information beyond the short term, the analysis of 82nd Avenye is limited to the years 1975 to 1985.

The impact of the completion of I205 on traffic along I80 and I5 is not certain. Most likely, however, traffic on I5 will decrease and traffic on I80 will decrease slightly or remain constant in the short term. However, absent concrete projections, it is assumed that I205 will have a short range impact on reducing I5 traffic volumes, while updated Port Authority information suggests that opening I205 could possibly generate enough additional traffic on I80 to have a devastating effect on the already overloaded highway. This assumption should be kept in mind when interpreting the analysis results.

Figures 4 through 7 present the results of the ground access capacity analysis for the four segments of interest. Appendix B details the assumptions and calculations behind these results.

4. Interpretation

a. 82nd Avenue

Between I80 and the airport, 82nd Avenue will be only a moderate source of congestion by 1982, the expected date of the completion of I205. South of I80, 82nd Avenue will, by 1980, operate at level of service "E" for more than four hours per weekday. This will cause long delays for those passengers using this route, but these should be tolerable due to the imminent opening of I205 and to the fact that only about 28% of the airport traffic uses this route.

b. Banfield Freeway (I80)

The Banfield Freeway is currently operating at level of service "E" for between 200 and 1,000 hours per year. It is expected that by 1985 the Freeway will operate at level of service "E" for over 1,000 hours per year, and the situation will worsen through the study period. The completion of I205, although not expected to reduce traffic on I80, may reduce traffic on north/south surface streets making it more appealing for the airport-bound passengers to exit onto surface streets before or shortly after the Freeway narrows to four lanes.

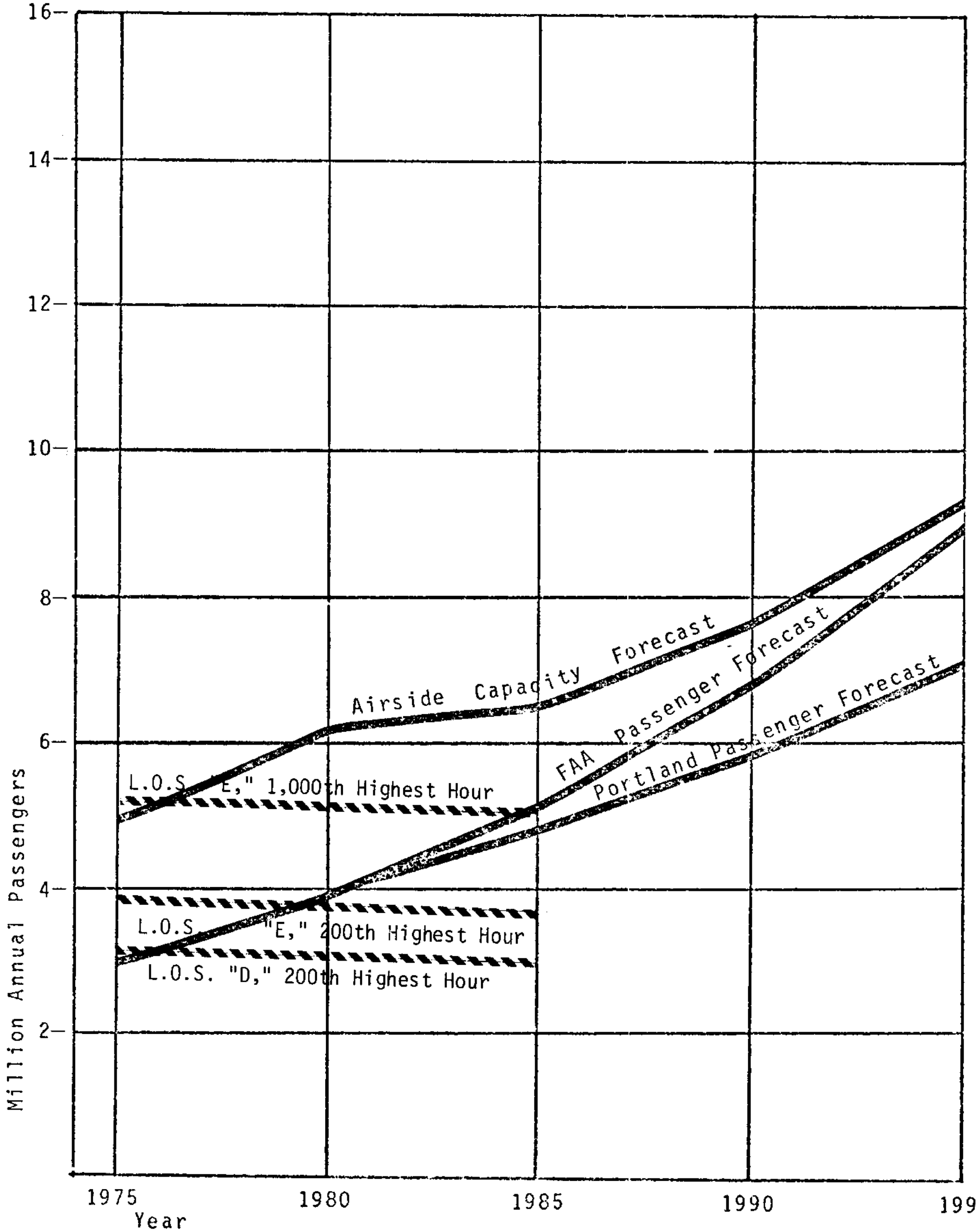

Figure 4

DEMAND/CAPACITY RELATIONSHIPS

82nd Avenue North of Columbia Boulevard

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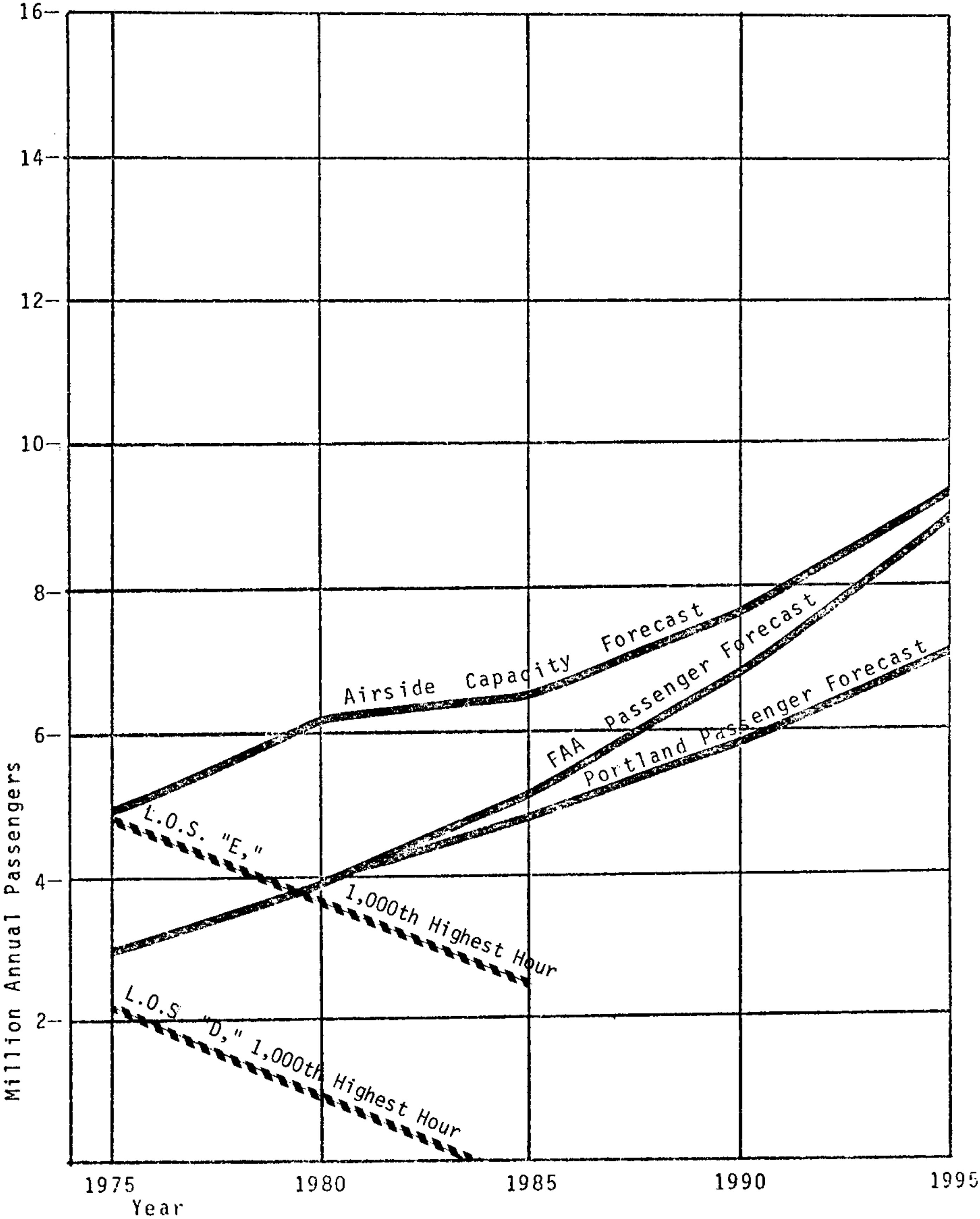

Figure 5

DEMAND/CAPACITY RELATIONSHIPS

82nd Avenue South of I80

454

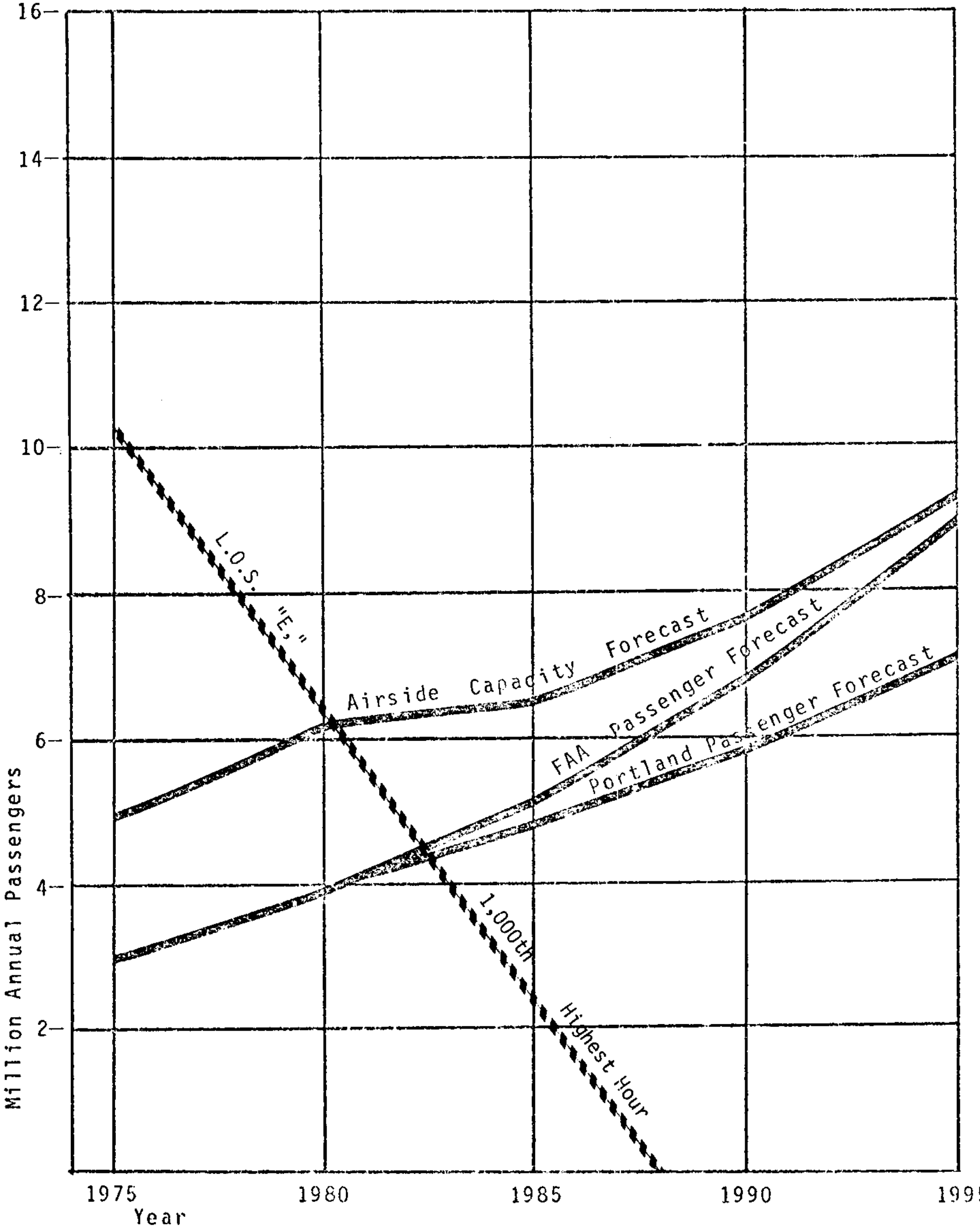

Figure 6

DEMAND/CAPACITY RELATIONSHIPS 455

Banfield Freeway (I80) Between Sandy Blvd. and 82nd Avenue

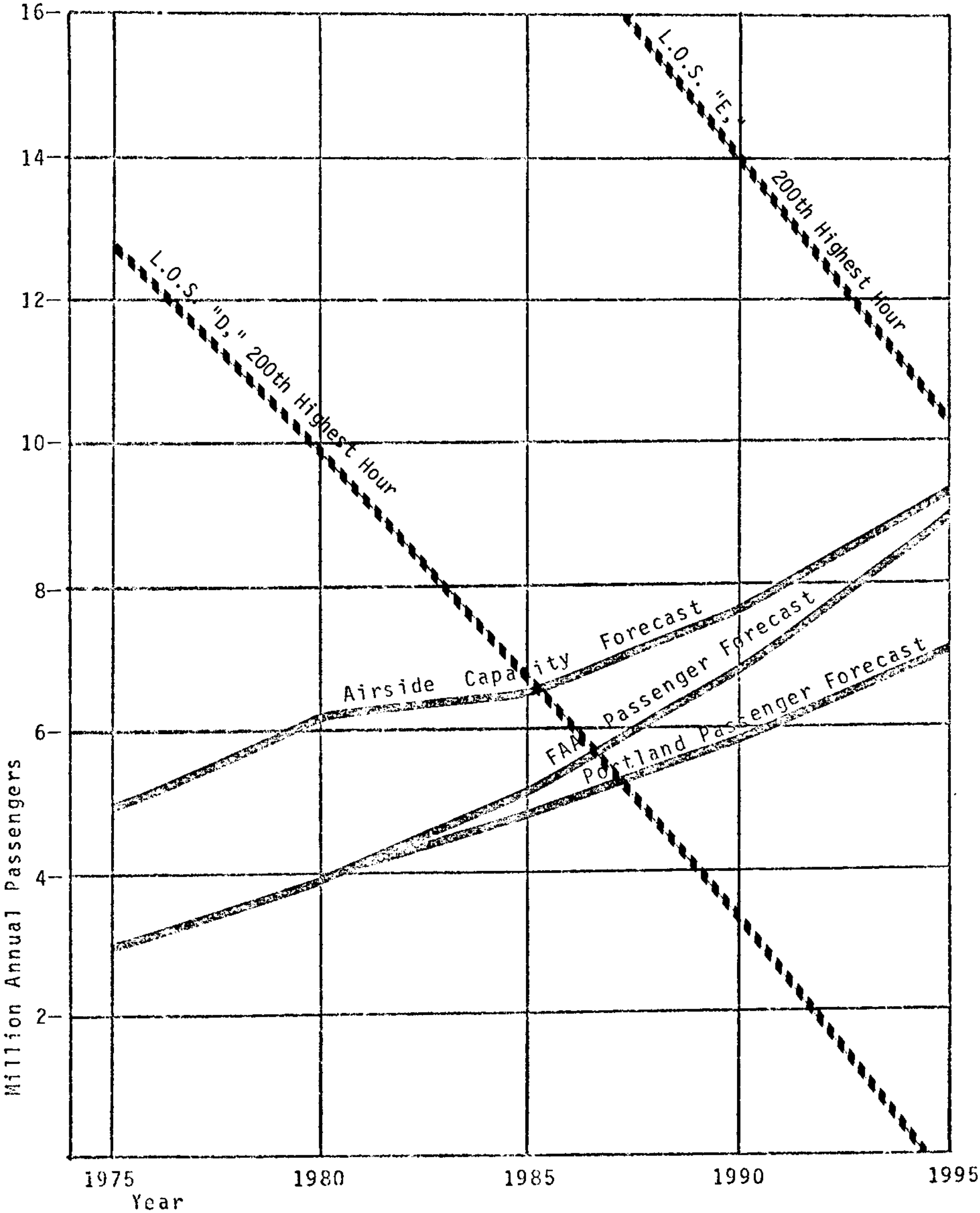

Figure 7
DEMAND/CAPACITY RELATIONSHIPS
I5 Just South of I80

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c. Interstate 5

Interstate 5 is not expected to become congested to the point where it would inhibit the growth of PIA. Even by 1995 and the optimistic demand forecast, I5 will operate at level of service "E" for less than one hour per weekday. The completion of I205 should improve the situation even more.

C. PROPOSED SOLUTIONS

The possible widening of the Banfield Freeway could benefit airport access by lessening congestion on that roadway. It is expected that completion of I205 will eliminate all access problems in the short term, except that associated with the four-lane stretch of the Banfield Freeway. Currently, several alternatives are under consideration for the improvement of the Banfield -- from the do-nothing alternative to an alternative that would make the Freeway six lanes between I5 and I205 and would include right-of-way for a light rail system. The price tag varies from $27 million dollars for minor modification of the Banfield to $188 million for the entire project. Funds are available from Federal money obtained for an earlier proposed highway which was never built.

The Master Plan work to date suggests that 82nd Avenue (between Columbia Boulevard and Airport Way) may need to be relocated to the east in order to accomodate needed airport facilities. The relocation has the benefit, however, of diverting a larger percentage of airport traffic to Airport Way and I205, thus reducing congestion on 82nd south of the airport. Funding sources for the extension of Airport Way and the relocation of 82nd Avenue are yet to be explored.

D. CONCLUSIONS

Portland International Airport currently has a severe access problem with level of service "E" encountered on the major access routes, 82nd Avenue and the Banfield Freeway. Relief from the congestion on 82nd Avenue is expected in 1982 when a new interstate highway, I205, is scheduled to open. This relief is not expected to extend to the Banfield Freeway. If the Banfield Freeway remains congested, there is probably little that can be done to alleviate the problem other than to widen the Freeway or to build new highways. The widening of Banfield Freeway is currently under study and a preliminary environmental impact statement has been completed. However, new highway construction is doubtful, with I205 considered to be the last major freeway construction in the metropolitan area 1/. Several alternatives are being considered along with the "do-nothing" alternative. Nevertheless, should the Banfield remain congested, there exist alternate access routes for those who would otherwise use the Banfield Freeway, namely the Banfield to Sandy Boulevard to 82nd Avenue (which limits the use of the Banfield to its six-lane section) or the more circuitous routes I5 to Marine Drive or Lombard Street.

1. Peat, Marwick, Mitchell and Co., PIA Masterplan, Working paper 4.3.

APPENDIX A

ROUTING OF AIRPORT ACCESS TRIPS

BY LOCAL ORIGIN/DESTINATION ZONE

Table A1 shows the distribution and routing of trips between the airport and specified local zones.

TABLE A1

ROUTING OF AIRPORT ACCESS TRIPS

BY LOCAL ORIGIN/DESTINATION ZONE

Zone	Percent 1/ Distributed	Routing	Percent by Route
(1)	(2)	(3)	(4)
Portland SMSA			
City of Portland			
CBD	5	I80, AV82	4
		I80, SB, AV82	1
Northeast	12	CB(EB), AV82	1
		CB(WB), AV82	1
		LS, AV82	4
		MD, LS	1
		SB, KS, AV82	5
Southeast	12	AV82	12
North	4	CB, AV82	1
		LS, AV82	2
		MD, LS	1
Southwest	12	I5, I80, SB, AV82	3
		I5, I80, AV82	9
Northwest	3	I80, AV82	1.5
		LS, AV82	1.5
Other Multnomah County	2	I80, AV82	2

Zone	Percent Distributed	Routing	Percent by Route
(1)	(2)	(3)	(4)
Other Washington County	11	I5, I80, AV82	1
		I5, I80, SB, AV82	1
		RT26, I405, I80, AV82	7
		RT26, I405, I80, SB, AV82	2
Other Claskamas County	9	AV82	9
Vancouver, Washington	8	I5, MD, LS	8
Other Clark County	2	I5, MD, LS	2
Other Oregon	16	I5, MD, LS	2
		I80, SB, AV82	2
		I80, AV82	5
		I205,AV82	7
Other Washington	4	I5, MD, LS	4

Key:

AV82	82nd Avenue
CB	Columbia Boulevard
EB	Eastbound
In	Interstate Highway n
KS	Killingsworth Street
LS	Lombard Street
MD	Marine Drive
RTn	Route n
SB	Sandy Boulevard
WB	Westbound

1/ Peat, Marwick, Mitchell & Co., Technical Memorandum 3.2, Nov. 29, 1977.

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

Daily vehicular capacities at level of service "D" were obtained from the Oregon Department of Transportation (ODOT) for 82nd Avenue north of I80 and for the Banfield Freeway (I80) at 47th Street. These daily capacities were assumed to be the capacities at which the road segments at issue operated for no more than 200 hours per year.

The capacity of 82nd Avenue south of I80 was assumed equal to the capacity of 82nd Avenue north of I80. The capacity of I5 just south of I80 was computed from the Highway Capacity Manual, Table 9.1, assuming a PHF of .91, and assuming six through lanes.

Average daily traffic in 1977 at the specified points were obtained from the ODOT. An annual growth rate for non-airport traffic of 1.6% was assumed in accordance with and equal to CRAG's forecasted annual growth in population and employment in the region.

Total traffic entering and leaving the airport (20,000 ADT 1977) was obtained from Appendix A - Airport Access and Parking. Peat, Marwick, Mitchell and Co., Nov. 29, 1977. The 1977 MAP (3.3115) was interpolated between 1975 and 1980 assuming constant growth based on Aviation Demand Forecasts, Task 3.2. Peat, Marwick, Mitchell and Co., July 29, 1977.

Demand/capacity relationships for 82nd Avenue were not computed after 1985 since it is assumed that I205 will be completed by 1985 at the latest. With the completion of I205, the joint capacity offered by it and the surface streets running between I80 and the airport is assumed to be quite ample through 1995.

Table B1

AIRPORT ACCESS CAPACITY

82nd Avenue North of Columbia Boulevard

Level of Service1/	Hrs./Year2/	Factor3/	Year 1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	17,455	17,455	17,455	17,455	17,455
		2	4,214	4,562	4,939	NA	NA
		3	13,241	12,893	12,516	NA	NA
		4	2.67	2.60	2.53	NA	NA
D	200	1	20,000	20,000	20,000	20,000	20,000
		2	4,214	4,562	4,939	NA	NA
		3	15,786	15,438	15,061	NA	NA
		4	3.19	3.12	3.04	NA	NA
D	1,000	1	25,946	25,946	25,946	25,946	25,946
		2	4,214	4,562	4,939	NA	NA
		3	21,732	21,384	21,007	NA	NA
		4	4.39	4.32	4.24	NA	NA
E	30	1	20,535	20,535	20,535	20,535	20,535
		2	4,214	4,562	4,939	NA	NA
		3	16,321	15,973	15,596	NA	NA
		4	3.30	3.23	3.15	NA	NA
E	200	1	23,529	23,529	23,529	23,529	23,529
		2	4,214	4,562	4,939	NA	NA
		3	19,315	18,967	18,590	NA	NA
		4	3.90	3.83	3.75	NA	NA
E	1,000	1	30,525	30,525	30,525	30,525	30,525
		2	4,214	4,562	4,939	NA	NA
		3	26,311	25,963	25,586	NA	NA
		4	5.31	5.24	5.17	NA	NA

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B2

AIRPORT ACCESS CAPACITY

82nd Avenue South of I80

Level of Service[1/]	Hrs./Year[2/]	Factor[3/]	Year 1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	17,455	17,455	17,455	17,455	17,455
		2	22,475	24,332	26,341	NA	NA
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	200	1	20,000	20,000	20,000	20,000	20,000
		2	22,475	24,332	26,341	NA	NA
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	1,000	1	25,946	25,946	25,946	25,946	25,946
		2	22,475	24,332	26,341	NA	NA
		3	3,471	1,614	NA	NA	NA
		4	2.05	0.95	NA	NA	NA
E	30	1	20,535	20,535	20,535	20,535	20,535
		2	22,475	24,332	26,341	NA	NA
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
E	200	1	23,529	23,529	23,529	23,529	23,529
		2	22,475	24,332	26,341	NA	NA
		3	1,054	NA	NA	NA	NA
		4	0.62	NA	NA	NA	NA
E	1,000	1	30,525	30,525	30,525	30,525	30,525
		2	22,475	24,332	26,341	NA	NA
		3	8,050	6,193	4,184	NA	NA
		4	4.76	3.66	2.47	NA	NA

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B3

AIRPORT ACCESS CAPACITY

Banfield Freeway Between Sandy Boulevard and 82nd Avenue

Level of Service[1/]	Hrs./Year[2/]	Factor[3/]	Year 1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	55,855	55,855	55,855	55,855	55,855
		2	82,635	89,460	96,850	104,849	113,510
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	200	1	64,000	64,000	64,000	64,000	64,000
		2	82,635	89,460	96,850	104,849	113,510
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	1,000	1	83,027	83,027	83,027	83,027	83,027
		2	82,635	89,460	96,850	104,849	113,510
		3	392	NA	NA	NA	NA
		4	0.22	NA	NA	NA	NA
E	30	1	67,702	67,702	67,702	67,702	67,702
		2	82,635	89,460	96,850	104,849	113,510
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
E	200	1	77,576	77,576	77,576	77,576	77,576
		2	82,635	89,460	96,850	104,849	113,510
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
E	1,000	1	100,639	100,639	100,639	100,639	100,639
		2	82,635	89,460	96,850	104,849	113,510
		3	18,004	11,179	3,789	NA	NA
		4	10.46	6.49	2.20	NA	NA

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B4

AIRPORT ACCESS CAPACITY

I5 Just South of I80

Level of Service 1/	Hrs./Year 2/	Factor 3/	Year 1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	89,091	89,091	89,091	89,091	89,091
		2	74,885	81,070	87,767	95,016	102,865
		3	14,206	8,021	1,324	NA	NA
		4	6.72	3.79	0.63	NA	NA
D	200	1	102,083	102,083	102,083	102,083	102,083
		2	74,885	81,070	87,767	95,016	102,865
		3	27,198	21,013	14,316	7,067	NA
		4	12.87	9.94	6.77	3.34	NA
D	1,000	1	132,432	132,432	132,432	132,432	132,432
		2	74,885	81,070	87,767	95,016	102,865
		3	57,547	51,362	44,665	37,416	29,567
		4	27.22	24.30	21.13	17.70	13.99
E	30	1	109,091	109,091	109,091	109,091	109,091
		2	74,885	81,070	87,767	95,016	102,865
		3	34,206	28,021	21,324	14,075	6,226
		4	16.18	13.26	10.09	6.66	2.95
E	200	1	125,000	125,000	125,000	125,000	125,000
		2	74,885	81,070	87,767	95,016	102,865
		3	50,115	43,930	37,233	29,984	22,135
		4	23.71	20.78	17.61	14.18	10.47
E	1,000	1	162,162	162,162	162,162	162,162	162,162
		2	74,885	81,070	87,767	95,016	102,865
		3	87,277	81,092	74,395	67,146	59,297
		4	41.29	38.36	35.19	31.76	28.05

1/ Per *Highway Capacity Manual*.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

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RENO INTERNATIONAL AIRPORT

CASE STUDY

CASE STUDY SUMMARY

Reno International Airport is located about four miles southeast of the Reno, Nevada Central Business District (CBD). In 1977, the airport handled 1.2 million passengers annually, more per capita than any city other than Las Vegas. The airport serves the resort cities of Reno, Sparks, and Lake Tahoe (Lake Tahoe also has some direct commercial air service). Reno and Sparks have been developing at the rapid rate of about 10% annually, and this rate is expected to continue through 1983, with even more rapid growth in the near term.

Because of Reno's rapid development, the city's arterial road system has not been able to keep pace with traffic demands. The airport access system is no exception. Several elements of the access system are currently at level of service "E" for about four hours per workday, and most other elements are expected to suffer similar problems by the early 1980's.

Capital expenditures for construction and relocation alternatives, as well as Transportation Systems Management (low capital improvements designed to facilitate traffic flow) are possible, but funds are lacking and local officials have been unable to agree on priorities for the limited funds available.

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A. BACKGROUND

1. General

Reno Internatinal Airport (RIA) is located in the state of Nevada, approximately four miles southeast of the Reno Central Business District (CBD). The airport serves both the Northwestern Nevada and Eastern California regions. Interstate 80 (East-West) and U.S. Route 395 (North-South) provide access for the majority of air passengers traveling to RIA from outlying areas. The last segment of trips to the airport must be made via surface streets (see Figure 1 and 2).

Classified as a medium hub airport by the Federal Aviation Administration, based on a volume of 1.2 million annual passengers, Reno International plays a vital role in economic regional development. RIA ranks second nationally in per capita enplanements primarily due to the abundant tourist trade in the vicinity (Las Vegas ranks number one). However, a growing distribution/light manufacturing industry also contributes significantly, accounting for an estimated 100,000 annual business trips. It is not surprising that expected local origin/destination growth is estimated at 10% annually from 1975 to 1983 and could be even greater with increased air services and airline marketing efforts.

The Reno area is experiencing a period of tremendous growth. The master plan report prepared for the City of Reno in 1976 has already become outdated and has effectively been telescoped to provide 1990 facilities by 1980. One major contributing factor has been the explosive development and expansion of hotel/casinos. In 1978 six new hotel/casinos are schedule to open, representing an investment of over 300 million dollars, and providing 200,000 square feet of casino area. Reno will experience a 100% increase in the number of first class hotel rooms and convention facilities. The largest of these new hotel/casinos is the MGM Grand/Reno which offers the world's largest casino area and has already booked, for 1978, 200 conventions representing 250,000 delegates. In addition to the hotel/casino development, Walt Disney Productions has plans for a year-round resort at Independence Lake scheduled to open by 1981. This 17,000 acre resort north of Lake Tahoe would offer recreational facilities and accommodations for many visitors to the area.

This unprecedented growth has caused considerable local and regional concern. In a recent newspaper article 1/ former Washoe County Commission Chairman, Dick Scott stated, "Take the worst traffic problem you can imagine and multiply it by five. That's how bad it will be six months or a year from now." Although some city officials take a more optimistic view of the congestion problem, it is the general consensus that significant action must be taken to alleviate the cities' traffic problem.

1/ Gazette, Journal, Reno, Nevada 4/9/78

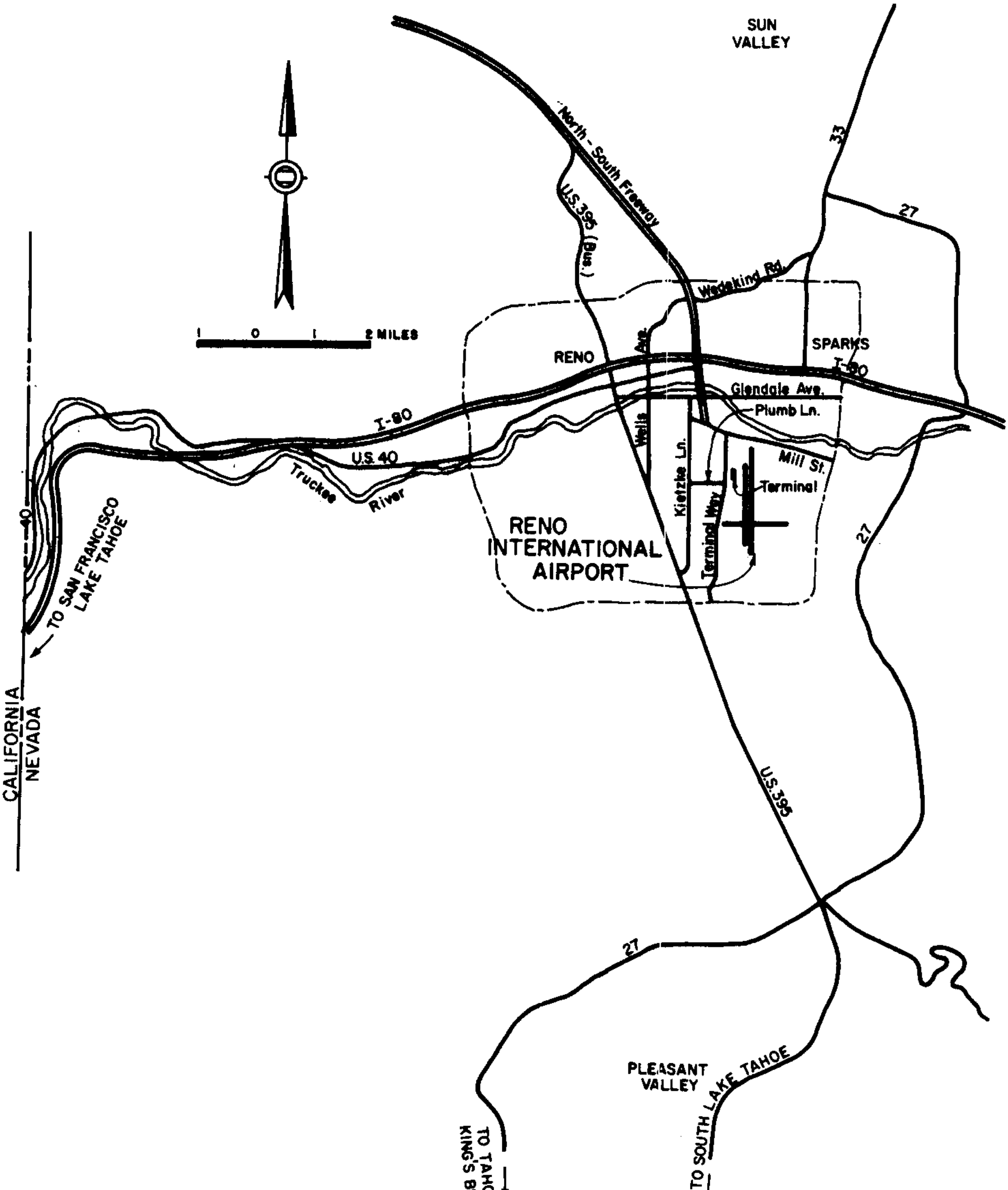

Figure I
RENO AREA

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Approximately 40 percent of all airport passengers originate or terminate their trips from the CBD. Since urban surface streets comprise a major segment of the airport ground access system, the city traffic congestion problem directly affects air travelers going to or leaving the airport.

2. Transportation Planning Structure

Currently, three agencies serve as area wide coordinators of ground transportation in the Reno area. The Washoe County Department of Regional Planning, the Regional Streets and Highways Commission and the Washoe County Area Transportation Study Policy Committee work within the Washoe County area to provide highway planning and implementation subject to the approval of the Reno City Council, the Sparks City Council and the Washoe County Commission.

WCATS Policy Committee is the Metropolitan Planning organization for the Reno area. The Washoe County Area Transportation Study (WCATS) is a working arm of the Washoe Council of Governments, created to provide long range and short term planning, consistent with the area developmental goals. WCATS is responsible for preparing the Overall Work Program for the region. The Nevada Highway Department, one of the founders of WCATS, is an active participant in the planning process at the State level. The Federal Highway Administration (FHWA) provides input to the planning process on a federal level and is represented at WCATS meetings.

The Washoe County Airport Authority is the airport operator. The WCAA is a primary contributor to the airport access planning process with representatives attending WCATS meetings and represented in the Washoe County Department of Regional Planning.

3. Highway Access

Ground access to Reno International Airport is provided almost exclusively by an intricate system of surface streets. Although a small percentage of air passengers use Interstate 80, the only major interstate highway in the vicinity, I80, is neither currently accessible nor practical for most passengers going to or leaving the airport. The largest single generator of airport traffic is the CBD (40% of all air passengers) located northwest of the airport. Originating traffic generally utilizes either Virginia Street to Plumb Lane or Mill Street to Terminal Way to get to the airport. These routes are already operating at intolerable levels of service for a significant number of hours per year.

Figure 2 presents a map of the access system roadways and the distribution of air passengers per route.

4. Transit Access

Private automobiles are the primary means of transportation to RIA, representing the access mode employed by just over fifty percent of all local origin/destination passengers. Other access modes break down approximately as

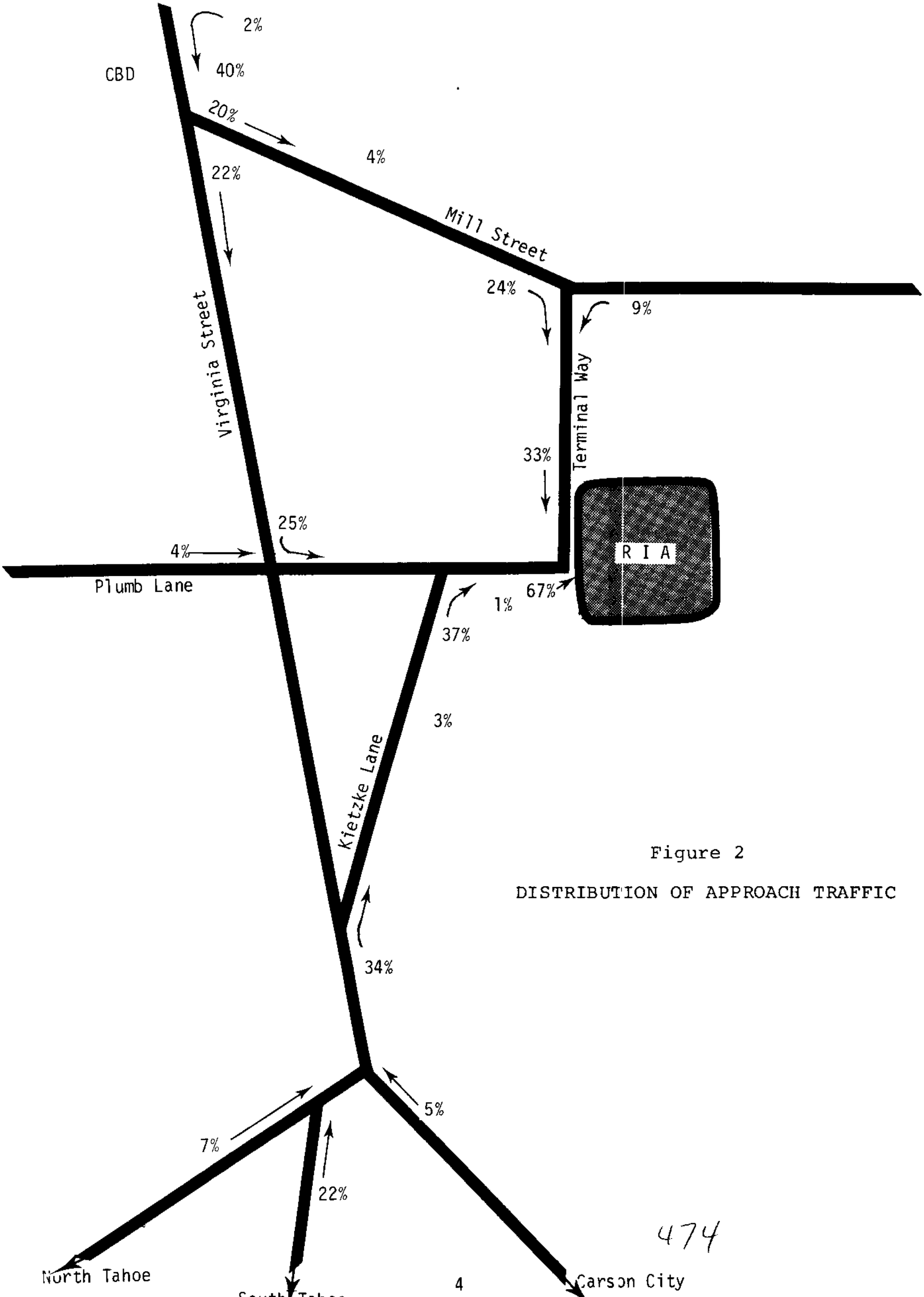

Figure 2

DISTRIBUTION OF APPROACH TRAFFIC

follows: taxis, 21 percent; rental cars, 16 percent; buses or limousines, 11 percent. These alternatives to private automobiles comprise a significant proportion of access trips to the airport. As part of the plan to reduce the number of vehicles using airport access routes, development of minibus and limousine service to the airport is being encouraged by the City of Reno and the Reno Chamber of Commerce. Due to the proximity of the CBD to the airport, increased transit operations can make significant contributions to relieving congestion in the immediate vicinity of the airport.

5. Internal Access

Vehicular ground access to Reno International Airport is possible via Terminal Way or Plumb Lane. The terminal area is located to the east of the main public parking facility, which is capable of accommodating approximately 440 automobiles. This parking area is encompassed by the existing roadway system that runs between the parking lot on the west side and the terminal to the east. Curb space is provided along the entrance roadway which passes in front of the terminal. A diagram of the existing airport internal access system is presented in Figure 3.

B. CAPACITY ANALYSIS

1. Passenger Forecast

Two forecasts of air passengers at Reno International Airport are presented in Table 1. Based upon the recent growth experienced in the Reno area and the Chamber of Commerce projection of a 10% annual growth rate for origin/destination passengers, these projections are presumed to be conservative. The FAA forecast extends only until 1988 and is projected to 1995 at the 1983-1988 growth rate. The Master Plan forecast extends to the year 1995 and has been interpolated to arrive at the figure for 1990. The FAA forecast is considerably below the Master Plan forecast, and appears inconsistent with Reno's recent growth spurt and the best judgment of local authorities.

2. Airside Capacity

Airside Capacity was calculated based on optimistic and conservative estimates as described in the Master Plan Report. The conservative PANCAP forecast was predicated on the assumption of no airside improvements through 1995. The optimistic forecast assumes completion of a parallel general aviation runway by 1985 and that RIA will pursue a policy aimed at redistributing general aviation activity to other airports in the region. PANCAP was then converted to annual passenger capacities by applying the factors for percent of air carrier and passengers per operation as indicated in the Master Plan. These calculations are presented in Table 2.

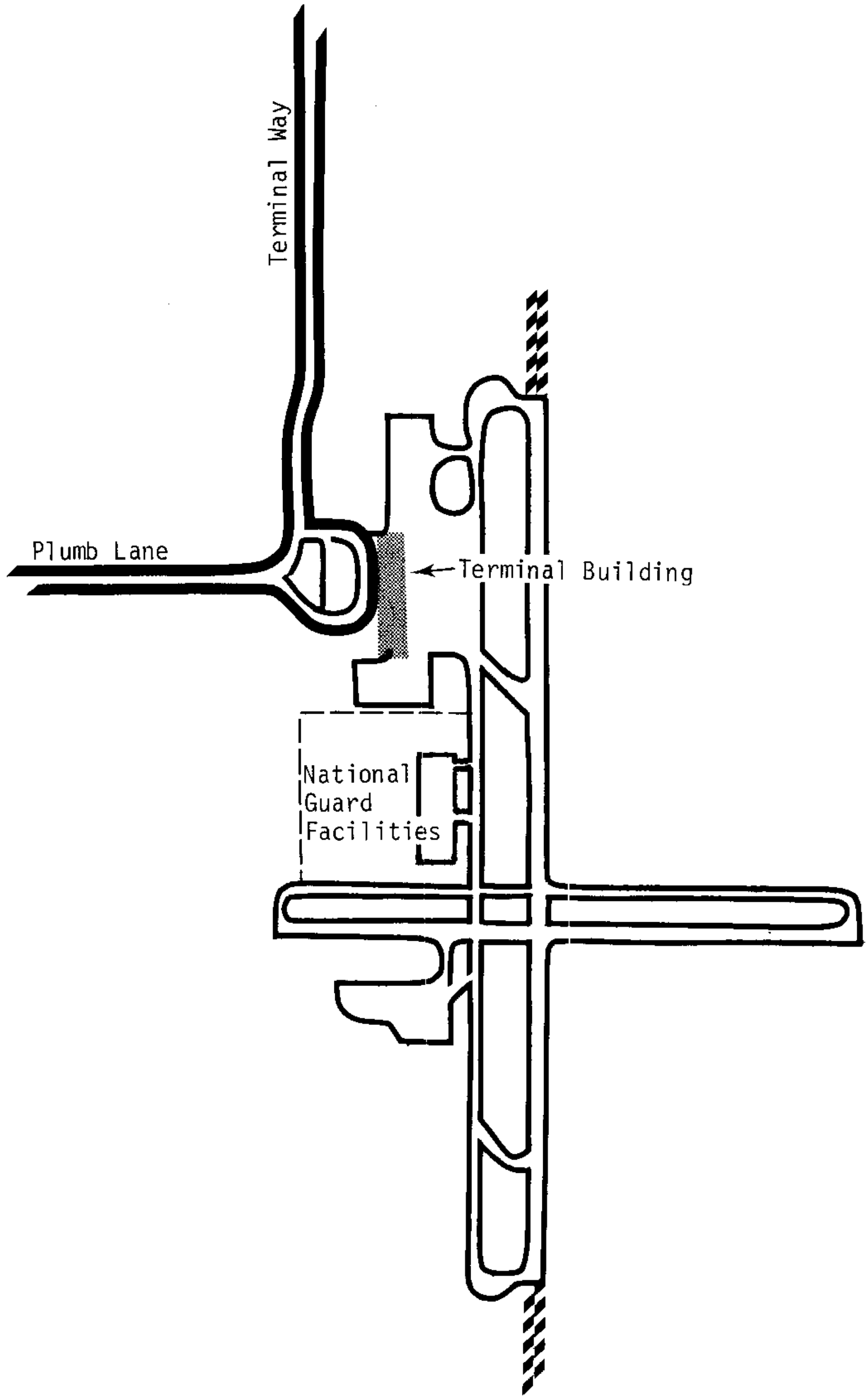

Figure 3
INTERNAL ACCESS ROADWAY SYSTEM

TABLE 1

FORECAST OF DEMAND

(Million Annual Passengers)

Year	FAA	Master Plan
(1)	(2)	(3)
1975	1.0 1/	1.0 1/
1980	1.4	2.0
1985	1.8 2/	2.8
1990	2.4 3/	3.7 2/
1995	3.1 3/	4.8

1/ Actual

2/ Interpolated

3/ Extended

TABLE 2

CALCULATION OF AIRSIDE CAPACITY

Year	PANCAP 1/	Percent Air Carriers 2/	Passengers/ Operation	Passenger (MAP) Capacity
(1)	(2)	(3)	(4)	(5)
Conservative				
1975	220,000	15.0	49.5	1.6
1980	220,000	15.0	56.4	1.9
1985	220,000	15.0	67.0	2.2
1990	220,000	14.0	74.5	2.3
1995	220,000	13.0	82.3	2.4
Optimistic				
1975	220,000	15.0	49.5	1.6
1980	220,000	16.0	56.4	2.0
1985	380,000	16.0	67.0	4.1
1990	380,000	16.0	74.5	4.5
1995	380,000	16.0	82.3	5.0

1/ Master Plan--Optimistic scenario assumes construction of parallel runway.

2/ Master Plan--Optimistic scenario assumes RNO adopts policy (policies) that will divert some GA to Reno/Stead Airport.

3. Ground Access Capacity

Current airport ground trips were assigned to major highways as shown in Appendix A. There were seven critical locations identified for capacity analysis:

(1) Virginia Street north of Mill Street

(2) Mill Street west of Terminal Way

(3) Terminal Way

(4) Plumb Lane

(5) Kietzke Lane

(6) Virginia Street north of Plumb Lane

(7) Virginia Street south of Kietzke Lane

Non-airport traffic was projected to 1995, assuming annual growth rate of 10% through 1980, 7% from 1980 to 1985, and 5% thereafter 1/. Calculations and methodology are presented in Appendix B. The resulting graphs for the critical highway segments are shown in Figures 4 through 10.

4. Interpretation

4.1 Virginia Street

Virginia Street currently is severely congested at two points--south of Kietzke (see Figure 10) and north of Plumb (see Figure 9). Both points operate at level of service "E" for about 1000 hours/year, or roughly four hours per workday. The steepness of the capacity curves is indicative of the fact that even without airport-related traffic, Virginia currently operates close to capacity and non-airport traffic is growing rapidly. The bottleneck south of Kietzke affects travelers originating from or destined for Carson City and the Lake Tahoe region, accounting for some 34% of

1/ 10% growth between 1975 and 1983 projected in "Think Reno..." Visitor Bulletin issued by Greater Reno Chamber of Commerce, Mid year 1977. Growth rates beyond 1980 were projected to reflect FAA and Master Plan, forecasts of demand through 1995.

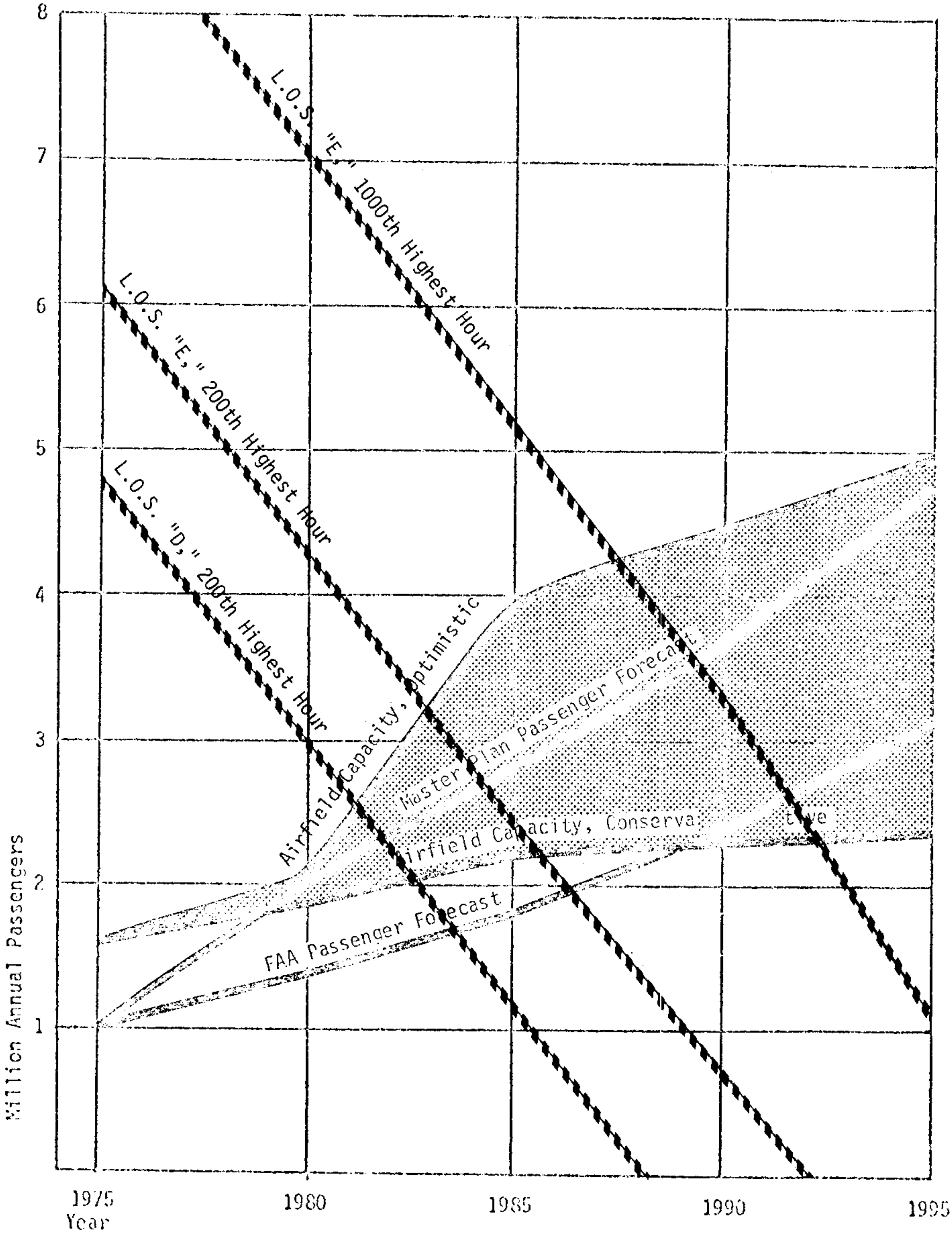

Figure 4

DEMAND/CAPACITY RELATIONSHIPS

Virginia North of Mill Street

480

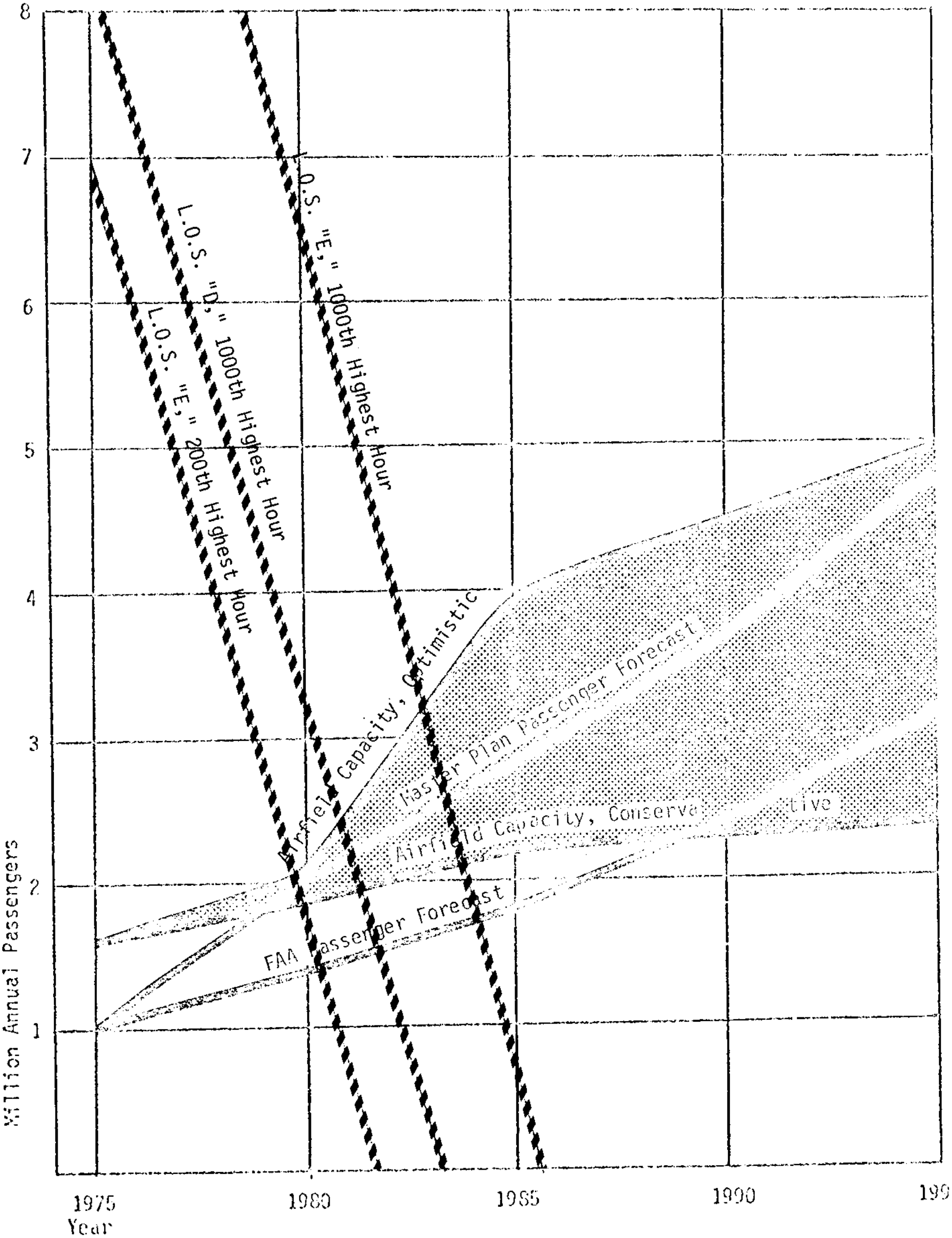

Figure 5
DEMAND/CAPACITY RELATIONSHIPS
Mill Street West of Terminal Way

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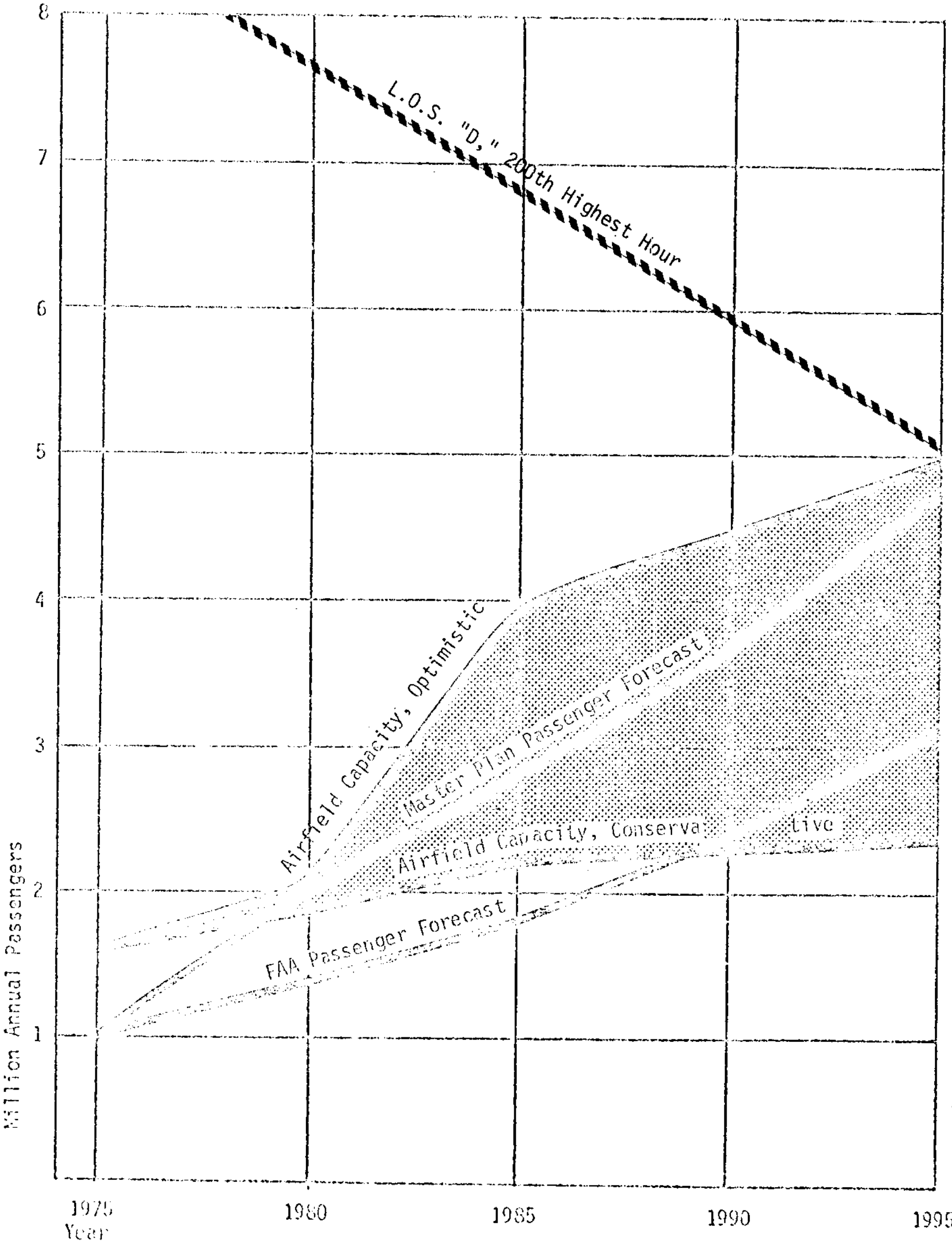

Figure 6
DEMAND/CAPACITY RELATIONSHIPS
Terminal Way
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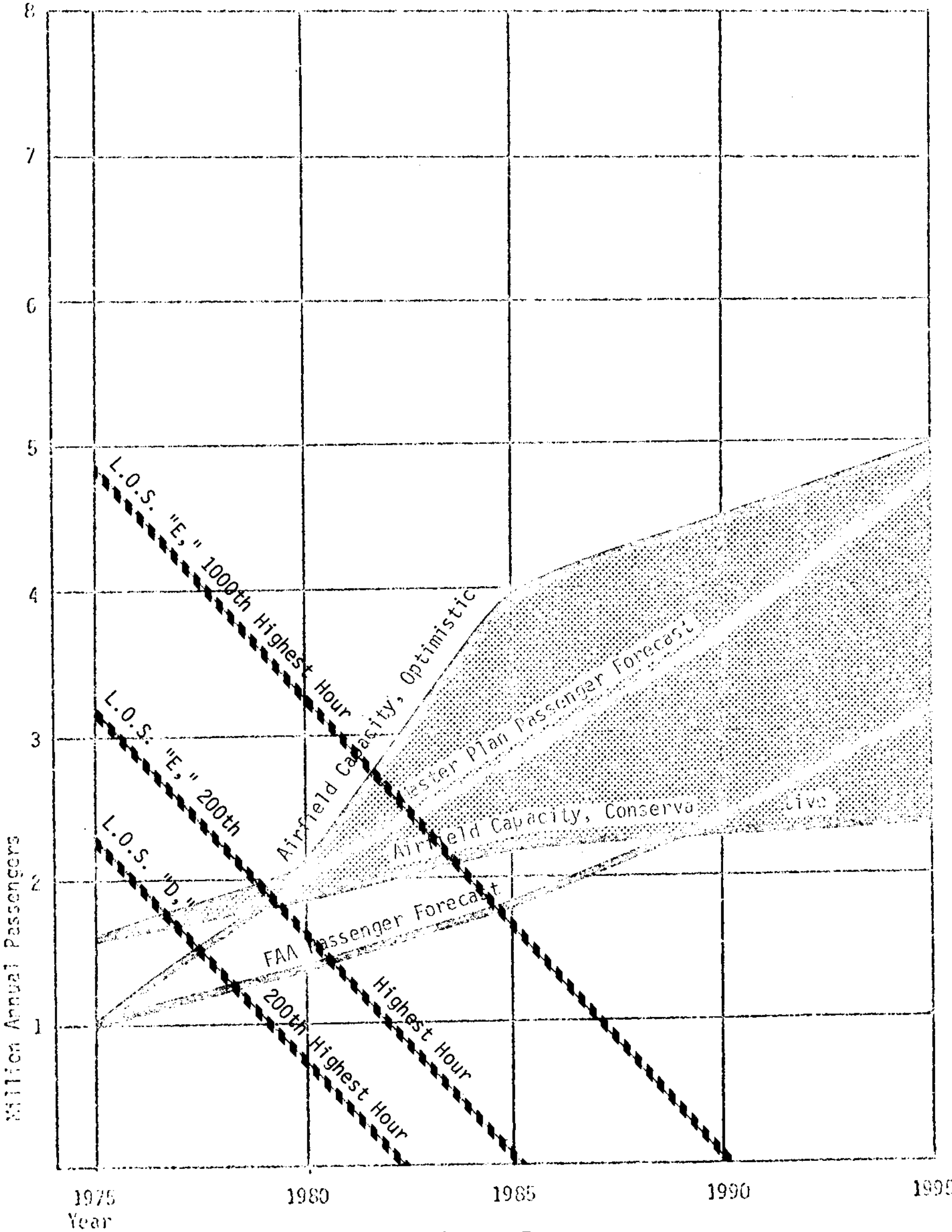

Figure 7

DEMAND/CAPACITY RELATIONSHIPS

Plumb Lane

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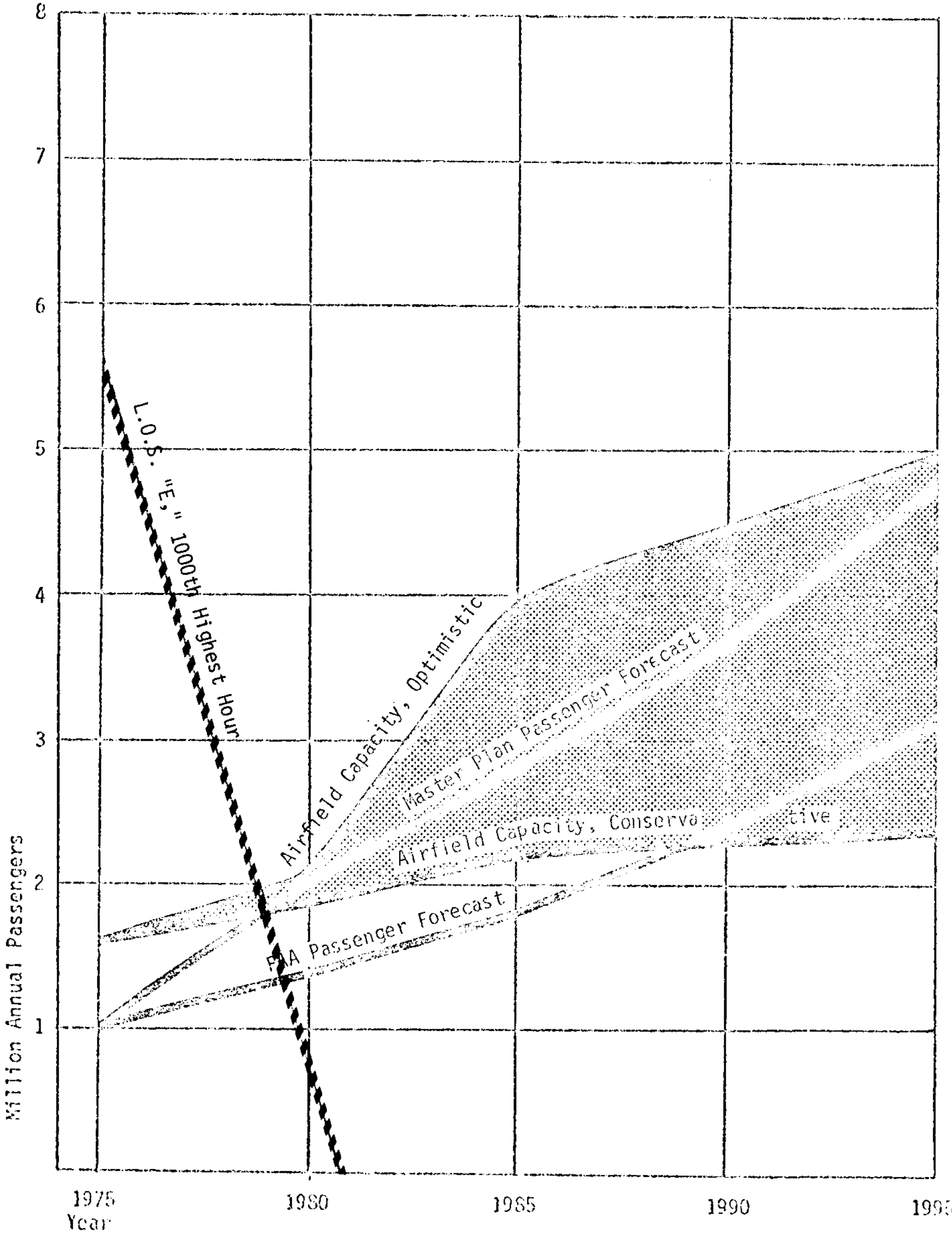

Figure 8
DEMAND/CAPACITY RELATIONSHIPS
Kietzke Lane

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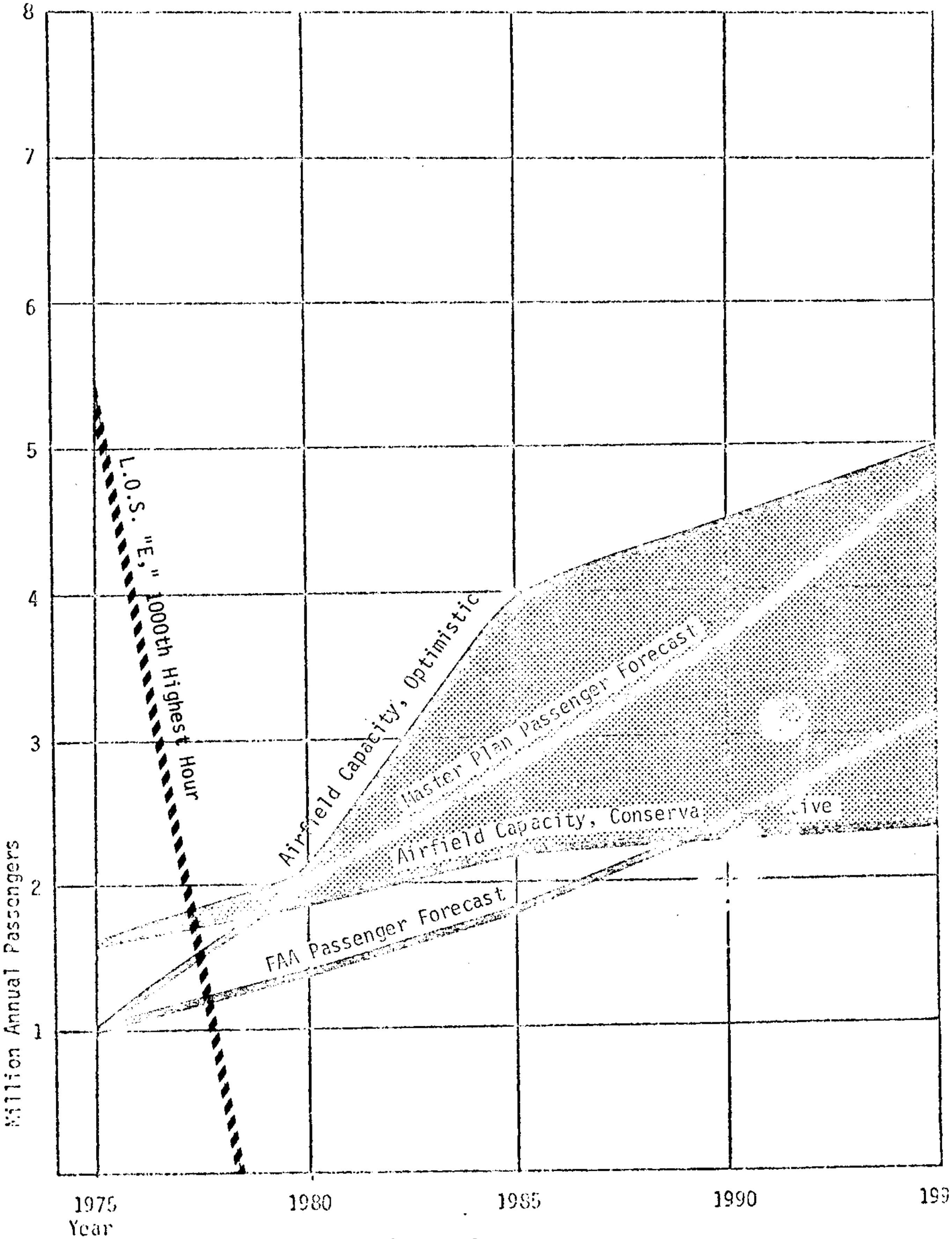

Figure 9

DEMAND/CAPACITY RELATIONSHIPS

Virginia North of Plumb

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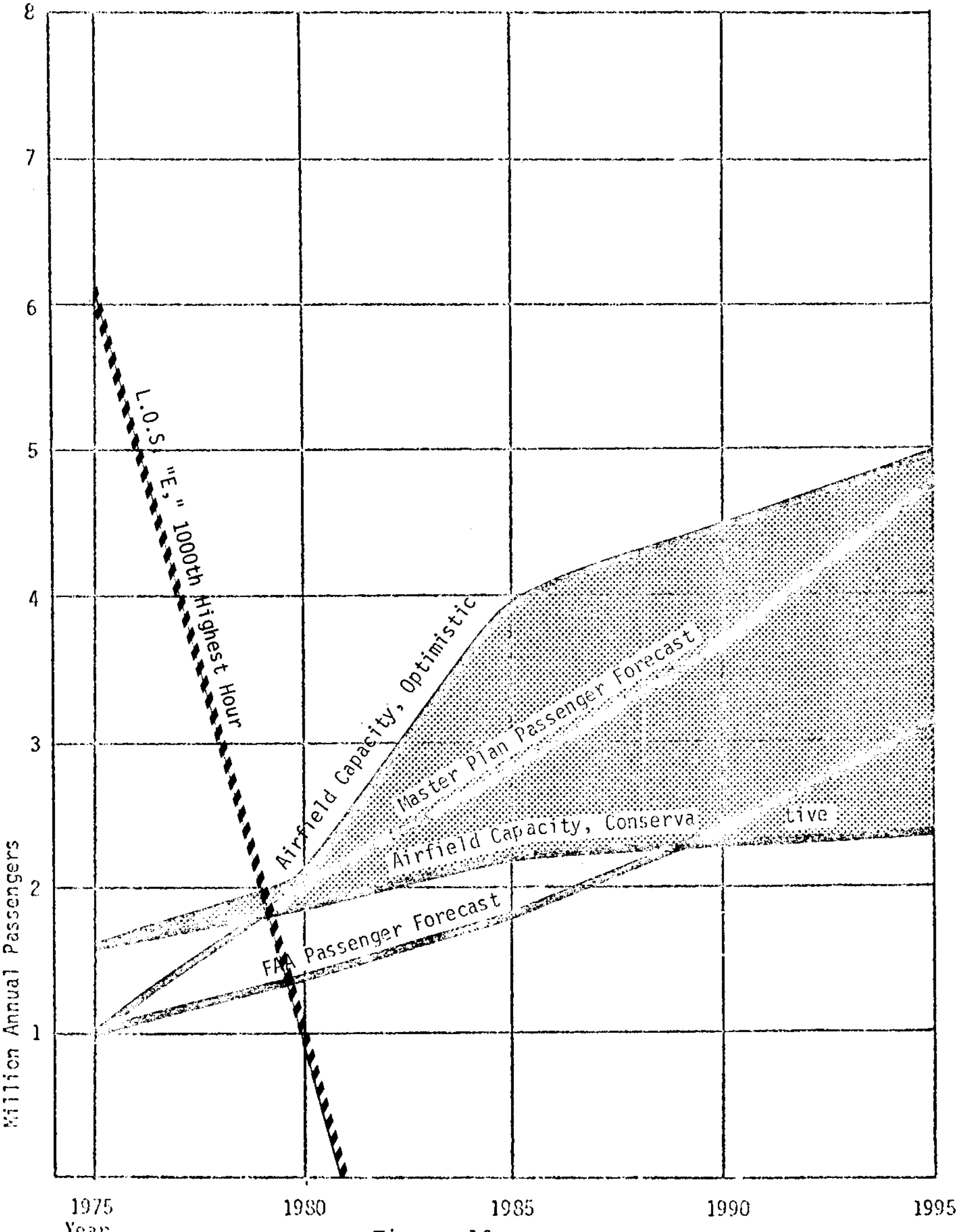

Figure 10

DEMAND/CAPACITY RELATIONSHIPS
Virginia South of Kietzke Lane

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airport users. There are no other convenient routes for most of these passengers. The bottleneck route of Plumb affects those from the CBD who use the Virginia-Plumb route to the airport, about 25% of the airport passengers. Other routes available to these passengers, primarily Mill St. to Terminal Way and various routes through residential areas, are also becoming congested.

Virginia north of Mill St. (see Figure 4) is used by about 42% of RIA's passengers. Currently, it is operating at level of service "D" but it is expected that by 1984 it will operate at level of service "E" for 200 hours/year.

4.2 Mill St. West of Terminal Way-It is expected that by the early 1980's, Mill St. will operate at level of service "E" for over 1000 hours/year (see Figure 5). This route is taken by some 24% of the airport travelers on their way from the CBD or points farther north to the airport.

4.3 Terminal Way-Our analyses show that Terminal Way will not be congested in the foreseeable future (see Figure 6). However, updated information from the City of Reno, Department of Airports indicates that the new extension of Terminal Way south of the airport entrance to Gentry Way (an east-west roadway connecting Terminal Way and several north-south roadways) has caused backups during certain hours of up to fifty vehicles attempting to enter Gentry at this intersection. Up until July 26, 1978, this intersection was operating with a stop sign on Termininal Way but not on Gentry, causing Terminal Way traffic to wait for a break in Gentry traffic before entering that street. On July 26, 1978, stop signs were placed on Gentry as well. Although measurements of the effect of this action on Terminal Way traffic have not been taken to date, airport officials believe that the new stop signs will help ease the congestion experienced at this intersection. The demand capacity relationships presented in this study reflect 1976 traffic flows prior to the extension of Terminal Way south beyond Plumb Lane.

4.4 Plumb Lane is currently operating at level of service "D", but, by the early 1980's, it will be operating at level of service "E" for 1000 hours/year (see Figure 7). Plumb Lane serves approximatly 67% of the airport passengers.

4.5 Kietzke Lane

Kietzke Lane currently is operating at level of service "E" for 1000 hours a week. It is the primary route between the airport and points south, serving some 37% of the air passengers. Plans are underway to widen the roadway, but this is not reflected in Figure 8 since the timing of improvements is uncertain.

4.6 Airside Capacity

The conservative forecast of airside capacity indicates that the airside will constrain airport capacity by 1980. However, in view of this potential constraint and the large fraction of general aviation operations at the airport, is is unlikely that the conservative forecast is realistic. The optimistic forecast assumes policies will be adopted to reduce general aviation activity and to meet any growth with a new general aviation runway. In this scenario, airside capacity will not constrain demand through the study period.

C. PROPOSED SOLUTIONS

The roadway access system to Reno International Airport is currently experiencing congestion problems on many of the major routes leading to the airport, and projected traffic growth will pose even greater problems in the future. In order to cope with rapidly increasing traffic, several solutions have been proposed that will help improve access to the airport.

One major project under consideration would be the extension of Route 395 south beyond Mill Street. This route would help divert some traffic from the heavily traveled surface streets by providing an alternate means of access. The extension of Route 395 south to Mill Street was recently completed; however, construction south beyond Mill Street has yet to be approved. In addition, the Greg Street extension to Terminal Way, which would provide direct access from the Sparks area, has been approved by all agencies. Several other capital alternatives, at various levels of development, are shown in Table 3.

Funding presents the single biggest impediment to access highway improvement. In March of 1978, the Washoe County Commission approved the sale of 7 million dollars in bonds for roadway construction. The Commission feels that an additional 15 million dollars worth of funds would be needed to support some 22 necessary projects. The problem of generating andd allocating additional funds for airport access highways is part of the general urban dilemma now facing City of Reno officials.

Recently, with the support of the Reno Department of Airports and the Reno Chamber of Commerce, individual operators have provided new minibus and limousine services to and from the airport. These services are modestly priced (limousine $2.00 and minibus $1.50 to any location in the city) and will help to decrease the number of vehicles using access roadways.

D. CONCLUSIONS

Due to the explosive development of Reno, the city is facing massive traffic jams. The routes to the airport are expected to be among the hardest hit, and many currently are operating at intolerable levels of service. Because regional growth is faster than had been expected, the need for roadway improvement funds is extensive, far exceeding what can be provided by the city and county. Many improvements have been recommended but are being held up due to the lack of funds and to the inability of local officials to agree on priorities for the limited funds available.

The extension of US 395 (a limited access road) from Mill St. to Virginia St. would undoubtedly provide the airport with the greatest relief. It would immediately ease access from the south, bypassing the congestion points on Virginia St. and Kietzke Lane. Improved access from the CBD, however, can probably only be achieved by incremental improvements to the existing surface road system.

TABLE 3

PROPOSED SOLUTIONS TO AIRPORT ACCESS PROBLEMS

Proposed Solutions	Initiator	Agency Resp. for Implem.	Funding Sources	Est. Cost (1976 Dollars)	Status
(1)	(2)	(3)	(4)	(5)	(6)
A. CONSTRUCTION					
1. Route 395 Extension	NHD	NHD	State of Nevada, FHWA	*	Has been extended south to Mill St. continuation uncertain
2. New access from Terminal Way and expansion of automobile parking	RDOA	RDOA	Airport Revenues and Revenue Bonds	$847,000	Underway-completion scheduled for 8/15/78
3. Construction of Greg St. connector to Terminal Way	Streets and Highways Master Plan	City of Reno, Sts. and Hwy. Commsn.	Available Street funds and Bond funds Sts. and Highway Commsn.	*	Approved by all agencies
4. Additional Roadway around National Guard facilities--Access from facilities to Terminal Way	RDOA	RDOA	Airport Revenues, Revenue Bonds	*	Scheduled
5. Vehicle Circulation Improvement--Internal Roadway Modification	RDOA	RDOA	Airport Revenues, Revenue Bonds	$100,000	Expected Completion 1980
6. Parking Lot Expansion	RDOA	RDOA	Airport Revenues, Revenue Bonds	$200,000	Expected Completion 1980

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Proposed Solutions	Initiator	Agency Resp. for Implem.	Funding Sources	Est. Cost (1976 Dollars)	Status
B. SERVICE IMPROVEMENT					
1. New Minibus and increased limousine service	Individual operators, RDOA, Reno Chamber of Commerce	Individual operators	Private	*	Expected to increase with demand
C. RELOCATION					
1. Separate car rentals from general airport traffic	RDOA	RDOA	Airport Revenues Revenue Bonds	*	Planning stages

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*Not available or unknown. Key of Abbreviations: NHD=State of Nevada Highway Department, RDOA=City of Reno Dept. of Airports

APPENDIX A

ROUTING OF AIRPORT ACCESS TRIPS

BY LOCAL ORIGIN/DESTINATION ZONE

Data compiled from a passenger survey given on August 18 and 19, 1974, at RIA, and presented in the Master Plan, was used to determine passenger originations and destinations. Table A1 shows how survey percentages were distributed to account for 100 percent of the passengers utilizing the ground access system and the assumed routings of these passengers to and from the airport.

TABLE A1

ROUTING OF AIRPORT ACCESS TRIPS

BY LOCAL ORIGIN/DESTINATION ZONE

Zone	Percent Per Survey	Percent as Distributed	Routing	Percent by Route
(1)	(2)	(3)	(4)	(5)
Reno CBD	36	40	MS, TW	20
			VS, PL	20
North Reno	5	6	MS, TW	4
			VS, PL	2
Southwest Reno	6	7	PL	4
			VS, PL	3
Southeast Reno	4	4	KL, PL	3
			PL	1
South Tahoe	20	22	VS, KL, PL	22
Sparks	8	9	MS, TW	9
North Tahoe	6	7	VS, KL, PL	7
Carson City	4	5	VS, KL, PL	5

Key:

KL	Kietzke Lane
MS	Mill Street
PL	Plumb Lane
TW	Terminal Way
VS	Virginia St.

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

One-directional hourly capacities (level of service "C") were obtained for Plumb Lane and Terminal Way from the Nevada Department of Highways. These were converted to level of service "D" and level of service "E" capacities (at 200 hours/year) by dividing by .83 and .71 1/, respectively. Since the Highway Department uses the same capacity for both roads (both four lane, signalized arterials, however only Plumb has a center median), the same capacity was used for the other four-lane arterials. This might slightly over-estimate the capacity of Virginia north of Mill since parking, which slows the flow of traffic, is allowed. It may also slightly underestimate the capacity of Virginia south of Kietzke and of Mill St., since both have separate turn lanes. Kietzke has both parking and turn lanes, so the capacity estimate is probably true.

Virginia Street will soon have a computer-controlled signal system, which will undoubtedly upgrade its capacity. No account was taken of this eventuality. Funds have been approved for the widening of Kietzke, but since no schedule of completion is available, this eventuality was also ignored.

Total traffic entering the airport (8201 ADT for 1975) was obtained from the 1976 Master Plan Report for Reno International Airport based on 1974-1975 growth rate. The 1975 MAP (1,045,420) was taken from Airport Activity Statistics of Certificated Route Air Carriers, 1975 by the Civil Aeronautics Board and the Federal Aviation Administration.

1/ Calculated from Figure 6.8 of Highway Capacity Manual.

Table B1

AIRPORT ACCESS CAPACITY

Virginia North of Mill St.

Level of Service 1/ (1)	Hrs./Year 2/ (2)	Factor 3/ (3)	Year 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	22,527	22,527	22,527	22,527	22,527
		2	9,721	15,656	21,958	28,025	35,767
		3	12,806	6,871	569	NA	NA
		4	3.87	2.08	0.17	NA	NA
D	200	1	25,813	25,813	25,813	25,813	25,813
		2	9,721	15,656	21,958	28,025	35,767
		3	16,092	10,157	3,855	NA	NA
		4	4.87	3.07	1.17	NA	NA
D	1,000	1	33,486	33,486	33,486	33,486	33,486
		2	9,721	15,656	21,958	28,025	35,767
		3	23,765	17,830	11,528	5,461	NA
		4	7.19	5.39	3.49	1.65	NA
E	30	1	26,500	26,500	26,500	26,500	26,500
		2	9,721	15,656	21,958	28,025	35,767
		3	16,779	10,844	4,542	NA	NA
		4	5.07	3.28	1.37	NA	NA
E	200	1	30,365	30,365	30,365	30,365	30,365
		2	9,721	15,656	21,958	28,025	35,767
		3	20,644	14,709	8,407	2,340	NA
		4	6.24	4.45	2.54	0.71	NA
E	1,000	1	39,392	39,392	39,392	39,392	39,392
		2	9,721	15,656	21,958	28,025	35,767
		3	29,671	23,736	17,434	11,367	3,625
		4	8.97	7.18	5.27	3.44	1.10

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B2

AIRPORT ACCESS CAPACITY

Mill West of Terminal Way

Level of Service 1/ (1)	Hrs./Year 2/ (2)	Factor 3/ (3)	Year 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	22,527	22,527	22,527	22,527	22,527
		2	16,994	27,369	38,386	48,992	62,527
		3	5,533	NA	NA	NA	NA
		4	2.94	NA	NA	NA	NA
D	200	1	25,813	25,813	25,813	25,813	25,813
		2	16,994	27,369	38,386	48,992	62,527
		3	8,819	NA	NA	NA	NA
		4	4.69	NA	NA	NA	NA
D	1,000	1	33,486	33,486	33,486	33,486	33,486
		2	16,994	27,369	38,386	48,992	62,527
		3	16,492	6,099	NA	NA	NA
		4	8.76	3.24	NA	NA	NA
E	30	1	26,500	26,500	26,500	26,500	26,500
		2	16,994	27,369	38,386	48,992	62,527
		3	9,506	NA	NA	NA	NA
		4	5.05	NA	NA	NA	NA
E	200	1	30,365	30,365	30,365	30,365	30,365
		2	16,994	27,369	38,386	48,992	62,527
		3	13,371	2,996	NA	NA	NA
		4	7.11	1.59	NA	NA	NA
E	1,000	1	39,392	39,392	39,392	39,392	39,392
		2	16,994	27,369	38,386	48,992	62,527
		3	22,398	12,023	1,006	NA	NA
		4	11.91	6.40	0.54	NA	NA

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B3

AIRPORT ACCESS CAPACITY

Terminal Way

Level of Service 1/ (1)	Hrs./Year 2/ (2)	Factor 3/ (3)	Year 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	22,527	22,527	22,527	22,527	22,527
		2	3,464	5,579	7,826	9,986	12,745
		3	19,063	16,948	14,701	12,541	9,782
		4	7.37	6.56	5.69	4.85	3.78
D	200	1	25,813	25,813	25,813	25,813	25,813
		2	3,464	5,579	7,826	9,986	12,745
		3	22,349	20,234	17,987	15,827	13,068
		4	8.65	7.83	6.96	6.12	5.06
D	1,000	1	33,486	33,486	33,486	33,486	33,486
		2	3,464	5,579	7,826	9,986	12,745
		3	30,022	27,907	25,660	23,500	20,741
		4	11.61	10.80	9.93	9.08	8.02
E	30	1	26,500	26,500	26,500	26,500	26,500
		2	3,464	5,579	7,826	9,986	12,745
		3	23,036	20,921	18,674	16,514	13,755
		4	8.91	8.09	7.22	6.39	5.32
E	200	1	30,365	30,365	30,365	30,365	30,365
		2	3,464	5,579	7,826	9,986	12,745
		3	26,901	24,786	22,539	20,379	17,620
		4	10.4	9.59	8.72	7.88	6.82
E	1,000	1	39,392	39,392	39,392	39,392	39,392
		2	3,464	5,579	7,826	9,986	12,745
		3	35,928	33,813	31,566	29,406	26,647
		4	13.90	13.08	12.21	11.38	10.31

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B4

AIRPORT ACCESS CAPACITY

Plumb Lane

Level of Service[1/] (1)	Hrs./Year[2/] (2)	Factor[3/] (3)	Year 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	22,527	22,527	22,527	22,527	22,527
		2	13,596	21,896	30,711	39,196	50,025
		3	8,931	631	NA	NA	NA
		4	1.70	0.12	NA	NA	NA
D	200	1	25,813	25,813	25,813	25,813	25,813
		2	13,596	21,896	30,711	39,196	50,025
		3	12,217	3,917	NA	NA	NA
		4	2.33	0.75	NA	NA	NA
D	1,000	1	33,486	33,486	33,486	33,486	33,486
		2	13,596	21,896	30,711	39,196	50,025
		3	19,890	11,590	2,775	NA	NA
		4	3.79	2.21	0.53	NA	NA
E	30	1	26,500	26,500	26,500	26,500	26,500
		2	13,596	21,896	30,711	39,196	50,025
		3	12,904	4,604	NA	NA	NA
		4	2.46	0.88	NA	NA	NA
E	200	1	30,365	30,365	30,365	30,365	30,365
		2	13,596	21,896	30,711	39,196	50,025
		3	16,769	8,469	NA	NA	NA
		4	3.19	1.61	NA	NA	NA
E	1,000	1	39,392	39,392	39,392	39,392	39,392
		2	13,596	21,896	30,711	39,196	50,025
		3	25,796	17,496	8,681	196	NA
		4	4.91	3.33	1.65	0.04	NA

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B5

AIRPORT ACCESS CAPACITY

Kietzke Lane

Level of Service[1/]	Hrs./Year[2/]	Factor[3/]	Year				
			1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	22,527	22,527	22,527	22,527	22,527
		2	22,966	36,987	51,876	66,209	84,501
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	200	1	25,813	25,813	25,813	25,813	25,813
		2	22,966	36,987	51,876	66,209	84,501
		3	2,847	NA	NA	NA	NA
		4	0.98	NA	NA	NA	NA
D	1,000	1	33,486	33,486	33,486	33,486	33,486
		2	22,966	36,987	51,876	66,209	84,501
		3	10,520	NA	NA	NA	NA
		4	3.63	NA	NA	NA	NA
E	30	1	26,500	26,500	26,500	26,500	26,500
		2	22,966	36,987	51,876	66,209	84,501
		3	3,534	NA	NA	NA	NA
		4	1.22	NA	NA	NA	NA
E	200	1	30,365	30,365	30,365	30,365	30,365
		2	22,966	36,987	51,876	66,209	84,501
		3	7,399	NA	NA	NA	NA
		4	2.55	NA	NA	NA	NA
E	1,000	1	39,392	39,392	39,392	39,392	39,392
		2	22,966	36,987	51,876	66,209	84,501
		3	16,426	2,405	NA	NA	NA
		4	5.67	.83	NA	NA	NA

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B6

AIRPORT ACCESS CAPACITY

Virginia North of Plumb

Level of Service[1/]	Hrs./Year[2/]	Factor[3/]	Year				
			1975	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	22,527	22,527	22,527	22,527	22,527
		2	28,314	45,600	63,956	81,626	104,178
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	200	1	25,813	25,813	25,813	25,813	25,813
		2	28,314	45,600	63,956	81,626	104,178
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	1,000	1	33,486	33,486	33,486	33,486	33,486
		2	28,314	45,600	63,956	81,626	104,178
		3	5,172	NA	NA	NA	NA
		4	2.64	NA	NA	NA	NA
E	30	1	26,500	26,500	26,500	26,500	26,500
		2	28,314	45,600	63,956	81,626	104,178
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
E	200	1	30,365	30,365	30,365	30,365	30,365
		2	28,314	45,600	63,956	81,626	104,178
		3	2,051	NA	NA	NA	NA
		4	1.05	NA	NA	NA	NA
E	1,000	1	39,392	39,392	39,392	39,392	39,392
		2	28,314	45,600	63,956	81,626	104,178
		3	11,078	NA	NA	NA	NA
		4	5.65	NA	NA	NA	NA

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

Table B7

AIRPORT ACCESS CAPACITY

Virginia South of Kietzke

Level of Service[1/] (1)	Hrs./Year[2/] (2)	Factor[3/] (3)	Year 1975 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	22,527	22,527	22,527	22,527	22,527
		2	22,848	36,797	51,610	65,868	84,067
		3	NA	NA	NA	NA	NA
		4	NA	NA	NA	NA	NA
D	200	1	25,813	25,813	25,813	25,813	25,813
		2	22,848	36,797	51,610	65,868	84,067
		3	2,965	NA	NA	NA	NA
		4	1.11	NA	NA	NA	NA
D	1,000	1	33,486	33,486	33,486	33,486	33,486
		2	22,848	36,797	51,610	65,868	84,067
		3	10,638	NA	NA	NA	NA
		4	3.99	NA	NA	NA	NA
E	30	1	26,500	26,500	26,500	26,500	26,500
		2	22,848	36,797	51,610	65,868	84,067
		3	3,652	NA	NA	NA	NA
		4	1.37	NA	NA	NA	NA
E	200	1	30,365	30,365	30,365	30,365	30,365
		2	22,848	36,797	51,610	65,868	84,067
		3	7,517	NA	NA	NA	NA
		4	2.82	NA	NA	NA	NA
E	1,000	1	39,392	39,392	39,392	39,392	39,392
		2	22,848	36,797	51,610	65,868	84,067
		3	16,544	2,595	NA	NA	NA
		4	6.2	0.97	NA	NA	NA

1/ Per Highway Capacity Manual.

2/ Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

3/ Key: 1 = highway capacity; 2 = nonairport-related traffic; 3 = capacity for airport-related vehicles; 4 = million annual passengers associated with 3.

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WORCESTER MUNICIPAL AIRPORT

CASE STUDY SUMMARY

CASE STUDY SUMMARY

WORCESTER MUNICIPAL AIRPORT

Worcester Municipal Airport is a non-hub airport located on a plateau on the northeastern limits of the city of Worcester and approximately 300 ft. above the elevation of the CBD.

The airport currently serves approximately 50,000 annual passengers on six daily scheduled flights to Boston, Manchester, N.H., and LaGuardia N.Y., Airports. This airport was included in the present study because of its potential role in the Massachusetts airport system.

Airport access is over a network of urban and rural roads. Level of service E is encountered at several critical intersections on the way from Worcester to the airport. There are, at present, no limited access connectors to the nearest freeways, I-290 and I-90.

Because of its favorable location above the city and because of its excellent airside facilities, the airport could, in principle, share in the growing demand on Boston's Logan Airport. In practice, however, the access problem precludes any significant expansion of activities at Worcester.

Access has been identified in master plan studies as a major problem for the airport. Because of conflicting priorities, however, access to the airport has not been acted upon in the Unified Work Program. An access study by the airport commission has resulted in a proposed access route to the nearest freeway, I-290, which in turn connects to routes to the airport's potential market areas.

Future activity at the airport will depend on integrated aviation systems and highway planning in eastern Massachusetts and on the acceptance by the public of access road construction to the airport.

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A. BACKGROUND

1. General

Worcester Municipal Airport is located on a plateau 300 ft. above the business district of Worcester in the northwesternmost corner of the City (Figures 1, 2). The airport is capable of handling up to 200,000 operations a year and could, in principle, serve a significant role in the Massachusetts aviation system. At present, however, only 80,000 operations are handled and these include only 6 scheduled air carrier flights a day to Boston, Manchester, N.H. and to LaGuardia, N.Y.

Airline passenger traffic to and from the airport is therefore at present insignificant and does not load the urban road system. On the other hand the roads leading to the airport are congested to such an extent that any increase of activity at the airport is difficult under present circumstances.

2. Planning Structure

A unified work program is prepared for submission to the intermodal planning group (IPG), by the Director of Transportation of the Central Massachusetts Planning Commission (CMPC). The Planning Commission represents 40 local communities in southern and central Worcester County and does comprehensive environmental planning as well as transportation planning.

Plans are being prepared for various alternative connections from I-290 to the airport access road but there has, as yet, been no public review of this plan. Because of the backlog of work at the CMPC, and because of the keen interest on part of the city of Worcester to provide access to the airport and to the industrial park, the city office for Planning and Community Development hasretained a private consulting firm to do planning for this connector and related corridor studies. The CMPC has appointed a group of professionals including traffic engineers of the city of Worcester to oversee this work. One proposed routing is along Mill Street to Main Street and then along Hope Street to I-290.

The connector would take traffic from the turnpike via I-290 well to the west of the center of the city where the main intercity traffic occurs.

3. Surface Access

Access to Worcester Airport at present is provided by private automobile and public taxi. There is no public bus or limousine service to the airport, nor any type of rail/rapid transit service. Thus, concern with airport access becomes a concern with highway routes connecting the airport with its market areas.

In the case of Worcester Municipal, there are no limited access connections to any part of the metropolitan area. City streets--with their attendant congestion--form the principal highway routes to the airport, although the last mile or so of any routing, being that portion ascending the airport

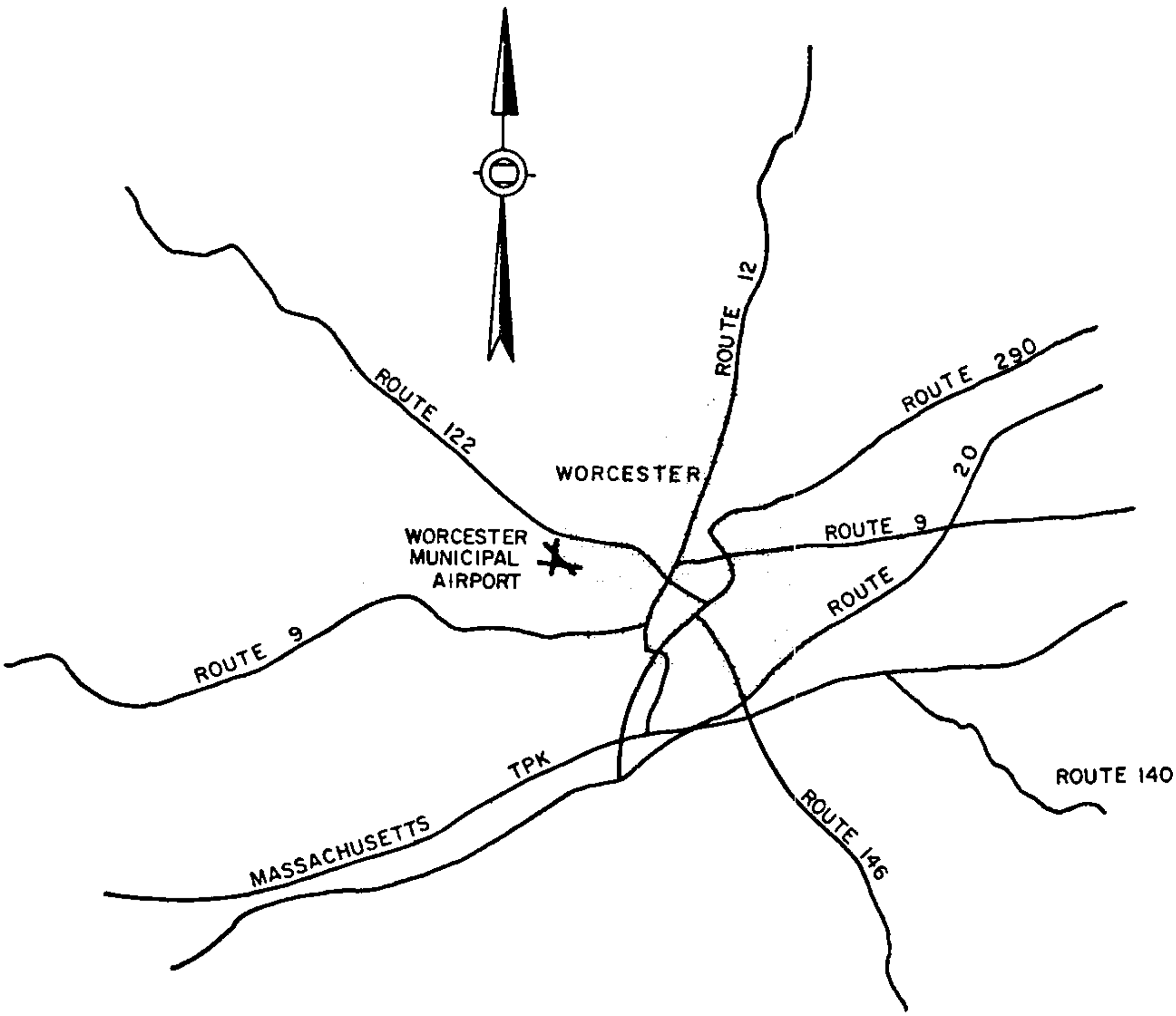
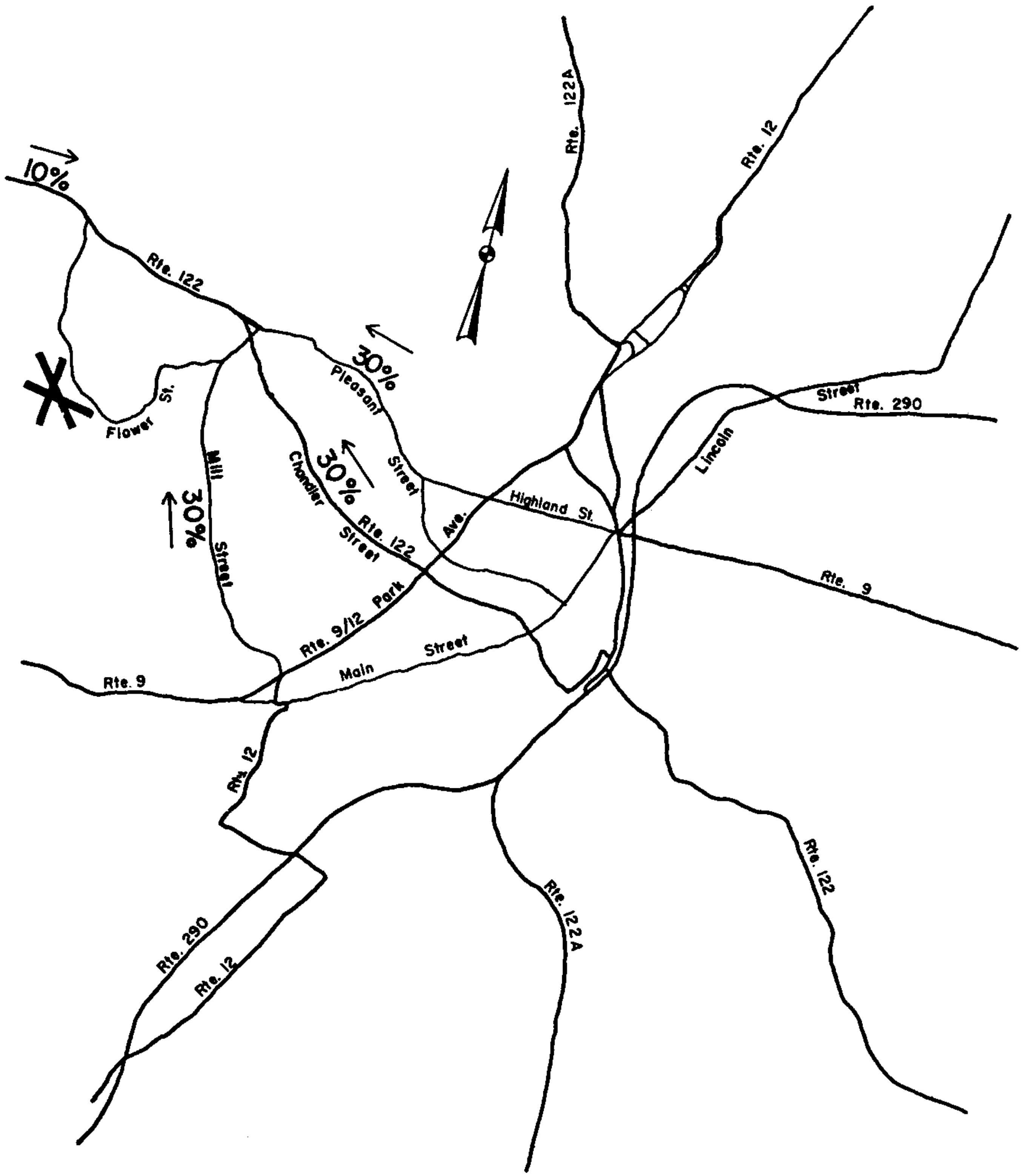


Figure 1

WORCESTER MUNICIPAL AIRPORT
& THE HIGHWAY SYSTEM NEAR WORCESTER

Figure 2
DISTRIBUTION OF APPROACH TRAFFIC



hill on airport property, does have restricted access. The trip by private car or taxi from the Worcester Central Business District can be made in about 10-15 minutes. In rush hours, this time can easily be doubled.

In terms of access to a broader market area, Worcester Airport is disadvantaged. I-290, an expressway serving the Worcester Central Business District, runs essentially southwest-northeast on the east side of Worcester opposite the airport (see Figure 1).

East-west routes through Worcester are congested. The Massachusetts Turnpike (I-90) lies several miles south of the city, and access from it via I-290 is no better, since the final stages of any route to the airport are identical. Access from the north and northeast requires penetration of the congested city or a circuitous routing. Route 122, a two-lane state rural road, serves the northwest directly, but the market in this area is limited.

An industrial Park has recently opened near the airport and truck traffic will pose an additional problem on the congested roads and intersections.

Three approaches to the airport are available from the east, northeast and south. (Figure 2) Mill Street, connecting into route 12 from the Turnpike and I-290 at Webster Square, is a 4-lane residential road. Parking on both sides restricts traffic flow to two lanes. The main bottleneck however, is Webster Square where routes 9 and 12 intersect Cambridge Street and Mill Street. Chandler Street (Route 122) is a 4-lane rural state road crossing I-290 near the center of Worcester on the way to the Turnpike. It is open to truck traffic but is congested along the entire stretch between CBD and the airport.

A third approach is over Pleasant Street from I-290 via Lincoln Square. This approach is largely through residential areas and the CBD.

4. Transit Access

The Worcester Regional Transit Authority operates three bus routes in the vicinity of the airport.

One route, along Mill Street terminates at the airport road--Mill Street intersection, approximately one mile from the terminal building. Other buses run along Chandler and Pleasant Streets. Their closest approach to the airport is at Chandler - Mill Street and Pleasant Street - Mill Street respectively.

A survey is currently in progress to determine whether a sufficient market potential exists to run one of the buses to the terminal building. Since the headway is typically 1/2 hour and since currently only 6 flights a day operate out of Worcester, considerable coordination would be required to create an acceptable service for passengers within the immediate service area of the transit system.

Rail service to Worcester is provided by Amtrak on a once-a-day, by-reservation-only train. This train makes stops along the potential market area of the Worcester Airport between Framingham and Worcester. The train does not, at this time, present a realistic mode of access; but in principle, a train and bus combination could be operated during the morning and evening rush hours if the airport were used by a larger number of passengers.

5. Internal Access

The airport is served by a loop off Mill Street leading up a steep grade to the plateau on which the airport and the industrial park are situated. The loop, known as Airport Drive, then returns to Pleasant Street along a softer grade.

With 500 spaces available for free parking, the airport internal access system is designed for about 300,000 annual passengers (as in the single gate terminal). Space for added parking facilities and increased road capacity is available on the grounds.

B. CAPACITY ANALYSIS

1. Passenger Forecasts

Table 1 represents an assessment of the potential Worcester air traffic submitted to the CAB at a 1972 hearing.

The actual history of air passenger travel is presented in Tables 2 and 3. Table 2 indicates that peak travel out of Worcester occurred during the mid 50's. As highway access to Logan Airport improved, more of the traffic was diverted from Worcester to Logan Airport with its better air access and more convenient schedules. Then, as ground access to Logan Airport became congested and because of the general increase in air travel, the decline in utilization at Worcester was halted. The FAA forecasts for Worcester is given in Table 3.

2. Airside Capacity

As pointed out previously the potential traffic of Worcester Airport is currently limited by its landside facilities and ground access to approximately 200,000-300,000 annual passengers.

PHOCAP was calculated on the basis of dual runway operation on the assumption of a 40% air carrier, 60% general aviation and military operations split. Weather data show 78% VFR and 9.5% IFR operating conditions. PHOCAP was converted into millions of annual passengers for 2 possible eventualities:

1. Present load factors (17%) and present runway constraints (DC 9 type planes, 100 seats)

2. 60% load factor, present runway constraints

Again it should be noted that the figures in Table 4 are realistic only in the sense that there are no land use constraints at present which would prevent the full development of airside and landside facilities at the Worcester Airport.

CAB Docket 22975

Exhibit ORH 210

TABLE 1

Potential Worcester Air Traffic Will Exceed 300,000 by 1973

Actual 1971 Worcester Traffic Enpl. & Depl. 1/	22,900
Adjusted 1971 Worcester Traffic 2/	29,400
Potential 1971 Worcester Traffic 3/	294,000

	1973		1974		1975	
Potential Worcester Traffic	323,400	4/	339,570	6/	356,349	7/
Estimated Worcester Traffic	107,800	5/	135,828	6/	160,477	7/
Estimated On-Line Worcester-Albany	10,780		13,580		16,040	
Estimated On-Line Worcester-Boston	21,560		27,160		32,080	
Estimated On-Line Worcester-New York	75,460		95,088		112,327	

1/ Worcester Information Responses.

2/ May through December traffic of 10,200 equal to 67.5% of full year (1969 experience).

3/ Assumes 10% of potential traffic used Worcester Airport.

4/ Estimated to increase 10% between 1971 and 1973.

5/ Estimated at 40% of potential traffic.

6/ Estimated at 40% of potential traffic. Potential traffic 5% above 1973.

7/ Estimated at 45% of potential traffic. Potential traffic 5% above 1974.

TABLE 2

Worcester's Passenger Traffic

Year	Enplaned	Deplaned	Total
	Number of Passengers		
1950	21,075	18,397	39,472
1955	40,972	39,907 1/	80,879
1960	32,647	31,143	63,790
1965	22,928	24,257	47,185
1970 2/	23,714	22,377	46,091
1974	23,787	23,193	49,926

1/ Estimated based on the ratio of enplaned to deplaned passengers for the years 1953- 1954 and 1959 - 1960.

2/ Mohawk on strike November 1970 to April 1971.

Source: Airport Activity Statistics of Certified Air Carriers, 195 through 1958, Air Transport Association of America. Worcester Airport Records.

Year 1977

TABLE 3

WORCESTER MUNICIPAL AIRPORT

FAA FORECAST

	Actual FY 1975	FY 1977	FY 1978	Forecast FY 1979	FY 1982	FY 1987
Enplaned Passengers (000)						
Air Carrier	18	20	21	23	27	36
Air Taxi	0	4	4	5	7	12
Operations (000)						
Air Carrier	5	5	5	5	6	7
Air Taxi	2	2	2	2	3	4
Itinerant	61	69	76	82	98	127
Total	84	94	104	113	132	165

TABLE 4

AIRSIDE CAPACITY

PHOCAP	PANCAP*	% Air Carrier	Millions of Annual Passengers #1	Millions of Annual Passengers #2
64	258,000	40%	1.75	6.17

*Based on the Logan Draft Master Plan Study showing PANCAP of 303,000 operations for 75 PHOCAP.

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3. Ground Access Capacity

Assignments for airport ground trips had to be made on the basis of available data on the potential market areas for the airport (Reference 3). The assignments are shown in Appendix A.

Five critical areas were selected for analysis and current traffic data were obtained from the Worcester Department of Traffic engineering (Reference 6). Future non-airport traffic was projected on an average annual compounded growth rate of 2.0% using data available from a 1972 study (Reference 4). Vehicle trips available for airport use were then converted into annual passenger capacity by assuming that each passenger generates .6 vehicle trips in a given direction, divided by the fraction assigned to the route under study. Calculations are given in Appendix B and the results are graphically presented in figures 3 to 7.

4. Interpretation

a. Access from the east and points south of the airport: These access routes are over busy CBD street and residential roads. Airside capacity will exceed LOS E groundside capacity by the late 1980's even for the lowest estimate of airside capacity (Figures 4, 5).

In fact, even the very low projected demand rate and the actual current demand for airport trips will exceed ground capacity by 1995.

b. The immediate vicinity of the airport: As figures 6 and 7 indicate, there will be no severe limitations on the lower estimated airside capacity until the early 1990's.

C. SOLUTIONS

The problems in this non-hub airport are caused by the absence of limited access highways in the vicinity of the airport. A remedy has been proposed (Figure 8) but public reaction to this proposal is as yet unknown.

If this airport is to realize its full potential as a major airport in the airports system plan of central and eastern Massachusetts it must involve at the very least some form of park and ride system for air passengers. On the other hand, if the airport is to realize its potential for cargo then a limited access highway connector must be constructed to connect the airport with I-90 and I290.

If the airport is not selected as a major airport for part of the regional traffic then it will remain a very insignificant traffic generator and access improvements will be incidental to the general traffic engineering solutions applied to the Worcester CBD and SMA.

Figure 3

DEMAND/CAPACITY RELATIONSHIP
CHANDLER ST. AT PARK ST. (NO. BOUND)

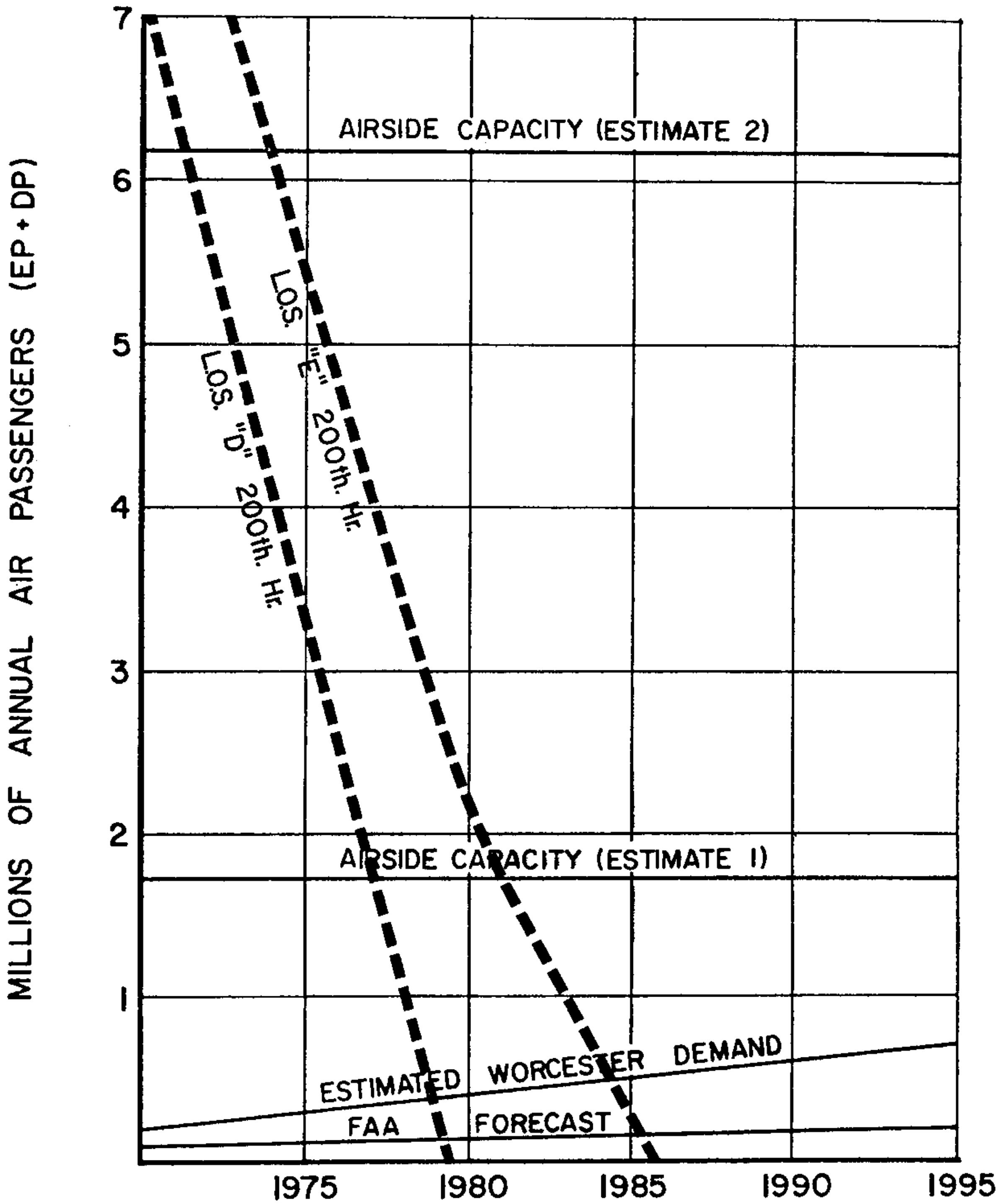

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Figure 4

DEMAND/CAPACITY RELATIONSHIP
SALSBURY ST. AT LINCOLN SQ.

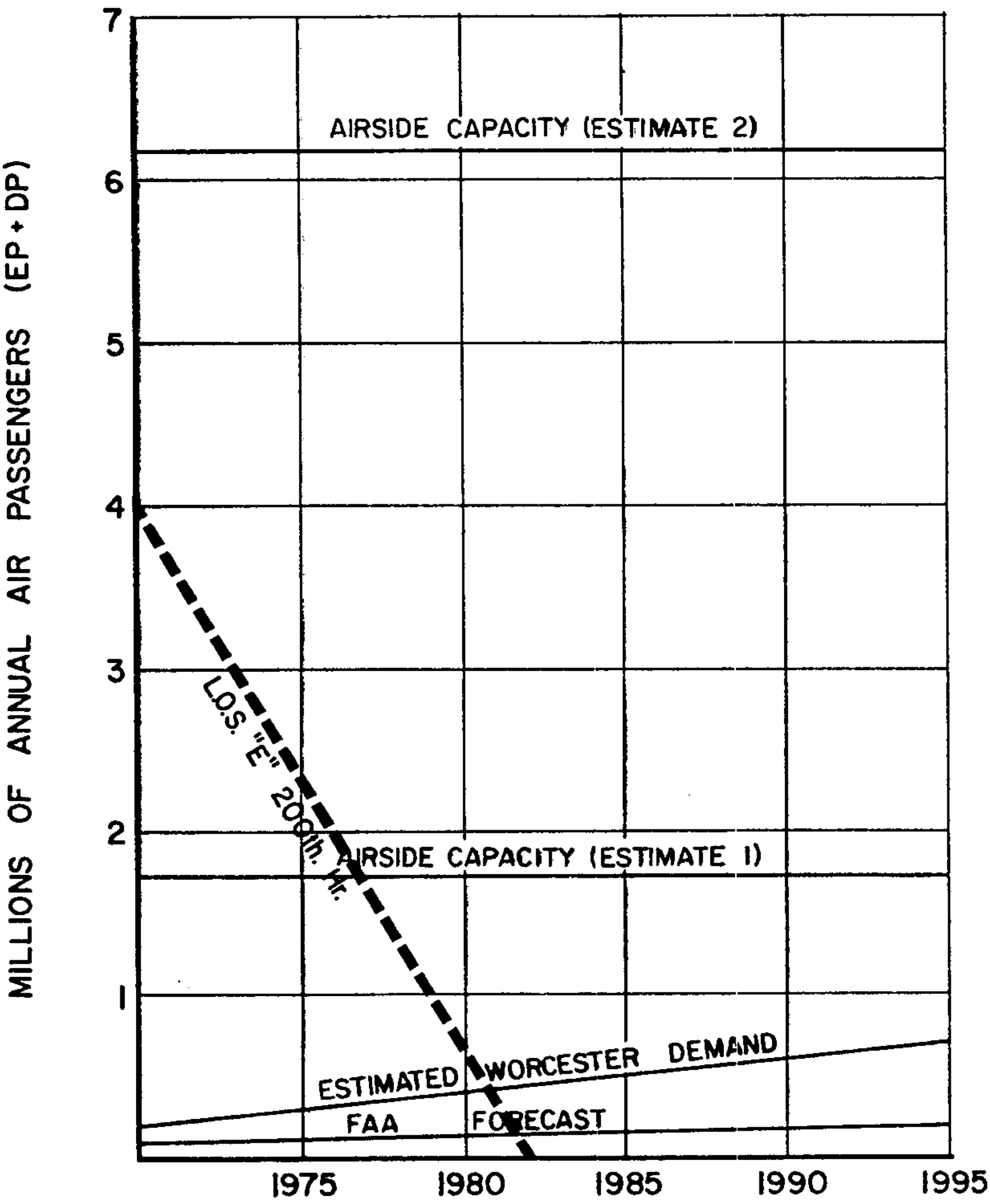

Figure 5

DEMAND/ CAPACITY RELATIONSHIP
WEBSTER ST. AT WEBSTER SQ. (NORTH BOUND)

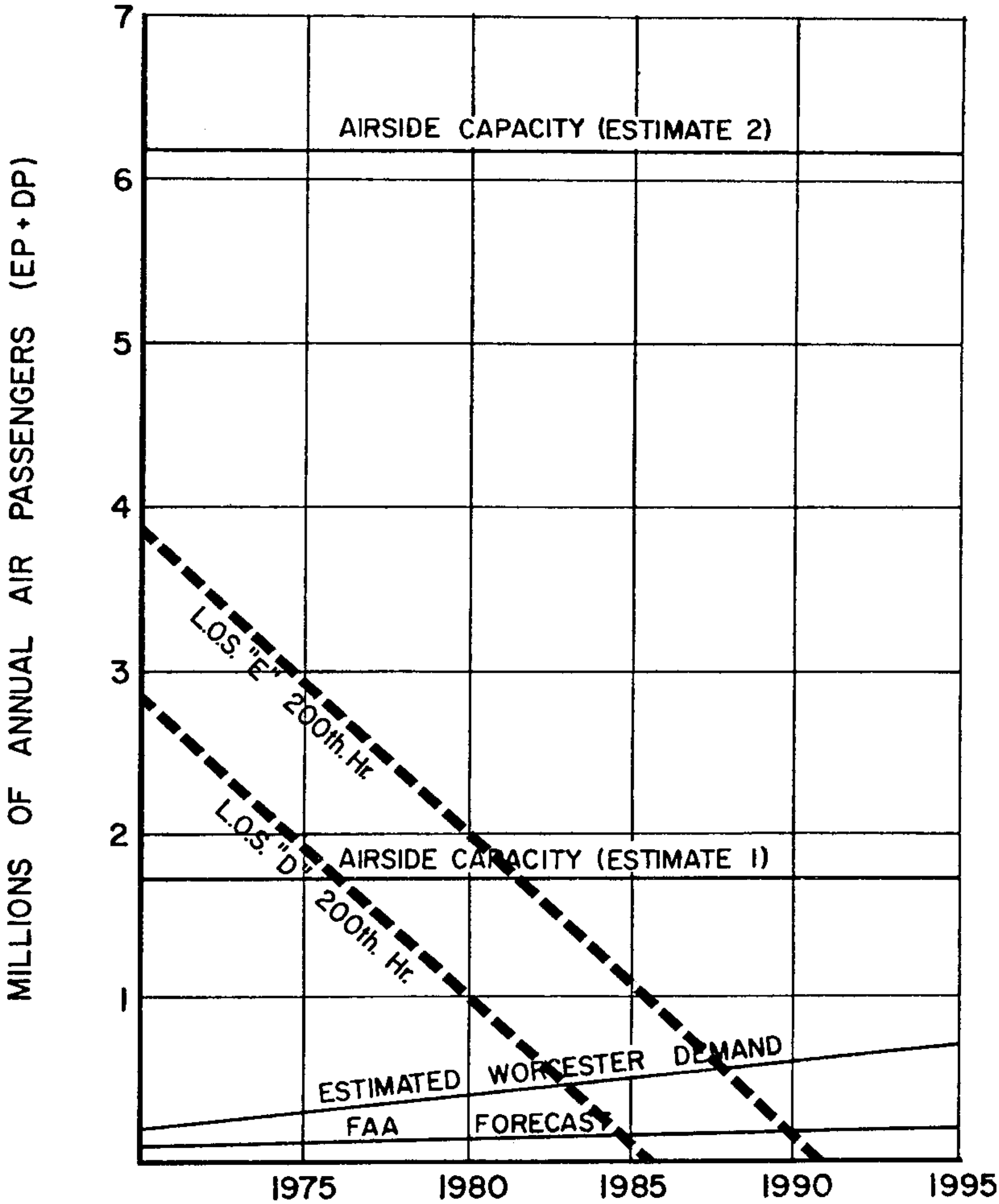

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Figure 6

DEMAND/CAPACITY RELATIONSHIP
CHANDLER ST. AT MILL STREET

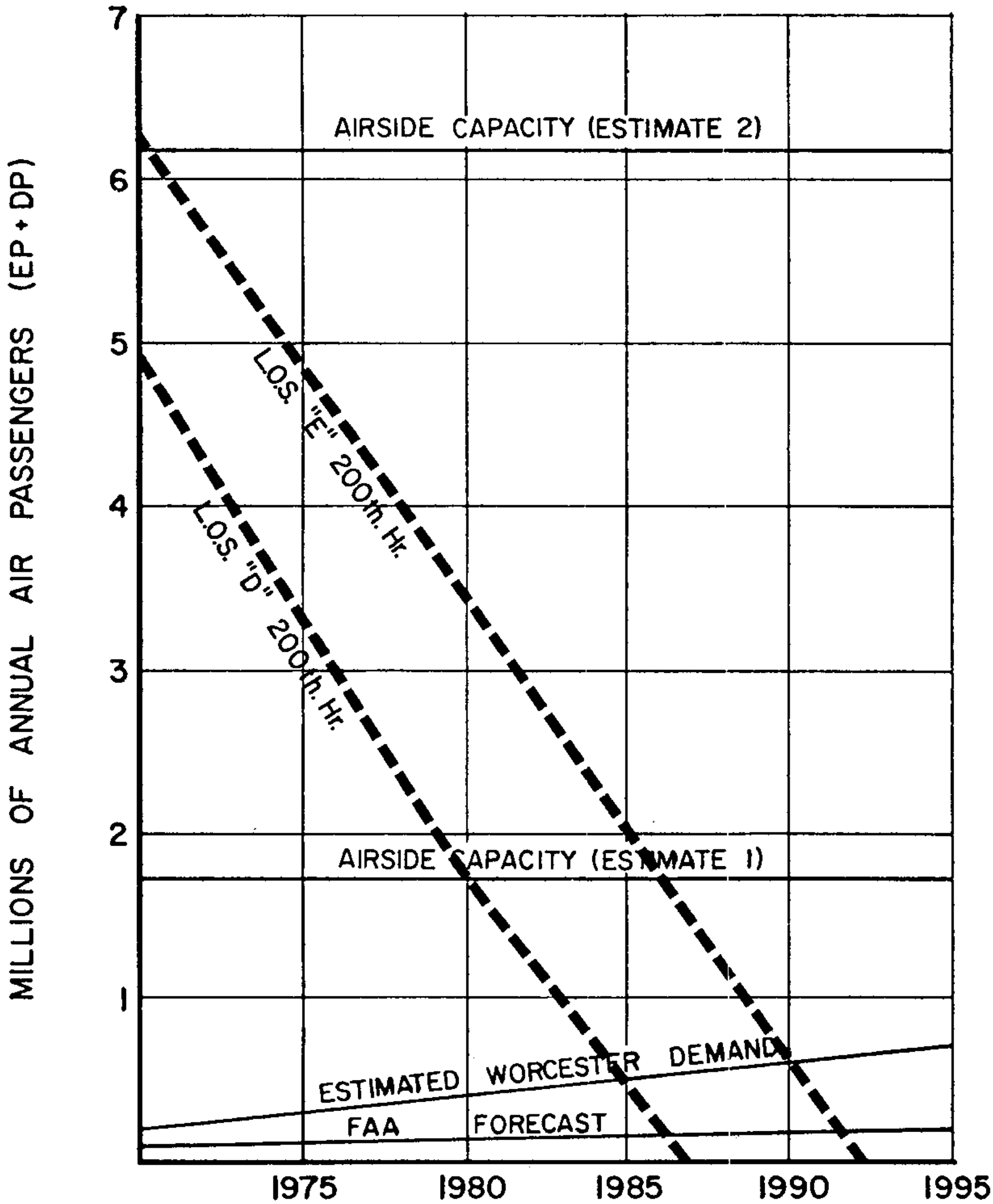

Figure 7

DEMAND/CAPACITY RELATIONSHIP
MILL ST. AT PLEASANT ST.

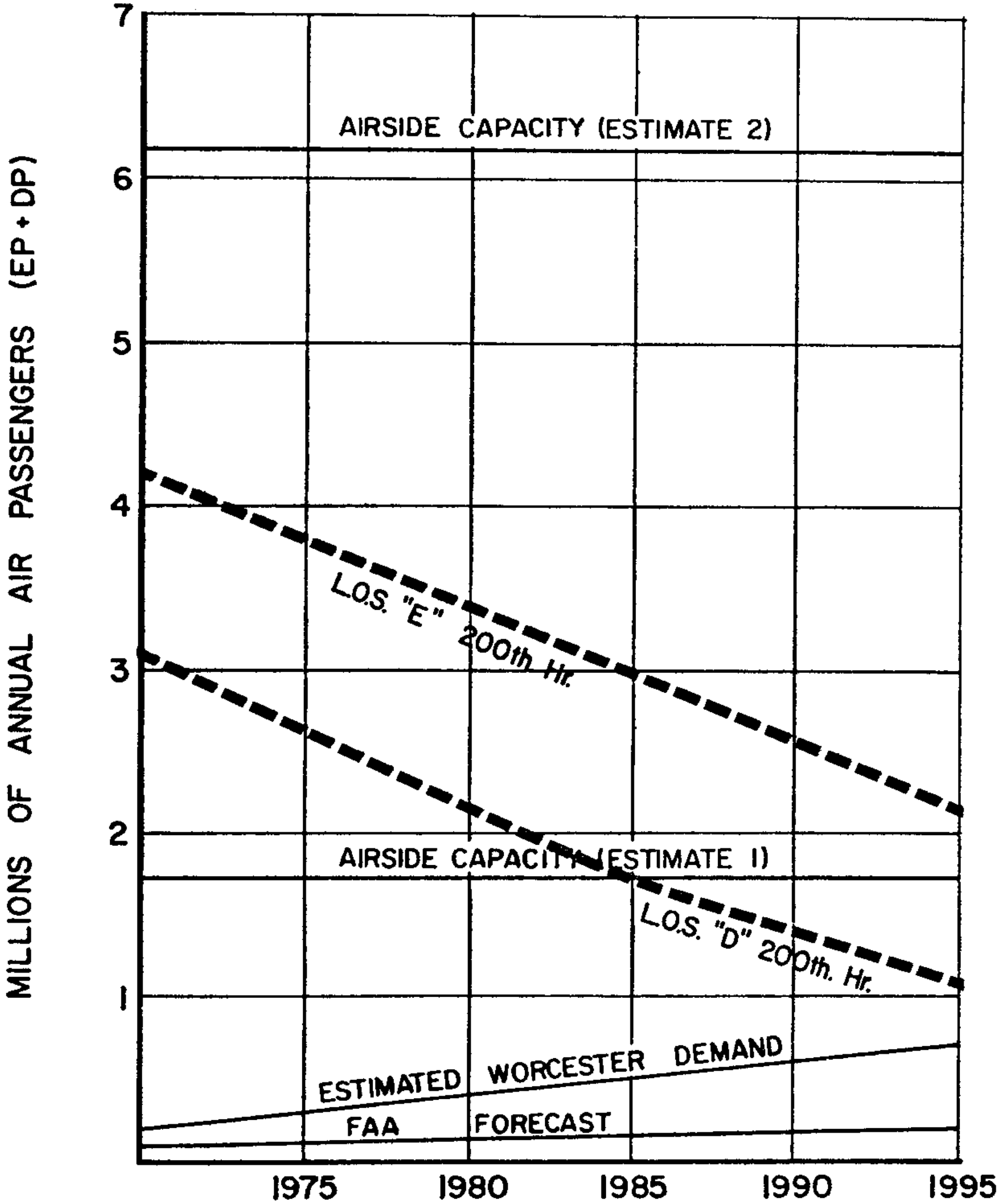

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Figure 8
PROPOSED CONNECTOR BETWEEN
I-290 AND THE AIRPORT

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D. CONCLUSIONS

Ground access and air access constrains the development of Worcester Airport. Because of the inaccessibility of the airport, very few potential passengers use the available scheduled flights; this in turn makes it unprofitable for airlines to schedule flights between Worcester and other logical market points such as Chicago or Washington, D.C.

At present, the access problem is not confined to the congestion of critical intersections but includes the lack of convenient and direct connections to the limited access highways I-90 and I-290.

Because of the insignificant traffic to the airport, airport access has had a low priority with the CMPC. This situation is now changing because of the emphasis by the city on the development of the industrial park just south of the airport. Federal funds are being used to plan access to the airport-industrial park complex but these funds came from allocations to the Office of Planning and Community Development rather than through the more conventional Metropolitan Planning Organization channel. If and when a direct connector to I-290 or I-90 is constructed, access will present no further problems even if some of the passenger and cargo traffic is diverted from Boston Logan Airport to Worcester.

If no connector is built to the airport then, as Figure 3-7 shows, congestion will remain the major constraint to aviation at Worcester Municipal Airport.

APPENDIX A

ASSIGNMENT OF AIRPORT TRAFFIC

No detailed survey of routes air-passengers take to the airport was available. The following assignments were made on the assumption that 90% of the vehicles approaching the airport come via the three approaches connecting into I-290 and the Turnpike (I-90).

East (Rte. 9)	Lincoln Square via City Streets to Pleasant Street	30%
CBD, South East and I-290	Vernon to Madison to Chandler (Rte. 122)	30%
Turnpike and Sth West	Rte. 12 and I-290 via Webster Street Webster Sq. to Mill St.	30%

The remaining 10% were assumed to come in from the north and northwest via Rte. 122 southbound.

In addition to the intersections within the CBD and south of the airport, the intersections of Chandler and Pleasant Street with Mill Street near the airport itself are of importance since all traffic coming to the airport from the three approaches to the south must turn into Mill Street southbound to get to the airport road. While some traffic might proceed to the Rte. 122-Airport Drive intersection 900 ft. to the west there as no data to support a split for that intersection and it was assumed that one-third of the westbound traffic passes the intersection of Pleasant Street and two-thirds that at Chandler Street.

APPENDIX B

COMPUTATION OF GROUND ACCESS CAPACITY

Since all approaches except the southbound lanes of Rte. 122 are urban roads, intersections form the main points of congestion. One critical intersection along each of the routes was selected to calculate ground access capacity as follows:

Chandler at Park Street

Salisburg at Lincoln Square

Webster Street at Webster Square

Traffic counts were obtained from the engineering department of the Worcester DPW and Peakhour demands were calculated. Peakhour demand varied from between .075 to .095 of ADT with an average of about .084 and peak traffic occurred generally during a two to three hour period (3 to 5 PM). These peak hour demand ratios were applied to those intersections for which only ADT data were available.

Capacities were read off Figures 6.7 and 6.9 of the Highway Capacity Manual using level of service related load factors as per Table 6.3 of the manual. To convert to millions of passengers, it was assumed that each average passenger generates about 1.2 two-way trips.

TABLE B1. AIRPORT ACCESS CAPACITY
(CHANDLER AT PARK STREETS, NO. BOUND)

L.O.S[1] (1)	Yrs./Yrs.[2] (2)	Factor (3)	1977 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	11,365	11,365	11,365	11,365	11,365
		2	11,600	13,048	14,133	15,005	16,567
		3	-	-	-	-	-
		4	-	-	-	-	-
D	200	1	13,022	13,022	13,622	13,622	13,622
		2	11,600	13,049	14,133	15,005	16,567
		3	1,422	-	-		
		4	2.1	-	-		
D	1000	1	16,464	16,464	16,464	16,464	16,464
		2	11,600	13,048	14,133	18,005	16,567
		3	4,846	3,416	2,331	1,459	-
		4	7.1	5.0	3.41	2.1	-
E	30	1	12,625	12,625	14,466	14,466	14,466
		2	11,600	14,133	14,133	15,005	16,567
		3	1,025	-	333	-	-
		4	1.5	-	.5	-	-
E	200	1	18,273	18,273	18,273	18,273	18,273
		2	11,600	13,048	14,133	15,005	16,567
		3	6,673	5,225	4,140	3,268	1,706
		4	9.7	7.6	6.0	4.7	2.5

[1] Per Highway Capacity Manual

[2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

[3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

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TABLE B2. AIRPORT ACCESS CAPACITY
(SALISBURY AT LINCOLN SQUARE SOUTH BOUND)

L.O.S.[1] (1)	Hrs./Yrs.[2] (2)	Factor[3] (3)	YEAR 1977 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	5,227	5,227	5,227	5,227	5,227
		2	6,800	7,431	8,285	8,796	9,712
		3	-	-	-	-	-
		4	-	-	-	-	-
D	200	1	5,989	5,989	5,989	5,989	5,989
		2	6,800	7,431	8.285	8,796	9,712
		3	-	-	-	-	-
		4	-	-	-	-	-
D	1000	1	7,565	7,565	7,565	7,565	7,565
		2	6,800	7,431	8,285	8,796	9,712
		3	765	134	-	-	-
		4	1.1	.2	-	-	-
E	30	1	6,818	6,818	6,818	6,818	6,818
		2	6,800	7,431	8,285	8,796	9,712
		3	18	-	-	-	-
		4	.02	-	-	-	-
E	200	1	7,812	7,812	7,812	7,812	7,812
		2	6,800	7.431	8,285	8,796	9,714
		3	1,012	381	-	-	-
		4	1.4	.6	-	-	-
E	1000	1	9,868	9,868	9,868	9,868	9,868
		2	6,800	7,431	8,285	8,796	9,712
		3	3,068	2,437	1,583	1,072	156
		4	4.5	3.6	2.3	1.6	.2

[1] Per Highway Capacity Manual

[2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

[3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) Million annual passengers associated with 3.

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TABLE B-3. AIRPORT ACCESS CAPACITY
WEBSTER STREET AT WEBSTER SQUARE

			YEAR				
L.O.S.[1] (1)	Hrs./Yrs.[2] (2)	Factor[3] (3)	1977 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	4,850	4,850	4,850	4,850	4,850
		2	4,545	4,960	5,533	5,879	6,491
		3	305	-	-	-	-
		4	.4	-	-	-	-
D	200	1	5,557	5,557	5,557	5,557	5,557
		2	4,545	4,960	5,533	5,879	6,491
		3	1,012	597	. 24	-	-
		4	1.5	.9	.0	-	-
D	1000	1	7,020	7,020	7,020	7,020	7,020
		2	4,545	4,960	5,533	5,879	6,491
		3	2,475	-	-	1,141	529
		4	3.6	-	-	1.7	.77
E	30	1	5,455	5,455	5,455	5,455	5,455
		2	4,545	4,960	5,533	5,533	6,491
		3	910	495	-	-	-
		4	1.3	.72	-	-	-
E	200	1	6,250	6,250	6,250	6,250	6,250
		2	4,545	4,960	5,533	5,879	6,491
		3	1,705	1,290	717	371	-
		4	2.5	2.0	1.0	.5	-
E	1000	1	7,895	7,895	7,895	7,895	7,895
		2	4,545	4,960	5,533	5,879	6,491
		3	3,350	2,935	2,362	2,016	1,404
		4	4.9	4.3	3.4	2.9	2.0

[1] Per Highway Capacity Manual
[2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.
[3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

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TABLE B-4. AIRPORT ACCESS CAPACITY
(CHANDLER AT MILL STREET)

L.O.S[1] (1)	Hrs./Yrs.[2] (2)	Factor[3] (3)	YEAR 1977 (4)	1980 (5)	1985 (6)	1990 (7)	1995 (8)
D	30	1	8,181	8,181	8,181	8,181	8,181
		2	7,500	8,195	9,138	9,702	10,712
		3	681	-	-	-	-
		4	1.0	-	-	-	-
D	200	1	9,374	9,374	9,374	9,374	9,374
		2	7,500	8,195	9,138	9,702	10,712
		3	1,874	1,179	236	-	-
		4	2.7	1.7	.4	-	-
D	1000	1	11,841	11,841	11,841	11,841	11,841
		2	7,500	8,195	9,138	9,702	10,712
		3	4,341	3,646	2,703	2,138	1,129
		4	6.3	5.3	3.9	3.0	1.6
E	30	1	9,091	9.091	9,091	9,091	9,091
		2	7,500	8,195	9,138	9,702	10,712
		3	1,591	896	-	-	-
		4	2.3	1.3	-	-	-
E	200	1	10,416	10,416	10.416	10,416	10,416
		2	7,500	8,195	9,138	9,702	10,712
		3	2,916	2,221	1,278	714	-
		4	4.3	3.3	1.9	1.0	-
E	1000	1	13,158	13,158	13,158	13,158	13,158
		2	7,500	8,195	9,138	9,702	10,712
		3	5,658	4,693	4,020	3,456	2,446
		4	8.3	7.2	5.9	5.0	3.6

[1] Per *Highway Capacity Manual*

[2] Number of hours/year during whi h level of service is equal to or worse than that shown in Column 1.

[3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

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TABLE B-5. AIRPORT ACCESS CAPACITY
MILL STREET AT PLEASANT STREET

L.O.S.[1]	Hrs./Yrs.[2]	Factor[3]	YEAR 1977	1980	1985	1990	1995
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	30	1	6,818	6,818	6,818	6,818	6,818
		2	4,500	4,917	5,483	5,821	6,427
		3	2,318	1,901	1,335	997	391
		4	1.7	1.4	1.0	.7	.25
D	200	1	7,812	7,812	7,812	7,812	7,812
		2	4,500	4,917	5,483	5,821	6,427
		3	3,312	2,895	2,339	1,991	1,385
		4	2.4	2.1	1.7	1.6	1.0
D	1000	1	9,868	9,868	9,868	9,868	9,868
		2	4,500	4,917	5,483	5,821	6,427
		3	5,368	4,951	4,385	4,047	3,441
		4	3.9	3.6	3.2	2.9	2.5
E	30	1	8,181	8,181	8,181	8,181	8,181
		2	4,500	4,917	5,483	5,821	6,427
		3	3,681	3,264	2,698	2,361	1,754
		4	2.7	2.4	2.0	1.7	1.3
E	200	1	9,374	9,374	9,374	9,374	9,374
		2	4,500	4,917	5,483	5,821	6,427
		3	4,874	4,457	3,891	3,553	2,947
		4	3.6	3.3	2.9	1.7	2.1
E	1000	1	11,841	11,841	11,841	11,841	11,841
		2	4,500	4,917	5,483	5,821	6,427
		3	7,341	6,924	6,358	6,020	5,414
		4	5.4	5.1	4.6	4.4	4.0

[1] Per *Highway Capacity Manual*

[2] Number of hours/year during which level of service is equal to or worse than that shown in Column 1.

[3] Key: 1) = Highway Capacity; 2) = Nonairport related traffic; 3) = Capacity for airport related vehicles; 4) = Million annual passengers associated with 3.

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SUPPLEMENT C

Federal Highway Administration (FHWA)

1978 UPDATE OF

GROUND ACCESS TO AIRPORTS

Form FHWA 121 (Rev. 5-73)

UNITED STATES GOVERNMENT

Memorandum

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

DATE: MAY 2 2 1978

In reply refer to: HHP-26

SUBJECT: INFORMATION:
Airport Ground Access Study

FROM : Acting Federal Highway Administrator

AOA#:
ACTION/~~INFORMATION~~: AEM-1
DUE DATE(S):
FOR SIGNATURE OF:
COORDINATION WITH/THRU:
INFORMATION COPY: AED-1

TO : Honorable Langhorne Bond
AOA-1 Administrator, Federal Aviation Administration

We are pleased to transmit the attached airport access information requested in your December 20, 1977, letter to former Federal Highway Administrator William M. Cox. The attached paper includes the traveltime and financial data for 55 large- and medium-hub airports for input to the supplemental Airport Ground Access report to the Senate Committee on Appropriations.

Karl S. Bowers

Attachment

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1978 Update of Ground Access to Airports

The Senate Appropriations Committee in their FY 1978 Department of Transportation Appropriation Bill mandated the Federal Aviation Administration (FAA) to conduct a comprehensive study of ground access to airports. The Federal Highway Administration (FHWA) in turn was requested by the FAA to participate by updating information on airport access travel characteristics previously provided in the 1968 and 1972 FAA studies. The FHWA participation primarily concerns the update and compilation of traveltime and travel speed information from the Central Business District (CBD) to the airport facility in 55 medium and large hub airports. In addition, the FHWA furnished the requested cost information on major Federal-aid highway projects that have or will improve access to these airport facilities.

DATA COLLECTION

The procedures and information gathered for this update to the extent possible, were similar to the previous studies. The two major exceptions were (1) the gathering of information on the estimated costs of major Federal-aid highway improvements to airport access; (2) and the traveltime and travel speed data collected within the airport property. As in the previous studies, the data collection and reporting effort was through field offices of the FHWA in cooperation with the FAA field offices, the States, and the metropolitan planning organizations (MPO).

Appendix A contains a copy of the Airport Access Information Sheet and a description of the airport access data items. For the 1978 update the new Dallas/Fort Worth International Airport was used instead of Dallas Love Field. Airport access travel characteristics (i.e., traveltime and travel speed) were reported from both CBD locations to the airport.

SUMMARY AND ANALYSIS

The airport access information reporting sheets received on 24 large and 31 medium hub airports were summarized in Tables 1 and 2 which are contained in this report. Table 1 summarizes the airport access data received for large hub airports and Table 2 summarizes this information for medium hub airports. The tables list all large and medium hub airports as defined by the FAA and contain the following information on each airport:

1. The total distance in miles to the airport, measured from the CBD starting location along the airport route to the airport departure terminal.

2. Total traveltime is given for the peak period only. It is the summation of the traveltimes experienced on each system of the airport route plus the traveltime experienced once within the airport property to reach the departure terminal.

3. Route miles is the mileage for each system making up the airport route. Traveltime (measured in minutes) and travel speed (measured in miles per hour) are given for the airport route under peak and off-peak travel conditions.

4. The percent of traveltime within the airport property (from airport boundary to the departure terminal). If there are several departure terminals and there is a significant difference in traveltime between the nearest and the most remote terminal, then the average mileage and average traveltime to the departure terminal area was used.

5. Public transportation lists existing public transportation which serves the airport from the CBD.

6. The percent change in 1978 peak-hour traveltime as compared to 1968 and 1972 peak-hour traveltimes for medium and large hub airports.

7. Estimated cost (in $1,000) of major Federal-aid airport access improvements are separated into two categories: (1) projects completed after 1967; and (2) projects that are under construction or programed.

The figures in Table 3 show 1978 airport access travel characteristics. The three main travel characteristics are travel distance, traveltime and travel speed. They are reported for CBD to airport boundary peak and off-peak travel.

The average travel distance along the designated airport route from the CBD starting location to the airport boundary for the large hub airports is 13.6 miles in 1978. For medium hub airports the average travel distance is 8.6 miles. Table 4 contains information on airport route mileage by highway system. The figures show for large hub airports that approximately 65 percent of the airport route (CBD to airport boundary) mileage is on the Interstate system, and approximately 51 percent for the medium hub airports. Moreover, approximately 98 percent of the airport route mileage for large hubs and 95 percent for medium hubs is on the Federal-aid highway systems. Service to airports and other transportation terminal facilities was an important criterion in location of the Interstate System and it is apparent these facilities have been well served by the system.

Traveltime is an important airport access performance measure. The figures in Table 3 show the average traveltime from the CBD to the airport boundary for both large and medium hub airports. The large hubs have an average peak hour traveltime of 28.5 minutes. The medium hubs have an average peak hour traveltime of 16.6 minutes. For comparative purposes, the traveltimes for each large and medium hubs are shown in Tables 5 and 6 from 1949 to 1978. Upon examining the traveltime data from 1972-1978 we find that in only several airports has traveltime changed by more than 5 minutes. As shown in Table 7, during the peak hour the average traveltime from 1972-1978 has increased slightly (+3.6 percent) for large hub airports while it has decreased slightly (-4.8 percent) for medium hub airports. For all airports traveltime has decreased 0.5 percent.

Average travel speed is the third travel characteristic examined in this update of ground access to airports. Average travel speed gives a measure for level of access service to the airport. The figures in Table 3 show the average travel speed from the CBD to the airport boundary for both large and medium hub airports. The travel speed during the peak hour averages 30 m.p.h. for the large hubs and 31.4 m.p.h. for the medium huds. In 1972 the peak hour travel speed averaged 30.6 m.p.h. for the large hubs and 30.5 m.p.h. for the medium hubs[1/]. It is interesting to note that off-peak speeds are higher for the large hubs. This can probably be explained by the higher percentage of large hub mileage on the Interstate System with its higher travel speed during uncongested periods. Graphs 1 and 2 depict the average peak hour speed respectively for the large and medium hub airports. Those airports below the average speed lines for large and medium hubs are experiencing travel speeds which are greater than the average. While the airports located above the average speed lines represent those airports whose travel speed is less than the average for all airports within their group of large or medium hub airports.

The estimated Federal-aid highway investment in highway projects that have or will improve access to these airports can be obtained from Tables 1 and 2. The estimated cost for airport access highway improvements completed after 1968 are $598 million for the large hubs and $514 million for the medium hubs. The estimated cost of airport access highway improvements that are under construction or programed are approximately $652 million for the large hubs and approximately $735 million for the medium hubs.

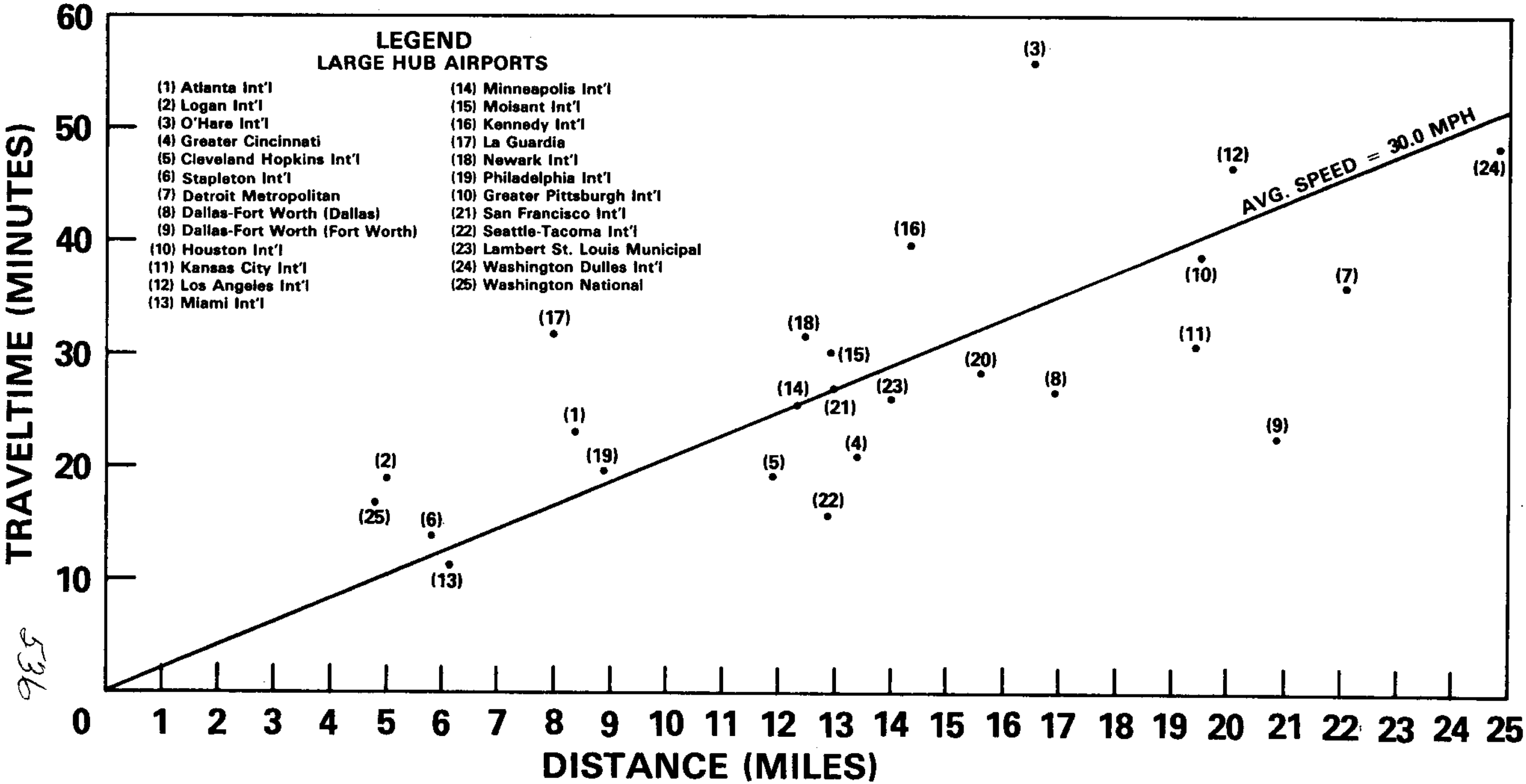
Although it is very difficult to accurately estimate Federal spending related to airport access it can be seen that significant investment has been reported on the field surveys. For several airports with available before and after traveltime data and highway improvement data we found that completion of Interstate highway links serving the airport provided significant improvements in traveltime. The Report to Congress, "The Status of the Nation's Highways: Conditions and Performance," indicates that vehicular travel per lane mile has increased in spite of the heavy investment in new highway facilities.[2/] However, even with the increase in vehicular travel on our highways, on the average airport traveltime still decreased from 1972-1978 for the combined large and medium hub airports as shown in Table 7.

1/ Silence and Chesshir. Reevaluation of Ground Access to Airports. Highway Research Record 439, 1973, pp. 19-27.

2/ Report to Congress, "The State of the Nation's Highways: Conditions and Performance," September 1977, page 9.

GRAPH 1 PEAK HOUR TRAVELTIME VS. DISTANCE
(AIRPORT ROUTE)

LARGE HUB AIRPORTS



GRAPH 2 PEAK HOUR TRAVELTIME VS. DISTANCE (AIRPORT ROUTE)

MEDIUM HUB AIRPORTS

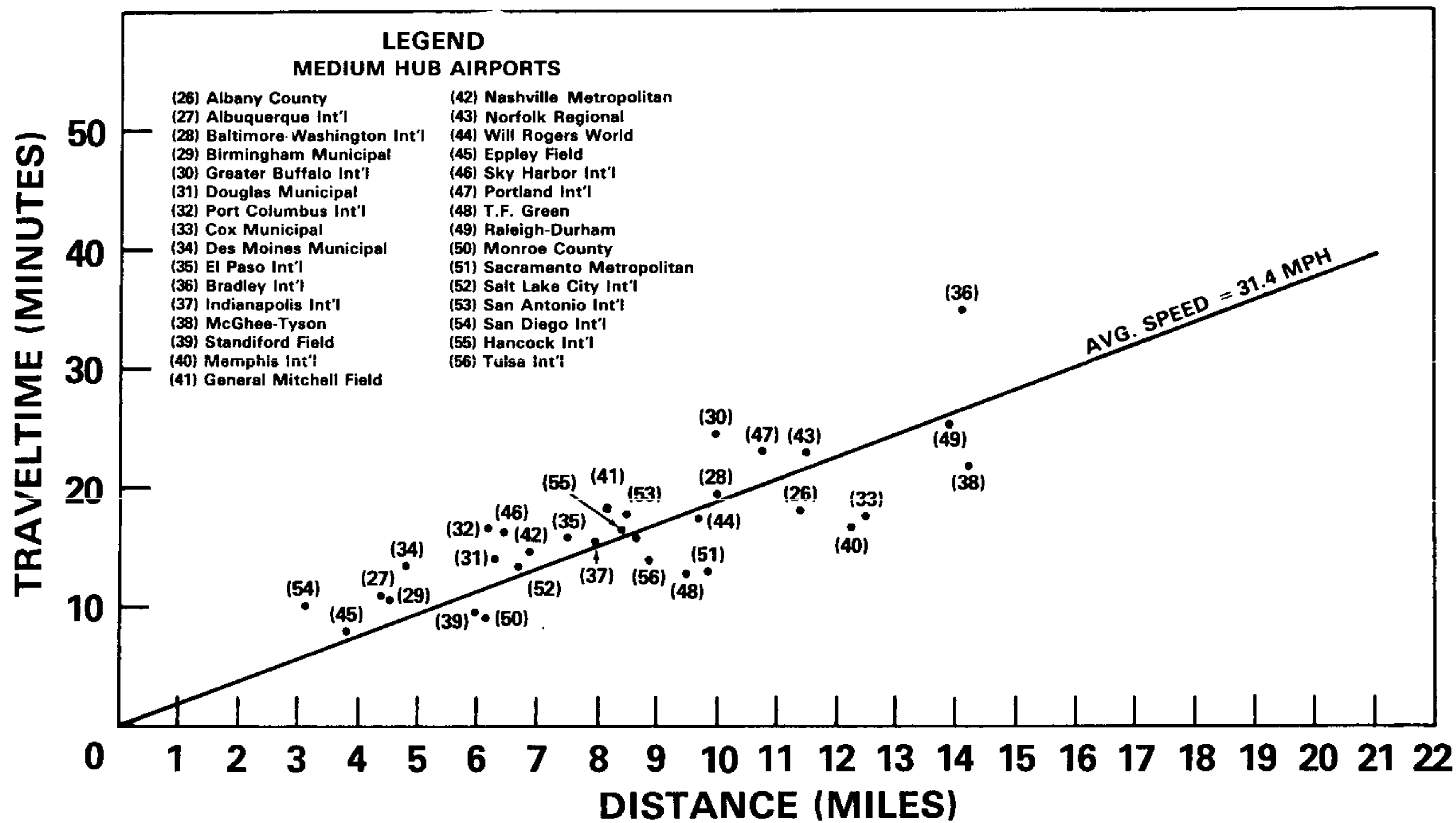


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Table 1

HIGHWAY ACCESS TO AIRPORTS
LARGE HUBS

CBD	Airport	CBD to Terminal 1978: Total Miles	CBD to Terminal 1978: Total Travel Time (Peak) min.	1978 Airport route (CBD to airport boundary.): Route Miles	Travel Time (minutes): Peak	Travel Time (minutes): Off-peak	Speed (mph): Peak	Speed (mph): Off-peak	% Peak Travel Time within Airport Property	Public Transportation	% Change of 1978 Peak Travel Time from 1972	% Change of 1978 Peak Travel Time from 1968	Major Federal-aid Airport Access Improvements Est. Cost ($1000): Completed after 1967	Major Federal-aid Airport Access Improvements Est. Cost ($1000): Under Construction or Programmed	Comments
Atlanta, GA	Atlanta	N.A.	N.A.	I = 6.6 FAU = 1.1 Non Fed = .7 8.4	23.7	15.7	21.3	32.1	N.A.	Bus Taxi Limo.	+6.7	-3.3	888	82,000	I-20 interchange with I-75/I-85 southbound traffic on I-75/I-85 is delayed by traffic merging from I-20
Boston, MA	Logan, Int'l.	5.6	20.3	I = .6 FAP = 2.7 FAU = 1.7 5.0	19	12	15.8	25	6.4	Bus Taxi Limo.	-33.3	-24.0	N.A.	None	Principal delay at Leverett Circle due to Police extending signal cycle length during peak periods.
Chicago, Ill.	O'Hare, Int'l.	18.7	63.0	I = 12.7 FAP = 1.5 FAU = 2.3 16.5	56	29	17.6	34.1	11.1	Bus Taxi Limo. Rapid Transit	+64.7	+24.4	5,075	12,000	Heavy pedestrian and vehicular traffic in CBD contribute to delay. Delays also encountered from near Kennedy-Edens bifurcation to Nagle Avenue. Rapid transit extension proposed.
Cincinnati, Ohio	Greater Cincinnati Airport	14.0	23.0	I = 12.10 FAU = 1.31 13.4	21.3	16.6	37.8	48.5	7.3	Taxi Limo	+20.3	- 6.5	None	None	No significant causes of delay.
Cleveland, Ohio	Cleveland Hopkins Int'l.	12.3	20.6	I = 10.9 FAU = 1.0 11.9	19.7	19.5	36.3	36.7	4.6	Bus Taxi Limo Rapid Transit	-20.2	-21.2	9,100	11,000	No significant causes of delay along the airport route. The completion of the connector has reduced route mileage by 2.6 miles. The traveltime to the airport has decreased accordingly.

HIGHWAY ACCESS TO AIRPORTS

LARGE HUBS

CBD	Airport	CBD to Terminal 1978: Total Miles	CBD to Terminal 1978: Total Travel Time (Peak) min.	1978 Airport routs (CBD to airport boundary.): Route Miles	Travel Time (minutes): Peak	Travel Time (minutes): Off-peak	Speed (mph): Peak	Speed (mph): Off-peak	% Peak Travel Time within Airport Property	Public Transportation	% Change of 1978 Peak Travel Time from: 1972	% Change of 1978 Peak Travel Time from: 1968	Major Federal-aid Airport Access Improvements Est. Cost ($1000): Completed after 1967	Under Construction or Programmed	Comments
Denver, CO	Stepleton Int'l.	6.2	15.3	FAU = 5.8	14.0	14.2	24.8	24.5	7.9	Bus Taxi Limo	- 2.0	-18.0	None	None	No significant causes of delay. Future automated rapid transit line is planned from CBD to airport.
Detroit, MI	Detroit Metro.	24.0	39.5	I = 17.0 FAP = 3.7 FAU = 1.5 22.2	36.5	34.1	37.0	39.5	12.5	Bus Taxi Limo Heli-copter	+14.0	-22.3	130,173	28,066	CBD traffic is the major causes of delay.
Dallas, TX	Dallas-Ft. Worth Regional	20.6	32.5	I = 5.15 FAP = 10.75 FAU = .85 16.85	27.4	26.8	36.6	37.5	15.7	Bus Taxi	N/A	N/A	7,760	23,300	Delay due to traffic congestion occurred on S.H. 183 during the peak period.
Fort Worth, TX	Dallas-Ft. Worth, Regional	24.7	28.4	I = 2.0 FAP = 18.7 FAU = .2 20.9	23.4	23.0	53.5	54.5	17.9	Bus Taxi	N/A	N/A	16,661	11,215	No significant delay.
Houston, TX	Houston Int'l.	22.3	43.6	I = 13.2 FAP = 4.9 Non Fed = 1.3 19.5	39.2	25.2	30.6	46.4	18.4	Taxi Limo	+13.3	+63.3	9,127	6,330	Heavy congestion with stop-and-go conditions on I-45 with average speeds of 26.4 mph inside I-610 loop and 28.3 mph between I-610 and Beltway during p.m. peak period.

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HIGHWAY ACCESS TO AIRPORTS

LARGE HUBS

CBD	Airport	CBD to Terminal 1978: Total Miles	CBD to Terminal 1978: Total Travel Time (Peak) min.	1978 Airport route (CBD to airport boundary.): Route Miles	Travel Time (minutes): Peak	Travel Time (minutes): Off-peak	Speed (mph): Peak	Speed (mph): Off-peak	% Peak Travel Time within Airport Property	Public Transportation	% Change of 1978 Peak Travel Time from: 1972	% Change of 1978 Peak Travel Time from: 1968	Major Federal-aid Airport Access Improvements Est. Cost ($1000): Completed after 1967	Under Construction or Programmed	Comments
Kansas City, Missouri	Kansas City, Int'l.	21.8	36	I = 18.7 FAU = .7 19.4	31	25	37.5	46.5	13.9	Bus Taxi Limo Inter-City Bus	-22.5	+24.0	28,300	181,732	In the peak hour there is considerable congestion on I-35 and I-29 in the vicinity of the Missouri River Bridge, This three-mile section is primarily responsible for the additional six minutes of peak hour traveltime over its off-peak traveltime.
Los Angeles, CA	Los Angeles Int'l.	21.0	51	I = 15.8 FAP = 1.6 Non Fed = 2.9 20.2	47	30	26	40.6	7.8	Bus Taxi	+17.5	+17.5	None	None	
Miami, FLA	Miami Int'l.	7.2	14.6	I = .9 FAU = 5.2 6.1	11.8	8.7	31.0	42.0	19.2	Bus Taxi Limo	+ 7.2	-50.8	N.A.	N.A.	Second stage rapid transit system proposes connection to airport.
Minneapolis, Minn.	Int'l.	13.2	26.7	I = 5.4 FAP = .8 FAU = 4.9 Non Fed = 1.2 12.3	25.1	18.9	29.4	39.0	12.0	Bus Taxi Limo	+41.0	+19.5	2,050	None	Significant delay was encountered on the non-Federal route consisting of travel within the CBD at the metered ramp entering the Interstate.

HIGHWAY ACCESS TO AIRPORTS

LARGE HUBS

CBD	Airport	CBD to Terminal 1978: Total Miles	CBD to Terminal 1978: Total Travel Time (Peak) min.	1978 Airport route (CBD to airport boundary.): Route Miles	Travel Time (minutes): Peak	Travel Time (minutes): Off-peak	Speed (mph): Peak	Speed (mph): Off-peak	% Peak Travel Time within Airport Property	Public Transportation	% Change of 1978 Peak Travel Time from: 1972	% Change of 1978 Peak Travel Time from: 1968	Major Federal-aid Airport Access Improvements Est. Cost ($1000): Completed after 1967	Major Federal-aid Airport Access Improvements Est. Cost ($1000): Under Construction or Programmed	Comments
New Orleans, LA	Moisant Int'l.	15.2	33.3	I = 11.3 FAP = 1.1 FAU = .4 12.8	30.1	22.8	25.5	33.7	9.6	Bus Taxi Limo	-8.5	+.3	33,000	16,000	Traffic is impeded by the merge of I-10 & I-610 at 17th St. and Canal Bridge causing a delay of 6.5 min.
New York, New York	Kennedy	17.5	47	I = 14.3	40	22	22.5	39	14.9	Bus Taxi Limo	-20.0	-20	None	46	
New York, New York	La Guardia	8.5	34.5	I = 6.8 FAP = 1.0 7.8	32	19.5	14.6	24.0	7.2	Bus Taxi Limo	0	+1.5	None	4,200	General traffic congestion along the airport route.
New York, New York	Newark Int'l.	13.3	34.5	I = 12.0 FAP = .5 12.5	32	23	23.4	32.6	7.2	Bus Taxi Limo	+39	+35	80,000	400	Programed improvement of additional lane to airport ramp off Rt. 1 & 9.
Philadelphia, PA	Phil. Int'l.	9.4	20.7	I = 2.9 FAP = 5.0 FAU = 1.0 8.9	19.7	15.1	29.1	35.4	4.8	Bus Taxi Limo Rapid Transit Future	-8.4	-17.9	217,164	202,067	Intersection of 26th St. on Penrose Ave. is major bottleneck on the airport route. Traffic signals along Market Street are uncoordinated; also double parking reduces number of travel lanes.
Pittsburgh, PA	Greater Pittsburgh Int'l.	16.1	29.7	I = 7.0 FAP = 8.6 15.6	28.1	17.6	33.3	53.0	5.2	Bus Taxi Limo	+ .3	N/A	11,380	38,700	Considerable delay at Fort Pitt Tunnel entrance.

HIGHWAY ACCESS TO AIRPORTS
LARGE HUBS

CBD	Airport	CBD to Terminal 1978		1978								% Change of 1978 Peak Travel Time from		Major Federal-aid Airport Access Improvements Est. Cost ($1000)		Comments
		Total Miles	Total Travel Time (Peak) min.	Airport route (CBD to airport boundary.) Route Miles	Travel Time (minutes) Peak	Travel Time (minutes) Off-peak	Speed (mph) Peak	Speed (mph) Off-peak	% Peak Travel Time within Airport Property	Public Transportation		1972	1968	Completed after 1967	Under Construction or Programmed	
San Francisco CA	San Francisco Int'L	13.9	29.1	I = 1.6 FAP = 10.9 Non Fed = .4 12.9	27.5	18.5	28.1	42.0	5.6	Bus Taxi Rail Air Taxi		-2.5	-21.4	46,000	35,000	For Northbound a.m. peak period, major congestion on Route 101 occurs from the Route 280 interchange to the Bryant Street on-ramp in San Francisco. Southbound p.m. peak period congestion occurs on Route 101 beginning on the Central Skyway to South of Route 280 interchange.
Seattle, WA	Seattle-Tacoma Int'l.	14.3	18.7	I = 11.1 FAP = 1.4 Non Fed = .4 12.9	16.6	16.4	46.6	47.2	11.2	Bus Taxi Limo		-4.6	-24.5	None	None	No significant causes of delay. A heliport is planned for the future.
St. Louis, MO	Lambert-St. Louis Municipal	15.2	29.0	I = 13.6 FAU = .4 14.0	26.0	18.0	32.3	46.6	10.3	Bus Taxi Limo		0	+1.9	1,231	None	Considerable congestion occurs at 5 lane to 3 lane merge on I-70.
Washington, D.C.	Dulles	N.A.	N.A.	I = 3.0 FAP = 21.8 24.8	49.0	36.0	30.4	41.3	N.A.	Bus Taxi Limo		+29.0	N.A.	N.A.	N.A.	
Washington, D.C.	National	N.A.	N.A.	I = .45 FAP = 4.25 4.7	17.4	15.5	16.6	18.6	N.A.	Bus Taxi Limo Metro-rail		-2.2	+2.3	N.A.	N.A.	

Table 2

HIGHWAY ACCESS TO AIRPORTS

MEDIUM HUBS

CBD	Airport	CBD to Terminal 1978		1978							% Change of 1978 Peak Travel Time from		Major Federal-aid Airport Access Improvements Est. Cost ($1000)		Comments
				Airport route (CBD to airport boundary.)											
		Total Miles	Total Travel Time (Peak) min.	Route Miles	Travel Time (minutes) Peak	Travel Time (minutes) Off-peak	Speed (mph) Peak	Speed (mph) Off-peak	% Peak Travel Time within Airport Property	Public Transportation	1972	1968	Completed after 1967	Under Construction or Programmed	
Albany, N.Y.	Albany County	12.1	20.5	I = 10.3 FAU = 1.1 11.4	18.5	16.7	40	41	9.5	Taxi Limo	-18.8	-25.4	187,300	3,400	New airport route. When the 1972 FHWA airport update was completed, I-787 and I-90 were not built.
Albuquerque, N.M.	Albuquerque Int'l.	N.A.	N.A.	I = 1.6 FAP = .3 FAU = .8 Other Fed = 1.0 Non Fed = .6 4.3	11.9	9.3	22.0	28.0	N.A.	Bus Taxi Limo	+14.4	+38.3	654	1,618	Virtually all delay caused by traffic signals.
Baltimore, MD	Baltimore-Washington Int'l.	10.5	20.8	FAP = 9.5 Other Fed = .5 10.0	19.7	17.3	30.5	34.7	5.3	Bus Taxi Limo	+ 3.7	+15.8	None	None	The new airport terminal construction caused some delay at the airport.
Birmingham, AL	Birmingham Municipal	5.1	12.0	FAU = 4.5	10.5	11.5	25.7	24.5	10.8	Taxi Limo	+ 5	-25.0	77,000	N. A.	No significant causes of delay along route, 3.1 miles of I-20 are programed.
Buffalo, N.Y.	Greater Buffalo Int'l.	10.2	25.0	FAP = 8.9 FAU = 1.1 10.0	24.5	17.4	24.4	34.3	2.4	Bus Taxi Limo	+15	+ 7.4	8,301	54,600	Significant delay on Kensington Expressway due to congestion on two lanes in each direction. Delay on Tupper Street (Delaware to Michigan) due to congestion and construction of the Elm-Oak Arterial.

HIGHWAY ACCESS TO AIRPORTS

MEDIUM HUBS

CBD	Airport	CBD to Terminal 1978: Total Miles	CBD to Terminal 1978: Total Travel Time (Peak) min.	1978 Airport route (CBD to airport boundary.): Route Miles	Travel Time (minutes): Peak	Travel Time (minutes): Off-peak	Speed (mph): Peak	Speed (mph): Off-peak	% Peak Travel Time within Airport Property	Public Transportation	% Change of 1978 Peak Travel Time from: 1972	% Change of 1978 Peak Travel Time from: 1968	Major Federal-aid Airport Access Improvements Est. Cost ($1000): Completed after 1967	Under Construction or Programmed	Comments
Charlotte, N.C.	Douglas Municipal	6.8	14.6	FAU = 6.3	13.4	13.0	28.2	29.0	17.8	Taxi Limo	-26.7	-38.6	N. A.	None	No significant causes of delay.
Columbus, Ohio	Port Columbus Int'l.	7.7	19.4	FAU = 6.2	16.6	15.8	22.2	23.3	14.0	Taxi Limo	-40.0	-24.5	None	200,000	This is a different airport route from 1972. This route is shorter; thus requires less traveltime and is the route used by Taxi and Limo. from CBD to airport.
Dayton, OH	Cox, Municipal	13.9	19.4	I = 9.7 Non Fed = 2.8 12.5	17.4	16.3	42.8	45.7	10.0	Taxi Limo	-19.8	-26.0	None	8,700	Access road from US 40 to airport terminal completed without Federal funds.
Des Moines, Iowa	Des Moines Municipal	5.0	15.5	FAU = 4.8	13.5	12.2	21.3	23.6	12.9	Taxi Limo	+10.6	- 3.5	2,174	4,780	No significant delay.
El Paso, TX	El Paso Int'l.	8.0	16.4	I = 6.0 FAU = 1.3 Non Fed = .3 7.6	15.6	12.6	29.0	36.0	5.2	Bus Taxi	-15.2	+11.4	173	15	1972 miles was overstated by 0.35 miles. No significant delay along the airport route.
Hartford, Conn.	Bradley Int'l.	14.7	36.3	I = 9.6 FAP = 4.2 FAU = .3 14.1	35.0	18.0	24.0	46.9	3.7	Bus Taxi Limo	+16.6	+16.6	None	250,000	During peak hour traffic volume on I-91 section of the airport access route exceeds the capacity of the highway resulting in traffic congestion.

HIGHWAY ACCESS TO AIRPORTS
MEDIUM HUBS

CBD	Airport	CBD to Terminal 1978: Total Miles	CBD to Terminal 1978: Total Travel Time (Peak) min.	1978 Airport route (CBD to airport boundary.): Route Miles	Travel Time (minutes): Peak	Travel Time (minutes): Off-peak	Speed (mph): Peak	Speed (mph): Off-peak	% Peak Travel Time within Airport Property	Public Transportation	% Change of 1978 Peak Travel Time from 1972	% Change of 1978 Peak Travel Time from 1968	Major Federal-aid Airport Access Improvements Est. Cost ($1000): Completed after 1967	Major Federal-aid Airport Access Improvements Est. Cost ($1000): Under Construction or Programmed	Comments
Indianapolis, Indiana	Indianapolis Int'l. (Wier Cook)	8.3	16.5	I = 4.9 FAU = 3.1 8.0	15.5	14.2	31	33.8	6.2	Bus Taxi Limo	-44.6	-37.0	32,930	None	The completion of I-70 has significantly decreased the traveltime to the airport.
Knoxville, TN	McGhee-Tyson	14.5	23.9	I = .9 FAP = 4.5 FAU = 8.8 14.2	22.6	19.9	37.7	43.5	5.4	Bus Taxi Limo	- 6.3	+20.3	N. A.	N. A.	Interchange at State Rt. 73 and the terminal entrance road has been completed.
Louisville, Kentucky	Standiford Field	7.3	11.0	I = 5.4 FAU = 1.3 Non Fed = .1 6.8	9.5	9.5	42.9	42.9	14	Bus Taxi Limo	-20.8	-37.0	7,809	4,690	No significant causes of delay.
Memphis, TN	Memphis Int'l.	12.9	19.3	I = 8.4 FAU = 3.7 Non Fed = .2 12.3	16.9	15.8	43.6	46.7	12.4	Bus Taxi Limo	- 7.1	-17.5	None	2,000	No significant causes of delay.
Milwaukee, WI	General Mitchell Field	8.6	21.0	I = 5.2 FAP = .2 FAU = 2.8 8.2	18.1	14.9	25.0	33.3	6.0	Bus Taxi Limo	+26.5	-5.8	23	11,165	No specific section of the route experienced significant delay.
Nashville, TN	Nashville Metro.	7.5	17.0	I = 5.0 FAU = 1.9 6.9	14.7	10.0	28.1	41.4	13.5	Bus Taxi Limo	0	+20.5	None	None	I-40 operates at level of service "E" during peak hour.

HIGHWAY ACCESS TO AIRPORTS

MEDIUM HUBS

CBD	Airport	CBD to Terminal 1978: Total Miles	CBD to Terminal 1978: Total Travel Time (Peak) min.	1978 Airport route (CBD to airport boundary.): Route Miles	Travel Time (minutes): Peak	Travel Time (minutes): Off-peak	Speed (mph): Peak	Speed (mph): Off-peak	% Peak Travel Time within Airport Property	Public Transportation	% Change of 1978 Peak Travel Time from: 1972	% Change of 1978 Peak Travel Time from: 1968	Major Federal-aid Airport Access Improvements Est. Cost ($1000): Completed after 1967	Under Construction or Programmed	Comments
Norfolk, VA	Norfolk Regional	11.8	24.9	I = 9.1 FAU = 2.3 11.4	22.3	14.5	30.7	47.1	6.4	Taxi Limo.	+36.0	+29.0	20,969	None	Major delay is experienced at the interchange of I-64 and Route 44 because traffic volume exceeds the capacity of the interchange.
Oklahoma City OK	Will Rogers World	10.2	18.0	I = 6.7 FAU = 3.0 9.7	17.0	14.0	34.2	41.5	5.5	Taxi Limo	-10.0	- 9.5	23,114	1,828	Construction detour on I-40 caused an estimated 2 minute increase in peak and off-peak traveltime.
Omaha, Neb.	Eppley Field	3.9	8.5	FAP .4 FAU = 3.4 3.8	8.0	7.6	28.5	30.0	6.3	Bus Taxi Limo	- 9.0	-27.2	N.A.	3,940	A 4-lane divided segment of Abbott Drive was completed in 1976. 1.6 miles of this segment is part of the airport access route.
Phoenix, AZ	Sky Harbor Int'l.	7.4	17.8	FAU = 6.40	15.9	14.1	24.2	27.2	10.7	Bus Taxi Limo. Mini-bus	-20.5	-10.6	2,406	1,464	No significant causes of delay.
Portland, OR	Portland Int'l.	12.1	26.5	I = 7.7 FAU = 3.1 10.8	23.7	18.3	27.3	35.4	10.5		+ 9.2	- 1.6	N.A.	N.A.	
Providence, R.I.	T.F. Green	N.A.	N.A.	I = 8.0 FAU = 1.4 9.4	12.7	10.5	44.4	53.7	N.A.	Bus Taxi Limo	0	-15.3	None	None	No significant causes of delay along the airport route.

HIGHWAY ACCESS TO AIRPORTS

MEDIUM HUBS

CBD	Airport	CBD to Terminal 1978		1978								% Change of 1978 Peak Travel Time from		Major Federal-aid Airport Access Improvements		Comments
				Airport route (CBD to airport boundary.)						% Peak Travel Time within Airport Property	Public Transportation			Est. Cost ($1000)		
		Total Miles	Total Travel Time (Peak) min.	Route Miles	Travel Time (minutes)		Speed (mph)							Completed after 1967	Under Construction or Programmed	
					Peak	Off-peak	Peak	Off-peak				1972	1968			
Raleigh, N.C.	Raleigh-Durham	14.1	26.0	I = 6.2 FAP = .7 FAU = 4.7 Non Fed = 2.3 13.9	25.4	21.8	32.8	38.2		4.7	Taxi Limo.	+14.9	-15.6	8,500	None	4.7 minutes delay at signalized intersections.
Rochester, N.Y.	Monroe County	6.4	10.1	I = 5.3 FAU = .8 6.1	9.4	8.6	39	42.6		8.8	Bus Taxi Limo.	-27.6	-52.0	55,972	85,231	New route is 1.91 miles longer but peak and off peak traveltimes are less.
Sacramento, CA	Sacramento Metro.	11.4	16.5	I = 8.9 FAU = .9 9.8	13.3	12.4	44.2	47.4		19.4	Taxi Limo.	-11.3	-36.6	27,969	None	No significant causes of delay along airport route.
Salt Lake City	Salt Lake City Int'l	7.1	14.2	I = 2.5 FAU = 4.2 6.7	13.2	14.1	30.5	28.7		8.1	Bus Taxi Limo.	- 5.7	-40.0	None	18,400	No significant causes of delay.
San Antonio, TX	San Antonio Int'l.	9.2	19.2	I = 1.0 FAU = .4 Non Fed = 7.1 8.5	17.6	13.6	29.0	37.5		8.3	Bus Taxi Limo	+17.3	+17.0	N/A	N/A	Congestion occured on airport route because of construction on adjoining U.S. 281. The construction work should be completed later this year; thus eliminating this problem.
San Diego, CA	San Diego Int'l.	3.4	11.3	FAU = 2.1 Other Fed.= 1.0 3.1	10.3	9.1	18.1	20.4		9.7	Bus Taxi Limo.	+.97	+8.4	None	None	Delays occur in CBD area due to traffic signal phasing. Delays occur along Harbor Drive during peak hours because of industrial site shift change.

HIGHWAY ACCESS TO AIRPORTS

MEDIUM HUBS

CBD	Airport	CBD to Terminal 1978		1978 Airport route (CBD to airport boundary.)					% Peak Travel Time within Airport Property	Public Transportation	% Change of 1978 Peak Travel Time from		Major Federal-aid Airport Access Improvements Est. Cost ($1000)		Comments
		Total Miles	Total Travel Time (Peak) min.	Route Miles	Travel Time (minutes) Peak	Travel Time (minutes) Off-peak	Speed (mph) Peak	Speed (mph) Off-peak			1972	1968	Completed after 1967	Under Construction or Programmed	
Syracuse, N.Y.	Hancock Int'l.	9.9	18.2	I = 6.3 FAU = 2.2 8.5	16.0	14.3	32	36	12.0	Taxi Limo.	+18.5	- 4.2	20,264	83,100	In general significant delay along the airport route was encountered on the city streets exiting the CBD.
Tulsa, OK	Tulsa Int'l.	9.4	15	I = 5.4 FAP = 2.4 FAU = 1.1 8.9	14.0	12.0	38	44.5	6.7	Bus Taxi Limo.	-10.3	-46.5	38,035	None	No significant delay along route.

Table 3

Airport Access Travel Characteristics

	Large Hub Airports		Medium Hub Airports	
	Peak	Off-Peak	Peak	Off-Peak
Average distance for route from CBD to airport boundary (miles)	13.6	13.6	8.6	8.6
Average traveltime from CBD to airport boundary (min.)	28.5	20.9	16.6	13.8
Average travel speed from CBD to airport boundary (m.ph)	30.0	38.4	31.4	36.7
Average percent traveltime on airport property to total traveltime from CBD to airport	9.8	--	8.3	--

Table 4

Percent Airport Route Mileage by Highway System

Highway System	Percent Airport Route Mileage	
	Large Hub Airports	Medium Hub Airports
Interstate	65.0	50.5
Federal-Aid Primary	23.6	11.7
Federal-Aid Urban	9.2	31.6
Federal-Aid Secondary	0.0	0.0
Other Federal	0.0	1.1
Total Federal	97.8	95.0
Non-Federal	2.2	5.1

Table 5

Peak Period Ground Travel Time in Minutes Between Central Business District and Airport, 1949, 1968, 1972 and 1978

Large Hubs

Airports	1949	1968	1972	1978
Atlanta Airport	30.0	24.5	22.2	23.7
Boston Logan International	35.0	25.0	28.5	19.0
Chicago O'Hare	-	45.0	34.0	56.0
Cleveland Hopkins	40.0	25.0	24.7	19.7
Dallas - Dallas-Fort Worth				27.4
Fort Worth - Dallas-Fort Worth				23.4
Greater Cincinnati	40.0	22.8	17.7	21.3
Denver Stapelton International	25.0	17.2	14.4	14.1
Detroit Metropolitan	-	47.0	32.0	36.5
Houston International	-	24.0	34.6	39.2
Kansas City International	-	25.0	40.0	31.0
Las Vegas	-	20.0	N.A.	
Los Angeles International	45.0	40.0	40.0	47.0
Miami International	35.0	24.0	11.0	11.8
Minneapolis International	-	21.0	17.8	25.1
New Orleans	20.0	30.0	32.9	30.1
New York Kennedy International	41.0	50.0	50.0	40.0
New York La Guardia	34.0	31.5	32.0	32.0
Newark International	48.0	23.7	23.0	32.0
Philadelphia International	23.0	24.0	21.5	19.7
Greater Pittsburgh International	-	N.A.	28.0	28.1
San Francisco International	30.0	35.0	28.2	27.5
Seattle-Tacoma International	35.0	22.0	17.4	16.6
Lambert-St. Louis Municipal	30.0	25.5	26.0	26.0
Washington Dulles International	-	1/	38.5	49.0
Washington National	30.0	17.0	17.8	17.4

1/ 1968 survey showed 52 minutes which seems high.

Source: Federal Highway Administration, Office of Highway Planning, Urban Planning Division, for 1968, 1972, and 1978. 1949 data from "City to Airport Highways", U.S. Department of Commerce, Civil Aeronautics Administration, April 1953.

Table 6

Peak Period Ground Travel Time in Minutes Between
Central Business District and Airport, 1949, 1968, 1972, 1978

<u>Medium Hubs</u>

Airports	1949	1968	1972	1978
Albany County	-	24.8	22.8	18.5
Albuquerque International	-	8.6	10.4	11.9
Baltimore Friendship	30.0	17.0	19.0	19.7
Birmingham Municipal	-	14.0	10.0	10.5
Greater Buffalo International	-	22.8	21.3	24.5
Charlotte, N.C. Douglas Municipal	20.0	21.8	18.3	13.4
Columbus Ohio International	20.0	22.0	27.7	16.6
Dayton Cox Municipal	20.0	23.5	21.7	17.4
Des Moines Municipal	10.0	14.0	12.2	13.5
El Paso International	-	14.0	18.4	15.6
Greensboro/Winston Salem	-	-	-	
Hartford, Connecticut Bradley Int'l.	-	30.0	30.0	35.0
Indianapolis Wier Cook Municipal	25.0	24.6	28.0	15.5
Knoxville McGhee-Tyson	25.0	18.7	24.0	22.5
Louisville Standiford Field	20.0	15.0	12.0	9.5
Memphis International	25.0	20.5	18.2	16.9
Milwaukee General Mitchell	-	20.7	14.3	18.1
Nashville Metropolitan	10.0	12.2	14.7	14.7
Norfolk Regional Airport	20.0	17.2	16.3	22.3
Oklahoma City Will Rogers	-	18.8	18.9	17.0
Omaha Eppley Field	8.0	11.0	8.8	8.0
Orlando	-	19.0	-	
Phoenix Sky Harbor International	-	17.8	20.0	15.9
Portland International	25.0	24.1	21.7	23.7
Providence T.F. Green	-	15.0	12.7	12.7
Raleigh-Durham	-	30.1	22.1	25.4
Rochester, N.Y.Monroe County	20.0	19.5	13.0	9.4
Reno	-	-	-	
Sacramento Metropolitan	-	21.0	15.0	13.3
San Antonio International	30.0	15.0	15.0	17.6
San Diego International	5.0	9.5	10.2	10.3
Syracuse, N.Y. Hancock	-	16.7	13.5	16.0
Tulsa International	15.0	26.2	15.6	14.0
Salt Lake City	15.0	22.0	14.0	13.2
Spokane	20.0	-	-	
	20.0	16.0	-	
	-	-	-	

Source: Federal Highway Administration, Office of Highway Planning,

Table 7

Average Percent Change of Airport Access Peak Hour Traveltime

From 1968-1978, 1972-1978

For Large Hub, Medium Hub, and Combined Large and Medium Hub Airports

Average Percent Change 1968-1978		Average Percent Change 1972-1978		Average Percent Change 1968-1978	Average Percent Change 1972-1978
Large Hub Airports	Medium Hub Airports	Large Hub Airports	Medium Hub Airports	Large and Medium Hub Airports	Large and Medium Hub Airports
+2.4	-12.6	+3.6	-4.8	-5.1	-0.5

Appendix A

Airport Access Information Sheet

Airport ______________________________

Major Urbanized Area CBD ______________________

CBD Starting Location ______________________

1a. Record miles and traveltime by system for the airport route (CBD to airport boundary)

	Miles by System		Traveltime (minutes) by System	
	Peak	Off-Peak	Peak	Off-Peak
Interstate	______	______	______	______
FAP	______	______	______	______
FAU	______	______	______	______
FAS	______	______	______	______
Other Federal	______	______	______	______
NonFederal	______	______	______	______
Total	______	______	______	______

1b. Record the miles and traveltime from airport boundary to departure terminal.

Miles	Traveltime (minutes)	
	Peak	Off-Peak
______	______	______

2. Briefly describe any significant causes of delay along the airport route.

3. Briefly describe present or proposed public transportation facilities and service to the airport.

4. Major Federal-aid airport access route improvements. List each project with brief description, type of improvement, route number, estimated length, and estimated cost.

a. Completed after 1967 — Estimated Cost

b. Under Construction

c. Programmed

5. Remarks

(Use additional sheets if necessary)

Airport Access - Description of Data Items

1. The airport route should be the most expeditious route from the central business district (CBD) starting location to the airport boundary (airport property). The airport route should start from the same CBD starting location used in the 1972 update on airport access, or from the main CBD taxi and airport limousine departure location if the starting location used in 1972 is unknown. The major CBD should be used if there is more than one CBD in the metropolitan area.

   Miles by system is the mileage for each system (Note: other Federal includes facilities such as FAA or Park Service roads) making up the airport route. Traveltime by system is the traveltime experienced on each system of the airport route. For question 1a of the Airport Access Information Sheet it will be necessary to record the miles and traveltime for each system of the airport route for the peak and the off-peak periods. The mileage to the airport in the off-peak period need only be recorded if the route is different than the peak period route. Peak period is the p.m. peak period referring to traveltime from the CBD starting location to the airport. For 1b record the mileage and traveltime from the airport boundary to the departure terminal for the peak and off-peak periods. If there are several departure terminals and there is a significant difference in traveltime between the nearest and the most remote terminal, then use the average mileage and average traveltime to the departure terminal area.

   A minimum of three traveltime runs from the CBD to the airport departure terminal should be made for the peak and off-peak periods. If there is significant variability in the traveltime runs recorded within the peak or off-peak period make additional traveltime runs to determine the average traveltime.

2. Briefly describe delays causing the most significant loss in traveltime along the airport route during the peak period.

3. Identify existing or proposed public transportation which serves the airport, such as taxi service, limousine service, bus, rail, etc.

4. Identify the major Federal-aid highway improvements (Interstate, other expressways, or other principal arterials) along the airport route, airport connectors, and other major highway facilities around the airport (e.g., within 2-5 miles of the airport boundary) which in your judgment have or will provide a significant improvement in airport access. Estimate the cost (Federal share only) of the major Federal-aid airport access improvements. List each project with a brief description, type of improvement, route number, estimated length, and estimated cost.

5. General remarks; comments on any major discrepancy between the current traveltime data and the previously collected data.

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