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New Air Carrier Airport Conceptual Design Study and Plan

Metropolitan Airports Commission

TRA Airport Consulting

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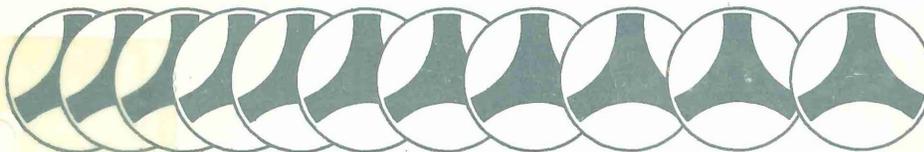
The Alliance

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January 1991



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Chapter 1

Summary

1.1 INTRODUCTION

This report was prepared by the Metropolitan Airports Commission (MAC) as part of the Conceptual Design Study and Plan for a new air carrier airport to serve the twin cities of Minneapolis and St. Paul and the surrounding region. This report presents the study and the conceptual plan.

The airport shown in the plan satisfies two goals. It has sufficient capacity to meet the region's air transportation needs for a 30-year period and it is consistent with the Development Guide of the Metropolitan Council. This report identifies and discusses the major issues that arose during formulation of the design and financing plans for a replacement air carrier airport for Minneapolis-St. Paul International Airport.

1.1.1 Legislative Background

State legislation directs the Metropolitan Airports Commission and the Metropolitan Council to take specific actions related to airport development in the Twin Cities metropolitan area.

In 1986 the state legislature directed MAC to prepare a ten-year development plan for Minneapolis-St. Paul International Airport (MSP). That same year the legislature directed the Metropolitan Council to make a determination of the long-term adequacy of MSP to meet the aviation needs of the metropolitan area through the year 2020.

Results of these two efforts were presented to the legislature, and in response, the Metropolitan Airport Planning Act was passed in 1989. This Act directs MAC and the Metropolitan Council to pursue a dual-track strategy which would allow for capacity improvements at MSP while keeping open the alternative of building a replacement air carrier airport. Among the results expected from the planning process are the following.

- Development of 30-year aviation goals.
- Development of 20- and 30-year plans for the existing airport.
- Development of a conceptual design for a new air carrier airport.
- Identification of a search area and site for a new airport.
- Preparation of a comprehensive development plan and environmental documentation for the site selected for a new airport.

With regard to a new airport, the 1989 legislation calls for the MAC, in consultation with the Metropolitan Council, to prepare a study of facility requirements, airport functioning,

and conceptual design for a new air carrier airport. Further, this legislation calls for MAC to prepare a conceptual design plan for a new airport. The conceptual design study and plan are to describe and satisfy air transportation needs for a prospective 30-year period and be consistent with the Development Guide of the Metropolitan Council.

A summary of the Conceptual Design Plan is contained in this chapter.

1.1.2 Project Parameters

The Conceptual Design Plan was undertaken using several basic parameters:

- One forecast of future aviation demand will be utilized for all airport planning.
- MSP will close as an airport if a new airport is built.
- All facilities currently existing at MSP will be provided at the new site.
- The replacement airport will be designed with sufficient capacity to accommodate the levels of demand forecast beyond the year 2020, and do so in a safe and efficient manner.
- A new airport will maximize environmental protection while minimizing community disruption.
- A new airport will be designed to minimize land area requirements.

1.2 ALTERNATIVE IDENTIFICATION AND EVALUATION

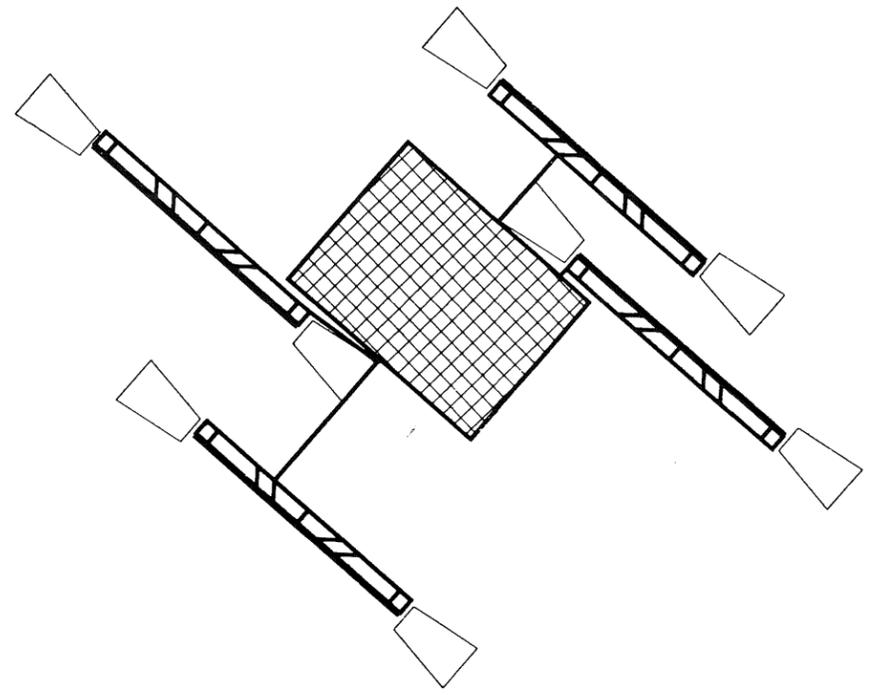
1.2.1 Introduction

Early on, the study focused on the form which a new airport might take. Two major categories of alternatives were studied. One of these was the airfield layout. The other was the terminal configuration. Once an optimal configuration for each was identified, they were merged and then all of the other required airport facilities were added. These included support facilities, airline maintenance, general aviation, and surface access. Results of the evaluation of each are presented in the following.

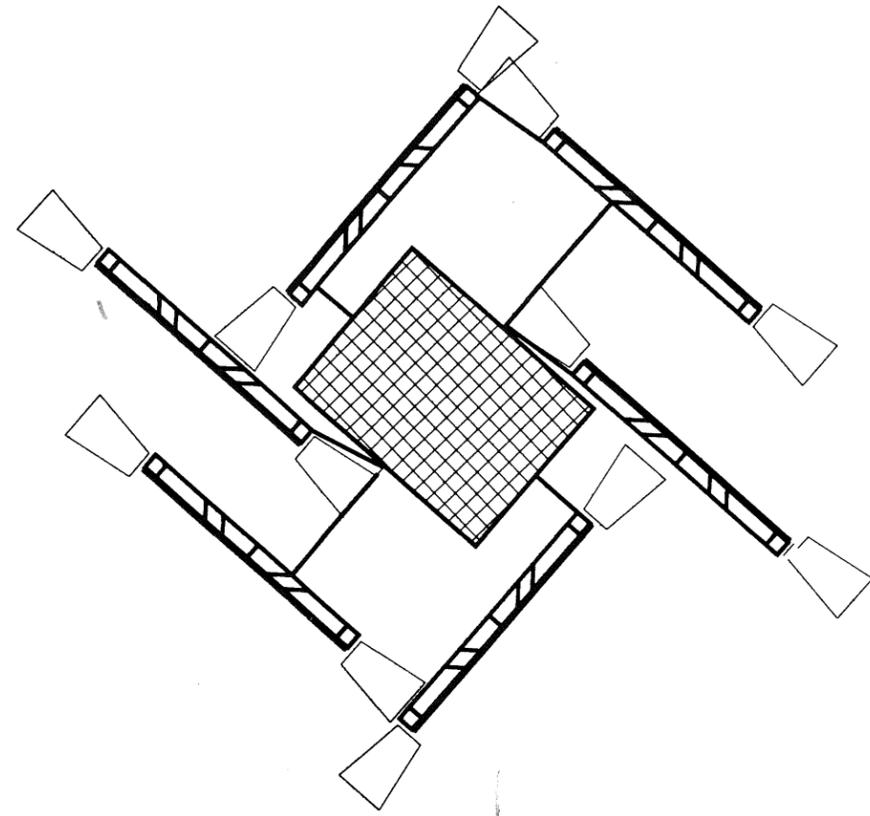
1.2.2 Airfield Layout Alternatives

In identifying alternatives for the layout of the airfield at a new airport, it was necessary to satisfy the previously discussed planning parameters. The following paragraphs briefly describe the three alternative airfield layouts evaluated in this Conceptual Design Study and Plan. They are shown in Figure 1-1.

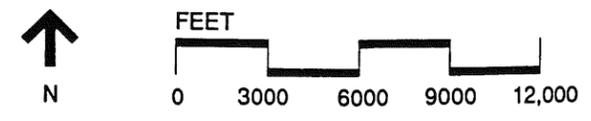
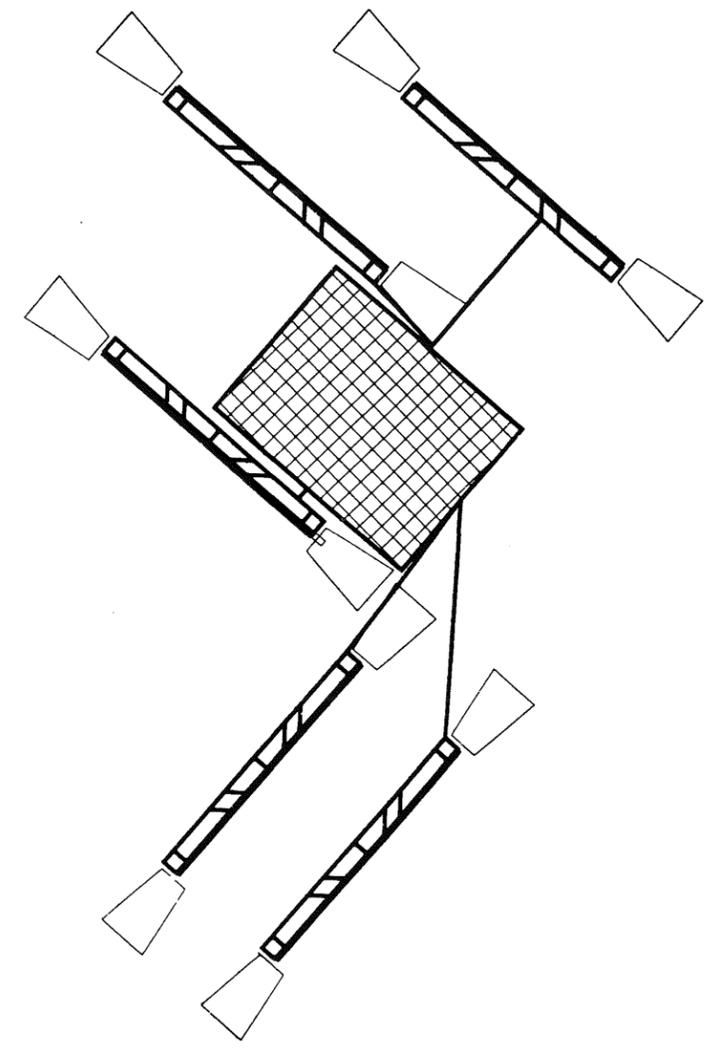
Airfield Layout Alternative P-2



Airfield Layout Alternative T-1



Airfield Layout Alternative L



- Alternative P-2. All runways are oriented in a northwest-southeast direction to align with predominant winds. The runways closest to the terminal area are separated by 8,000 feet. The third parallel runway is located 5,000 feet from the nearest runway to provide for triple simultaneous independent instrument approaches. The fourth runway is 2,500 feet from its neighboring runway to assure independence from wake turbulence concerns, while minimizing taxi distances and providing for simultaneous, independent departures in Instrument Flight Rule (IFR) conditions.
- Alternative T-1 has six runways located around the terminal area. The separation between the inner two of the four runways in the primary direction of operation is again 8,000 feet, with 5,000 feet between the northern parallel runways and 4,300 feet between the southern runways. The two runways in the secondary direction are located on either side of the terminal area, in a manner that is designed to provide maximum flexibility for airspace operation, consistent with minimum taxiing distances.
- Alternative L has five runways, with all runways in the primary and secondary directions on the same side of the terminal area. This minimizes the stagger (or offset) between the runway thresholds and focuses aircraft operations in two of the quadrants around the airport. Runway locations again seek to minimize the distance which aircraft must taxi.

From these three, Airfield Alternative T-1 was selected. Criteria used in the evaluation were: operational efficiency, land requirements, and cost. The following are the primary reasons supporting this choice.

- The layout provides a high level of capacity in all four directions.
- The converging runway layout minimizes the distance which aircraft must taxi.
- Arrival and departure runways are segregated, thus minimizing delay.
- Crosswind coverage during winter wind conditions is high.
- The operating theory underlying this layout is similar to the one being used at the new airport in Denver and has FAA approval.

1.2.3 Terminal Configuration Alternatives

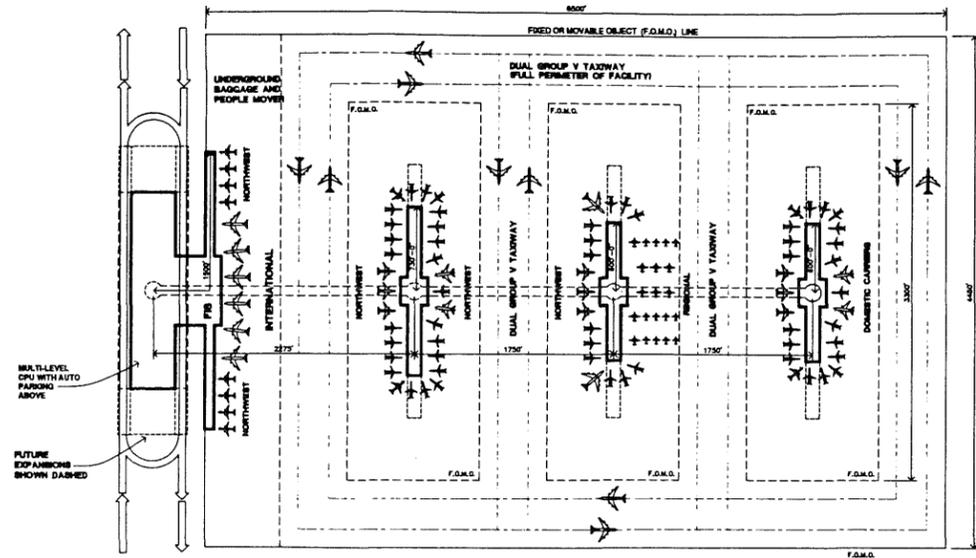
Described in this section are the five terminal configuration alternatives evaluated in the Conceptual Design Study and Plan. They are shown in Figure 1-2.

- Alternative 1. This is a centralized configuration. There is a central processor unit (CPU) which houses ticketing and bag claim on different levels. Concourses off the CPU accommodate international traffic. All other gates are located in three satellite concourses. An underground people-mover system links the CPU with the satellites.
- Alternative 2. This is another configuration which links together a CPU and satellite concourses with an underground people-mover system. There is one large satellite with four piers which is sufficient in size to accommodate all of the operations of Northwest Airlines (NW) and the international carriers. All other aircraft gates are located in a second satellite.
- Alternative 3. This configuration combines elements of centralized processing with piers. The CPU is directly linked to two piers. An underground people-mover is also provided. Additional gates are provided in concourses located immediately adjacent to the CPU.
- Alternatives 4A and 4B. These two alternatives are identical except for the manner in which they accommodate the regional carrier. Both are centralized configurations. In each, the CPU is linked to the two satellites via an underground people-mover. The people-mover is now a loop rather than an out-and-back system, as in the other alternatives. The satellite closest to the CPU is of sufficient size to accommodate all of NW's operations. The regional carriers are located in a concourse attached to the CPU in Alternative 4A. In 4B they are accommodated in the satellite most distant from the CPU, which has been enlarged for this purpose.

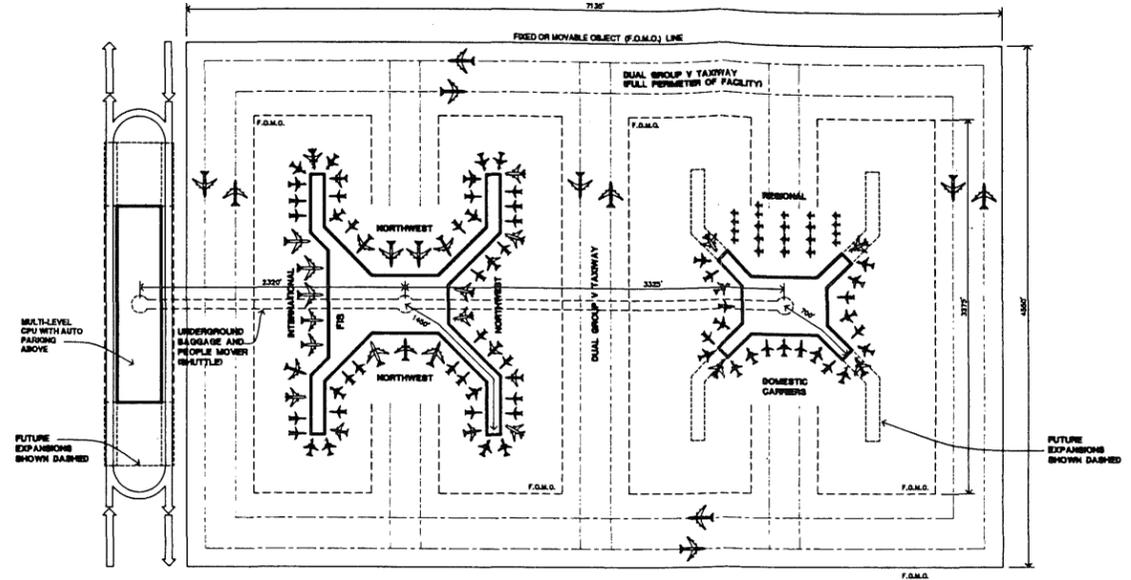
All five terminal configuration alternatives were subject to rigorous evaluation. Criteria employed in this effort were: passenger convenience, operational efficiency, ease of construction, expandability, and cost. Application of these evaluation criteria to the alternatives led to the choice of Alternative 4B for the following reasons:

- Passenger access between automobile parking and passenger processing facilities is convenient.
- Walking distances for passengers are the least of all the alternatives.
- The time passengers spend traversing the terminal is also minimal.
- The layout provides direct and readily understandable routes between aircraft gates for domestic, regional, and international connecting passengers.
- Aircraft maneuvering in the terminal area is unconstrained.
- Separation of airside and landside facilities (in the satellite concourses and the CPU, respectively) allows phased project implementation.

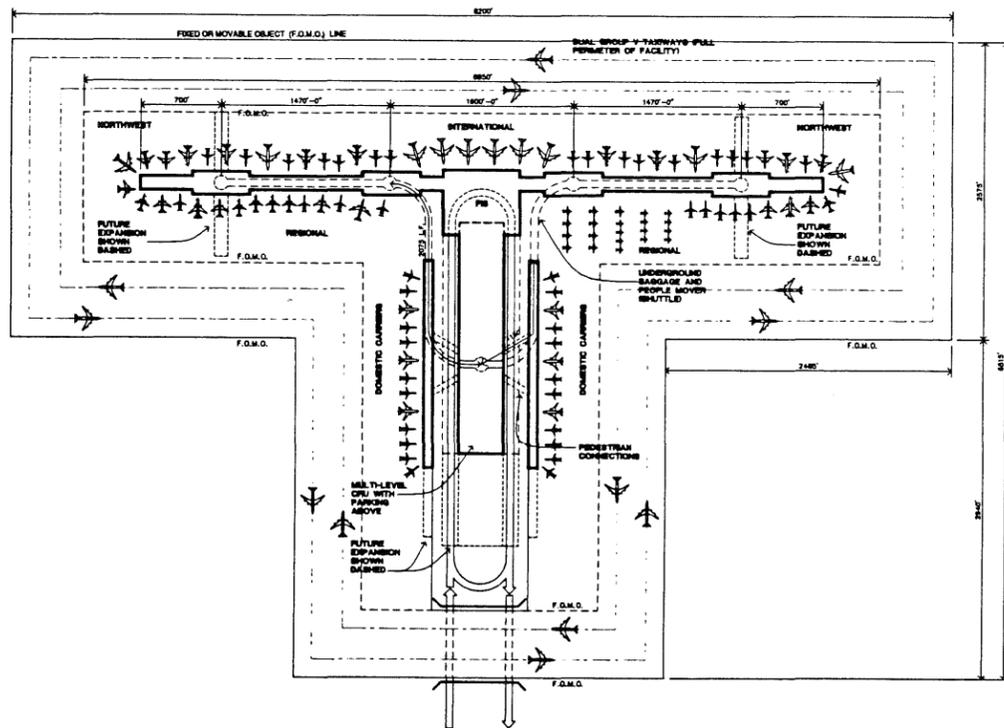
Terminal Configuration Alternative 1



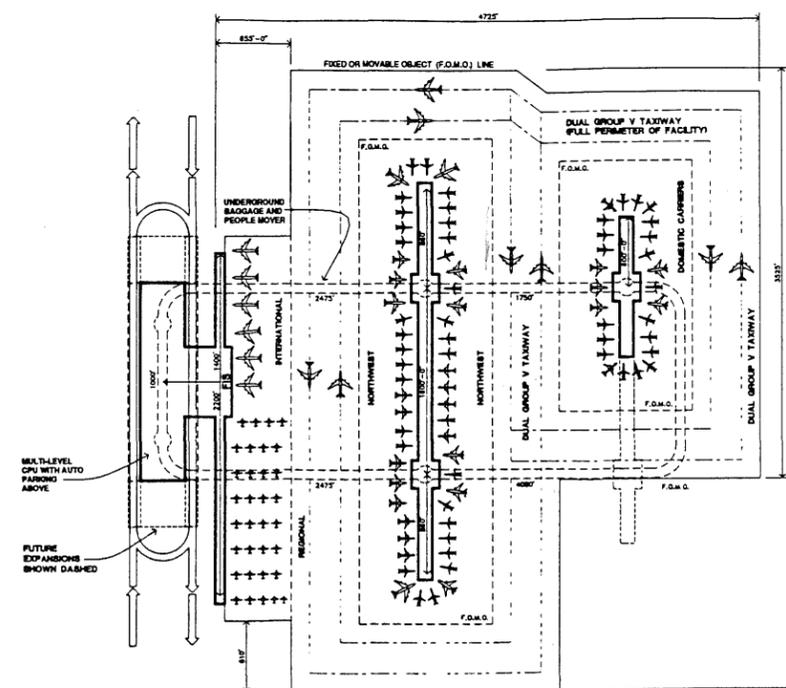
Terminal Configuration Alternative 2



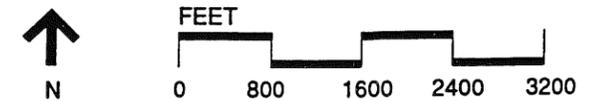
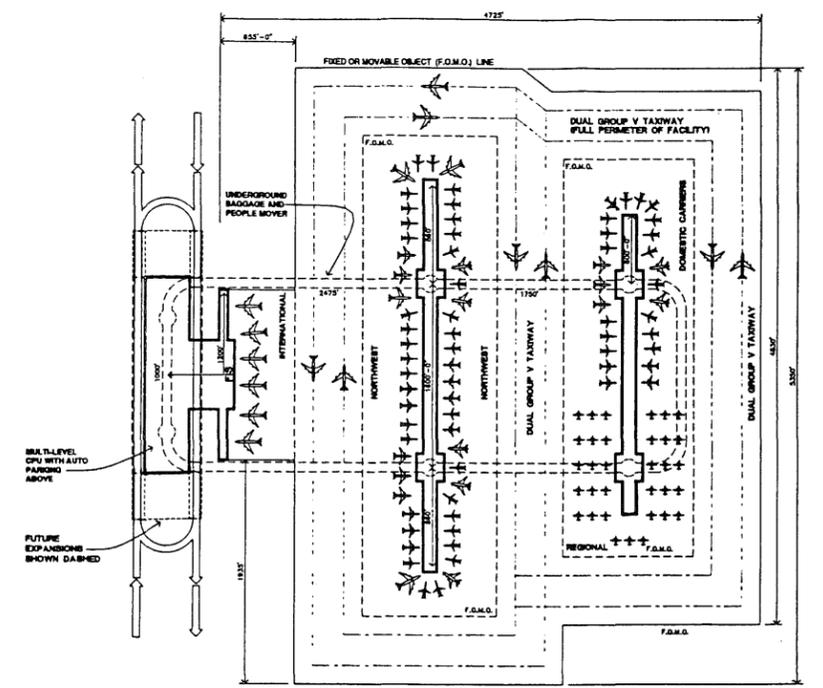
Terminal Configuration Alternative 3



Terminal Configuration Alternative 4A



Terminal Configuration Alternative 4B



1.2.4 Conceptual Design Plan

Shown in Figure 1-3 is the Conceptual Design Plan for a proposed new air carrier airport. The plan combines airfield Alternative T-1 with terminal configuration Alternative 4B. Access roads from two directions are also shown, as are all support, maintenance, airline, and military facilities.

1.3 FINANCING AND COST

1.3.1 Methods of Financing

Typically, airport sponsors rely on multiple sources of funding for major airport development -- principally, bonding financing (debt), federal grants-in-aid, and internally generated cash flow. In addition, tenant financing can be an important source of funding for certain types of airport facilities, and other agencies of the federal government can be important sources of funding for access facilities and services. Finally, other local agencies and private utility companies are likely to play a role in financing some of the infrastructure of a new airport, such as extension of utilities to the new airport site and upgrading of local roads to provide airport access.

New sources of funding that may play a more significant role in the financing of airport development projects in the future include passenger facility charges (PFCs), the use of private capital ("privatization"), direct contributions from sponsoring political jurisdictions ("public investment"), and designated locally imposed aviation taxes (primarily on the sale of aviation fuel). Proceeds from the sale, lease, or other disposition of the existing airport site are also important equity contributions in the financing plan for a new airport project.

Traditionally, no single financing source can satisfy the funding requirements of a large-scale airport development project. Development of a new air carrier airport will require a credible, balanced financing plan that incorporates a number of the funding sources mentioned above.

1.3.2 Financing Issues

The prospect of developing a new air carrier airport raises a number of important issues that need to be considered in developing an appropriate, credible financing plan. These issues include (1) determining the optimal debt structure (the types of debt instruments to be used and the structure of that debt); (2) maximizing the availability of federal aid, (3) realizing the equity of the existing airport site, and (4) maximizing the contribution of internal cash flow to pay for front-end costs.

Under current statutes, the Metropolitan Airports Commission is empowered to issue only general obligation revenue bonds -- bonds secured by a back-up pledge of ad valorem taxes in the metropolitan area. The development of a new air carrier airport is likely to cost somewhere between \$2 billion and \$3 billion, exclusive of any replacement of Northwest Airlines maintenance base facilities that may be required.

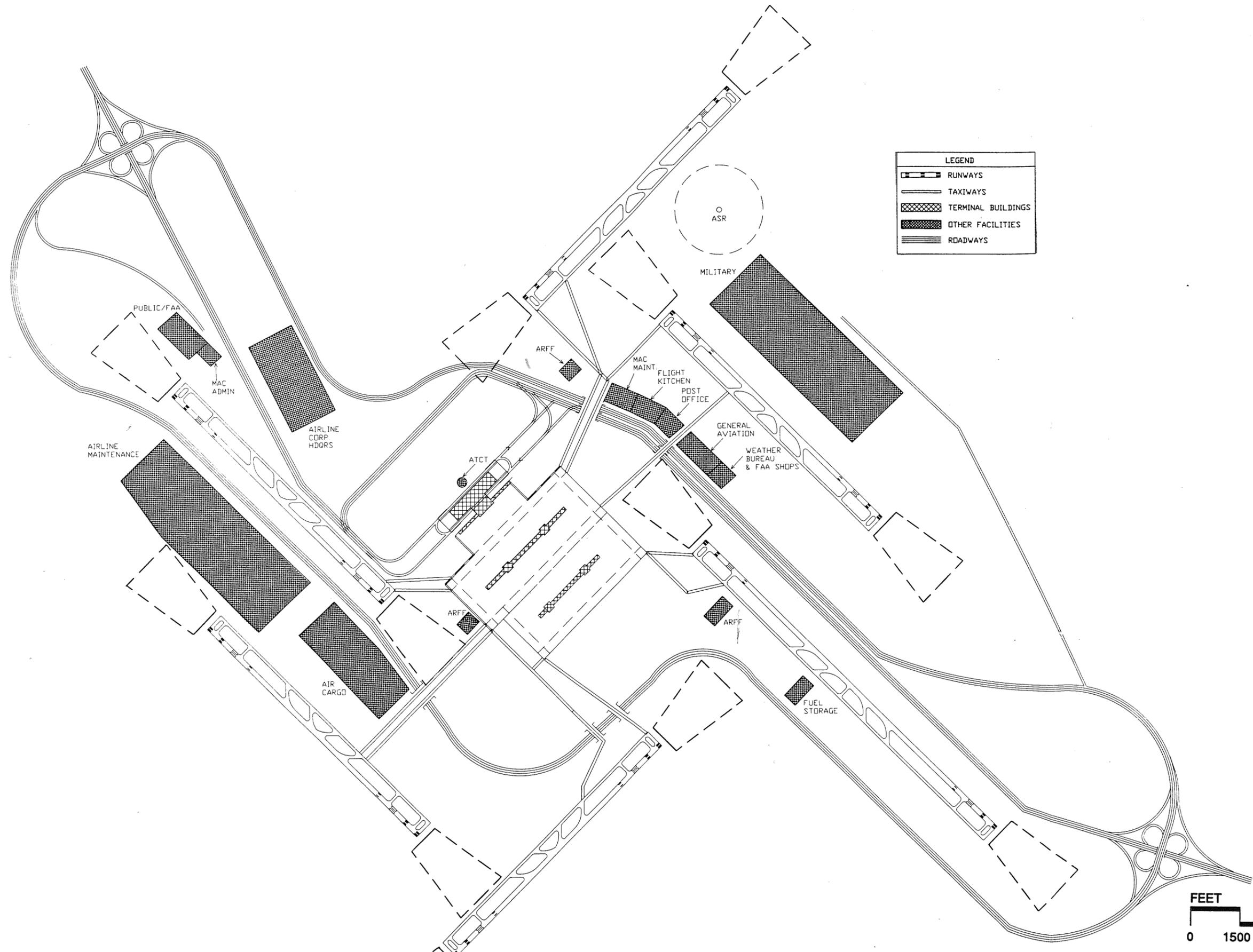
It seems unlikely that the state legislature would authorize new tax-supported debt of such magnitude. Therefore, MAC will probably not be able to rely solely on any one type of funding source for financing a new airport, and some combination of general obligation revenue bonds and pure revenue bonds will be needed.

Securing a multi-year letter of interest (LOI) from the Federal Aviation Administration will be an important step in the financing of a new airport. An LOI will demonstrate a significant federal commitment to the project and, in turn, be supportive of the project when MAC sells bonds to finance it.

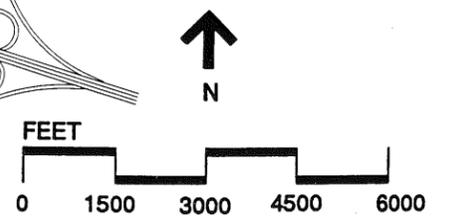
In order to maximize the return of the future disposition of Minneapolis-St. Paul International Airport, the sale should be accomplished over a long enough period of time to allow absorption of the land at fair market value. It is unlikely, therefore, that MAC could realize all of the equity it has in MSP until many years after the opening of a new airport. One important aspect of the financing plan will thus be to devise a strategy to take into consideration as much of the equity of the existing airport as possible, even though the funds would not be available at the time a new airport is constructed. Such a strategy might involve a combined fixed-rate/variable-debt structure, with the proceeds from the disposition of MSP dedicated to paying down variable rate debt.

As demonstrated in other airport development projects, the ability of the airport sponsor to generate and accumulate internally generated cash flow (revenues in excess of operating expenses and debt service requirements) is very important in project initiation. Once a decision is made to construct a new airport, several strategies may become important:

- Limit further capital investment at MSP in order to preserve funds for new airport development.
- Reassess rate policies and accelerate amortization of existing assets, if possible, to recover costs as quickly as possible and enhance cash flow.
- Develop a plan for retiring existing debt.
- Dedicate internal cash flow to "front-end" costs of new airport development, thus deferring debt issuance as long as possible (thereby minimizing capitalized interest costs).



LEGEND	
	RUNWAYS
	TAXIWAYS
	TERMINAL BUILDINGS
	OTHER FACILITIES
	ROADWAYS



If a decision is reached to build a new airport, some portion of the surplus revenues from MSP should be reserved each year to build up a capital fund for new airport development.

1.3.3 Project Cost and Sources of Funding

Following the development of the Conceptual Design Plan, a cost estimate was prepared. Many of the new airport costs are very uncertain. Since this study is being carried out without definition of a specific site, costs such as land acquisition, utilities, and off-site access cannot be accurately determined. For this reason, a range of costs was developed in these areas. Estimates of the costs for airfield and terminal facilities are more accurate; however, even here, the level of detail in the Conceptual Design Plan is very general and costs must be viewed in this context. After a specific site has been selected, and a development plan for that site has been prepared, a level of detail will exist that allows a cost estimate with a greater degree of accuracy to be prepared.

The cost estimate is shown in Table 1-1. This estimate will be subject to inflation from the present to the time of construction. For this analysis, it was assumed that site acquisition for a new airport would begin in 1998 and that the project would be completed between 1999 and 2003, with a date of beneficial occupancy of January 1, 2004.

Assuming 0, 2, and 4 percent rates of inflation, the resultant total cost estimates can be summarized as follows.

<u>Rate of Inflation</u>	<u>Low Cost (in millions)</u>	<u>High Cost (in millions)</u>
0%	\$3,735	\$4,128
2%	4,619	5,094
4%	5,690	6,262

Should a decision be made to proceed with a new airport, it would be important to plan the construction over the shortest possible time frame in order to minimize financing costs. The cost of capitalizing interest during the construction of a major development project is a very significant element of the financing cost.

Rough projections of sources of funding for a new airport were developed to illustrate one potential approach (i.e., set of assumptions) for funding. The major sources of funding (for the 0 percent inflation assumption) might include:

	Low Cost Estimate (in millions)	High Cost Estimate (in millions)
AIP grants-in-aid	\$225	\$225
Passenger facility charges (PFC) (including the net proceeds of bonds secured by PFC revenues)	283	283
Net cash flow from present revenues during the 1995-2003 period	95	95
Net proceeds of special facility revenue bonds issued for the airline maintenance facilities element of the project	869	869
Direct tenant funding	0	0
Direct federal funding	159	159
Funding of access improvements by other state and local agencies	179	242
Net proceeds of additional general obliga- tion revenue bonds issued by the Metropolitan Airports Commission	298	298
Net proceeds of new revenue bonds issued by the Metropolitan Airports Commission	<u>1,627</u>	<u>1,957</u>
	<u>\$3,735</u>	<u>\$4,128</u>

These projections illustrate one possible approach for funding a new airport project. In the future, it will be appropriate to develop a specific funding and financing plan. Further, it will be important to assess the implications of funding requirements on future airline rates and charges and overall airport cash flow and debt service coverage.

Table 1-1
Cost Estimate

	Costs ¹
Site Acquisition:²	\$94,400,000 - \$288,600,000
Site Preparation:	\$300,000,000
Airside Facilities:	
Runways	\$120,000,000
Taxiways	200,000,000
Aprons	200,000,000
Navigational Aids	40,000,000
Perimeter Road	<u>15,000,000</u>
Total	\$575,000,000
Landside Facilities - Terminal Area:	
Terminal Building ³	\$341,900,000
Automated People-Mover System	<u>182,400,000</u>
Total	\$524,300,000
Landside Facilities - Surface Access:	
Public Access Roadways ⁴	\$287,100,000 - \$387,200,000
Service Roads	<u>45,300,000</u>
Total	\$332,400,000 - \$432,500,000
Landside Facilities - Parking:	
Public and Employee Parking ⁵	\$137,600,000 - \$196,400,000
Public Transportation Parking ⁶	<u>23,500,000</u>
Total	\$161,100,000 - \$219,900,000
Support Facilities:	
Airline Maintenance and Support ⁷	\$694,800,000
Air Cargo ⁸	57,700,000
Military ⁹	100,000,000
Fuel Storage and Distribution	23,100,000
General Aviation	15,400,000
Rental Car Storage and Service	13,800,000
Airport Support ¹⁰	23,100,000
Federal Services ¹¹	<u>26,900,000</u>
Total	\$954,800,000

(continued)

Table 1-1
Cost Estimate
(continued)

	Costs ¹
Utility Infrastructure: ¹²	
Water Supply and Distribution	\$20,000,000
Wastewater Collection and Treatment	20,000,000
Stormwater Retention and Treatment	<u>25,000,000</u>
Total	\$65,000,000
Total (excluding Site Acquisition)	\$2,912,600,000 - \$3,071,500,000
Total plus Fees and Contingency at 25%	\$3,640,700,000 - \$3,839,400,000
Site Acquisition	\$94,400,000 - \$288,600,000
TOTAL PROJECT COST ¹³	\$3,735,100,000 - \$4,128,000,000

Notes:

1. Costs based on Runway Layout Alternative T-1 and Terminal Configuration Alternative 4B.
2. Preliminary cost estimates for land acquisition were prepared by Robert Boblett Associates, Inc., based upon an analysis of land sales and generalized land uses in townships located within the proposed Metropolitan Council search areas. The large range represents uncertainties regarding the following factors: (1) acreage requirements (15,000-30,000 acres); (2) differing land values in northern vs. southern areas; (3) presence or absence of residential, commercial, or industrial developments; (4) relocation requirements; (5) valuation uncertainties, legal fees, and other costs potentially associated with condemnation proceedings; and (6) inability to prevent land speculation occurring between now and the ultimate date of acquisition. There has been no attempt to factor inflation into the analysis.
3. Includes new Central Plant sized to serve Terminal Building(s). Excludes automobile parking and curbside circulation roads.
4. The lower cost alternative assumes upgrading of one major connection to the regional surface transportation system. The higher cost alternative assumes upgrading of two such connections.
5. The lower cost alternative assumes a freestanding parking structure; the higher cost alternative assumes auto parking is located above the CPU. The only employee parking requirements included in this cost are for terminal building employees.
6. Public transportation loading and queuing area assumed to be located on the third level of the terminal building.

Table 1-1
Cost Estimate

Notes (continued):

7. Includes ground service equipment, cabin service, flight kitchens, and aircraft maintenance.
8. Includes scheduled airlines, all-cargo carriers, small-package carriers, and freight forwarders. Required taxiways and taxiway connections are also included.
9. Includes on-airport Navy Marine Corps Reserve, Air Force, Air National Guard, and officers' mess and firing range. Excludes off-airport Army and Navy facilities.
10. Includes Aircraft Rescue and Firefighting (ARFF) building and equipment, MAC administrative offices, MAC airport maintenance facilities, monitoring equipment for air, water, and noise, and a public safety facility.
11. Includes air traffic control tower (ATCT) and space for the Weather Bureau, FAA administrative offices, FAA shops, and the U.S. Post Office.
12. Assumes electric and gas service and telecommunication infrastructure will be provided by the respective suppliers.
13. Project cost equals construction cost plus fees and contingencies.

Chapter 2

Goals and Objectives

2.1 INTRODUCTION

The ultimate success of the Airport Conceptual Design Study is closely tied to goals and objectives. The more that the plan is responsive to local, regional, and state goals and objectives, both explicit and implicit, the more effective it will be.

The specific goals and objectives which were identified express ends that relate in a desired physical, social, or economic context to how the airport should develop and how it should be operated.

For the purpose of this study, goals were defined as conditions to be achieved. Goals can be stated, but the degree of their achievement may not be easily quantifiable. Objectives are therefore defined as the detailed, quantifiable steps which lead toward the achievement of goals.

2.2 GOALS AND OBJECTIVES

2.2.1 Goal No. 1

Develop airport facilities which will meet the future aviation needs of passengers, the community, and users; provide enhanced levels of air service; and further the economic development of the State of Minnesota.

Objectives:

- Fully meet public travel demands and airline requirements for airfield capacity. Provide runway capacity for the estimated demand in terms of both annual and hourly operations.
- Provide runway length to meet the year-round needs of all domestic and international departures (scheduled and non-scheduled), including transatlantic and transpacific flights.
- Provide an adequate number of domestic turbojet aircraft gates to meet airline requirements, assuming that the region's air carrier airport serves as a principal hubbing airport through 2020.

- Provide facilities that are "user friendly." Provide signing for terminal buildings, roadways, and other facilities which is easy to comprehend, and a physical layout of buildings which provides a cohesive visual image.
- Provide an international arrivals facility which is well integrated with domestic terminal facilities and adequately sized to encourage airline development of additional international routes.
- Provide facilities for regional airlines to maintain and enhance their functions as feeders to scheduled air carriers and as point-to-point carriers. Designate regional aircraft parking spaces located together with code-sharing air carriers, and also provide for separate regional airline gates.
- Maintain and enhance the attractiveness of the Twin Cities area as an airline hub, and so stimulate airport-related employment and airline investment in corporate facilities, including headquarter functions and aircraft maintenance facilities.
- Encourage "non-essential" general aviation and military activity to relocate to the metropolitan area's general aviation reliever airports.
- Provide opportunities for development of services for business and corporate-type general aviation activity which supports and interacts with air carrier operations at the airport.
- Provide other facilities needed to support a full range of aviation services and a high level of service to the public, including a public heliport to meet the forecasted demand levels. Where possible, consolidate functions into specific land use areas. Provide facilities for concessionaires to maximize revenues from this source.

2.2.2 Goal No. 2

Minimize costs to users of the airport.

Objectives:

- Minimize airside congestion through construction of runways and taxiways where the costs of providing the additional capacity are less than the additional operating costs associated with aircraft delays.
- Lay out terminal facilities so that unconstrained flows between the terminal area and runways are achieved and congestion and delay are minimized.
- Minimize airspace congestion and delays for all aircraft operations through procedural changes and/or provision of additional navigational aids.

- Provide efficient access to the airport from the regional highway system, with minimal delays, and provide for potential connection to the proposed regional light rail transit system.
- Facilitate movement of passengers and baggage so that gate-to-gate walking distances and maximum gate-to-gate connection times are minimized, using mechanical conveyance devices, if necessary.
- Provide a barrier-free access and terminal environment.

2.2.3 Goal No. 3

Develop the airport in a manner which is flexible and adaptable to changing conditions.

Objectives:

- Develop the airside in a manner such that options for development are retained to respond to changes in the types or sizes of aircraft using the airport and to changes in FAA standards.
- Develop terminal facilities using concepts which permit ready responses to expansion or reductions in operations, while maintaining passenger service and revenue flows.
- Acquire adequate land to meet contingencies for future demand, while minimizing disruption to the community and roadway system.

2.2.4 Goal No. 4

Provide an airport that is safe and reliable.

Objectives:

- Provide all navigational and landing aids which enhance the safety and reliability of operations.
- To the maximum extent possible, protect state and federally mandated safety areas, runway protection zones, and other clear areas.
- Provide Aircraft Rescue and Firefighting (ARFF) access roads and facilities to obtain specified response times under all-weather conditions.
- Provide a facility which has all-weather capabilities (wind, visibility, ice, snow).

2.2.5 Goal No. 5

Develop an airport that is consistent with state, regional, and local plans and economic development policies.

Objectives:

- Develop the airport as the region's primary air carrier airport consistent with the national and metropolitan airport system plans.
- Develop the airport in accordance with applicable land use and transportation plans.
- Achieve a level of service and airport-user convenience so that the airport is a positive factor in regional economic development decisions.
- Achieve capacities of the airfield and the terminal area systems so that the airport is an attractive location for major airline maintenance activities.

2.2.6 Goal No. 6

Develop the airport and the airport vicinity to minimize and reduce adverse aircraft noise and other environmental effects.

Objectives:

- Locate airport facilities so as to minimize land-taking and to minimize and reduce the adverse effects of noise and air pollution on residents, employees, and community facilities.
- Locate airport facilities and access facilities so that growth of associated uses may best be controlled through land use planning and zoning.
- Provide a facility which minimizes effects on other environmental concerns (water quality, flora and fauna, etc.).

Chapter 3

Assumptions and Parameters

3.1 INTRODUCTION

This chapter addresses the planning assumptions and parameters which served as the basis for technical analyses for the New Air Carrier Airport Conceptual Design Plan. The intent of the chapter was to ensure that the different elements of the analytical work were completed in a manner that was consistent and complementary to the work being done concurrently in the Long-Term Comprehensive Plan for Minneapolis-St. Paul International Airport. Assumptions and parameters are described for the following planning and functional areas:

- Airfield
- Terminal Area
- Surface Access
- Cargo, General Aviation, and Airport Support

It was assumed that the Airport Improvement Program (AIP) or its successor will continue in essentially the same form as at present after 1992. The availability of entitlement and discretionary funding is anticipated to maintain pace with inflation.

In the absence of military officials indicating that there will be a change in the local military mission, it was assumed that activity levels will remain constant and that all existing facilities will be required at a new airport.

The following assumptions were used to define the financial and institutional factors that may affect the development of an airport.

3.2 AIRFIELD

The airspace/airfield planning assumptions and parameters presented in this section were based on established FAA and industry planning and design criteria and Air Traffic Control aircraft/airfield operational procedures.

The airfield was planned to provide adequate runway and taxiway capacity to meet forecast 2020 operational levels during visual and instrument meteorological conditions. Given the airport's role as an air carrier connecting hub, the operating configurations of the runway system should be sufficiently flexible so as to adapt to the varying demand patterns associated with peak aircraft arrival and departure flows. The following criteria were used in evaluating airspace/airfield capacity.

3.2.1 Airfield Capacity

The following assumptions were used to calculate the capacity of airfield layout alternatives.

- Hourly VFR and IFR capacities for each principal runway configuration were calculated using the data incorporated in the FAA AC 150/5060-5, *Airport Capacity and Delay*.
- Delay calculations were based on the existing hourly/weekly/monthly peaking characteristics, and weather conditions.
- Delay costs were based on weighted 1989 aircraft operating costs.

3.2.2 Airfield Layout

Airfield layouts were planned using the criteria in FAA AC 150/5300-13, *Airport Design*, for Aircraft Design Group V. Using these criteria, future aircraft such as the B-747-400, which has a wingspan of approximately 213 feet, will be able to operate effectively on the airfield. Criteria for Group V aircraft can be summarized as follows.

- Minimum spacing between two independent parallel ILS approach runways is 4,300 feet.
- Existing ATC rules allow a third independent parallel ILS approach runway provided the runway is at least three nautical miles from the nearer of the other two independent ILS approach runways.
- Minimum spacing for independent parallel arrival and departure runways is 2,500 feet.
- The minimum spacing of 2,500 feet for independent parallel arrival and departure runways in IFR conditions may be reduced through the development of improved wake vortex detection/avoidance systems. The new-technology Microwave Landing System (MLS) is one system the FAA is currently considering. The MLS has the ability to provide multiple approach/glide paths that would allow smaller aircraft to avoid the wake vortices generated by heavy aircraft.
- The FAA is currently testing procedures to reduce separation distances for all runway spacing criteria. These tests, if successful, will be monitored and incorporated into the planning.

- A 400-foot separation between runway centerline and parallel taxiway is the minimum required for Group V aircraft types. A 600-foot separation is used to allow placement of navaids and high-speed exit taxiways between runways and parallel taxiways.
- Runway length requirements were determined from aircraft performance data supplied by the FAA and aircraft manufacturers.
- Runway exit taxiways are located and designed to facilitate an average runway occupancy time of 50 seconds or less by aircraft landing.
- The potential impact of the new-technology supersonic or hypersonic aircraft on airfield layout requirements and other airport facilities was examined and available criteria identified.

3.2.3 Operational Procedures

The following operational procedures were applied to the 2020 plan. They are consistent with FAA orders and manuals (FAA Orders 8260.3B, 7110.9B, and others).

- Precision approach capability (ILS/MLS) was assumed for each runway end. Category II or III criteria were applied to two runway ends in each primary operating direction.
- A minimum straight-in distance of 11-1/2 nautical miles to each arrival runway threshold was provided. An approach course extended to 20 miles may be needed to provide the flexibility required to handle the large volume of traffic anticipated.
- Aircraft descent gradients in the terminal airspace required to meet standard three-degree approach slopes was assumed in constructing approach procedures.

The FAA is currently examining a number of potential changes to their operational procedures. Some of these changes are now being tested at airports. The proposed changes include:

- Independent IFR approaches to converging runways that do not rely on visual separation techniques required in FAA Order 7110.98.
- Reduction of the present minimum diagonal separation of 2 nautical miles between aircraft on parallel approach paths separated by 2,500 feet or more, to a new separation of 1.5 nautical miles with improved surveillance techniques.

3.2.4 Operational Safety

The airport must provide a safe operating environment for aircraft. The FAA has developed criteria for airport design¹ which will help assure safe operations on the airport. These criteria are presented in These criteria, relating to runway safety areas, obstacle-free areas, runway protection zones, and obstruction and hazards to air navigation, were used.

In addition to these criteria, other safety objectives which in some cases do not have any specific FAA criteria were considered and, where appropriate, included in airport design.

- Aircraft, passengers, employees, and fixed or movable objects were protected from the effects of jet blast.
- Flight paths were constructed so that the effects of aircraft wake vortices are minimized. The advancement of MLS technology will aid in developing flight tracks which avoid the effects of wake vortices.
- All aircraft operational surfaces are visible from the Air Traffic Control Tower.
- Where possible, independent airspace and runway and taxiway operations have been provided to minimize the need to coordinate between aircraft arrival, departure, and ground movements.
- Taxi distances from the terminal area to the furthest runway ends are kept within minimum safety limits with regard to aircraft taxiing criteria (brake and tire overheating, etc.).
- Wind coverage of the runway system was maximized within an allowable crosswind component of 20 knots and tailwind component of 5 knots. A minimum of 95 percent coverage has been provided.

3.2.5 Navigational Aids

This section covers general siting assumptions for navigational aids (navaids) and air traffic control (ATC) facilities. The facilities addressed include air traffic control facilities, meteorological facilities, electronic facilities, and visual navaids.

1. FAA AC 150/5300-13, *Airport Design*.

Air Traffic Control Facilities

Air traffic control facilities include air traffic control towers, radar facilities, and communications facilities.

- The air traffic control tower (ATCT) will be sited in accordance with the requirements of FAA AC 150/5300-13, *Airport Design*.
- The most advanced Airport Surveillance Radar (ASR-9 or better) will be included as part of the Terminal Radar Approach Control (TRACON) facility.
- Airport Surface Detection Equipment (ASDE) was provided to observe aircraft and vehicle ground movement during periods of poor visibility or when visibility from the control tower is restricted.

Meteorological Facilities

The purpose of meteorological facilities on the airport is to detect and alert controllers to changing weather patterns and conditions.

- The current method to detect wind shear and microburst near ground level, the Low-Level Wind Shear Alert System (LLWAS), will continue to be used.
- Runway Visual Range (RVR) sensors, installed adjacent to ILS runways to provide measurements of horizontal visibility, will remain as the method for accomplishing this function.

Aircraft Approach Guidance System

An Instrument Landing System (ILS)/Microwave Landing System (MLS) to provide the lateral, longitudinal, and vertical guidance necessary for an instrument-assisted aircraft landing will be provided on all runways.

Visual Guidance System

Visual guidance systems provide the pilot with course and height indicators during the visual segment of an approach. Two types of approach lighting systems will be provided. They are: ALSF-2 for CAT III approaches and MALSR for CAT I approaches. All runways will be equipped with High Intensity Runway Lighting (HIRL) and all taxiways will be equipped with Medium Intensity Taxiway Lighting (MITL) or centerline lighting. All CAT III runways will be equipped with Touchdown Zone Lighting (TDZ) and Centerline Lighting (CL). Precision Approach Path Indicators (PAPI) will be provided on all landing runways to provide descent guidance under visual conditions.

3.3 TERMINAL AREA

There is no single, universally accepted set of assumptions, criteria, or standards for planning terminal facilities at airports. The assumptions shown here are largely derived from the FAA Advisory Circular on terminal planning and design (AC 150/5360-13), combined with assumptions developed in the *MSP 2000+ Plan* and information obtained as part of this study and the knowledge and experience of the Consultant.

Subject areas in which assumptions have been generated are as follows:

- Passengers and Visitors
- Airline Space
- Airport Space

In addition, a "calibration" calculation was performed. It consisted of a comparison between the facility requirements for the existing level of airport activity and the information on existing terminal facilities contained in the *1989 MAC Space Allocation Report*. This comparison suggested areas where adjustments to the assumptions or criteria described in this section were needed.

3.3.1 Passengers and Visitors

The passengers fall into three categories, each of which places different demands on the terminal system. The three are: originating passengers, terminating passengers, and connecting passengers. Originating passengers check in at one of two places: the ticket counter or the gate. Terminating passengers can be divided into two groups, those who do and those who do not use baggage claim. Connecting passengers fall into three categories: intra-line, inter-line, and those continuing on the same flight.

Assumptions relative to passenger and visitor characteristics are summarized in Table 3-1. These assumptions are based on characteristics of large-hub airports.

Table 3-1

Passenger and Visitor Assumptions

Profile Variable	Value
Ratio of baggage per domestic passenger (All Passengers)	1.5
Ratio of baggage per international passenger (All Passengers)	3.0
Ratio of visitors to domestic air carrier passengers (Peak Hour)	1.5
Ratio of visitors to international passengers (Peak Hour)	2.5
Ratio of visitors to regional/commuter passengers (Peak Hour)	0.7

Source: TRA Airport Consulting and HNTB.

3.3.2 Airline Space

Airline space requirements include ticketing areas, airline offices, baggage claim and processing areas, and operations spaces. For this study, the data and standards to facilitate use of the Equivalent Aircraft concept (EQA) were obtained from inventory and forecast work.

Holdroom area requirements were derived from the FAA Advisory Circular standards and subject to review by the MAC and the airlines. Terminal gate frontages and other dimensional requirements for the apron area were also obtained from the FAA Circular. Airline club space requirements were obtained from the airlines. These figures are shown in Table 3-2.

Table 3-2
Airline Space Requirements

Element	Area
Departure or Holdroom Area by Aircraft Capacity:	
281-420 seats	3,800 SF
221-280 seats	2,500 SF
161-220 seats	2,000 SF
111-160 seats	1,500 SF
81-110 seats	675 SF
Airline Club Room Area (per location):	
Northwest Airlines	4,500-5,000 SF
Other airlines	2,500-3,000 SF
Terminal Gate Frontage:	Use FAA data on individual aircraft types

Source: TRA Airport Consulting, HNTB, and the *MSP 2000+ Plan*.

3.3.3 Airport Space

Non-airline airport space is defined as concession areas, federal inspection services (FIS), and airport/building and non-public revenue spaces. Assumptions regarding space requirements for these various functional areas are described in the following sections.

Concession Area

FAA Advisory Circular 150/5360-13 provides suggested space allowances for concession areas. These are presented as a range of values. Review of the *MSP 2000+ Plan Report* appendices show that the assumptions used were consistently on the high side of the FAA criteria. Therefore, this study will generally use the FAA range of criteria for concession areas, favoring the high side of the range. Values from the *MSP 2000+ Plan* are used when they are higher than FAA criteria. Table 3-3 summarizes these requirements.

Table 3-3

Concession Area Space Requirements

Element	Area Requirements (SF)
News and Tobacco	700 per million annual enplanements
Gifts and Apparel	700 per million annual enplanements
Barber Shop/Shoe Shine	480 per million annual enplanements
Rental Car Counter	800 per million terminating passengers
Advertising Displays	100 per million annual enplanements
Flight Insurance	180 per million annual enplanements
Lockers	80 per million annual enplanements
Telephones	110 per million annual enplanements
Duty Free Shops	700 per million annual enplanements (international passengers only)
Foreign Currency Exchange	50 per million annual enplanements (international passengers only)
Other Concessions (bookstores, business centers, etc.)	700 per million annual enplanements
Food and Beverage Areas:	
Fixed space (constant)	3,000 SF
Additional Space/Enplanement	FAA Criteria using 40% factor
Distribution of Space (%):	
Food Preparation	25%
Restaurant and Snack Bar	45%
Cocktail Lounge	25%
Miscellaneous	5%

Sources: FAA AC 150/5360-13, TRA Airport Consulting, HNTB, and the *MSP 2000+ Plan*.

Federal Inspection Services

Space for federal inspection services is provided as specified in the *MSP 2000+ Plan*. Any additional space requirements are provided following the standards outlined in the FAA AC 150/5360-13, Chapter 6, Table 6-1. The following table summarizes FIS space requirements from the *MSP 2000+ Plan*.

Table 3-4
FIS Space Requirements

Element	Area Requirements (SF)
INS, Customs, and Agriculture Department area	10.0 per peak hour deplanement
Inbound baggage delivery area	10.0 per peak hour deplanement
Baggage claim area	30.0 per peak hour deplanement
Queuing area per station	2,520 SF
Inspection area per station	1,820 SF
Exit area per station	784 SF
Cart storage per station	400 SF
Offline circulation area	3,600 SF
Cashier area	300 SF
Restroom area	400 SF
FIS employee area	1,500 SF

Source: TRA Airport Consulting, HNTB, and the *MSP 2000+ Plan*.

Airport/Building Areas

Space requirements for airport management and security, as well as for building mechanical and structural areas, were determined through discussions with MAC personnel combined with data from the *MSP 2000+ Plan*. These requirements are summarized in Table 3-5.

Table 3-5
 Airport/Building Space Requirements

Element	Area Requirements
Airport Administration	10,000 SF
Fire exit area as percent of total area	4%
Mechanical and Maintenance area as percent of total area	10%
Building Structural area as percent of total area	5%

Source: TRA Airport Consulting, HNTB, and the *MSP 2000+ Plan*.

Non-Revenue Public Spaces

Space requirements for public circulation, restrooms, and other non-revenue public areas were derived using the methodology outlined in FAA AC 150/5360-13. Results were checked for reasonableness by review of space standards developed in the *MSP 2000+ Plan* and through the calibration process described in the introduction to this section.

3.4 SURFACE ACCESS

Assumptions based on observation, previous analysis, and other sources of traffic engineering information were used for the surface access, circulation, and automobile parking facilities analysis.

3.4.1 Roadway

Regional Travel

A Regional Travel Model has been developed and is maintained by the Metropolitan Council and the Minnesota Department of Transportation. This model was used to obtain a forecast of the overall traffic volumes expected on the regional highway system in the airport area at the available forecast horizons. The forecasts were reviewed to assure that expected airport-generated travel is accurately represented in the model.

Airport Trip Generation

It is anticipated that the airport will generate trips in proportion to the level of originating air travel activity. In 1986, MSP generated approximately 58,000 vehicle trip ends per average weekday. In 1986, there were 4.44 million passenger enplanements at MSP.² This study assumes that a new airport will generate 13,000 average weekday vehicle trip ends per million annual originating trips.

Capacity

Since the roadway system on the airport operates in a manner identical to roadways outside the airport, operating characteristics, guidelines, and capacities can be described and calculated using assumptions and data found in the *1985 Highway Capacity Model*.³

3.4.2 Automobile Parking

Demand for parking at the existing airport is composed of two segments. These are: parking for air travelers and terminal visitors, and parking for employees. These categories are discussed in the following.

Travelers and Visitors

In 1964, the parking demand rate was calculated to be 1,170 spaces per million annual enplanements. In 1974, the parking demand rate at the airport had increased to 1,380 spaces per million annual enplanements. By 1984, the parking demand rate at the airport was measured at 1,350 spaces per million annual enplanements. Thus, the demand rate appears to have leveled out. This study assumes that the parking demand rate at a new airport will remain at the current level being experienced at MSP.

The study assumes that the airport will provide a supply of parking adequate to meet the demand for public parking by air passengers and terminal visitors.

The study calculates a public parking demand based on a rate of 1,700 parking spaces per million annual passenger enplanements.

2. 4,010,231 domestic air carrier originations; 290,700 regional and air taxi enplanements; 52,684 domestic non-scheduled enplanements; 77,349 scheduled international enplanements; 10,821 non-scheduled international enplanements; and 4,441,785 total trips with local trip ends.

3. *1985 Highway Capacity Manual*, Transportation Research Board, Washington, D.C., 1985.

Employees

Northwest Airlines maintains its base of operations at MSP. This means that there are substantially more NW employees at MSP than would be located at another airport without the mainbase operation. This study assumes that the mainbase will be moved to the new airport. Growth in mainbase employment may be different from growth in air passenger activity, however, and forecasts of parking demand for mainbase employees have been kept separate from those for other airport employees.

Parking demand by airport employees other than airline mainbase employees is assumed to vary in proportion to the level of air passenger activity.

3.4.3 Airport-Specific Facilities

There are several facilities for vehicle circulation and loading/unloading functions at an airport which require special attention. These are curbside loading and unloading of passengers, public transportation access, and rental cars. The operation and the capacity of these facilities have been studied to quantify their current and future operating characteristics.

Curbside - Lindbergh Terminal Unloading

Curbside unloading for passengers is currently located on the second level of the terminal building drive in an area convenient to the airline ticket counters. The principal activity along this curb is passenger drop-off. Some air passenger pick-up (about 10 percent of traffic) also occurs. Currently, the average curbside dwell time in this area is 2.6 minutes. Observation of this activity revealed that there is significant opportunity for reduction in the average dwell time. This can be accomplished through increased awareness by the public of the "loading and unloading only" restriction in force in this area.

Curbside - Lindbergh Terminal Loading

The area for curbside loading is located on the lower level of the terminal building adjacent to the airline baggage claim area. The principal activity along this curb is passenger pick-up, although some passenger drop-off also occurs (about 13 percent of traffic). Currently, the average curbside dwell time in this area is 7.0 minutes. Observation of this activity revealed that there is significant opportunity for reduction in the average dwell time. This can again be accomplished through an increased awareness by the public of the "loading and unloading only" restriction in force in this area.

Curbside - Humphrey Terminal

Passenger pick-up and drop-off occur on the same curb at the Humphrey Terminal. Currently, the average dwell time at the Humphrey Terminal curb is 13.5 minutes. Again, a reduction in the average dwell time is possible with a higher degree of enforcement.

Curbside - General

Lanes in curbside areas are generally operated during peak periods as follows. There is a curbside lane, a "double-parking" lane, a "triple-parking" lane, and another lane reserved for flowing traffic. This operation is efficient in use of the available width. However, individual vehicles parked in the curbside lane are occasionally trapped by vehicles parked in outer lanes. Studies have shown that the capacity of the combination of a curbside lane and a "double-parking" lane is 175 percent of the capacity of the curbside lane, and the capacity of the combination of a curbside lane, a "double-parking" lane, and a "triple-parking" lane is 225 percent of the capacity of the curbside lane. For the new airport, triple-parking will not be considered acceptable.

Public Transportation

At MSP at the present time, passenger pick-up by various public transportation modes occurs in a designated area adjacent to the terminal. Surveys conducted at MSP found that, of originating and terminating passengers, 3.9 percent use taxis, 2.4 percent use courtesy vehicles (hotel/motel shuttles, corporate shuttles, etc.), 3.2 percent use scheduled limousine service, 1.0 percent use scheduled bus service, and 0.6 percent use chartered bus service.

At the Humphrey Terminal, the only significant public transportation mode is taxis. Surveys have shown that approximately 3 percent of arriving passengers use taxis.

Passenger drop-off by public transportation modes is mixed with private vehicles at the curb. Consideration of the space needed for this function is included in the requirements.

Rental Cars

A survey of passengers found that 6.6 percent of originating and terminating passengers use rental cars. This study assumes that this pattern will continue. Based on current operations at MSP, car rental operations will require five acres per million annual originations. About 20 percent of the total is needed to accommodate ready vehicles and the remaining 80 percent is needed for vehicle maintenance and storage.

3.5 CARGO, GENERAL AVIATION, AND AIRPORT SUPPORT

The following assumptions apply to the cargo, general aviation, and airport support facilities to be provided at a new air carrier airport.

3.5.1 Cargo

Facilities have been planned according to the criteria in FAA Advisory Circulars, coupled with planning ratios developed in the *MSP 2000+ Plan*. Space designated for cargo will be used specifically for cargo-related functions. The airport will not become a primary or major hub for a cargo carrier or similar function, but will serve as the regional air cargo collection and distribution center.

3.5.2 General Aviation

The MAC policy of not encouraging general aviation operations at MSP will continue at the new airport. Reliever airport facilities will be provided in the region to meet demand levels through the forecast period. While it is likely that the new airport would be less restricted with respect to general aviation facilities, the operating environment and the MAC policy will restrict general aviation activity to those types which are compatible with the commercial traffic.

3.5.3 Administration and Maintenance

It is assumed that MAC will be the operating agency for a new airport. Administrative and maintenance facilities will therefore be required. These will be provided at a level proportional to the increase in traffic and the size of physical plant.

3.5.4 Security and Safety

MAC will continue to operate its own police and fire departments. MAC will also, as a minimum, meet the requirements of federal regulations regarding security screening and ARFF operations.

3.5.5 Fuel Storage

Although alternative fuels may be introduced during the 30-year planning period, it is assumed that fossil fuels will remain predominant. Sites and acreages for storage of fuel will be identified. Distribution of fossil fuel will be via an under-pavement hydrant distribution system.

3.5.6 Other Facilities

Space will be provided on the new airport to accommodate all of the following tenants: the FAA, the U.S. Weather Service, the U.S. Postal Service, airline flight kitchens, commercial/public facilities, and the military.

Chapter 4

Existing Conditions

4.1 INTRODUCTION

The purpose of this chapter is to document existing airport conditions. On one level, this task requires no effort whatsoever. No new air carrier airport exists. Thus, documentation of existing facilities, if this logic were carried to an extreme, could be skipped completely.

Documentation is warranted, however, for at least two compelling reasons. One is that certain information is of value wherever airport facilities are located. The second reason has to do with the precedent set by existing conditions. Every airport has unique attributes and levels of service which are appropriate to local conditions. These establish precedents which new facilities should appropriately acknowledge, if not incorporate and honor.

In July of 1989 the Metropolitan Airports Commission (MAC) began work on a Long-Term Comprehensive Plan for the Minneapolis-St. Paul International Airport (MSP). This study updated the existing conditions inventory previously compiled as part of the *MSP 2000+ Plan*. The descriptions contained here draw extensively from this updated material.

4.2 EXISTING AIRPORT FACILITIES

This section describes the airfield, terminal area, and surface access facilities that compose the existing Minneapolis-St. Paul International Airport. The inventory of facilities described herein is based on conditions as they existed in December 1990.

4.2.1 Airfield

The major airfield elements are summarized herein. Included are the airfield system comprising the runway, taxiway, and the apron network.

RUNWAYS

The existing airfield layout of Minneapolis-St. Paul International Airport, as illustrated in Figure 4-1, consists of three active runways: two parallel runways, 11R-29L and 11L-29R oriented northwest/southeast and separated by 3,400 feet; and Runway 4-22, oriented northeast/southwest. Runway 11R-29L is 10,000 feet long by 200 feet wide. Runway 11L-29R is 8,200 feet long by 150 feet wide, and Runway 4-22 is 8,256 feet long by 150 feet wide.

TAXIWAYS

Runways 11R-29L, 11L-29R, and 4-22 are each served by main parallel taxiways (Taxiways A, E, and C, respectively) and a series of exit taxiways permitting immediate access to the main terminal apron areas. Southwest of Runway 11R-29L, Runway 4-22 has an additional dual parallel taxiway (Taxiway D) which provides access to the Humphrey Terminal area as well as a north-south taxiway which serves the cargo area and Northwest Airlines maintenance and support complex. In addition to the main parallel taxiways, a second set of inner parallel taxiways to each runway exists east of Runway 4-22. All of these are apron edge taxiways, which provide flexibility to maneuver into the terminal. The entire taxiway network is depicted in Figure 4-1.

APRONS AND AIRCRAFT PARKING

The taxiway system previously described provides access to and from numerous apron areas that are utilized for parking and maneuvering aircraft, service vehicles, and equipment. These aprons are shown on Figure 4-1 and basically fall into the following categories: passenger terminal aprons, aircraft maintenance aprons, air cargo aprons, fixed base operator aprons, mixed and joint-use aprons, and airfield aprons.

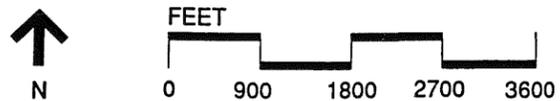
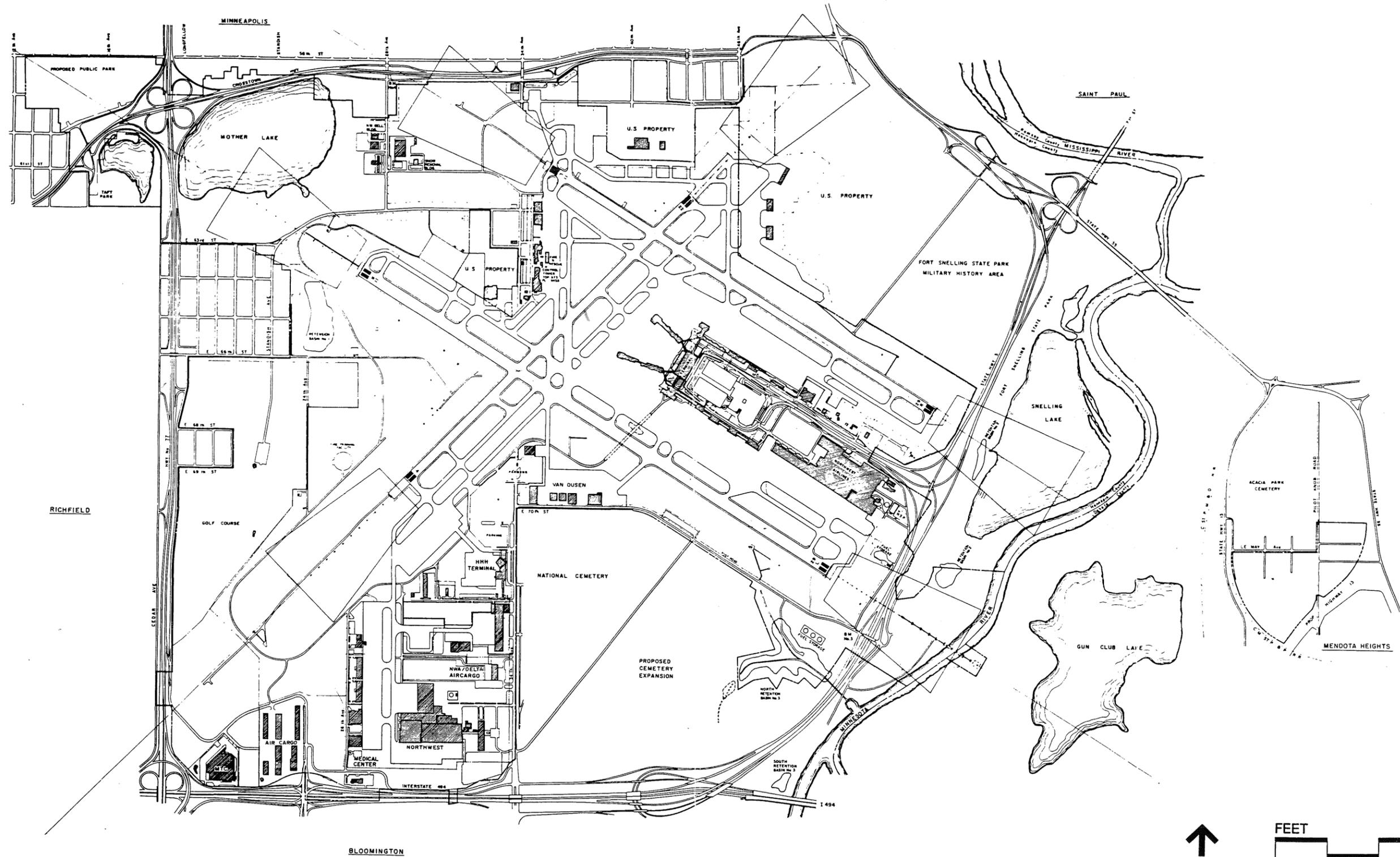
The apron at the Lindbergh Terminal serves both arrivals and departures of domestic air carriers, regional airlines, and some international departures. The length of apron is 8,900 feet. This measurement, in general, indicates the combined wingtip-to-wingtip clearance of all aircraft that would be parked on the terminal apron and provides a measure of gate capacity potential. The area of the apron is 682,300 square yards or 141 acres.

The apron at the Humphrey Terminal serves all international arrivals, and some non-scheduled air carriers. There are two apron areas utilized by the Humphrey Terminal, one adjacent to it and a remote parking apron. A short taxiway connects the two aprons. The first is 560 feet by 600 feet and is set up to handle 5 narrow-body or 3 wide-body aircraft. The second apron is 1,330 feet by 445 feet. It can handle 6 narrow-body or 3 wide-body aircraft. Collectively, a maximum of 12 narrow-body and 7 wide-body aircraft can be parked and serviced at the Humphrey Terminal.

4.2.2 Terminal Area

LINDBERGH AND HUMPHREY TERMINALS

The Lindbergh Terminal serves as the terminal for all scheduled domestic passenger activity. Existing terminal facilities, including the regional commuter terminal, presently comprise 1,517,320 square feet. The existing terminal area configuration is shown on Figure 4-2 and described in the following.



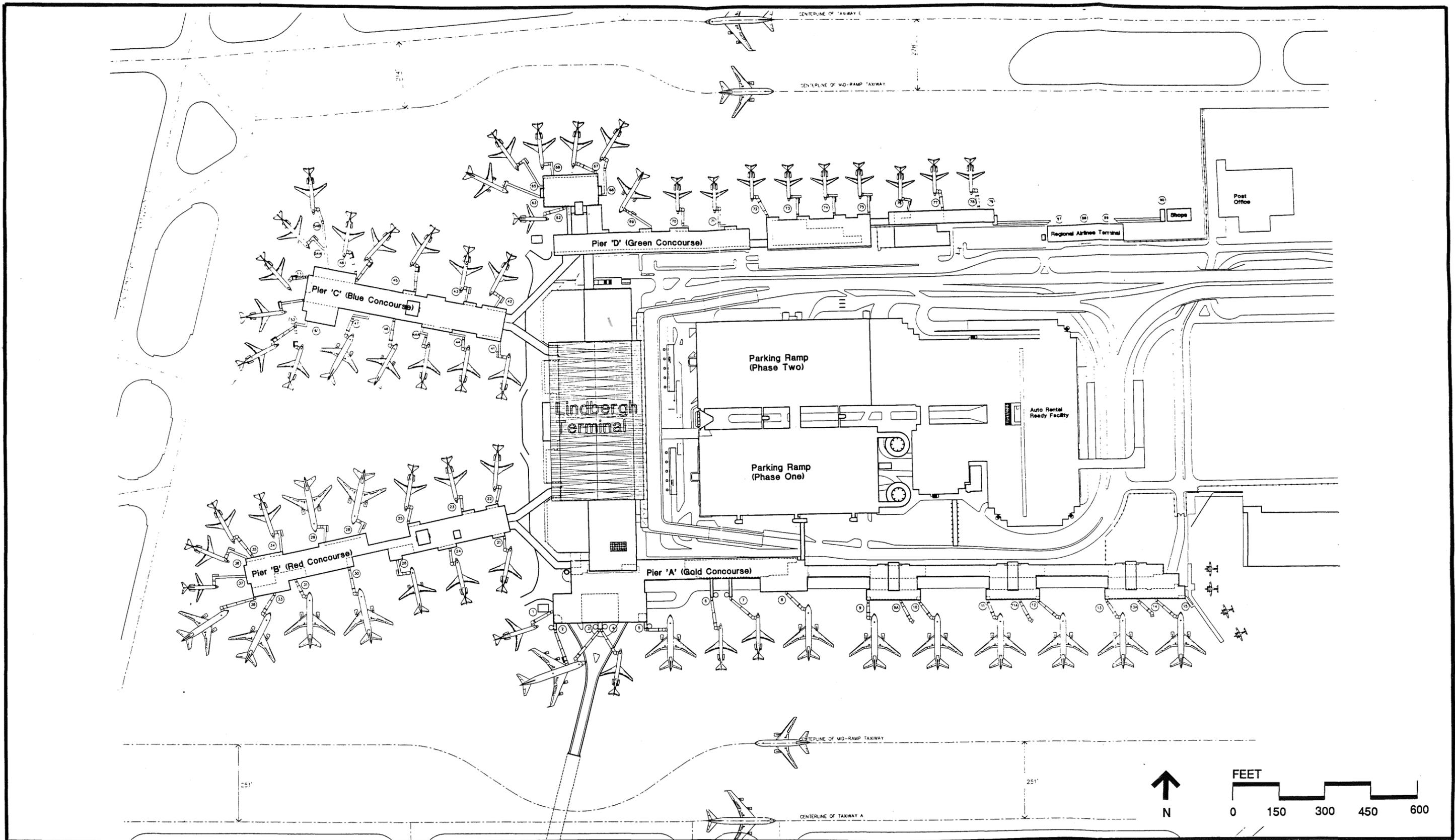


Figure 4-2
**Existing Terminal Configuration,
 Minneapolis-St. Paul International Airport**

The front of the building is served by a two-level roadway connected to a single-level access road loop. Conceptually, the existing terminal complex consists of a central building and four piers connected to the main terminal to create an "H" configuration.

The central building has four levels: the basement level contains public parking, mechanical rooms, and storage space; the ground or lower level has facilities for baggage claim and make-up, police, ground transportation, and auto rental; the main or upper level contains ticketing and waiting areas with related food/beverage services, shops, and concessions; and a mezzanine level offers space for airport and airlines' staffs, office rental and mechanical equipment rooms.

Attached to this central building are four passenger boarding piers. These piers, designated A, B, C, and D, are identified as the Gold, Red, Blue and Green Concourses. Contained on the upper level of these piers are the airline departure lounges for assembling passengers. Also on upper levels are airline offices, mechanical rooms, food/beverage facilities, airline VIP rooms, shops, and public service facilities. Located on lower levels are airline operations, maintenance, and some presently unoccupied space.

Gold Concourse: Pier A. The Gold Concourse is a two-level concourse with 17 gates connected by circulation linkages. The pier extends eastward, 1,950 feet from the south end of the main terminal. Passengers are assisted in traversing this distance by four 350-foot-long moving sidewalks.

A 20-foot-wide connector bridge allows secure passenger circulation to the Red Concourse. Northwest Airlines (NW) occupies all gates on this concourse.

Red Concourse: Pier B. The Red Concourse is a 16-gate, two-level, linear boarding pier extending 861 feet westward from the south end of the Lindbergh Terminal. A 20-foot-wide bridge connects this concourse to the main terminal. All gates are occupied by Northwest Airlines except Gates 34, 35, 36 and 37, which are occupied by TransWorld and Canadian Airlines.

Blue Concourse: Pier C. The Blue Concourse is a 16-gate, two-level, linear boarding pier extending 641 feet westward from the north end of the Lindbergh Terminal. A 20-foot-wide bridge allows secure passenger circulation to the Green Concourse. The 16 gates are occupied by the following airlines: American, Continental, Delta, Midway, Northwest, Pan Am, United, and USAir.

Green Concourse: Pier D. The Green concourse is a 17-gate, two-level linear boarding pier extending eastward 1,443 feet. These gates are designed as three separate piers linked by two circulation bridges.

Gates 62 through 79 are occupied by Northwest Airlines. They are located on the second level except for the extreme east gate, 79, which is located on the apron level and is used by a regional carrier, Express One.

The regional airline terminal is a single-level, 20,200-square-foot facility connected to the Green Concourse. A security checkpoint is located at the west end of the regional terminal. This four-gate facility includes ticket counters, a lobby area, airline ticket offices, and baggage claim.

The Humphrey Terminal is a single-story building with Federal Inspection Services processing area located in a converted hangar. This building serves as the arrival terminal for all international passengers and also serves some charter operations.

The Federal Inspection Services (FIS) facility has a maximum capacity of approximately 400 people. In general, therefore, only one wide-bodied aircraft is processed at a time.

NORTHWEST AIRLINES HUB

Northwest Airlines currently handles about 80 percent of the total passengers at the airport. The traffic includes both passengers that originate and terminate at MSP and those that connect. Because of this, travel distances are critical, both from gates to the central building and between gates. The current "H" configuration of the Lindbergh Terminal presents walking distances that are extreme for both connecting and origin/destination passengers. Although the distance is supplemented by moving sidewalks, originating and terminating passengers may travel in excess of 2,400 feet from gate to curb.

Connecting passengers consist of those passengers that are connecting between two NW flights or between regional carriers and other scheduled MSP air carrier departures. These connecting passengers may have to travel in excess of 4,000 feet. In the case of connections between the Green and Gold or the Gold and Blue concourse gates, passengers must additionally exit and re-enter through security, a process that may further increase their travel time between gates.

TRAVELER AND VISITOR PARKING

Long-term and short-term parking is located directly east of the main terminal building in a parking garage which handles approximately 9,000 cars on eight levels. Short-term parking is on the lowest level.

Additionally, there is a remote, reduced-rate, long-term surface lot. Shuttle buses for the remote lot drop passengers at the arrivals level at the south end of the terminal. A small surface lot for oversized vehicles is located off the service road adjacent to the rental car garage.

RENTAL CARS

All rental car transactions are completed in a two-level Auto Rental Ready Facility. Rental car counters are located in a building on the west side of the parking structure. The cars

are returned to the upper level of the structure. Passengers travel to and from the Auto Rental Ready Facility via a shuttle van.

4.2.3 Surface Access

REGIONAL SURFACE ACCESS

Minneapolis-St. Paul International Airport is served by several components of the regional highway system, providing convenient access from all directions. These facilities and the areas they serve include:

- - **I-494** - Dakota County from the east, south, and west; Hennepin County from the west.
 - **TH 55** - Downtown and south Minneapolis from the north; Dakota County from the south.
 - **County Road 62 (Crosstown Highway)** - West and central Hennepin County from the west.
 - **TH 5** - St. Paul and Ramsey County from the east.
 - **TH 77** - Dakota County from the south; south Minneapolis from the north.

Regional roadway facilities shown in Figure 1-1 are all currently in place, with the exception of the TH 77/I-494 improvements. (The frontage roads in the vicinity of the Air Cargo facility have been completed, and the TH 77/I-494 and the 24th Avenue/I-494 interchanges are currently under construction and are scheduled for completion in 1991.)

Annual average daily traffic counts on regional highways in the area around the airport for 1986 were obtained from Mn/DOT's 1986 Traffic Volumes map and are reported in Table 4-1.

Table 4-1

1986 Annual Average Daily Traffic on Adjacent Regional Highways
Minneapolis-St. Paul International Airport

	Location	1986 Annual Average Daily Traffic
TH 5	East of Glumack Drive	43,000
	West of Glumack Drive	42,500
	North of TH 55	47,200
I-494	West of TH 5	66,800
	East of TH 77	89,000
	East of TH 5 (River Bridge)	41,600
TH 55	North of TH 5	34,500
	South of TH 5 (Mendota Bridge)	27,700
CSAH 62	West of TH 77	69,000
	East of TH 77	45,200
	West of TH 55	35,000
TH 77	South of CSAH 62	46,000
	North of I-494	47,500
	River Bridge	61,100

Source: Minnesota Department of Transportation.

LINDBERGH TERMINAL ACCESS

All access to the Lindbergh Terminal is from TH 5 to Glumack Drive (Airport Road). Drivers approaching the Lindbergh Terminal area from TH 5 may exit Glumack Drive at several locations before arriving at the terminal building. Right exits to the service road provide access to the Post Office, car rental offices, and regional airlines. A right exit leads to the Northwest Main Base and its employee parking lot. A left exit provides access to the car rental return area and the general and short-term parking areas. Beyond the parking areas, drivers may select the upper roadway (ticketing level), the lower inner roadway (baggage claim level), or the lower outer roadway (taxi and courtesy van loading area and underground parking garage).

Traffic volumes on access and circulation roadways are given in Table 4-2.

Table 4-2

Annual Average Daily Traffic
 Access Roads to Terminal Areas
 Minneapolis-St. Paul International Airport

Location	1985 Annual Average Daily Traffic
<u>Lindbergh Terminal</u>	
Main entrance roadway - inbound	21,700
Main entrance roadway - outbound	22,000
Upper-level roadway	7,200
Lower-level inner roadway	5,200
Lower-level outer roadway	2,500
<u>1986 Annual Average Daily Traffic</u>	
<u>Humphrey Terminal</u>	
34th Avenue, North of I-494	11,000
Post Road, West of TH 5	4,400

Source: Minnesota Department of Transportation and BRW, Inc.

Curbside. Current curbside loading and unloading facilities include a single four-lane upper roadway serving the ticketing level of the terminal, which is 660 feet long. A four-lane inner lower roadway which is 760 feet long (designated for private automobiles only) and an outer lower roadway (designated for taxis and public transportation vehicles only) serve the baggage claim level of the terminal.

Dwell time at the curb varies depending on the location and activity. See Table 4-3.

Table 4-3

August 1985 Summary of Lindbergh Terminal
Curbside Survey (Dwell Times)
Minneapolis-St. Paul International Airport

Location	Action	Mean Dwell Time (Minutes)
Upper roadway:	Drop off	2.6
	Pick up	5.7
Lower inner roadway:	Drop off	3.2
	Pick up	7.8

Source: BRW, Inc.

Public Parking. Public parking includes parking by air travelers and terminal visitors. The current parking supply is shown in Table 4-4.

Table 4-4

Available Automobile Parking Spaces
Minneapolis-St. Paul International Airport

Location	Existing Spaces
Short-term: Ramp	698
General: Ramp	8,042
Valet: Garage	320
EconoLot: 34th Ave.ue	2,557

Source: BRW, Inc.

Employee Parking. MAC reserves 900 parking spaces in a lot on 34th Avenue for employees of concessionaires and MAC employees who work in the terminal buildings. Approximately 2,500 permits are issued for use of these spaces.

Rental Car Parking. The car rental facility in the ramp has 490 spaces for rental cars in the pick-up area and 364 spaces for rental cars in the drop-off area.

Taxicabs/Limousines/Courtesy Vans/Public Bus. Taxicabs, limousines, and courtesy vans generally unload passengers on the upper roadway (ticketing level) and load passengers on the outer lower roadway (baggage claim level). Buses generally unload and load on the inner lower roadway.

The number of vehicles and time of observation of taxicabs, limousines, and courtesy vans were recorded by observers at the entrance to the upper-level roadway and at the exit from the lower-level roadway. The number of passengers in the vehicle, excluding the driver, was also recorded. A summary of the average daily vehicles and passengers carried during the survey period is shown in Table 4-5.

Table 4-5
August 1985 Public Service Vehicles/Passengers - Lindbergh Terminal
Minneapolis-St. Paul International Airport

Location	Vehi- cles	Pax/ Vehicle	Vehi- cles	Pax/ Vehicle	Vehi- cles	Pax/ Vehicle	Vehi- cles	Pax/ Vehicle
Upper Roadway	2,542	1.50	714	3.56	1,564	2.77	2	5.00
Lower Roadway	4,191	1.36	721	3.74	2,250	2.10	23	6.52

Source: BRW, Inc., Survey August 18-24, 1985, 7:00 a.m.-10:00 p.m.

Airport Shuttle Bus. The airport shuttle buses provide service between the Lindbergh Terminal, the employee parking lot, the EconoLot, and the Humphrey Terminal. The vehicles operate every ten minutes throughout most of the day and every twenty minutes during early morning hours.

The average daily ridership during the survey period was about 3,200 passengers (1985 Survey).

HUMPHREY TERMINAL ACCESS

Access to the Humphrey Terminal area is via either TH 5 at the Post Road (West 70th Street) interchange or I-494 at the 34th Avenue interchange area. Both Post Road (West 70th Street) and 34th Avenue are collector-type streets. Driveways along Post Road serve the taxi staging area and fixed base operators. Driveways along 34th Avenue serve Northwest Airlines facilities, the Humphrey Terminal, a portion of air cargo operations, the EconoLot, and the employee parking lot. The intersection of Post Road (West 70th Street) with 34th Avenue is controlled with stop signs.

Annual average daily traffic counts are shown in Table 4-2.

Curbside. The Humphrey Terminal loading and unloading activity occurs along a grade-level curbside, which is approximately 550 feet long, located at the front of the building. A four-lane roadway serves the loading and unloading curbside. Another 550 feet of curbside is provided for public transportation (mostly taxis) loading on the far side of the four-lane roadway which is serviced with a two-lane roadway.

Surveys conducted at the Humphrey Terminal found that the average dwell time at the curbside is 13.5 minutes (1985 Survey).

Public Parking. People using the Humphrey Terminal park in the EconoLot just north of the terminal. The EconoLot is also used by long-term users from the Lindbergh Terminal, and it contains 2,557 parking spaces.

Taxicabs/Limousines/Courtesy Vans/Public Bus. Most public transportation vehicles are available on an on-call basis at the Humphrey Terminal. The Metropolitan Transit Commission provides regular route service on 34th Avenue serving the Humphrey Terminal.

Airport Shuttle Bus. See above.

GENERAL AVIATION AND AIR CARGO ACCESS

Air cargo facilities are located in the southwest corner of the airport. The majority of vehicles serving the air cargo facilities access the airport via the 24th Avenue interchange with I-494.

The general aviation facilities are located along 34th Avenue and Post Road (West 70th Street). Access to this area is either from TH 5 via Post Road (West 70th Street) or I-494 via 34th Avenue.

4.3 AIRPORT SUPPORT

In addition to the airfield, terminal area, and surface access facilities and functions, a number of activities are ongoing at MSP in support of the airport. These include airline maintenance, air cargo, general aviation, the military, and others.

Chapter 5

Activity Forecast

5.1 INTRODUCTION

This chapter presents the forecast of aviation activity at Minneapolis-St. Paul International Airport (MSP), prepared as part of the Long-Range Comprehensive Plan. This forecast represents aviation demand levels for the Twin Cities and will be applicable to a new airport. The chapter contains a discussion of the issues and complexities associated with forecasting aviation activity at MSP and also examines the most likely future economic and demographic conditions for the metropolitan area. These socioeconomic forecasts are used to develop projections of air carrier enplanements and aircraft activity. In addition to forecasts of air carrier activity, projections are made of regional, international, and non-scheduled carrier enplanements and operations, cargo tonnage and operations, the number of general aviation based aircraft and their operations, and military operations.

The first section of this chapter presents data on the historical levels of aviation activity at Minneapolis-St. Paul International Airport. The data contain information on passengers enplaned at the Airport by scheduled and non-scheduled air carrier and regional airlines. Data are also presented on passenger airline operations and operations of cargo, general aviation, and military aircraft. For the most part, the period of coverage is calendar years 1972 through 1988.

5.2 HISTORICAL LEVELS OF AVIATION ACTIVITY

5.2.1 National Carriers

PASSENGERS

MSP has exhibited strong growth in air carrier enplanements over the past decade. The only major decline in total passengers, in 1980, was likely caused by the dramatic increases in fuel prices which led to increases in fares in a period of general economic recession. A smaller decrease in activity was recorded in 1988, again most likely as a result of increased fares and restrictions on discount tickets. The significant increase in enplanements in 1979, the first full year after airline deregulation, was primarily attributable to Northwest Airlines (NW) and Republic Airlines (RC), both of which used MSP as a major connecting hub airport for their systems. Another significant increase in enplanements occurred in 1985, when NW and RC substantially increased their connecting operations at MSP. NW absorbed RC's operations in September of 1986, but the combined market share of the two carriers has remained constant (78 to 80 percent) through the 1983-1988 period.

While the number of passengers enplaned by other carriers has declined since deregulation, the number of carriers providing significant levels of service (1,000 annual departures) initially increased. From 1972 to 1980 there were seven to eight carriers (including NW and RC). The number of carriers began to increase in 1981 and by 1986 had reached twelve. By 1988 this number had declined to eight. Most of the remaining carriers are providing limited service (fewer than six daily flights), primarily connecting MSP to the other carriers' hub airports. The continuing acquisitions, mergers, and in some cases financial difficulties, in the airline industry will likely lead to a continued reduction in the number of carriers serving MSP.

Through most of the period, connecting activity has accounted for the largest portion of the increases in enplanements. This connecting activity increased as both NW and RC added to their connecting complexes at MSP. There was a reduction in connecting activity in 1988, leading to a slight decrease in the number of total air carrier enplanements at the same time that originations were continuing to increase. Preliminary 1989 information indicates that this trend has been reversed and that connecting passengers are once again increasing more rapidly than originating passengers.

In addition to passenger measures (enplanements and originations), which primarily affect landside facility requirements, the associated aircraft activity is important in determining overall facility requirements. There was a significant increase in the number of enplanements per departure in 1987, as NW was able to consolidate its operations following acquisition of RC. This increase in load factor permitted a reduction in the number of aircraft departures while passenger enplanements continued to increase.

AIRCRAFT OPERATIONS

It is common to equate air carrier activity with operations using turbojet or jet aircraft with more than sixty seats. In most instances air carriers use turbojet aircraft, and regional carriers use turboprop aircraft with fewer than sixty seats. However, at MSP, NW continued to use a significant number of Convair turboprop aircraft to serve low-density, short-haul markets through December 1988. In many instances, the markets served by NW with Convairs are now served by regional carriers.

The distinction between air carrier (large turbojet) and regional carrier (small turboprop) equipment is important since there are significant differences in the facility requirements of each.

Currently, all turbojet aircraft serving MSP have sixty seats or more, whereas turboprop aircraft have fewer than sixty seats. This may change in the future, with the possible emergence of propfan technology for 100- and 150-seat aircraft, and the possible introduction of

small (50-seat) turbojet aircraft¹ for use in regional markets. Likewise, the distinction between air carriers and regional carriers will probably blur as air carriers continue to acquire equity interest in regional carriers. For the purpose of developing the forecasts, air carriers will be defined as those carriers that principally operate aircraft with more than sixty seats, and regional carriers will be defined as those carriers that principally operate aircraft with fewer than sixty seats.

For much of the forecasting work, the small turboprop (fewer than sixty seats) operations by air carriers will be treated as if they were regional operations. This is done since the nature of these operations (markets and equipment) and facility requirements are more consistent with those of regional carriers.

5.2.2 Regional Carriers

Regional carriers serve the smaller communities within a several-hundred-mile radius of a large hub airport, such as MSP, using turboprop aircraft with fewer than sixty seats. The high growth rates at MSP are not surprising, since this sector of the aviation industry has nationally exhibited strong growth. As is true nationally, much of the growth in regional carrier activity has occurred since deregulation, as the larger carriers withdrew from the smaller markets and regional carriers began service in already well-established markets. The surprising feature of MSP regional carrier activity is that the growth has occurred even though RC (and now NW) has continued to serve many smaller markets which would have typically been abandoned to regional carriers.

Beginning in late 1985, many of the regional airlines began to enter into code-sharing arrangements with the major air carriers. Under such an arrangement, the regional airline uses the air carrier's airline code in published schedule and reservation systems and the carriers coordinate their schedules to improve connecting services. This practice is now common and has provided substantial benefits to the regional airlines by increasing traffic. Regional carrier enplanements increased 85 percent between 1985 and 1986, and continued to increase at significant but more moderate rates through 1988.

As with regional carrier enplanements, regional departures nearly doubled since code-sharing began in late 1985. While the trend in enplanements per departure has exhibited considerable fluctuation, the overall increase in enplanements per departure is consistent with national statistics. The average aircraft size of 23.6 seats is slightly higher, but comparable, to the industry-wide average of 19.2 seats.²

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1. The Canadair RJ and Shorts FJX are both 50-seat jet aircraft currently under consideration for development.
 2. *FAA Aviation Forecasts: Fiscal Years 1989-2000.*

5.2.3 International and Charter Carriers

Most of the commercial activity at MSP is accounted for by the domestic scheduled activity of air carriers and regional carriers. However, there are two other types of passenger activity -- international (scheduled and non-scheduled) and domestic non-scheduled (charter) operations.

Prior to 1980, international service at MSP consisted almost entirely of charter flights. In 1980 NW began scheduled international service to northern Europe, later followed by service to Japan. Scheduled international passenger service at MSP is now dominated by NW, which in the peak summer months provides at least daily nonstop service to northern European destinations. In the winter months, the service frequency drops to approximately three flights per week. In addition to direct services, Minneapolis-St. Paul passengers use domestic flights to other major gateway cities for connecting flights to foreign destinations. KLM will initiate service to Amsterdam on April 1, 1991. Canadian service is included in domestic activity.

There was a reduction in non-scheduled activity during the 1980-1983 period, corresponding to airline deregulation and the national economic recession. However, since 1983 there has been a rapid increase in the number of non-scheduled passengers at MSP. Aircraft departures have not increased as rapidly as passenger enplanements, indicating that the number of passengers per aircraft departure is increasing. Although some non-scheduled activity is conducted by scheduled air carriers, most is conducted by exclusive charter operations. The principal non-scheduled carriers at MSP are Sun Country Airlines and American Trans Air.

5.2.4 Cargo and Mail

Tables 5-1 and 5-2 present data on aviation activity at MSP, including cargo activity, for the period 1972-1988. Typical of most airports, total cargo tonnage has fluctuated over the years, following the general ups and downs of economic expansion and recession. Also typical of the air cargo industry in general are the dramatic changes that have occurred in recent years with the emergence of the small-package express companies (e.g., Federal Express) and the growth in all-cargo carriers following deregulation. In the early 1970s, virtually all cargo services were provided by the scheduled passenger carriers and most of the cargo moved in the "belly" of passenger flights. Today NW is the only passenger carrier which operates dedicated all-cargo flights at MSP.

Table 5-1

History of Passenger Enplanements and Air Cargo Activity
Minneapolis-St. Paul International Airport

Year	<u>Annual Passenger Enplanements</u>					<u>Annual Air Cargo (Enplaned Tons)</u>					<u>Mail</u> (Enplaned Tons)
	<u>Domestic Scheduled</u>		Inter-national	Non-Scheduled	Total ^a	<u>Passenger Carriers</u>		All-Cargo Carriers ^c	Small Package ^d	Total	
	Air Carrier	Regional				Air Carrier ^b	Regional				
1972	2,728,698	15,137	128	--	2,743,963	36,367	93	0	0	36,460	19,158.9
1973	3,069,157	14,402	0	--	3,083,559	46,300	100	0	0	46,400	20,121.6
1974	3,225,025	16,155	0	--	3,241,180	51,070	112	0	0	51,182	20,078.0
1975	3,228,564	21,255	0	--	3,249,819	45,079	126	0	0	45,205	21,717.3
1976	3,559,928	26,484	0	--	3,586,412	46,470	150	0	0	46,620	24,733.2
1977	3,768,227	28,021	0	206,972	4,003,220	46,544	112	0	837	47,493	26,048.2
1978	3,856,777	35,226	372	241,157	4,133,532	42,661	98	0	1,191	43,950	23,927.1
1979	4,588,271	49,087	0	218,745	4,856,103	51,784	171	143	1,691	53,789	27,271.2
1980	4,285,217	42,547	28,662	153,441	4,509,867	40,388	173	755	1,852	43,168	23,650.8
1981	4,391,802	30,137	57,871	139,954	4,619,764	35,051	78	7,335	2,050	44,514	23,393.3
1982	5,071,395	75,774	50,574	157,264	5,355,007	29,309	111	10,071	4,937	44,428	24,767.7
1983	5,702,094	118,783	49,474	172,430	6,042,781	34,067	122	11,923	6,601	52,713	24,909.4
1984	5,986,288	130,610	73,014	245,014	6,434,926	43,350	140	11,579	7,630	62,699	28,717.4
1985	7,114,367	156,825	83,533	352,841	7,707,566	42,656	136	8,069	8,088	58,949	42,476.6
1986	7,845,494	290,700	81,700	291,656	8,509,550	32,502	144	14,610	15,870	63,126	45,367.0
1987	8,171,206	366,374	85,023	259,621	8,882,224	34,450	176	29,366	27,014	91,008	47,358.4
1988	8,023,121	397,835	64,708	348,910	8,834,574	31,348	158	30,786	34,826	97,118	42,977.1

Sources: FAA/CAB, *Airport Activity Statistics*; Minneapolis-St. Paul International Airport data.

^aDoes not include non-scheduled passengers prior to 1977.

^bIncludes all-cargo flights by NW, UA, and AA.

^cIncludes: Flying Tiger, Zantop, Viking, Far North, Emerald, Evergreen, Summit, Mountain Air, Northland Air, Comair, Southern Air, Spirit of America, Basler Aviation, CF Air Freight, Connie Kalitta, Corporate Air, Sioux Falls Aviation, Viking Express, and Blackhawk Airways.

^dIncludes: Federal Express, Emery, Airborne, Orion, UPS, Purolator, and DHL Airways.

Table 5-2

History of Aircraft Activity
Minneapolis-St. Paul International Airport

	Domestic Air Carrier	Regional and Air Taxi	Scheduled Inter- national	Non- Scheduled ^a	Passenger Aircraft Total	All- Cargo Carriers ^b	Small Package ^c	General Aviation	Military	Total Aircraft Activity
1972	57,849	3,239	10	--	61,098	925	0	92,687	15,910	170,620
1973	63,356	3,266	8	--	66,630	779	0	97,191	14,180	178,780
1974	62,129	3,444	3	--	65,576	549	0	86,353	9,180	161,658
1975	61,913	4,236	0	--	66,149	426	0	89,321	7,985	163,881
1976	64,148	4,682	0	--	68,830	267	0	96,764	6,222	172,083
1977	66,185	4,503	0	2,045	72,733	256	252	103,239	6,260	182,740
1978	59,334	5,507	3	2,565	67,409	177	407	115,106	6,698	189,797
1979	71,623	6,153	0	2,007	79,783	315	391	116,738	6,080	203,307
1980	73,262	6,064	169	1,486	80,981	577	263	114,260	6,604	202,685
1981	73,169	4,952	230	1,833	80,184	696	260	97,278	5,606	184,024
1982	75,225	11,419	193	1,776	88,613	708	642	82,303	5,359	177,625
1983	85,065	16,962	183	2,187	104,386	836	816	83,548	5,100	194,686
1984	94,915	17,969	253	1,645	114,782	1,488	1,559	93,367	7,721	218,917
1985	110,095	15,730	314	2,178	128,317	1,406	1,317	106,715	14,020	251,775
1986	115,880	25,260	340	1,532	143,012	3,241	3,004	71,406	6,869	227,532
1987	106,770	28,205	307	1,832	137,114	4,512	3,299	70,050	8,676	223,651
1988	105,781	29,444	257	2,012	137,494	4,940	4,134	68,634	6,698	221,900

Sources: FAA/CAB, *Airport Activity Statistics*; Minneapolis-St. Paul International Airport data.

^aDoes not include non-scheduled activity prior to 1977.

^bIncludes all-cargo flights by NW, UA, and AA, as well as Flying Tiger, Zantop, Viking, Far North, Emerald, Evergreen, Summit, Mountain Air, Northland Air, Comair, Southern Air, Spirit of America, Basler Aviation, CF Air Freight, Connie Kalitta, Corporate Air, Sioux Falls Aviation, Viking Express, and Blackhawk Airways.

^cIncludes: Federal Express, Emery, Airborne, Orion, UPS, Purolator, and DHL Airways.

Since deregulation, most passenger carriers have chosen to emphasize their passenger operations and most, if not all, of the growth in air cargo tonnage and operations has come from new carriers.

Air mail activity is also shown in Table 5-1. Virtually all of the mail volume at MSP is currently carried by the scheduled passenger carriers. Some mail is occasionally carried on board all-cargo carriers such as Viking International or Zantop. The significant increase in mail volume in 1985 reflects operational changes by the U.S. Postal Service to originate and terminate more mail at MSP.

5.2.5 General Aviation

Data on MSP general aviation operations is presented in Table 5-2. There has been virtually no growth in general aviation activity over the period. Substantial increases in the ownership and operating costs of general aviation aircraft have offset growth in this segment of aviation activity at MSP as it has done elsewhere in the U.S. Also, periods of general aviation activity decline coincide with periods of rapid escalation of fuel prices and/or high interest rates. General aviation activity increased in 1984 and 1985, with the decline in fuel prices. The impact of these economic factors has been more pronounced on the local general aviation operations, which have declined significantly over the period. The recent decline (1986-1988) reflects the Airport's policy of supporting general aviation facility development at other MAC airports and encouraging light general aviation aircraft users to relocate to these airports.

5.2.6 Military

In addition to civil aviation activity at MSP, there is military activity associated with the Air National Guard and U.S. Air Force Reserve facilities. Table 5-2 contains the historic level of military operations at MSP. Over most of the period, the decline in military operations was the result of the virtual elimination of local aircraft operations.

5.2.7 Summary

Tables 5-1 and 5-2 contain a summary of airport activity at MSP over the period from 1972 through 1988. Total passenger enplanements have grown from 4.0 million in 1977, just prior to deregulation, to 8.8 million in 1988, a 7.5 percent annual rate of increase. Over the same period, passenger aircraft departures have grown from 72,733 to 137,494, a 6.0 percent annual increase.

5.3 FORECAST OF AVIATION ACTIVITY

Macroeconomic forecasting techniques were utilized in producing the forecasts in this study. Macro, or top-down methodologies as they are known in the vernacular, extrapolate aviation growth trends from economic and demographic variables which are known to be closely tied to levels of aviation activity -- specifically, population, employment, and income. To forecast future aviation activity at MSP, economic and demographic projections prepared by the U.S. Department of Commerce, Bureau of Economic Analysis, were utilized. Forecasts of population and employment for the Minneapolis-St. Paul metropolitan statistical area (MSA)³ are shown in Table 5-3. Comparable national figures are also included to serve as a basis of comparison.

Table 5-3

Population and Employment Projections: 1988 to 2020
 Minneapolis-St. Paul Metropolitan Statistical Area
 and the United States
 (thousands)

Year	Minneapolis-St. Paul (MSA) Population	United States Population	Minneapolis-St. Paul (MSA) Employment	United States Employment
1988 (actual)	2,387.5	245,807.0	1,523.1	114,177.0
1995	2,566.4	259,085.0	1,677.6	131,554.0
2000	2,688.6	267,464.0	1,782.0	138,338.0
2005	2,801.8	275,177.0	1,861.1	143,257.0
2010	2,892.1	282,446.0	1,893.2	144,990.0
2015	2,985.3	289,906.0	1,925.8	146,744.0
2020	3,036.9	293,997.0	1,926.1	146,353.0

Sources: U.S. Department of Commerce, Bureau of Economic Analysis, 1985 OBERS BEA Regional Projections, 1985; U.S. Bureau of the Census as reported in *Statistical Abstract of the United States, 1989*; and Economic Report to the President January 1989.

3. The definition of the MSA includes the counties of Anoka, Carver, Chisago, Dakota, Hennepin, Isanti, Ramsey, Scott, Washington, Wright, and St. Croix, WI.

5.3.1 Forecast Methodology

Long-term forecasting is always difficult due to the uncertainties associated with general economic and demographic conditions, corporate decision-making by the air carriers, and the influence of new technology. It is especially complicated at MSP, which has recently experienced significant changes in traffic levels and types of service. The most significant such change was the merger of NW and RC, the two dominant carriers. Forecasts based solely on the long-term historical trend would not properly acknowledge the reductions in operations associated with the merger. However, forecasts based on the most recent traffic figures would less than adequately consider the strong long-term growth pattern exhibited at MSP and the fundamental changes in the types of services. The air carrier forecasts incorporate both the long-run historical trends and the changes that have occurred with the merger and are likely to have an influence on the long-run development of air carrier services at MSP.

In estimating future air carrier activity, separate forecasts were made of originating passengers and connecting enplanements. Forecasts of originating passengers are related to expected changes in economic/demographic conditions for the Minneapolis-St. Paul area. Projections of air carrier connecting enplanements were based on assumptions regarding likely growth in hubbing operations at MSP. The assumptions regarding connecting activity are critical to the overall forecasts.

The forecasts are presented for specific points in time. In addition to 1988, the base year, the years for which forecasts were prepared are: 1995, 2000, 2005, 2010, 2015, and 2020. While the forecast represents a reasonable assessment of what future conditions will be, there is a level of uncertainty regarding economic conditions, aircraft technology, and airline corporate policies. This requires that the forecast be used with flexibility. The forecast is best understood to be an assessment of future activity levels, loosely tied to future years, which trigger actions in the airport improvement program as needed.

Except for general aviation activity, the forecast is unconstrained. This means that it does not take into account any airport development constraints that could reduce aviation activity below what market forces would dictate.

5.3.2 National Carriers

PASSENGERS

The forecast of future national air carrier activity was produced by first forecasting originating passenger traffic, then extrapolating to obtain total enplanements. Originating passengers are travelers who begin their trips at MSP (connecting passengers are excluded). Thus, relationships between local socioeconomic conditions and numbers of originating passengers can be developed.

In preparing the forecast of originations, total historical originations were adjusted downward. This was done to remove the originating passengers associated with turboprop operations. These passengers are covered in the forecast of regional carrier activity which follows.

Average real fare levels were assumed to change through the year 2000 at the rate forecast by the FAA. After that, they are expected to remain constant. Over the study period, originations are expected to increase at a 1.4 percent annual growth rate. The socioeconomic projections indicate that the most rapid growth period will be in the near term.

To project air carrier enplanements, a ratio of enplanements to originations was applied to the forecasted originations. Since deregulation in 1978, the ratio of enplanements to originations has increased from 1.42 to 1.88, an annual increase of 2.8 percent. The ratio of enplanements to originations at MSP is still below the average for comparable airports which serve as connecting hubs for major air carriers. Historic data for the hub airports elsewhere in the U.S. indicates that, over time, those airports with high connecting ratios are becoming less intensive in connecting activity. Simultaneously, those with lower ratios are increasing their connecting intensity. The forecast of future air carrier enplanements at MSP therefore assumes that the ratio of enplanements to originations will continue to rise at the historical rate of 2.8 percent per year until it reaches an average of 2.40. This will occur in 1997. In later years, it will remain constant. Applying these enplanement ratios to the origination forecasts produces the enplanement forecasts shown in Table 5-4.

AIRCRAFT OPERATIONS

The conversion of passenger enplanements to aircraft departures is accomplished by determining the number of enplanements per departure. MSP's average air carrier aircraft seat count is 139.6. This number is below the national domestic fleet average of 153. The estimated 10,170,212 seat-departures for January through August 1989, together with the air carrier enplanement level of 5,604,463 over the same period, indicates an enplaning load factor of 55.1 percent.

The FAA is forecasting continued growth in both average aircraft size (measured by seats) and load factor, through the year 2000. The average size of aircraft will increase by 1.33 seats per year and load factor will increase by 0.53 percent per year. On the basis of the known aircraft acquisition plans of NW and the emphasis on MSP as a connecting hub, these national growth rates are appropriate for MSP. Between 2000 and 2010, this forecast assumed that the growth rate of aircraft size will be half the 1988-2000 rate. After 2010, because of an anticipated leveling off of passenger traffic, there will be no additional increases in aircraft size. Load factors will remain constant after the year 2000.

Table 5-4

Forecast of Passenger Enplanements and Air Cargo Activity, 1988 to 2020
Minneapolis-St. Paul International Airport

	1988	1995	2000	2005	2010	2015	2020
Annual Passenger Enplanements							
Domestic Sched. Air Carrier ^a	7,904,873	11,105,000	13,498,000	14,513,000	15,024,000	15,555,000	15,749,000
Regional and Air Taxi ^a	516,083	659,000	760,000	861,000	952,000	1,054,000	1,145,000
International Scheduled	64,708	288,000	476,000	670,000	982,000	1,323,000	1,663,000
Domestic Non-Scheduled	275,418	355,000	444,000	540,000	632,000	741,000	845,000
International Non-Scheduled	73,492	95,000	118,000	144,000	169,000	198,000	225,000
Total	8,834,574	12,502,000	15,296,000	16,728,000	17,759,000	18,871,000	19,627,000
Peak Month Passenger Enplanements							
Domestic Scheduled Air Carrier	805,000	1,131,000	1,374,000	1,478,000	1,530,000	1,584,000	1,603,000
Regional and Air Taxi	55,000	70,000	81,000	92,000	101,000	112,000	122,000
International Scheduled	10,000	33,000	55,000	77,000	113,000	152,000	191,000
Domestic Non-Scheduled	41,000	53,000	66,000	80,000	94,000	110,000	126,000
International Non-Scheduled	19,000	25,000	31,000	38,000	45,000	52,000	59,000
Combined (August)	887,000	1,256,000	1,538,000	1,681,000	1,784,000	1,895,000	1,969,000
Average Day Peak Month Passenger Enplanements							
Domestic Scheduled Air Carrier	25,968	36,484	44,323	47,677	49,355	51,097	51,710
Regional and Air Taxi	1,774	2,258	2,613	2,968	3,258	3,613	3,935
International Scheduled	323	1,065	1,774	2,484	3,645	4,903	6,161
Domestic Non-Scheduled	1,323	1,710	2,129	2,581	3,032	3,548	4,065
International Non-Scheduled	613	806	1,000	1,226	1,452	1,677	1,903
Combined (August)	28,600	40,500	49,600	54,200	57,500	61,100	63,500
Peak Hour Passenger Enplanements							
Domestic Scheduled Air Carrier	4,057	5,655	6,815	7,271	7,465	7,728	7,821
Regional and Air Taxi	363	409	454	497	529	587	640
International Scheduled	290	550	612	804	1,042	1,476	1,664
Domestic Non-Scheduled	468	605	753	912	1,072	1,255	1,437
International Non-Scheduled	301	396	491	602	713	824	935
Combined (August, 1900-1959)	4,183	5,815	7,205	7,685	8,117	8,482	8,821
Peak Hour Passenger Deplanements							
Domestic Scheduled Air Carrier	3,843	5,336	6,427	6,854	7,033	7,281	7,369
Regional and Air Taxi	323	409	470	530	578	641	699
International Scheduled	290	550	612	804	1,042	1,476	1,664
Domestic Non-Scheduled	421	545	678	822	966	1,131	1,295
International Non-Scheduled	228	300	372	456	540	624	708
Combined (August, 1900-1959)	4,035	5,582	6,719	7,394	7,623	7,958	8,321
Annual Air Cargo (Enplaned Tons)							
Passenger Carriers	31,506	30,000	29,000	28,000	28,000	27,000	27,000
All-Cargo Carriers	30,786	41,000	49,000	56,000	59,000	62,000	62,000
Small Package/Express	34,826	51,000	63,000	73,000	76,000	82,000	82,000
Mail	42,977	61,000	70,000	77,000	80,000	83,000	83,000
Total	140,095	183,000	211,000	234,000	243,000	254,000	254,000

Source: MSP Long-Term Comprehensive Plan.

a. NW CVR enplanements included with regional carriers.

Multiplying enplanements per departure by enplanements produces the forecast of air carrier departures. Because of the increases in enplanements per departure, the number of departures, and therefore operations, increases at a slower rate than enplanements. See Table 5-4.

Table 5-6 shows the air carrier fleet operating at MSP which would be consistent with projected average aircraft size, existing carrier fleet, and stated aircraft acquisition plans by NW. Over the forecast period, several aircraft currently in the design and development stages, such as the MD-90, MD-11, and A340, will come into service. During the next 31 years, aircraft which are not now currently under development will also come into use. Although most of these will fill market niches occupied by current aircraft types, two new aircraft categories will appear: a 600-seat jumbo jet and a supersonic or hypersonic aircraft (SST/HST). These have been included at the end of the forecast period.

PEAK PERIOD

In order to properly size terminal facilities, annual activity must be converted to monthly, daily, and hourly figures. Many of the facility requirements are related to operations, enplanements, or originations during the average day of the peak month or the peak hour of the average day of the peak month. August is and will remain the peak month for air carrier aircraft departures with 8.94 percent of the annual operations.

Present peak hours will remain the same in the future. One change will occur, however. The relative severity of the peaking will diminish over time as the effective operating day is extended in the early morning and late evening. Also, more flights will be scheduled during the slack periods of the day. The filling-in of slack periods is likely to occur as NW schedules additional connecting complexes of flights throughout the day.

Based on activity profiles of similar airports, projected hourly activity distributions were prepared for 1988 through 2020. Based on these, forecasts of peak operations were prepared. Discussions with NW officials caused an additional connecting bank (about half the average size) to be included in the 10:00 to 10:59 p.m. time period.

Tables 5-4 and 5-5 present the forecast of peak period national carrier passenger and aircraft activity.

Table 5-5

Forecast of Aircraft Operations, 1988 to 2020
Minneapolis-St. Paul International Airport

	1988	1995	2000	2005	2010	2015	2020
Annual Aircraft Operations							
Domestic Scheduled Air Carrier	201,708	256,400	282,000	293,400	294,000	304,400	308,200
Regional and Air Taxi	68,742	73,800	76,800	79,800	88,200	97,600	106,000
International Scheduled	514	1,126	1,508	1,922	2,392	2,954	3,588
Domestic Non-Scheduled	3,246	3,906	4,494	5,272	5,994	7,026	8,012
International Non-Scheduled	778	948	1,124	1,342	1,540	1,804	2,050
All-Cargo Carriers	9,886	12,200	13,800	15,000	15,000	15,800	15,800
Small Package/Express Carriers	8,268	11,200	13,200	14,600	14,400	15,600	15,600
General Aviation ^a	68,634	55,500	49,800	49,800	49,800	49,800	49,800
Military	6,698	6,700	6,700	6,700	6,700	6,700	6,700
Total	368,474	421,780	449,426	467,836	478,026	501,684	515,750
Peak Month Aircraft Operations							
Domestic Scheduled Air Carrier	18,034	23,000	25,200	26,200	26,200	27,200	27,600
Regional and Air Taxi	6,360	7,000	7,200	7,600	8,400	9,200	10,000
International Scheduled	66	144	192	244	304	376	458
Domestic Non-Scheduled	630	758	872	1,022	1,162	1,362	1,552
International Non-Scheduled	182	220	262	312	358	420	478
All-Cargo Carriers	872	1,076	1,218	1,324	1,324	1,394	1,394
Small Package/Express Carriers	730	988	1,166	1,288	1,270	1,376	1,376
General Aviation ^a	6,483	5,242	4,704	4,704	4,704	4,704	4,704
Military	703	703	703	703	703	703	703
Combined (August)	32,926	37,910	40,189	41,903	42,780	44,875	46,205
Average Day Peak Month Aircraft Operations							
Domestic Scheduled Air Carrier	582	742	813	845	845	877	890
Regional and Air Taxi	205	226	232	245	271	297	323
International Scheduled	2	5	6	8	10	12	15
Domestic Non-Scheduled	20	24	28	33	37	44	50
International Non-Scheduled	6	7	8	10	12	14	15
All-Cargo Carriers	28	34	40	42	42	44	44
Small Package/Express Carriers	24	32	38	42	40	44	44
General Aviation ^a	216	175	157	157	157	157	157
Military	23	23	23	23	23	23	23
Combined (August) ^b	1,062	1,223	1,296	1,352	1,380	1,448	1,490

Source: MSP Long-Term Comprehensive Plan.

Note: An operation is either a takeoff or a landing. Sometimes these are referred to as an arrival or a departure, respectively.

^aGeneral aviation numbers assume existing airport site through forecast period.

^bTotals are Average Day/Peak Month.

Table 5-6

Forecast of Airport Fleet Mix Operating at
Minneapolis-St. Paul International Airport, 1988 to 2020

Aircraft Type	Percent of Total Daily Aircraft Departures						
	1988	1995	2000	2005	2010	2015	2020
CNA/PAG/BEC	3.32	2.21	1.69	1.34	1.09	1.10	1.07
BE9	1.00	0.70	0.34	0.17	0.18	0.19	0.21
J31/SWM/DH6	9.55	6.89	5.97	4.47	4.67	4.89	5.07
SF3/SH6/DH8	2.13	3.82	3.97	4.16	4.53	4.76	4.99
DC3	0.16	0.09	0.06	0.03	0.03	0.03	0.03
ATR	0.00	1.92	2.22	2.52	2.73	2.88	3.04
CVR	2.62	0.10	0.06	0.00	0.00	0.00	0.00
F27/YS11/HS7	2.82	3.88	4.40	5.66	6.20	6.51	6.81
F50	0.00	0.87	1.37	1.71	1.85	1.95	2.06
LOF	0.14	0.09	0.00	0.00	0.00	0.00	0.00
RJ/FJX	0.00	0.17	0.34	0.43	0.46	0.49	0.51
F28	0.18	0.17	0.17	0.17	0.18	0.19	0.21
B11	0.18	0.00	0.00	0.00	0.00	0.00	0.00
DC9	3.60	1.73	0.16	0.00	0.00	0.00	0.00
F100/146	0.00	1.51	1.84	2.12	2.08	1.98	1.92
D9S	13.81	14.07	9.90	3.18	0.00	0.00	0.00
D95	4.85	3.81	3.41	3.12	0.00	0.00	0.00
M80/A320	5.23	15.82	18.47	21.73	24.22	23.26	23.30
737	0.00	0.24	0.12	0.00	0.00	0.00	0.00
73S	1.74	1.11	0.366	0.03	0.00	0.00	0.00
733/M90	2.37	2.53	5.67	13.54	16.19	17.80	17.64
727	2.01	1.28	0.49	0.06	0.00	0.00	0.00
72S	13.89	7.34	5.19	0.93	0.00	0.00	0.00
707	0.18	0.09	0.00	0.00	0.00	0.00	0.00
D8S	0.56	0.58	0.51	0.28	0.00	0.00	0.00
757	4.82	6.25	8.91	9.62	10.05	9.63	9.37
767/A31	0.00	0.09	1.23	1.69	2.05	1.97	1.91
AB3	0.00	0.09	0.38	0.41	0.43	0.42	0.26
L15	0.23	0.35	0.57	0.20	0.11	0.05	0.00
D10	3.02	5.74	5.52	5.30	5.05	2.56	1.45
MD11/A340	0.00	0.36	1.95	2.70	3.23	4.88	5.93
747	1.16	1.36	1.85	2.35	2.85	2.51	2.23
747+	0.00	0.00	0.00	0.00	0.00	0.37	0.56
SST/HST	0.00	0.00	0.00	0.00	0.00	0.33	0.46
GA Jet	6.44	5.63	5.28	5.07	4.96	4.73	4.60
GA Turboprop	4.24	2.62	2.02	1.94	1.90	1.81	1.76
GA TE Piston	3.89	2.40	1.85	1.78	1.74	1.66	1.61
GA SE Piston	4.06	2.51	1.93	1.86	1.82	1.73	1.69
C130	1.82	1.59	1.49	1.43	1.40	1.34	1.30
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: MSP Long-Term Comprehensive Plan.

5.3.3 Regional Carriers

PASSENGERS

Forecasting regional carrier activity is difficult due to a lack of detailed market data and the significant changes that have occurred since deregulation within this sector of the aviation industry. Adding to these general forecasting difficulties is the fact that at MSP, RC (now NW) maintained extensive turboprop activity.

The regional carrier enplanement forecast is shown in Table 5-4. Regional carrier enplanements are forecast to increase from 516,083 enplanements in 1988 (including NW Convair enplanements) to 1,145,000 enplanements in 2020, an annual increase of 2.5 percent. Although the rate of increase in regional carrier enplanements is slightly greater than that forecast for domestic air carrier enplanements, the growth rate is much less than has occurred among regional carrier passengers in recent years. This reflects the maturing of the regional carrier market as the one-time increases resulting from deregulation and code-sharing are fully absorbed. The forecast anticipates a lesser rate of increase than the most recent FAA Terminal Area Forecast for commuter enplanements at MSP. The forecast rate of increase is greater, however, than that contained in the Minnesota State Aviation System Plan, applicable to the Greater Minnesota airports that comprise a major portion of the regional carrier market for MSP.

AIRCRAFT OPERATIONS

The conversion of enplanements to aircraft operations is, as with the national carriers, based on enplanements per departure. The MSP average turboprop aircraft size is 27.1 seats. This is higher than the national average of 19.2 seats due to the inclusion of the RC/NW Convairs. The average seat size of 27.1 seats, when combined with actual 1988 regional carrier aircraft departures of 34,371, produces an estimate of 931,454 regional carrier seat departures for 1988. Combined with regional carrier enplanements (516,083), the average enplaning load factor exceeds 55 percent.

The FAA forecasts a 4.0 percent annual growth rate in the average size of regional carrier aircraft through the year 2000. The MSP average is already above the national average. Therefore, this forecast assumed that the average regional carrier aircraft size at MSP will increase from a 1988 base year level of 23.6 seats (i.e., the NW Convairs are excluded). Average regional aircraft size at MSP will increase at the rate projected by the FAA through 1995. Between 1995 and 2005 the growth in average regional carrier aircraft size at MSP will be half the FAA level. A growth rate in regional carrier aircraft size slower than that of the FAA rate is used because otherwise the number of regional carrier aircraft departures would decline at the same time that enplanements were continuing to increase.

No additional growth in aircraft size is forecast beyond 2005. The average load factor is forecast to grow at the FAA forecast rate for regional carriers through 2000 and remain constant thereafter.

The forecast of regional carrier operations is shown in Table 5-5. Table 5-6 contains information on projected changes in the turboprop aircraft fleet operating at MSP.

PEAK PERIOD

As with the national carriers, facility requirements for regional carriers are based on peak period activity levels rather than annual totals. Data from MSP indicates that, like the national carriers, peak regional carrier activity occurs in summer. July is the peak month for regional carriers, with the month accounting for 9.47 percent of the annual aircraft departures. It was assumed that July will continue to be the peak month.

Tables 5-4 and 5-5 show the forecast of peak period regional carrier passenger and aircraft activity.

5.3.4 International and Non-Scheduled Carriers

SCHEDULED INTERNATIONAL CARRIERS

Passengers

This section presents an analysis of scheduled international carrier activity. For the purposes of this study, U.S. DOT organizational conventions are used, which include U.S. and Canadian traffic with domestic activity and define all other activity as international.

Commencement of direct scheduled international service from MSP in 1980 had a dramatic impact on scheduled international traffic at the airport. A high growth rate in international enplanements, compared to domestic originations, is used in this forecast and is consistent with the assumption that NW will develop more domestic feed to MSP as an international gateway hub for its Pacific and/or North Atlantic routes.

In addition to the growth in the existing international traffic at MSP, there is another, and potentially larger, source of scheduled international traffic -- Minneapolis-St. Paul passengers that originate a domestic trip at MSP and connect to an international flight at another gateway. The number of these passengers is at least twice as great as the number of passengers that originate directly at MSP. As international services improve at MSP in terms of frequencies and destinations, some of these passengers will use MSP for international flights. This study assumed that 50 percent of the passengers using other North Atlantic and Pacific gateways are divertable to MSP international flights. In this forecast, it

was assumed that potentially divertable passengers will grow at the same rate as the FAA national forecast rate for individual enplanements and that NW will actually divert an increasing share of these passengers to MSP international services until the end of the forecast period.

Table 5-4 shows the estimate of total scheduled international enplanements at MSP, including passengers diverted from other gateways.

Aircraft Operations

Because of NW's dominance of scheduled international services, scheduled enplanements were converted into departures using NW operational factors. NW utilizes Boeing 747 aircraft on its international routes from MSP and in 1988 averaged 251.8 enplanements per departure. With 399 seats per aircraft this produced a 63.1 percent enplaning load factor. Given the relatively large existing size of aircraft in scheduled international service, no additional increases in aircraft size were projected. Load factor was assumed to increase at the rate forecast by the FAA until the year 2000 and to remain constant thereafter. Table 5-5 contains the forecasted scheduled operations.

Table 5-6 presents fleet mix information. The Boeing 747 will continue be supplemented by additional long-range aircraft, such as the MD-11 and A340, and new aircraft such as a 600-seat jumbo jet and a supersonic or hypersonic transport.

Peak Period

August is the peak month for international passenger enplanements, accounting for 14.7 percent of the annual total. September is the peak month for aircraft departures. However, since August is clearly the peak month for enplanements, and since it has virtually the same number of aircraft departures as September, August is used as the peak month for scheduled international activity.

Because of the small number of daily scheduled aircraft departures, ranging from fewer than two at present to about seven by 2020, it is difficult to project peak hour departures, particularly since they are very sensitive to individual air carrier decisions. In estimating the number of future peak hour aircraft arrivals and departures at MSP, daily distribution patterns at other international airports were examined.

International scheduled carrier peak period activity is summarized in Tables 5-4 and 5-5.

NON-SCHEDULED INTERNATIONAL CARRIERS

The level of non-scheduled international activity at MSP has exhibited wide fluctuations over the past decade. Because of these wide fluctuations, the correlation between non-

scheduled international enplanements and socioeconomic conditions is not as strong as in the case of scheduled enplanements. However, a relationship was identified between non-scheduled international enplanements and metropolitan area income. This was used to produce the forecast shown in Table 5-4.

Existing non-scheduled international aircraft will increase in size at the same rate as the FAA national forecast rate for international aircraft size (in number of seats) through 2000, at half the 1988-2000 rate between 2000 and 2010, and will remain constant thereafter. The fleet mix forecast for non-scheduled international carriers is characterized by the gradual replacement of older existing aircraft by new equipment and the eventual introduction of next-generation aircraft.

Peak period non-scheduled international passenger and aircraft activity is summarized in Tables 5-4 and 5-5.

NON-SCHEDULED DOMESTIC CARRIERS

The FAA does not develop national forecasts of aircraft size (in number of seats) for the charter carrier aircraft fleet. It was assumed that the average aircraft size for non-scheduled carriers will increase at the same rate as domestic scheduled carriers. Because average enplaning load factors on these aircraft are already very high, no further increases in load factor were projected. Consequently, the number of enplanements per aircraft departure is projected to increase at the same rate as aircraft size.

The assumptions used in developing the fleet mix for non-scheduled domestic air carriers are similar to those used in developing the scheduled air carrier fleet mix. A gradual replacement of existing aircraft with newer models, and the eventual introduction of the next generation of large aircraft is anticipated.

The methodology used to forecast peak month, average day peak month, and peak hour passenger enplanements and deplanements is the same as that used to calculate peaking characteristics for scheduled carriers. Because existing load factors are high, however, no additional increase in load factor was assumed during peak hours.

Tables 5-4 and 5-5 contain a summary of annual and peak period non-scheduled domestic activity.

5.3.5 Cargo and Mail

This section contains forecasts of cargo and mail shipped by air. Cargo is defined to include the business of passenger carriers, all-cargo carriers, and small-package/express carriers. Currently the U.S. Postal Service contracts with air cargo carriers rather than passenger carriers to ship its Express Mail packages, and these tonnages have been included with air cargo.

The pattern of air cargo traffic at MSP has followed the industry trends. For many years in a regulated industry, the air carriers emphasized passenger operations. The result was minimal cargo tonnages. Following deregulation, a dramatic increase in air cargo volumes occurred, carried by all-cargo carriers and the small-package express companies.

The forecast of total enplaned freight and express cargo at MSP is provided in Table 5-4. In distributing the total tonnage between types of service, it was assumed that the average annual relative change in tonnage in each category, with respect to the change in total tonnage over the past five years, would continue into the future. Implicit in the forecast is the assumption that small-package/express tonnage will continue to grow rapidly, that all-cargo freight will grow at a more moderate pace, and that passenger carrier cargo will continue to decline.

The conversions of forecasted all-cargo carrier and small-package/express enplaned tonnage levels to departures are shown in Table 5-5. Since the tonnage attributed to passenger air carrier activity will move in the belly space of existing passenger flights, there will be no additional departures associated with air carrier tonnages. The current (1988) tons per departure for the all-cargo carriers is 6.355. Since there is an increasing use of the older two- and three-engine jet aircraft and turboprop aircraft by all-cargo carriers, the lower, current figure is used as typical of the types of all-cargo carrier aircraft operated at MSP. Over the forecast period, the all-cargo carrier average tons per departure will increase 1.0 percent per annum to 7.910 in 2010, after which it will remain constant to reflect the use of such aircraft as 727-200s in place of 727-100s. In 1988 there were 101 all-cargo aircraft departures by NW. These passenger carrier all-cargo aircraft departures were projected to grow at the same rate as passenger carrier cargo and were then added to the all-cargo aircraft departures presented in Table 5-5. For the small-package/express companies, average tons per departure was also increased 1.0 percent per year until 2010. This caused a change from 8.424 to 10.486 enplaned tons.

Changes in the all-cargo and small-package/express carrier fleet mix are reflected in Table 5-6. The forecasts project a gradual increase in aircraft size combined with the replacement of older aircraft types with newer types. It was anticipated that the cargo carriers would lag slightly behind the passenger carriers in the adoption of new aircraft, as has been the historical case.

October is the peak month for air cargo activity, representing 8.83 percent of total departures, but there is relatively little variation from month to month. Peak period activity is summarized in Table 5-5.

Table 5-4 presents the forecast of enplaned mail tonnage. As a basis for forecasting mail carried by air, it was assumed that airline deregulation and current U.S. Postal Service practices would continue in the future. This includes the fact that all mail moves in the belly space of passenger flights.

5.3.6 General Aviation

General aviation operations at MSP and the nation as a whole have exhibited wide fluctuations as the result of both general economic conditions and ownership/operating costs. Table 5-5 presents the forecast of general aviation aircraft operations. This forecast was derived by using the assumption that the number of itinerant operations will change at the same rate as based aircraft, adjusted by the FAA forecast change in the number of hours flown (a proxy for operations) to based aircraft through 2000. The relationship between based aircraft and itinerant operations was assumed to remain constant thereafter. Local operations were assumed to be eliminated by 1988.

Table 5-5 also presents the forecast of peak period operations for general aviation. As with most airports, general aviation is more active at MSP in summer than in winter. The peak month is June, accounting for 9.45 percent of annual activity. It was assumed that existing relationships between annual, peak month, average day peak month, and peak hour operations will remain at existing levels through the forecast period.

5.3.7 Military

Since military operations are related to national and international political factors rather than local economic conditions, future military aircraft operations are held constant at the 1988 level of approximately 6,700. The number of local operations is estimated to decline to zero. Table 5-5 presents the forecast of annual and peak military aircraft operations.

The peak month for military aircraft operations is June, which represents 10.49 percent of annual operations. It is assumed that the existing relationship between annual, peak month, average day peak month, and peak hour operations will remain the same throughout the forecast period.

5.3.8 Summary

Total passenger enplanements at MSP are forecast to increase from 8.8 million in 1988 to 18.4 million by 2020, an average annual increase of 2.3 percent. Over the same period, total aircraft operations are forecast to increase from 368,474 to 515,750, an average annual increase of 1.1 percent. The principal increases are expected during the first half of the forecast period, largely the result of the expected growth in connecting passenger activity. Towards the end of the forecast period, growth of all activity measures is lower, reflecting basic economic/demographic conditions and the assumption that there is no further relative increase in hubbing activity. Tables 5-4, 5-5, and 5-6 contain a summary of this material.

Chapter 6

Facility Requirements

6.1 INTRODUCTION

This chapter identifies the facilities that are required at a new airport if it is to accommodate the forecast demand levels. Requirements have been developed for all of the various functional areas included within the airfield, terminal area, surface access system, and support areas. Detailed discussions on the rationale behind the facility recommendations are contained in the following.

6.2 RUNWAY LAYOUT REQUIREMENTS

6.2.1 Overview

The runway configuration of a new airport will need to be oriented so as to combine the most efficient operating mode of the runway system and the best runway alignment for wind coverage. A new airport will require sufficient capacity to meet forecasted average daily demand during both visual flight rule (VFR) and instrument flight rule (IFR) conditions, keeping delays at reasonable cost levels. The basic criterion for adding runways will be to evaluate amortized construction cost in relation to delay cost savings. Additionally, flexibility for expansion of the runway system (e.g., additional runways) for growth beyond the year 2020 will be incorporated.

6.2.2 Demand

As shown in Chapter 5, annual operations are forecast to reach 478,026 and 515,750 in the years 2010 and 2020, respectively. With these demand levels, average day operations will be 1,310 in 2010 and 1,412 in 2020. Peak hour operations during the average day will be 105 in 2010. By 2020, peak hour operations will increase to 117. Average day hourly distributions for the years 2010 and 2020 are provided in Table 6-1.

Table 6-1

Hourly Distribution of Average Day (Average Month) Operations
in Years 2010 and 2020

Hour	Year 2010	Year 2020
0600 - 0659	42	46
0700 - 0759	83	91
0800 - 0859	86	91
0900 - 0959	72	79
1000 - 1059	62	66
1100 - 1159	75	82
1200 - 1259	87	92
1300 - 1359	105	117
1400 - 1459	56	58
1500 - 1559	41	43
1600 - 1659	70	76
1700 - 1759	95	103
1800 - 1859	94	102
1900 - 1959	98	104
2000 - 2059	59	64
2100 - 2159	65	70
2200 - 2259	69	75
2300 - 2359	17	18
0000 - 0559	32	35

Source: HNTB.

6.2.3 Wind and Weather

Using all-weather wind data from the Minneapolis-St. Paul International Airport Climatological Summary for the years 1948 through 1978, wind coverages for alternate runway alignments were determined. This data was used since, although ceiling and visibility conditions can vary considerably from point to point, wind velocities and directions are consistent throughout the area. The FAA recommends a 20-knot maximum crosswind component for determining the wind coverage for runways 150 feet wide (typical air carrier runway width). Other considerations such as drifting or falling snow could also indicate that a crosswind runway is necessary.

The wind rose for MSP is presented in Figure 6-1. Table 6-2 presents the coverages for various compass headings. The heading providing the best wind coverage for all-weather conditions with a 20-knot crosswind component is the 146-degree/326-degree alignment. This alignment provides a 99.8 percent coverage. Additional coverages with a 15-knot

crosswind are shown in the table to demonstrate the orientations that best cover winds in the 15- to 20-knot range.

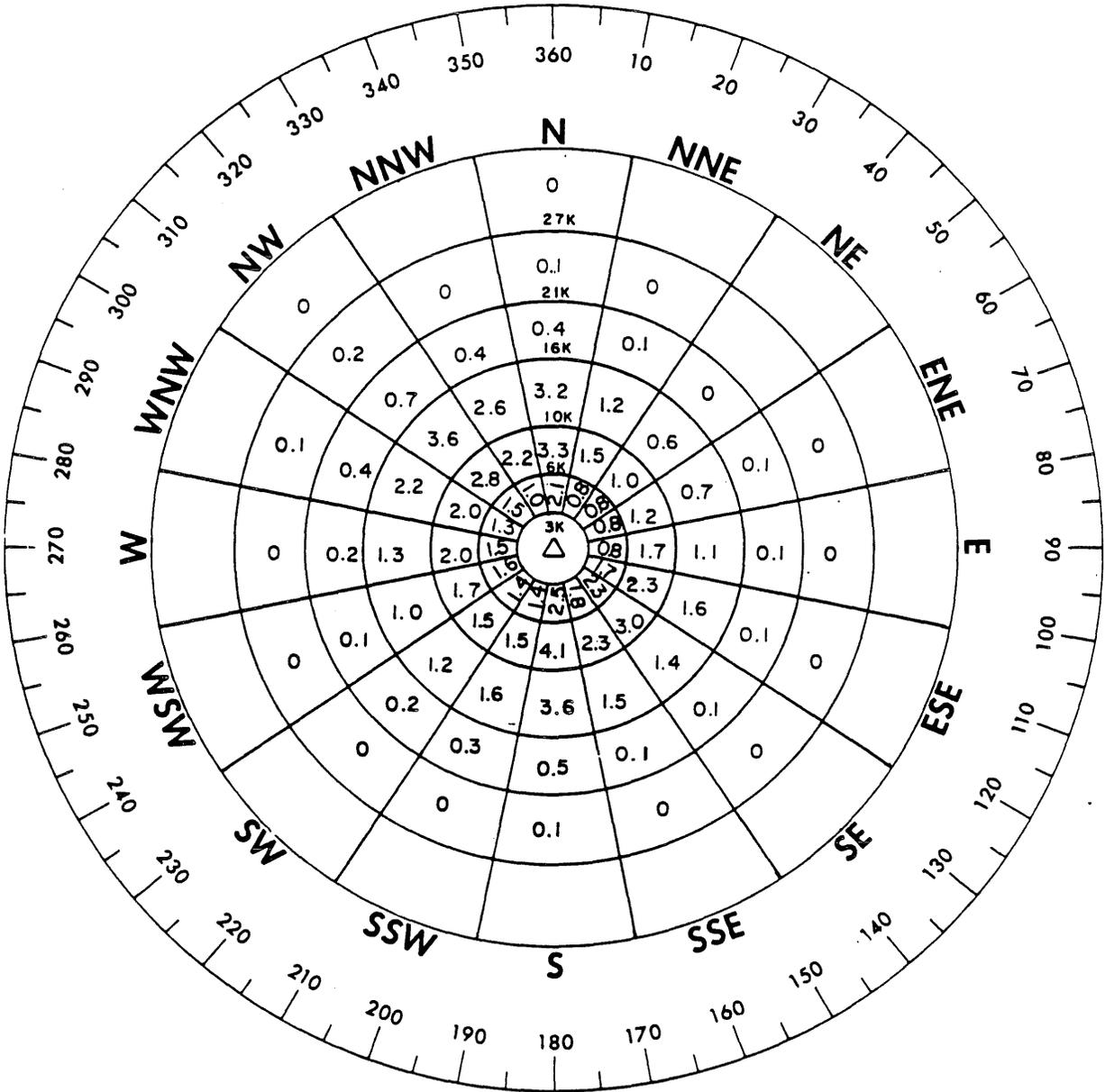
Table 6-2
All-Weather Wind Coverage
(Percentages)

Runway Heading	15 Knot Crosswind	20 Knot Crosswind
18/36	97.0	99.5
01/19	96.4	99.4
2/20	95.8	99.2
3/21	95.2	99.1
4/22	94.9	99.0
5/23	94.9	99.0
6/24	95.0	99.1
7/25	95.4	99.2
8/26	95.7	99.3
9/27	96.1	99.4
10/28	96.7	99.5
11/29	97.4	99.7
12/30	97.8	99.7
13/31	98.1	99.8
14/32	98.2	99.8
15/33	98.2	99.8
16/34	97.9	99.8
17/35	97.5	99.7

Source: National Oceanic and Atmospheric Administration.

Analysis of the MSP Climatological Summary indicates that roughly 1.3 percent of the year, or 4.6 days, prevailing winds are out of the northeast and southwest during snow and icing conditions. Based on this data and conversations with the MAC and FAA Air Traffic Control Tower staff, it is likely that a crosswind runway(s) will be required so that aircraft operations can continue during these poor weather conditions.

Two general combinations of ceiling heights and visibilities have been identified to determine how traffic may be handled at the airport. Additionally, there are three separate IFR approach minimums that affect how efficiently the airport may be used.



Calms Δ = 10.2%

Source: NOAA Observations at Minneapolis-Saint Paul between 1948 and 1978.



The minimum requirements for VFR operations are a ceiling height of 1,000 feet and 3 miles visibility. When the ceiling and visibility are below these minimums, all operations at the airport must follow instrument flight rules. Data collected by the U.S. Air Force (USAF) indicates that VFR weather conditions occur approximately 90.8 percent of the year. This provides a detailed breakout of the percent occurrence of various ceiling and visibility conditions which supplements the NOAA data.

Within these VFR conditions, when the ceiling is above 2,500 feet (AGL) and visibility is greater than 5 miles, all approaches to the runway system can be made using visual flight rules. USAF data indicates that these conditions occur approximately 72.0 percent of the time. When the ceiling is below 2,500 feet or visibility is less than 5 miles (18.8 percent of the time), those aircraft operating with an instrument flight plan must follow instrument approach procedures until visual contact with the runway is made.

There are three ceiling and visibility minimums that can control how efficiently the airport may be used in IFR conditions (9.2 percent of the year).

The FAA has approved the use of converging instrument approaches at some airports. The ceiling and visibility minimums for this type of procedure are as low as a 700-foot ceiling and 2 miles visibility. This procedure could be used with ILS Category I systems 4.3 percent of the time at a new airport.

A new airport will be below the converging approach minimums approximately 4.9 percent of the time. Standard ILS approaches, Category I, have 200-foot approach minimums and one-half mile visibility. Category I ILS approaches can be used approximately 4.3 percent of this time.

When the ceiling or visibility are below the Category I approach minimums, either Category II or III approaches are required for operations. These types of approaches have ceiling and visibility minimums of 100 feet and one-quarter mile visibility down to zero feet and zero visibility. IFR conditions that require these types of approaches occur approximately 0.6 percent of the year. The occurrences of the various ceiling/visibility conditions are summarized in Table 6-3.

Table 6-3

Summary of Ceiling and Visibility Criteria

Ceiling	Visibility	Occurrence (%)
<u>VFR</u>		<u>90.8</u>
≥ 2,500' AGL	> 5 miles	72.0
1,000' - 2,500' AGL	3 to 5 miles	18.8
<u>IFR</u>		<u>9.2</u>
≥ 700' AGL	≥ 2 miles	4.3
200' - 700' AGL	≥ 1/2 mile	4.3
< 200' AGL	< 1/2 mile	0.6

Source: U.S. Air Force Environmental Technical Applications Center (12/4/87).

6.2.4 Demand/Capacity Analysis

To determine the number of runways required at a new airport, busy hour operations in both VFR and IFR conditions were analyzed. Typical VFR and IFR capacities for two, three, and four independent runways were compared to the forecast level of hourly operations. Table 6-4 is a comparison of these capacities and an hourly distribution of forecast operations for the years 2010 and 2020.

Table 6-4

Forecast of Hourly Operations
and Typical Runway Capacities in 2010 and 2020

Hour	Activity Forecast		Arrival or Departure Peak	Typical Runway Capacities (Arrival/Departure Peaks)		
	Year 2010	Year 2020		VFR		IFR
0600 - 0659	42	46	A			
0700 - 0759	83	91	D	2-Runway System ^a	107/110	98/105
0800 - 0859	87	90	A			
0900 - 0959	72	79	D	3-Runway System ^a	160/167	108/117
1000 - 1059	62	66	A			
1100 - 1159	76	82	D	3-Runway System ^b	160/167	115/123
1200 - 1259	88	92	A			
1300 - 1359	105	117	D	3-Runway System ^c	160/167	147/155
1400 - 1459	56	59	D			
1500 - 1559	41	45	D	4-Runway System ^a	209/210	109/119
1600 - 1659	70	75	A			
1700 - 1759	95	103	D	4-Runway System ^b	209/210	121/130
1800 - 1859	94	101	A			
1900 - 1959	97	103	D	4-Runway System ^c	209/210	158/170
2000 - 2059	58	64	D			
2100 - 2159	65	69	A			
2200 - 2259	69	74	D			
2300 - 2359	17	19	A			
0000 - 0559	32	35	N/A			

Source: HNTB analysis.

^aAssumes two independently spaced IFR runways.

^bAssumes two independently spaced and one dependently spaced IFR runways.

^cAssumes three independently spaced IFR runways.

CAPACITY OF TWO INDEPENDENT-RUNWAYS

Two independent runways have a capacity of 107 and 98 operations per hour in VFR and IFR conditions, respectively, based on arrival peaking conditions, and 110/105 operations per hour in departure peaking conditions. Although demand in the year 2010 will not exceed the maximum VFR hourly capacity, there is one hour where demand will exceed 90 percent of capacity and an additional three hours where demand will exceed 80 percent of capacity. Three of these hours are in succession. By 2020, demand will exceed 80 percent of capacity for seven hours.

During IFR conditions, hourly demand in horizon year 2010 will exceed capacity for one hour, exceed 90 percent of capacity for an additional four hours, and exceed 80 percent of capacity for one hour. Three of these hours occur between 5 and 8 p.m. By 2020, demand will approach (80 percent of capacity) or exceed capacity for seven hours.

CAPACITY OF THREE INDEPENDENT RUNWAYS

VFR capacity for three independent runways is 160-167 operations per hour, assuming they are independent during VFR conditions. Peak hour demand in the year 2020 will represent approximately 70 percent of the capacity.

During IFR conditions, the hourly capacity of the runway system will vary between 108 (two independent runways) and 147 (three independent runways) operations per hour (arrival peak), depending upon runway separations. The three-runway configuration with runway separations sufficient to accommodate only two independent IFR traffic streams will experience similar IFR capacity constraints as the two-independent-runway system described earlier. In 2010, demand in one hour per day will equal capacity, exceed 90 percent of capacity for four hours, and exceed 80 percent of capacity for one hour. By 2020, the peak hour demand will approach or exceed the capacity of the runway system for seven hours.

A three-runway system with sufficient separation to accommodate two independent and one dependent IFR traffic streams will have an IFR hourly capacity of approximately 115 operations per hour (arrival peak). This configuration will experience one hour per day in 2010 where demand will exceed 80 percent of capacity. By 2020, demand will equal capacity for one hour, exceed 90 percent of capacity for one hour and 80 percent of capacity for three successive hours.

Finally, a three-runway system with sufficient separation to accommodate three IFR traffic streams will have an IFR capacity (arrival peak) of approximately 147 operations per hour. With this configuration, no hours of the day will have a demand that exceeds or approaches capacity in 2010 or 2020.

CAPACITY OF FOUR INDEPENDENT RUNWAYS

VFR capacity for a four-independent-runway configuration is approximately 209-210 operations per hour. Demand in the years 2010 and 2020 will always be less than the runway system capacity.

Similar to the three-runway layout, IFR capacity will vary between 109 and 148 operations per hour (arrival peaks), depending upon the separation between runways. For a runway configuration with runway separations sufficient to accommodate two independent IFR traffic streams only, capacity will be 109 operations per hour (arrival peak). This is slightly higher than the three-runway system, because some additional departures can be accommodated. With this configuration, demand equals capacity for one hour, exceeds

90 percent of capacity for four hours, and exceeds 80 percent of capacity for one hour of the day in the year 2010. Three of these hours are in succession. By 2020, demand in the peak hour will approach or exceed capacity for seven hours.

A four-runway configuration with sufficient separation for two independent and one dependent IFR traffic streams has a capacity of 121 operations per hour (arrival peak). With this configuration, demand in 2010 during IFR conditions exceeds 80 percent of capacity for one hour. By 2020, one hour will equal IFR capacity, exceed 90 percent of capacity for one hour, with one additional hour exceeding 80 percent of capacity.

A four-runway configuration with three independent IFR traffic streams has a capacity of 148 operations per hour. Demand in the years 2010 and 2020 will always be less than 80 percent of capacity.

SHORT RUNWAY

A short runway intended to handle commuter and general aviation aircraft operations can be incorporated into each of the runway layouts described previously. This idea will be analyzed as part of the alternative evaluation.

6.2.5 Delay Analysis

Average runway delay per operation for each of the runway configurations described previously (two, three, and four runways) was estimated using the FAA Annual Delay Model. The capacity review showed that a new airport will need at least two independent and one dependent IFR traffic streams. As shown in Table 6-5, average delays with this type of runway configuration in 2010 will have an annual cost of delay to the airlines of \$12 million.¹ By 2020, average delay costs of up to \$16 million are anticipated.

1. All delay costs are based on arrival and departure delay costs obtained from the *World Aviation Directory* (Summary and Winter '89), U.S. Department of Transportation, Form 41s, and *Business and Commercial Aviation* (June 1988).

Table 6-5

Forecast of Average Annual Delay and Cost
(aircraft operating costs in millions of dollars)

Runway Configuration and IFR Traffic Streams		Year 2010		Year 2020	
		Minutes per Operation	User Costs	Minutes per Operation	User Costs
Two-Runway	(2 IFR)	2.97	\$31.1	3.89	\$43.4
Three-Runway	(2 IFR)	1.50	\$15.7	1.85	\$20.6
Three-Runway*	(2.5 IFR)	1.17	\$12.2	1.39	\$15.6
Three-Runway	(3 IFR)	1.07	\$11.2	1.28	\$14.2
Four-Runway	(2 IFR)	1.17	\$12.2	1.44	\$16.1
Four-Runway	(2.5 IFR)	.84	\$8.8	.99	\$11.2
Four-Runway	(3 IFR)	.75	\$7.8	.87	\$9.7
Five-Runway	(3 IFR)	.60	\$6.2	.69	\$7.7

Source: HNTB analysis.

* Two independent and one dependent IFR traffic streams.

A three-runway configuration with three IFR arrival streams serves demand efficiently. With this runway configuration, average delays in the year 2010 are 1.07 minutes per operation and delay cost is \$11.2 million. Average delays in the year 2020 are 1.28 minutes, with a delay cost of \$14.2 million.

The FAA currently permits a maximum of three independent IFR traffic streams at an airport. However, adding a fourth independent VFR runway to these configurations can reduce projected delay for the years 2010 and 2020 at a new airport even further. Assuming that the runways have separations sufficient to allow for two independent and one dependent IFR traffic streams, average delay in the year 2010 represents an annual delay cost of \$9 million. By the year 2020, average delay cost with this four-runway configuration is \$11 million.

Assuming there is sufficient separation between runways to allow three independent IFR traffic streams, delays during IFR conditions can be reduced further. Average delay for this four-runway configuration in the year 2010 results in an annual delay cost of \$8 million. By the year 2020, average delays with this configuration will have a delay cost of \$10 million.

Table 6-5 is a summary of the runway configurations and their associated delays and delay costs for the years 2010 and 2020.

6.2.6 Number of Runways

The number of runways required for a new airport depends upon the overall capacity need and the number of runway orientations selected. Previously, a northwest/southeast configuration was identified as having the highest wind coverage, with 99.8 percent coverage for a 20-knot crosswind component. By orienting these runways in a single direction, the number of runways required can be kept to a minimum. The demand/capacity analysis verifies that at least three runways are required to effectively serve forecast demand levels. However, it also suggests that four runways may be needed to reduce the level of delay to an acceptable level.

Although a single direction can satisfy the FAA requirement of 95 percent wind coverage with a 20-knot crosswind component, a second orientation is desirable. During the winter months, blowing, drifting, and falling snow and ice associated with northeasterly/southwesterly winds make the clearing of drifting snow from northwest/southeast oriented runways difficult (as demonstrated at MSP). This can result in strong crosswinds on slippery runways, which can significantly reduce their crosswind component. Without a second runway orientation, the airport may have to close until snow removal crews can remove snow from the runways. Analysis of weather data for MSP, obtained from the National Climatic Center, indicates that such conditions occur approximately 1.3 percent of the year.

Furthermore, with only one runway orientation, more aircraft are required to operate with higher crosswinds. The provision of a second runway orientation allows aircraft to operate more directly into the wind, when the primary runway direction is experiencing strong crosswinds.

With a two-direction orientation, five runways are required. Two of these runways must be aligned for crosswinds and drifting snow, with three of these runways aligned for good overall wind coverage, perpendicular to the crosswind runways. The crosswind runways will be integral parts of principal operating configurations as wind conditions permit.

6.3 RUNWAY REQUIREMENTS

6.3.1 Landing and Takeoff Length

Runway length requirement calculations were made based on a number of assumptions: (1) that the average high temperature (in July) will be 83 degrees F., as it is at MSP; (2) that the new airport will be at an elevation of 841 feet MSL, the same as MSP; and (3) that there will be no runway gradient. Calculations were made for predominant aircraft in the forecast traffic mix at Maximum Takeoff Weight and Maximum Landing Weight. Additionally, takeoff lengths for varying stage lengths were made using payload factors of 100 percent passengers, 50 percent cargo. These calculations are presented in Table 6-6.

Aircraft assumed to be in service at the time a new airport would be operational were examined. Some aircraft currently used for domestic flights (e.g., 727-200s) may not be in service or will be used on a limited basis. The following is a list of those aircraft anticipated to be in frequent use on most domestic flights in the future.

MD-80/90	B-767-200
B-737-300	A-320-200 and
B-737-400/500	A-321
B-757-200	BAe-146-200

After reviewing the runway lengths required for these aircraft, a length of 9,000 feet was determined necessary for runways used routinely for departures. This length is sufficient for departures by the older, limited-service 727-200s and 737-200s with stage lengths of 1,600 miles or less. Furthermore, a 727-200 with a stage length of up to 1,900 miles and a payload of 100 percent passengers and 50 percent cargo could depart from a runway of this length.

International flights (those beyond North and Central America) will most likely be served by the following aircraft:

B-747-200	A-300-600, 330, and 340
B-747-400	A-330 and A-340
B-767-300ER	(no data available for
B-777 (no data available)	A330 and A340)
DC-10-40	MD-11/12 (no data available)
L-1011	

At Maximum Takeoff Weight, these aircraft require up to 14,400 feet of runway (DC-10-40) for departures. However, Northwest Airlines has plans to modify the engines on the DC-10-40s such that flights to Europe will require lengths of approximately 11,000 feet. Northwest does not have plans to use this aircraft on flights from Minneapolis to the Orient. Therefore, the B-747-200, with a length requirement of 12,300 feet, is the critical aircraft.

Table 6-6

Runway Length Requirements
for Design Loads (1) and at Maximum Weights
Uncorrected for Runway Gradient

Aircraft	Required Takeoff Length (feet) at Design Load								Maximum Takeoff Weight (lbs.)	Required Length at Maximum Takeoff Weight	Required Landing Length at Maximum Landing Weight
	500 Mi Trip	1000 Mi Trip	1500 Mi Trip	2000 Mi Trip	3000 Mi Trip	4000 Mi Trip	5000 Mi Trip	6000 Mi Trip			
B-727-200 (JT8D-15)	5,739	6,605	7,539	8,911	-	-	-	-	189,000	10,233	5,379
B-737-200 (JT8D-15)	5,768	6,663	-	-	-	-	-	-	112,600	6,907	5,447
B-737-300 (CFM56-3-B1)	5,165	5,856	6,809	-	-	-	-	-	124,500	6,910	5,545
B-737-400 (CFM56-3-B1)	5,545	6,153	7,091	-	-	-	-	-	138,500	8,034	5,253
DC-9-30 (JT8D-9)	5,875	7,573	-	-	-	-	-	-	115,000	8,696	5,486
DC-9-50 (JT8D-17)	6,362	-	-	-	-	-	-	-	124,500	10,039	5,584
MD-82 (JT8D-217)	5,822	6,547	7,636	-	-	-	-	-	149,500	8,351	5,739
B-747-200B (JT9D-7A)	5,078	5,496	6,002	6,488	7,646	8,979	10,780	-	785,000	12,286	8,366
B-747-400 (PW4056)	5,817	5,934	6,031	6,128	6,975	8,025	9,134	11,630	870,000	12,089	8,254
B-757-200 (PW4037)	4,543	4,864	5,224	5,613	6,518	-	-	-	240,000	7,782	5,545
B-767-200 (CF6-80A)	4,825	4,995	5,370	5,768	6,693	-	-	-	315,000	6,979	5,684
B-767-300ER (CF6-80C2-B4)	5,482	5,754	6,055	6,420	7,339	7,996	9,565	-	380,000	9,572	6,625
L-1011-385-1 (RB211-22B)	5,720	6,323	6,955	7,626	-	-	-	-	430,000	9,835	6,493
DC-10-40 (JT9D-20)	6,294	7,236	8,168	9,588	13,325	-	-	-	555,000	14,400	6,800
A-300-600 (JT9D-7R4H1)	5,044	5,404	6,094	6,766	-	-	-	-	363,760	9,300	6,216
A-320-200 (CFM56-5A1)	5,010	5,214	6,663	7,626	-	-	-	-	158,731	7,623	5,756
BAe 146-200 (ALF502R-5)	4,011	5,452	-	-	-	-	-	-	89,500	6,758	4,067

(1) 100% Passenger Load; 50% Cargo Load

Sources: FAA AC 150/5325-4; B-737, B-747, B-757, B-767, MD-80,
A300, A320, BAe 146, Planning Manuals.

Flights to London and other Western European cities by B-747, B-767, and DC-10-40 aircraft require departure runway lengths between 8,000 feet and 12,300 feet for a typical payload of 100 percent passengers and 50 percent cargo. With long-haul international flights expected to be limited, a single runway of 12,500 feet is adequate.

For predominant landing runways, the lengths need to be sufficient to accommodate the most demanding aircraft as well as meet the length requirements of advanced instrument approach systems.

Large aircraft such as the B-747-400 require one arrival runway 8,300 feet long. At this length, all other aircraft are able to use this runway for arrivals. Since a new airport requires more than two arrival runways for capacity purposes, the additional runways need to be at least 8,000 feet long. This length will accommodate most aircraft except the B-747-200B and B-747-400 at Maximum Landing Weight. Additionally, this length is the minimum recommended length for a Category II/III ILS runway by the Air Transport Association. Given the 8,300-foot landing requirement for B-747-400 landings and the 9,000-foot length for departures, all runways (except one 12,500-foot runway) are planned to be 9,000 feet long.

6.3.2 Runway Width

A typical runway width for Group V aircraft is 150 feet. This dimension meets the needs of the aircraft discussed previously. Future Group VI aircraft may require a 200-foot runway width. Although there are currently no Group VI aircraft in service, the 12,500-foot runway should have a width of 200 feet.

6.3.3 Runway Clearances

Runway clearances addressed in this section include Building Restriction Lines (BRL), aircraft parking limit lines, and runway safety areas. Each of these criteria provides clearances from potential hazards for routine operations for aircraft operating on the airport's runways.

BRLs provide the necessary clearances between buildings or other fixed objects and runway centerlines. The BRL should be located to identify suitable locations for building areas on the airport. The FAA recommends that the BRL encompass the runway protection zones, areas required for the airport traffic control tower clear line of sight, the runway visibility zone, and all airport areas with less than a 35-foot clearance under FAR Part 77 surfaces. To determine the maximum permissible height of structures at any location, a 7:1 sloping line beginning 500 feet from the runway centerline was used.

Aircraft parking limit lines define the closest distance that the tail of an aircraft parked at the terminal can be to a runway, according to FAR Part 77 criteria. Aircraft parking limit lines are particularly useful in developing airport terminal concepts. At a new airport, a 945-foot aircraft parking limit (distance from runway centerline) must be maintained at gates accommodating B-747 aircraft, a 907-foot limit line used for DC-10/L-1011/A330/A340 aircraft at other gates, and an 816-foot limit for gates serving B-757 aircraft or smaller.

The runway safety area is provided for airplanes which undershoot, overrun, or veer off the runway. It also provides improved accessibility for firefighting and rescue equipment during emergencies. The FAA standard runway safety area for transport runways is 500 feet wide along the entire length of the runway, 250 feet on each side of the centerline, and extends 1,000 feet beyond the runway ends at the full 500-foot width. This area should be graded and free of structures, traverse ways (road, railroads, etc.), and parking areas, although frangibly mounted nav aids may be permitted because of their essential function. The safety area should be capable of supporting airplanes without causing structural damage to the airplane or injury to its occupants. Runway safety areas will be required for all of the runways at a new airport.

6.4 TAXIWAY REQUIREMENTS

Full-length parallel taxiways should be provided for all runways. Additionally, parallel and apron edge taxiways should be provided for two-directional taxiing around the terminal area. All runways incorporate state-of-the-art spiral exit taxiways to minimize runway occupancy times of landing aircraft. Detailed taxiway layouts are addressed in subsequent phases of the study.

According to FAA criteria, taxiway clearance requirements (centerline to fixed or movable objects) are 193 feet for Group VI aircraft, 160 feet for Group V (B-747-400) aircraft, and 129.5 feet for Group IV (DC-10/L-1011) aircraft. While Group V criteria have been used for the overall planning of a new airport, provisions for Group VI aircraft have been incorporated into the design of the terminal area.

For those areas requiring two parallel taxiways, apron areas, or taxiways to runway ends, the separation between taxiways should be 267 feet for Group V aircraft. Separation between parallel taxiways for the longest runway should be 324 feet for Group VI aircraft.

6.5 NAVIGATIONAL AND LANDING AID REQUIREMENTS

All runway ends should be provided with ILS/MLS approach equipment. Additionally, two or more runways should have Category II or III ILS equipment (or its MLS equivalent).

6.6 TERMINAL REQUIREMENTS

6.6.1 Introduction

The facility requirements for the passenger terminal area at a new air carrier airport are presented in this section. Separate analyses were undertaken for domestic, regional, international, and charter passengers. Descriptions and facility requirements are provided for each of these categories individually and in summary form. For each category, facility and user characteristics are discussed and facility needs summarized. As stated in the activity forecast chapter, "regional" and "commuter" airlines are defined to be the same.

Requirements for the passenger terminal were developed using a passenger simulation computer model. This model integrates the standards set forth in FAA guidance materials such as the *Apron and Terminal Building Planning Manual* with the practical knowledge of TRA Airport Consulting in terminal design issues and relevant industry standards.

This analysis was supplemented by information obtained by applying the methodology set forth in FAA Advisory Circular 150/5360-13, "Planning and Design Guidelines for Airport Terminal Facilities," and related reference materials. In addition, the results of several user surveys which were performed for the ongoing Long-Term Comprehensive Plan MSP and earlier planning efforts were incorporated into the work. While these surveys were performed at MSP, it is reasonable to assume that the results are generally applicable to a new air carrier airport. The following discussions provide details on the factors used in projecting future space requirements as well as the basic assumptions used in analyzing the individual terminal elements.

6.6.2 Domestic Terminal

In this section, the basis on which facility requirements for domestic passenger activity were calculated is presented. As part of this effort a general discussion of domestic passenger terminal facility elements is provided.

PASSENGER AND FACILITY CHARACTERISTICS

Each airport and the passengers it serves have unique characteristics. Characteristics unique to MSP that influence terminal planning, and specific information relevant to a new air carrier airport for the Twin Cities area, are presented in the following.

Passengers

The sizing and types of facilities required at an airport terminal building are influenced by the number, types, and characteristics of passengers being served. Previous chapters in this report present data on the socioeconomic and demographic characteristics of the Twin

Cities area and the activity forecasts, through the year 2020. As this data shows, the combination of locally generated demand and through and connecting passengers using Northwest Airlines (NW) has created significant increases in forecast demand levels: from 7.904 million enplanements in 1988 to 15.75 million enplanements in 2020. Additional information on projected passenger activity, particularly peak period data, is provided in Chapter 5.

A passenger survey performed at MSP in the summer of 1985 provides a large amount of useful information on passenger characteristics. This survey indicated that there were on average (over the period of the survey) 1.2 visitors (well-wishers/greeters) per domestic passenger. The number of connecting passengers influences this ratio, since these passengers typically do not generate visitors. If connecting passengers are not considered, the ratio increases to 2.1 visitors per originating and terminating passenger. However, the survey indicates that during the peak hour this ratio declines to approximately 1.7. The ratio during the peak hour was used in the calculation of facility requirements.

The number of bags per passenger impacts the size of inbound and outbound baggage facilities. At MSP, airline-generated data shows an average of 1.5 checked bags per domestic passenger.

Airline Station

MSP is one of NW's primary hubs. It is a major transfer point for NW passengers. This study assumes that a new air carrier airport replacing MSP will continue to be a NW hub and have the same high level of connecting passengers. Approximately 47 percent of the domestic scheduled passengers at MSP are connecting passengers and may never have need to use all of the available facilities. Connecting passengers are expected to be 58 percent of the total by the end of the forecast period.

Terminal Design

The configuration of terminal facilities has a significant influence on facility requirements. Decentralized or unit terminals often duplicate space, while centralized terminals of the same size do not. The Lindbergh Terminal at MSP is a centralized terminal. Its size has increased on an incremental basis in response to increases in demand. Terminal area development has also been influenced by site constraints. The resulting building configuration, a passenger terminal with four attached concourses and international and regional terminal areas, does not represent an optimum configuration for either current or projected future needs. This type of terminal configuration necessitates a redundancy in certain passenger service facilities and circulation space. At the Lindbergh Terminal, space dedicated to circulation accounts for approximately 30 percent of the total terminal area.

At a new airport, development of an optimum configuration should be possible. Consolidation of airline operations, for example, should allow more efficient circulation and less duplication of domestic, regional, and international passenger processing facilities. Thus it was assumed that circulation space at a new airport would be 25 percent of the total.

At the existing terminal, mechanical and electrical systems account for 12 percent of the total terminal area. This percentage was also used in developing requirements for a new airport.

Other Terminal Building Tenants

Besides the airlines and concessions directly associated with passengers, the domestic terminal at MSP has numerous other tenants. All of them in some way serve the aviation industry. These tenants occupy 1 percent of the total terminal building space. For this study, it was assumed that these types of tenants will continue to occupy 1 percent of total terminal area. One of the largest terminal tenants is the Metropolitan Airports Commission, which occupies over 39,000 square feet of terminal building space. It was assumed that office space requirements for the MAC will remain constant.

FACILITY REQUIREMENTS

Facility requirements for the domestic air carrier terminal at a new airport were determined by analyzing a number of terminal elements, which are discussed in this section. Table 6-7 summarizes the assumptions used in developing the facility requirements. The requirements themselves are presented in Table 6-8.

Table 6-7

Assumptions for Domestic Terminal Facilities

Terminal Element	Factor	Comment/Source
1. Transfer Passengers	1988 = 47% 2020 = 58%	Forecast chapter
2. Visitors per Passenger	1.7	Passenger Survey (1985)
3. Baggage per Passenger	1.5	Airline Survey (1989)
4. Peak Hour Passengers	Varies	Forecast chapter
5. Ticketing Rates	2.6 min./ passenger	Average of existing (3.0) vs. airline goal (2.2) from Airlines Surveys
6. Security Inspection Rate	600 people/hr.	Industry Standard
7. Area/Security Station	120 SF	FAA Guidelines
8. Visitors through Security	75%	Consultant Estimate
9. Peak Period of Peak Hour	20 minutes	FAA/Industry Standards
10. Peak Hour Passengers in Peak Period	50%	FAA/Industry Standards
11. Ticket Counter Frontage	12.0 LF/2 agent positions	FAA Guidelines (lower than MSP existing)
12. Depth/Ticket Counter	10 LF	Existing/FAA Guidelines
13. ATO Depth/LF Frontage	30 LF	FAA Guidelines
14. Queuing Area/Person	13 SF	Industry Standard
15. Baggage Claim Device Frontage	185 LF/Device	Assume large 2-feed rectan- gular devices larger than existing at MSP
16. Visitors in Bag Claim	25%	Consultant Estimate
17. Baggage Claim Lobby Area/Person	15 SF	Industry Guidelines
18. Baggage Claim Service Goal	15 minutes	Industry Guidelines
19. Inbound Baggage SF/Claim Device	4,900 SF	FAA Criteria
20. Restrooms (Public)	1,800 SF/500 peak hour pax	FAA Criteria
21. Gift & News Concessions	2,500 SF/million annual enpl.	FAA Criteria
22. Rental Car and Limo	350 SF/million annual enpl.	FAA Criteria
23. Barber/Shoeshine	110 SF/million annual enpl.	FAA Criteria
24. Insurance	30 SF/million annual enpl.	FAA Criteria
25. Other	270 SF/million annual enpl.	FAA Criteria
26. Miscellaneous Tenant	1% Total Terminal Area	Inventory
27. General Circulation	25% Total Terminal Area	Consultant Estimate
28. Mechanical/Electrical	12% Total Terminal Area	Inventory

Source: TRA Airport Consulting.

Table 6-8

Domestic Terminal Requirements

Terminal Element	Unit of Measurement	Year 2010	Year 2020
Departing Passengers			
Ticket Counters			
Frontage	LF	1,146	1,202
Agent Positions	#	191	200
Area	SF	11,460	12,020
ATO	SF	38,980	40,860
Ticket Lobby	SF	57,320	60,080
Outbound Baggage	SF	111,840	116,340
Airline Administration	SF	8,610	8,900
Security Stations	#	22	23
Arriving Passengers			
Baggage Claim Lobby	SF	74,750	74,750
Devices	#	13	13
Device Frontage	LF	2,405	2,405
Inbound Baggage	SF	58,800	63,700
Baggage Service	SF	3,660	3,970
Gate Facilities			
Passenger Waiting Areas	SF	212,110	213,200
Concourse Circulation	SF	-- See General Circulation --	
Ramp Operations	SF	230,700	239,200
VIP Clubs	SF	18,300	18,900
Public Spaces			
Restrooms/Nursery	SF	53,750	56,310
Concessions			
Food Preparation	SF	15,700	15,980
Snacks/Restaurants	SF	65,400	66,600
Cocktails	SF	39,240	39,960
Miscellaneous Food	SF	10,460	10,560
Gift & News	SF	37,600	39,400
Traveler's Aid/USO	SF	3,770	3,770
Rental Car/Limo	SF	5,300	5,500
Other Concessions	SF	6,300	6,500
Miscellaneous Tenants	SF	21,940	22,510
Mechanical/Electrical Systems	SF	263,295	270,085
Heating Plant	SF	20,000	20,000
Building Administration	SF	39,435	39,435
General Circulation	SF	<u>658,230</u>	<u>675,230</u>
Total Domestic	SF	2,066,950	2,123,760

Source: TRA Airport Consulting.

Enplaning Passenger Areas

Upon arrival at the terminal building, the first processing facilities normally used by enplaning passengers are the curbside check-in unit and the ticket counter. Their baggage, once checked, is processed through the outbound baggage make-up areas.

The number of ticket agent positions is directly tied to the number of originating passengers requiring processing within the peak 20-minute period. Once this element is determined, other parameters such as total ticket counter length and counter area can be estimated.

Baggage make-up area requirements are determined from calculations which take into account the total number of peak hour passengers, the number of airplane gates being served, and the average number of bags being checked by each passenger. A baggage sorting factor is included to assure that the volume of connecting baggage is being taken into account. The sorting facility need not be located in the same place as the make-up area. It may perform more efficiently if located in the ramp area. The actual location should be determined by the individual airlines.

The activity forecast provided data on peak hour passengers. Airline surveys supplied information on parameters such as ticket counter design standards, passenger processing times and goals, and baggage facilities.

Transition Areas

Once through processing, enplaning passengers proceed to the passenger transition areas. These consist of the security checkpoints, passenger waiting areas, and aircraft loading equipment. In these areas, facility requirements are determined by the volume of enplaned passengers.

Requirements for security checkpoints are determined by the volume of originating enplaned passengers who must be processed during peak periods. Since the number of units is affected by the number of access points, the requirement determined from peak hour passenger levels represents a minimum. Some airports allow only ticketed passengers access to the concourse. At MSP there is no restriction. This requires an assessment of the number of greeters and well-wishers. The security station processing rate used is shown in Table 6-7.

The number of passenger waiting areas and their size is determined by a combination of the number of enplaning passengers (both originating and connecting), the number of aircraft gate positions, and the size of the largest aircraft capable of using each gate. Passenger waiting area requirements were based on airline standards for hub locations. These are consistent with FAA guidelines, and are shown in the following.

<u>Aircraft Design Group*</u>	<u>Number of Seats per Aircraft</u>	<u>Passenger Waiting Area Dimensions</u>
III	61-160	2,000 SF
IV	161-280	4,000 SF
V	>280	5,000 SF

*As defined by FAA Advisory Circulars.

Deplaning Passenger Areas

Deplaning passenger areas include those facilities used by passengers as they transition from the airside to the surface access system. Connecting passengers are considered to be deplaning only to the point where they have begun to search for the aircraft to which they will connect. This point is when they enter the corridor from the aircraft loading bridge. From this point on in their journey they are classified as enplaning passengers.

Facilities provided for deplaning passengers focus primarily on baggage claim. Included are inbound bag areas, claiming devices, and baggage service areas. Requirements were determined using the level of peak hour passengers; the arrival rate of aircraft during the peak hour (considering both their number and type), and the type of baggage sorting and claiming systems in use.

Processing rates and related assumptions for baggage claim areas and systems are shown in Table 6-7. The analysis also assumed that future inbound baggage processing areas will be shared, as they are today.

Airline Operational Areas

In addition to the public service areas already described, the airlines require space in the terminal building for operational purposes. This includes: administration, maintenance, and other uses that do not require public access. Specific examples include: ticketing (ATO) offices, ramp operation areas, and VIP lounges.

Facility requirement parameters for ticketing offices are shown in Table 6-8. These are based on the length of ticket counter frontage.

Besides the traditional airline ramp operations space, a new airport needs to include space for certain facilities which are directly related to Northwest Airlines' Minneapolis-St. Paul hub operations. These include, but are not limited to, the following types of spaces: (1) central flight line storage areas, (2) space for employee training, and (3) space for baggage lost-and-found.

The future requirements for these and other ramp operations facilities were derived from airline surveys and the activity forecast. Results are aggregated into a general category called "airline ramp operations." VIP space requirements were determined in a similar manner.

Public Circulation Areas

The next major area to be examined is public circulation space. Included in this category are the ticket lobby, baggage claim lobby, concourse circulation spaces, and restrooms. The number of peak hour passengers is the primary determinant of space for this category. For the ticket lobby, the number of peak hour originating passengers and their associated visitors is used as the indicator. A peaking characteristic of 50 percent of the total peak hour traffic within a 20-minute period was applied. Space was allocated on the basis of 13 square feet per individual. This includes area for passengers with bags to queue up, and adequate space for circulation behind the queues.

To calculate the size of the bag claim lobby, the number of peak hour terminating passengers serves as the basis. The previously employed factor of 50 percent in 20 minutes is used, as is the number of visitors and the layout of claim devices and baggage cart areas. It was assumed that the passenger baggage claim area will be spatially defined and that non-passengers will be discouraged from entering the claim area. Conservatively, it was assumed that 25 percent of visitors accompanying passengers will enter the claim area.

The amount of concourse circulation space required is a function of the number of aircraft gate positions, the layout of the terminal building, and the means used to transport passengers between areas (walkways, power walks, or an automated people-mover system). Because of the uncertainties associated with predicting concourse circulation, this space category was combined with general circulation. Space requirements were then estimated for the combined total.

The amount of public restroom space required is determined by the total number of peak hour passengers and visitors. Building layout and other convenience-related factors also have an influence. To project future requirements for restroom spaces, the existing ratio of restroom space to peak hour passengers and visitors at MSP was determined and utilized in the calculation of future need.

Passenger Service Areas

Passenger service areas at the domestic terminal are separated into the following categories for facility planning purposes: Food Services (subdivided into food preparation, snacks, cocktail area, and miscellaneous areas); Gift and News; Auto Rental; Traveler's Aid/USO; and Other Concession Space.

To calculate the space required to accommodate concessions, projected levels of daily originating, terminating, and connecting passengers and their associated visitors were first identified. These were then used in conjunction with either existing space-per-passenger ratios or FAA space criteria. It was assumed that retail areas will be encouraged in the terminal facility to both provide a high level of passenger service and enhance airport revenue generation.

Rental car counter and office space needs were projected using the existing ratio of available space per terminating passenger at MSP applied to the forecast level of deplaned passengers terminating their trip in the Twin Cities area.

Administrative, Support, and Miscellaneous Areas

In addition to the areas previously described, portions of the passenger terminal buildings at MSP are presently used to house a variety of non-public functions. These include office space and the space needed to contain the facilities and equipment required to support the functions of the building. Specific examples are MAC and FAA airport office space and space for HVAC equipment.

Future requirements for these areas are not directly related to any particular activity indicator. For this study it was assumed that a new airport passenger terminal will have these revenue and non-revenue generating functions. Administration offices are programmed to remain constant over the planning period. Other spaces are forecast to grow as a constant percentage of total terminal area.

SUMMARY

Table 6-8 presents a summary of the facility requirements for all of the domestic terminal areas discussed in this section. The areas shown in this table are cumulative.

As seen in Table 6-8, the total terminal area space requirement is 2,123,760 square feet in the year 2020.

6.6.3 Regional Terminal

Because of the difference in the operations of regional airlines and those of the scheduled domestic airlines, the facility requirements of the regional airlines were calculated separately. The analysis was performed using the criteria and methodology outlined in FAA Advisory Circular 150/5360-13, "Planning and Design Guidelines for Airport Terminal Facilities." In order to adapt this methodology for use at MSP, it was applied to the existing regional activity. The results were then compared to existing facilities. This produced a set of adjustment factors that were applied to a facility requirements analysis obtained from forecast regional activity.

PASSENGER AND FACILITY CHARACTERISTICS

The passenger terminal building serves as a point of transition for commuter air carrier passengers. They may be local O&D passengers or connecting to or from scheduled domestic, international, or charter flights. Some of the basic characteristics that influence planning for regional facilities in a new air carrier airport for the Twin Cities area are as follows.

Passengers

The sizes and types of facilities required are primarily determined by the number of regional passengers. Forecast data shows commuter traffic will increase from 516,083 enplanements in 1988 to 1.145 million enplanements in 2020. The character of regional passenger traffic at MSP is anticipated to remain unchanged if a new air carrier airport is built.

Airline Station

This analysis assumes that a new air carrier airport replacing MSP will continue to have a high level of connecting passengers. It is expected that the present role of commuter carriers feeding passengers to the scheduled air carriers will continue.

Terminal Design

Regional carrier activity will be consolidated with all other passenger activity into the main terminal complex.

FACILITY REQUIREMENTS

Facility requirements for the regional carriers at a new airport were determined by analyzing a number of terminal elements. Facility requirements were developed for departures processing, arrivals processing, public restrooms, and concession areas. Passenger waiting area was calculated on a total or consolidated basis rather than by determining the space required at each gate.

Table 6-9 shows the facility requirements for each of the functional areas required for regional air carrier passengers. The areas shown on this table are cumulative, showing the total area required during that particular period. The gross terminal area is forecast to be 45,200 square feet by the year 2020.

Table 6-9
Regional Terminal Requirements

Terminal Element	Unit of Measurement	Year 2010	Year 2020
Departures Processing			
Ticket Counters			
Frontage	LF	180	195
Agent Positions Area	#	25	27
ATO	SF	1,440	1,560
Lobby/Waiting Area	SF	4,000	4,200
Outbound Baggage	SF	-	-
Arrivals Processing			
Baggage Claim	SF	-- See Lobby/Waiting Area --	
Inbound Baggage	SF	-- See Lobby/Waiting Area --	
Gate Facilities			
Waiting Areas	SF	-- See Lobby/Waiting Area --	
Concourse Circulation	SF	-- See General Circulation --	
Ramp Operations	SF	3,600	4,300
Public Spaces			
Restrooms	SF	2,400	2,900
Concessions	SF	1,000	1,000
Mechanical/Electrical Systems	SF	1,990	2,260
Building Administration	SF	-	-
General Circulation	SF	<u>10,770</u>	<u>12,180</u>
Total Regional/Commuter	SF	39,800	45,200

Source: TRA Airport Consulting.

6.6.4 International Terminal

This section describes the analysis of terminal facility requirements for international air carriers. Facility requirements for international charter carrier activity were included in this analysis primarily because both depend upon the same federal inspection services. Methodologies for calculations of international air carrier terminal facility requirements are similar to those used in the domestic air carrier terminal area.

PASSENGER AND FACILITY CHARACTERISTICS

Primary characteristics of international terminal facilities and their users are presented in the following. The existing international terminal at MSP has some characteristics that differ from typical practice and FAA guidelines. In this study, prevailing guidelines are used to estimate facility requirements for the international facilities at a new airport.

Passengers

Activity data for this analysis was obtained from Chapter 5, Activity Forecast. These forecasts show that international enplanements will increase from 138,200 in 1988 to 684,000 in 2020.

As with planning for the domestic terminal, the 1985 MSP survey, combined with airline surveys, provides important information for this analysis. From these surveys, the number of visitors per passenger was determined to be 2.3. From the same sources, the number of checked bags per passenger was estimated to be 2.0. This is different from the information assembled for the domestic terminal. In general, international travelers have more visitors and baggage than domestic scheduled passengers. They also spend a longer period of time in the terminal prior to departure.

Airline Station

The activity forecast indicates that Minneapolis-St. Paul will experience significant growth in the number of international arrivals and departures. This growth will require a major examination of the manner in which international passengers are processed.

Terminal Design

The majority of the space required for international operations houses Federal Inspection Services, specifically customs and immigration. Passenger processing space, as well as administrative offices, is associated with these activities. Passenger waiting areas, also called holdrooms, and concourse area are a relatively small portion of total facility space. Enplaning international passengers may depart from any domestic holdroom, and deplaning U.S. and foreign national passengers directly enter secure, sterile FIS facilities.

FACILITY REQUIREMENTS

As with the domestic passenger terminal facilities, assumptions about passenger characteristics, design standards, and passenger or baggage processing rates were required for the analysis. Table 6-10 summarizes these assumptions for the international passenger terminal facilities. While many of the parameters are identical to those for domestic facilities, there are some key differences. Among the most significant are the following.

- International passengers have higher visitors-per-passenger and baggage-per-passenger ratios than do domestic passengers.
- Consistent with FIS requirements, no greeters are permitted in the international baggage claim area. Individuals meeting arriving international passengers must wait in areas adjacent to the secure FIS area. These areas have been calculated as a portion of general circulation.

FIS Area

Space requirements for FIS facilities were estimated using criteria contained in the FAA's "Apron and Terminal Planning Manual" and the more recent Terminal Advisory Circular. These references assume a two-step FIS process. First, passengers stop for an Immigration and Naturalization Service (INS) inspection, and then second, for a U.S. Customs Service (UCS) inspection. Recent developments in the area of FIS facility design are stressing a one-step processing concept, where INS and UCS functions are combined. However, established facility planning criteria for this concept are not yet available.

International Non-Scheduled Carrier

Non-scheduled or charter international activity is forecast to be about 12 percent of the total international activity by 2020. In this study, charter activity is incorporated into the international facilities. In other words, a separate area for non-scheduled international activity is not planned.

Table 6-10

Assumptions for International Terminal Facilities

Element	Factor	Comment/Source
1. Transfer Passengers	0%	Consultant Assumption
2. Visitors per Passenger	2.3	Passenger Survey (1985)
3. Baggage per Passenger	2.0	Airline Survey (1989)
4. Peak Hour Passengers	Varies	Forecasts Section
5. Ticketing Rates	2.6 min./ passenger	Average of existing (3.0) vs. airline goal (2.2) from Airlines Surveys
6. Security Inspection Rate	600 people/hr.	Industry Standard
7. Area/Security Station	120 SF	FAA Guidelines
8. Well-Wishers through Security	30%	Consultant Estimate
9. Peak Period of Peak Hour	20 minutes	FAA/Industry Standards
10. Peak Hour Passengers in Peak 20-Minute Period	50%	FAA/Industry Standards
11. Ticket Counter Frontage	12.0 LF/2 agent positions	FAA Guidelines (higher than MSP existing)
12. Depth/Ticket Counter	10 LF	Existing/FAA Guidelines
13. ATO Depth/LF Frontage	30 LF	FAA Guidelines
14. Queuing Area/Person	13 SF	Industry Standard
15. Baggage Claim Device Frontage	185 LF/Device	Assume large 2-feed rectan- gular devices larger than existing at MSP
16. Greeters in Bag Claim	0%	Consultant Estimate
17. Baggage Claim Lobby Area/Person	19 SF	Inventory
18. Baggage Claim Service Goal	15 minutes	Industry Guidelines
19. General Circulation	15% Total Terminal Area	Consultant Estimate
20. Mechanical/Electrical Systems	10% Total Terminal Area	Consultant Estimate

Source: TRA Airport Consulting.

SUMMARY

Using the model and methodologies described in this section, facility requirements were calculated for the international terminal. These are summarized in Table 6-11. Overall, the international operations are forecast to require 398,840 square feet of area by 2020.

6.6.5 Domestic Non-Scheduled Carrier Terminal

This section presents the terminal facility requirements for domestic non-scheduled passengers.

Input data for the domestic charter activity analysis was obtained from the Activity Forecast chapters. Enplanements are forecast to increase from 275,418 passengers in 1988 to 845,000 in 2020.

The 1985 MSP Survey provided information on domestic charter passenger characteristics. From the data in this survey, the ratio of visitors to passengers was estimated to be 2.3 to 1. The number of checked bags was estimated at 2.0 per passenger. These figures are higher than those for domestic scheduled passengers. This is because domestic charter activity is largely vacation travel.

Using the methodologies described previously, facility requirements were calculated for the domestic charter air carriers. These are summarized in Table 6-12. Overall, these operations are forecast to require 223,060 square feet of terminal area by 2020.

Table 6-11

International Terminal Requirements

Terminal Element	Unit of Measurement	Year 2010	Year 2020
Departing Passengers			
Ticket Counters			
Frontage	LF	301	480
Agent Positions	#	50	80
Area	SF	3,010	4,800
Airline Support Area	SF	9,030	14,390
Ticket Lobby	SF	15,050	23,980
Outbound Baggage	SF	17,650	27,310
Gate Facilities			
Passenger Waiting Areas	SF	25,000	25,000
Concourse Circulation	SF	-- See General Circulation --	
Ramp Operations	SF	7,000	10,900
Arriving Passengers/FIS			
Baggage Claim	SF	25,860	43,100
Devices	#	3	5
Device Frontage	LF	750	1,250
Inbound Baggage	SF	17,430	29,050
Baggage Service	SF	920	1,530
INS Processing Area	SF	11,940	19,030
INS Offices	SF	1,070	1,300
UCS Processing Area	SF	27,450	43,860
UCS Offices	SF	4,270	6,540
FIS General Employee Areas	SF	5,790	7,870
Exit/Cashier	SF	7,430	11,680
Public Spaces			
Restrooms	SF	3,750	5,990
Concessions			
Gift & News	SF	3,220	5,430
Food and Beverage	SF	8,550	14,070
Duty Free	SF	2,380	2,900
Mechanical/Electrical Systems	SF	26,290	39,880
Building Administration	SF	400	400
General Circulation	SF	<u>39,440</u>	<u>59,830</u>
Total International		262,930	398,840

Source: TRA Airport Consulting.

Table 6-12

Domestic Non-Scheduled Carrier Terminal Requirements

Terminal Element	Unit of Measurement	Year 2010	Year 2020
Departing Passengers			
Ticket Counters			
Frontage	LF	424	566
Agent Positions	#	71	94
Area	SF	4,240	5,660
Airline Support Area	SF	12,710	17,000
Ticket Lobby	SF	21,180	28,320
Outbound Baggage	SF	14,570	18,980
Security Stations	#	6	8
Arriving Passengers			
Inbound Baggage	SF	14,700	19,600
Baggage Claim	SF	17,250	23,000
Baggage Service	SF	920	1,220
Devices	#	3	4
Frontage	LF	555	740
Gate Facilities			
Passenger Waiting Areas	SF	18,730	25,860
Ramp Operations	SF	8,150	10,800
Concourse Circulation	SF	-- See General Circulation --	
Public Spaces			
Restrooms	SF	2,890	3,880
Concessions			
Gift and News	SF	2,890	3,860
Food and Beverage	SF	4,380	5,860
Mechanical/Electrical Systems	SF	16,780	22,310
Building Administration	SF	--	--
FBO Office	SF	3,260	3,260
General Circulation	SF	<u>25,180</u>	<u>33,450</u>
Total Charter	SF	167,830	223,060

Source: TRA Airport Consulting.

6.6.6 Summary of Terminal Requirements

Table 6-13 summarizes terminal facility requirements for all categories of air carrier activity. Included are the following types of carrier activity: domestic, regional, international, and domestic charter. International charter activity was consolidated with scheduled international. By the year 2020, total terminal facility requirements are estimated to be 2,787,800 square feet.

The space requirements shown in Table 6-13 are conservative. This is because reductions in square footages are possible if a centralized configuration is adopted. Such economies are possible in a variety of passenger waiting facilities: ticketing and claim lobbies, passenger holdrooms, and overall circulation. However, the magnitude of any space reduction can be accurately determined only after the development of a detailed design plan.

6.7 SURFACE ACCESS REQUIREMENTS

This section describes year 2020 surface access facility requirements for a new airport, including the regional access system, automobile parking, and on-airport circulation.

6.7.1 Regional Access System

Trips to and from a new airport by air travelers, airport employees, and airport visitors will use the regional highway system. The regional highway system includes freeways and other major and minor arterials which connect parts of the metropolitan area to each other, to other parts of the state, and to other states.

Traffic counts conducted at MSP indicate that travel is generated at the airport at the rate of 13,000 average weekday trip ends per million annual air travel originations. At this rate, in the year 2020, the airport is expected to generate 120,000 average weekday trips (the total of inbound and outbound trips). Year 2020 average weekday evening peak hour traffic is estimated to be 5,900 vehicles per hour inbound and 6,100 vehicles per hour outbound. Year 2020 average weekday morning peak hour traffic is estimated to be 5,700 vehicles per hour inbound and 4,100 vehicles per hour outbound.

Table 6-13

Summary of Terminal Facility Requirements

Terminal Element	Unit of Measurement	Year 2010	Year 2020
Departing Passengers			
Ticket Counters			
Frontage	LF	2,051	2,443
Agent Positions	#	337	401
Area	SF	20,150	24,040
Ticket Lobby	SF	108,150	129,180
Outbound Baggage	SF	144,060	162,630
Security Stations	#	33	39
Airline/ATO Space	SF	73,330	85,350
Arriving Passengers			
Baggage Claim	SF	117,800	140,850
Devices	#	19	22 ^a
Device Frontage	LF	3,710	4,395 ^a
Inbound Baggage	SF	90,930	112,350 ^a
Baggage Service	SF	5,500	6,720 ^a
FIS	SF	57,950	90,280
Gate Facilities			
Passenger Waiting Areas	SF	255,840	264,060
Ramp Operations	SF	249,450	265,200
VIP Clubs	SF	18,300	18,900
Public Space			
Restrooms/Nursery	SF	62,790	69,000
Concessions			
Food/Beverage	SF	143,730	153,030
Concessions	SF	56,310	61,690 ^b
Miscellaneous Tenants	SF	25,710	26,280 ^c
Mechanical/Electrical Systems	SF	308,355	334,535
Building Administration	SF	43,095	43,095
General Circulation	SF	733,620	780,690
Heating Plant	SF	<u>20,000</u>	<u>20,000</u>
Total Area	SF	2,535,070	2,787,880

Source: TRA Airport Consulting.

^a Includes International.

^b Includes Duty Free.

^c Includes FBO.

The type of roadway facility needed to accommodate traffic to and from a new airport depends on several factors: (1) the places where airport trips begin; (2) the location of a new airport relative to those trip ends; and (3) the level of service to be provided. The forecasted peak hour traffic volumes can be accommodated at Level of Service "C" with four through lanes in each direction, or at Level of Service "E" with three through lanes in each direction. The actual configuration of the road or roads providing access to a new airport will depend on the number of roads serving the airport, on the directional distribution of airport trips, and on the amount of other traffic simultaneously using the roadways.

Public transportation (regular-route bus service) carries about one percent of the travel to and from MSP. The access need described above assumes that public transportation will continue to serve only a small number of trips. There is a possibility that use of public transportation for airport trips could increase if the service provided is very convenient and competitively priced, and if the alternatives (mainly taxi service and airport parking) are relatively inconvenient and expensive. Even under the best conditions, roughly one-fourth of peak hour airport trips would have to be diverted to transit to reduce the size requirement of access roadways.

At this time, the metropolitan area is considering implementation of a light rail transit system. If the decision is made to build a light rail transit system, service to a new airport may be possible depending on the location of a new airport site and its proximity to light rail transit lines.

6.7.2 Automobile Parking

Automobile parking requirements have been developed for the following categories: travelers and visitors, employees, rental cars, and other. Traveler and visitor parking is frequently referred to as public parking.

TRAVELERS AND VISITORS

The demand for automobile parking by air travelers and terminal visitors is related to the number of annual originations. Studies at MSP have identified a public parking demand of 1,700 parking spaces per million annual originations. Year 2020 public parking requirements have been estimated to total 14,100 spaces (11,000 long-term spaces and 3,100 short-term spaces).

A parking facility with 14,100 spaces would occupy about 97 acres on one level. If the parking is provided in a parking structure, it would have six to eight levels. Such a structure (or structures) would occupy between 15 and 20 acres.

EMPLOYEES

Employees for whom parking is provided include those working in the terminal building, at the Northwest mainbase, and at all other airport facilities. The terminal employee parking facility currently provides parking only for employees working in the airport terminal building. With few exceptions, all other airport facilities must provide their own employees' parking within their own facility. The Northwest mainbase provides by far the largest employee parking facility at the airport; the other airport tenants also provide parking for their own employees.

Demand for terminal employee parking has been found to be related to annual enplanements. A terminal employee parking demand of 102 parking spaces per million annual enplanements was identified in 1988. Year 2020 parking requirements for terminal employees were estimated at a total of 2,010 spaces.

Demand for parking by employees working at other facilities at the airport is dependent on details of the actual facilities located at the airport, and is considered in the site needs for each of these facilities.

RENTAL CAR

Current rental car operations at MSP indicate that five to six acres of parking space per million annual originations is required. Year 2020 parking requirements for rental car operations were estimated at 47 acres (10 acres for ready vehicles and 37 acres for vehicle maintenance and storage).

OTHER

Other parking requirements at the airport (public transportation and other vehicle fleets, maintenance, service and security vehicles, and loading areas for delivery vehicles) are dependent on details of the actual facilities served by these other vehicles, and are considered in the site needs for each of these facilities.

6.7.3 On-Airport Circulation

On-airport circulation facilities link the regional freeway system with parking facilities and terminal buildings and other pedestrian facilities.

ROADS

The airport will generate traffic during peak hours at a rate of 5,900 vehicles per hour inbound and 6,100 vehicles per hour outbound. This level of traffic would require a divided roadway of four lanes in each direction providing access from the regional freeway system.

If more than one access roadway served the airport, lane requirements would depend on the distribution of traffic among the various access roadways.

CURBSIDE LOADING AND UNLOADING

The requirement for curbside space at a new airport terminal is a function of the amount of origin-and-destination air travel and the average curbside dwell time. See Table 6-14.

Table 6-14

Terminal Curb Length Requirements

ELEMENT	<u>Enforcement Activity/Dwell Times (minutes)</u>		
	<u>Present</u>	<u>Moderate</u>	<u>Aggressive</u>
	2.6 Unloading 7.0 Loading	2.0 Unloading 5.0 Loading	2.0 Unloading 3.0 Loading
TERMINAL CURB LENGTH REQUIREMENTS (linear feet)			
<u>Departures - Unloading</u>			
Private Automobiles	1,040	800	800
Taxis	180	140	140
Public Transportation	<u>920</u>	<u>920</u>	<u>920</u>
Total	1,910	1,640	1,640
<u>Arrivals - Loading</u>			
Private Automobiles	2,530	1,790	1,070
Taxis	430	320	190
Public Transportation	<u>550</u>	<u>550</u>	<u>550</u>
Total	3,510	2,660	1,810

Source: BRW.

Curbside dwell time is also influenced by the rules established for use of the curbside area and by the degree to which those rules are enforced. The calculation of curbside length requirements for a new airport considered three degrees of regulation/enforcement activity. An anticipated average dwell time was hypothesized for each.

The first assumed that the current degree of enforcement would remain, resulting in curbside dwell times of 2.6 minutes on the ticketing level and 7.0 minutes on the baggage claim level of the terminal. The second degree of enforcement reduced the dwell times to 2 minutes on the ticketing level of the terminal and to 5 minutes on the baggage claim level. This was accomplished by moderately increasing the degree of enforcement. The

final case assumed an aggressive degree of enforcement. Dwell times were reduced to 3 minutes on the baggage claim level. However, it was assumed that the 2 minutes on the ticketing level would not improve.

The curb length requirement for the private automobile segment of the demand assumes a three-lane roadway with one lane used for circulation and two lanes used for loading and unloading.

Use of public modes of transportation can be made significantly easier by locating loading areas in a single, readily accessible area. The public transportation area should include stops for regular-route and charter buses, a light rail transit station, and loading areas for taxis, limousines, hotel/motel courtesy vehicles, auto rental shuttles, remote-parking shuttles, and any other for-hire or courtesy shuttle vehicles.

6.8 AIR CARGO REQUIREMENTS

This section presents the projected requirements for cargo facilities through 2020. Cargo operations are grouped in the following manner.

- Cargo facilities operated by scheduled air passenger carriers;
- Cargo facilities operated by all-cargo and small-package carriers;
- Freight forwarders.

The forecast of enplaned freight and express indicates that cargo tons carried by passenger carriers will drop from 31,506 in 1988 to 27,000 in the year 2020. Conversely, the forecast of cargo tons carried by all-cargo carriers is estimated to grow from 30,786 in 1988 to 62,000 in the year 2020 and cargo tons carried by small package and express carriers is to grow from 34,826 in 1988 to 82,000 tons in 2020.

From a review of local experience and with the use of industry standards it was determined that each square foot of warehouse and office space could process an average of 0.75 total tons per year. This amount is reflective of low-volume operations with manual sorting and handling and relatively slow turnover. Airport records indicate that some carriers' and forwarders' enplaned tons are not equal to deplaned tons, but on the average they are the same. For example, MAC records for 1988 at MSP indicate a split of 51/49 percent of enplaned/deplaned air cargo.

Utilizing the total tons per square foot of building space (warehouse + office) a factor of 0.75 is applied to the forecast volumes. The space requirements were then calculated and are summarized in Table 6-15.

Table 6-15

Air Cargo Facility Requirements

Air Cargo Groups	2010	2020
Air Carrier:		
Total Tons	56,000	54,000
Building Space (SF)	74,700	72,000
Site (Acres) ^a	8.8	9.3
All-Cargo and Small Package:		
Total Tons	270,000	288,000
Building Space (SF)	360,000	384,000
Site (Acres) ^a	65.0	76.3
Freight Forwarders:		
Total Tons	179,800 ^b	187,200 ^b
Building Space (SF)	239,700	249,600
Site (Acres) ^a	20.0	22.9

Source: Ralph White Associates.

^aIncludes aircraft parking apron, as appropriate, but excludes taxiway access.

^bAssumes forwarders handle 80% of air carrier and 50% of all cargo and small package activity.

6.9 GENERAL AVIATION REQUIREMENTS

This section deals with the facility requirements for general aviation activity and related fixed base operations (FBO). It was assumed that a separate and distinct space will be provided elsewhere for air cargo operations and that the general aviation operations area will be used exclusively to house this function. It should be noted that the forecast of demand for general aviation used in this study differs from the one shown in the MSP Long-Term Comprehensive Plan. The policy at MSP is to give priority to air carrier operations and to encourage general aviation activity at the reliever facilities. Since a new airport can be constructed with whatever capacity is wanted, space was provided to accommodate unconstrained general aviation demand.

The forecasts of general aviation operations and based aircraft for a new airport are provided in Table 6-16.

Table 6-16

Forecast of General Aviation Activity

Year	2010	2020
Based Aircraft ^a	50	75
Operations per Based Aircraft	220	220
Operations by Based Aircraft	11,000	16,500
Operations by Transient Aircraft	<u>49,760</u>	<u>74,000</u>
Total Operations ^b	60,760	90,500

Source: MSP Long-Term Comprehensive Plan.

^a Turbojet aircraft only.

^b All itinerant operations.

It was assumed that each locally based aircraft will average 220 annual operations. Thus, of the total annual operations forecasted, the breakdown shown in Table 6-16 was assumed to estimate transient aircraft operations.

Using the assumed transient aircraft operations together with the based aircraft forecast, a determination of future facility requirements was calculated and is summarized in Table 6-17. Assumptions applied are as follows.

- Hangar floor space is based on 2,300 square feet per based aircraft.
- Apron space provided for transient aircraft is 5,400 square feet per aircraft, which includes circulation, clearance, and ramp vehicle operations.
- The peak number of transient aircraft parked was determined by dividing annual operations by 2 to calculate arrivals; 9 percent of arrivals was used to calculate peak month demand; peak month was divided by 31 to determine average day peak month; and it was assumed that 30 percent of all GA aircraft would remain on the apron during peak periods.
- Site requirements are based on the assumption that apron and hangar space will occupy 65 percent of the total area, with 35 percent of the total being allocated to auto parking, equipment, fuel storage, and landscaping.

Table 6-17 presents facility requirements for general aviation.

Table 6-17
General Aviation Requirements

Element	Year 2010	Year 2020
Hangar Floor Space (SF)	115,000	172,500
Apron Space (SF)		
Based Aircraft	270,000	405,000
Transient Aircraft	116,900	174,000
TOTAL	501,900	751,500
Site (Acres)	17.7	26.5

Source: Ralph White Associates.

6.10 REQUIREMENTS FOR OTHER FACILITIES

This section examines the requirements of airline and airport support functions. Included in this category are the following.

- Airport Administration and Maintenance
- Airline Maintenance Hangars and Operational Support
- Fuel Storage
- Aircraft Rescue and Firefighting
- Flight Kitchen
- Federal Functions
- Commercial/Public Functions
- Utilities
- Airline Corporate Offices
- Military

6.10.1 Airport Administration and Maintenance

A listing of existing airport administration and maintenance facilities at MSP is provided in Table 6-18. This identifies the functions for which space is required.

Table 6-18

Existing Airport Administration and Maintenance Areas
Minneapolis-St. Paul International Airport, 1988

Area/Function	Building Space (SF)	Site (Acres)
MAC Offices	43,024	2.3
Maintenance Area		7.7
Equipment Storage	45,173	
Material	10,690	
Pole Barn	<u>5,600</u>	
Subtotal	61,463	
Boiler Plant	1,500	0.1
Storage Building No. 16	22,600	1.0
Paint Spray Building	1,248	0.1
Paint, Carpenter, and Electrical Shop	1,600	1.7
West Terminal Area Admin. Office (Maintenance/Security)	396	N/A
Regulator and Emergency Generator Bldg.	<u>480</u>	<u>N/A</u>
Subtotal	132,311	12.9
Stock Pile Area ^a	<u>0</u>	<u>6.0</u>
TOTAL	132,311	18.9

Source: Ralph White Associates.

^aStorage of salt, miscellaneous construction supplies, and equipment. Area is approximate and not well defined.

The requirements for future facilities in this category were based on staff size, materials, and equipment needed to maintain the facilities and grounds owned and operated by MAC.

Requirements for airfield pavement, apron expansion, and terminal building space assume that a new airport would have 50 percent more paved areas and terminal facilities than have been planned at MSP in the same time period. Based upon this assumption, the space shown in Table 6-19 is needed. Space for day-to-day operation of the airport is housed in the terminal building. This and related functions such as building maintenance, security, and commission meeting areas are assumed to be located in a new terminal area and are discussed elsewhere in this section.

Table 6-19

Airport Administration and Maintenance Requirements

Function/Area	Building Space (SF)	Site (Acres)
MAC Offices	64,500	3.5
Maintenance Area		11.6
Equipment Storage	67,800	
Material	16,000	
Pole Barn	<u>8,400</u>	
Subtotal	92,200	
Boiler Plant	2,300	0.1
Storage Building	33,900	1.5
Miscellaneous Shops	5,600	2.7
Public Safety Building	3,000	0.7
Stock Pile Area	<u>0</u>	<u>9.0</u>
TOTAL	201,500	29.1

Source: Ralph White Associates.

6.10.2 Airline Maintenance Hangars and Operational Support

The number and size of aircraft maintenance hangars will be determined by the airlines. This facility requirement is not predictable exclusively by reference to activity levels. These facilities are typically tied to factors such as the location of airline headquarters, the location of cities selected as hubs, fleet size, maintenance scheduling, climate, and location of terminating flights. A precise determination of these requirements is thus not possible. However, a general discussion of the possibilities is.

To understand the current airline maintenance situation and magnitude of facilities, Table 6-20 is provided. This shows conditions as they existed at MSP in 1988 in terms of site acres, number of aircraft maintenance slots, and the relationship between these functions.

Table 6-20

Existing Airline Maintenance Hangars and Operational Support Areas
Minneapolis-St. Paul International Airport, 1988

Airline	Acres	Aircraft Parking Positions in Hangars	Average Acres per Aircraft Parking Position
Northwest Airlines:			
Building B	91.12	5 Narrow 5 Wide 2 B-747	7.59
Building C	87.71	6 Narrow 2 Wide 2 B-747-400	8.77
Subtotal	178.83	11 Narrow 7 Wide 4 B-747	8.12
Mesaba Airlines	5.23	3 F-27 3 Metros	0.87
Sun Country Airlines	4.48	1 Wide	4.48
Zantop Airlines	0.51	1 Narrow	0.51
TOTAL	189.05	12 Narrow 8 Wide 6 B-747 4 Small	6.30

Source: Ralph White Associates.

In estimating the size of future airline maintenance areas, the following assumptions were made.

- Northwest, Mesaba, and Sun Country Airlines are headquartered in Minneapolis and will continue to provide major aircraft maintenance and overhaul at MSP.
- American, United, and Midway Airlines, which have hubbing operations in Chicago, will continue to do aircraft maintenance requiring hangars there.

- Continental, Pan Am, and USAir have relatively low-volume operations at MSP and will provide aircraft maintenance at other stations.
- TWA has a hubbing operation in St. Louis and will likely provide aircraft maintenance at this location.
- Delta has hangar facilities in Chicago and will not require the same at MSP.

Combining these assumptions with information on acres per aircraft hangar position and acres per departure at large-hub airports, it was estimated that 328 acres should be reserved for possible airline maintenance hangar space. Table 6-21 shows the relationship of aircraft hangar positions to average day peak month arrivals. Table 6-22 shows the calculation used to estimate the number of aircraft maintenance hangar positions and acres required in the year 2020.

Table 6-21

Aircraft Hangar Positions at MSP as a Percentage
of Average Day Peak Month Arrivals in 1988

Carrier Category	ADPM Arrivals ^a	Aircraft Hangar Positions	Aircraft Hangar Positions as Percentage of ADPM Arrivals
Scheduled Domestic and International	292.0	22	7.52
Regional & Air Taxi	102.5	6	5.85
Non-Scheduled Domestic and International	<u>13.5</u>	<u>1</u>	<u>7.41</u>
TOTAL	408.0	29 ^b	7.11 (Avg.)

Source: MSP Long-Term Comprehensive Plan and Ralph White Associates.

^aADPM refers to Average Day, Peak Month.

^bExcludes Zantop.

Table 6-22

Airline Maintenance Hangars
and Operational Support Area Requirements, Year 2020

Carrier Category	ADPM ^a Arrivals in 2020	Aircraft Hangar Positions as Percentage of ADPM Arrivals	Required Aircraft Hangar Positions in 2020	Acres/Aircraft Hangar Position	Acres Required in 2020
Scheduled Domestic and International	451.0	7.52	34	8.93	303.6
Regional and Air Taxi	161.5	5.85	10	0.96	9.6
Non-Scheduled Domestic and International	<u>35.5</u>	<u>7.41</u>	<u>3</u>	4.93	<u>14.8</u>
TOTAL	658.0	7.14 (avg.)	47		328.0

Source: MSP Long-Term Comprehensive Plan and Ralph White Associates.

^aADPM = Average Day, Peak Month.

6.10.3 Fuel Storage

To estimate future fuel storage requirements, annual and average day, peak month aircraft departures that were fueled at MSP from FBO and air carrier facilities in 1988 were determined. See Table 6-23.

Table 6-23

History and Forecast of Aircraft Departures
at Minneapolis-St. Paul International Airport

	1988 Actual		Year 2020	
	Annual	ADPM	Annual	ADPM
<u>Air Carrier Fuel Source</u>				
Air Carrier Domestic	100,854	291	154,100	445
Non-Scheduled (20%)	388	3	1,000	7
Regional	34,371	103	53,000	162
International (Scheduled)	257	1	1,431	6
Cargo (10%)	898	3	1,560	4
TOTAL	136,768	401	211,091	624
<u>FBO Fuel Source</u>				
Non-Scheduled (80%)	1,552	10	4,000	27
International (Non-Sched.)	57	1	299	2
Cargo (90%)	8,081	23	14,040	40
General Aviation	34,317	108	45,250	144
TOTAL	44,007	142	63,589	213

Source: Ralph White Associates.

Next, the number of gallons per departure was estimated. Today, FBO-handled aircraft take an average of 545 gallons per departure, and air carrier aircraft take 1,969 gallons per departure.

To forecast future fuel consumption, the following assumptions were made regarding aircraft fuel efficiency and fleet mix.

- In the near and long term, potential fuel savings of 25 to 45 percent are expected to occur due to the introduction of more fuel-efficient aircraft into the fleet. The introduction of this equipment is dependent to a degree on fuel costs.
- The activity level of small-size general aviation aircraft will decline in the future. Corporate jet activity will grow at a new airport and will be handled by the FBOs.

The first assumption suggests a reduction in the overall fuel consumption requirement. The second assumption suggests an increasing fuel storage requirement in the FBO storage areas.

Using these assumptions, the following future fuel-per-departure rates were developed: (1) Air Carrier -- 1,800 gallons per departure, and (2) FBO-Handled Activity -- 1,190 gallons per departure.

Daily consumption in the year 2020 is shown in Table 6-24.

Table 6-24
Forecast of Daily Fuel Consumption, Year 2020

Fuel Source	Departures (ADPM in 2020)*	Average Fuel/ Departure (gallons)	Daily Requirement (gallons)
Air Carrier	624	1,800	1,123,200
FBO	<u>213</u>	1,190	<u>253,470</u>
TOTAL	837		1,376,670

Source: Ralph White Associates.

* ADPM = Average Day, Peak Month.

The final step in determining facility requirements for fuel storage was to calculate the amount of bulk storage required to assure a constant 7-day supply. Interviews with the current fueling system contract operator indicated that the following operational assumptions should be used in formulating future requirements.

- Fuel arriving at the MSP tank farm is delivered through supply pipelines which have their origins at several sources. The fuel arrives in batches, and a full tank supply is not always transmitted. It was assumed that the delivery policy of transmitting, on average, 25,000 barrels per shipment (1,050,000 gallons) sixteen times per month will continue. This equates to one-half tank per delivery, with one-day settlement time.
- The current level of contamination will continue unchanged. This will require one hour of settlement time per vertical foot delivered. With a tank height of 54 feet, a full tank requires 2-1/4 days to settle.
- Minimum tank size will be 2,000,000 gallons.
- Currently, all fuel for the airlines is comingled -- one system for all carriers with the same suppliers. It is assumed that this arrangement will continue. A change

in this policy would greatly increase the size and complexity of the storage and distribution system.

- The bottom of the proposed fuel storage tanks, which holds 800,000 gallons, is below the distribution line. It is required for settlement, and will not be considered storage.
- The current policy is to maintain a 5-day supply. However, due to a large number of unknowns, which include future fuel availability, delivery policy, and pipeline down time, as well as future flexibility, a 7-day supply was used as the basis for the plan.
- Fuel handled by the FBOs will be distributed from satellite facilities. However, the bulk storage will be from a common system.

For the year 2020, the following methodology was used to calculate the required number of tanks and the area to be reserved for fuel storage.

Total Reserve	7 days
Daily Fuel Consumption (2020)	1,376,700 gal.
Seven-Day Reserve	9,636,900 gal.
One-Day Active Tank	<u>2,013,300 gal.</u>
Subtotal	11,650,200 gal.
Plus 12% for settlement	13,048,224 gal. (total storage)

$$\text{Tanks Required} = \frac{\text{Total Storage (gal.)}}{\text{gallons/tank}} = \frac{13,048,224}{2,268,000} = 6$$

$$\text{Acres Required} = \text{Tanks} \times .50 \text{ acres/Tank} = 3.0$$

In addition, a service center is required for offices, tank and hydrant truck parking and maintenance, employee lockers and related facilities, and employee parking. This facility will occupy 3.8 acres in 2020. Thus the total acres for fuel storage and operator facilities is 6.8 acres.

6.10.4 Aircraft Rescue and Firefighting

Aircraft rescue and firefighting (ARFF) requirements for airports serving air carrier operations are outlined in Federal Aviation Regulation (FAR) Part 139.49. The criteria set forth in FAR Part 139.49 regarding equipment and service resulted from research by the FAA and the ICAO Rescue and Fire Fighting Panel (RFFP II). Studies conducted by these two agencies identified the practical and theoretical fire areas of an aircraft and the corresponding amounts of extinguishing agents. These data led to the identification of five

classes of airports referred to as an "Index." The indexes are referred to by the letters A through E. There are ARFF equipment requirements associated with each. To determine the applicable airport index, the length of the longest large aircraft, operated by an air carrier performing an average of five scheduled departures per day (computed on an annual basis) is used as a basis.

The longest length aircraft forecast to be operated by an air carrier at a new airport, with an average of at least five scheduled departures per day, is the Boeing 747. Since this aircraft is more than 200 feet in length, the ARFF requirements for a new airport are Index E.

It was assumed that the equipment presently in use at MSP will be relocated to a new airport and further that over the planning period it will be maintained and upgraded to meet or exceed federal and local regulations. Index E calls for the provision of one lightweight, quick-response vehicle and at least two additional self-propelled fire extinguishing vehicles, having the total capability of carrying 500 pounds of dry chemicals and 6,000 gallons of water for foam production. The vehicles presently used at MSP and their extinguishing agent capacity are listed in Table 6-25. As shown, the entire fleet of ARFF vehicles at MSP have the cumulative total capability to carry 13,425 gallons of water; 1,730 gallons of aqueous film-forming foam (AFFF); and 1,500 pounds of dry chemicals. The first three vehicles, which include the Oshkosh T-6 and two Oshkosh T-12 units, are the primary rescue vehicles and have 7,925 gallons of water; 1,025 gallons of AFFF; and 1,000 pounds of Halon 1211. Both groups exceed the federal requirement.

Table 6-25

Fire Extinguishing Agent Capacity
at Minneapolis-St. Paul International Airport, 1988

Vehicle Identification	Vehicle Remarks	Water (gallons)	AFFF (gallons)	Halon 1211 (pounds)
1. Oshkosh T-6	Quick response	1,585	205	500
2. Oshkosh T-12	--	3,170	410	500
3. Oshkosh T-12	--	3,170	410	--
4. King Fischer	Hard surface only	4,500	500	--
5. Oshkosh P-19	Military version	1,000	205	500
Total All Units		13,425	1,730	1,500
Total Items 1-3		7,925	1,025	1,000
Index E Requirement		6,000		500

Source: Ralph White Associates.

The service requirements of FAR Part 139.49 specify that at least one firefighting and rescue vehicle, as required by the applicable airport index, be capable of reaching the midpoint of the farthest runway serving air carrier operations from its assigned post within 3 minutes from the time of the first alarm to the time of initial agent application; at least one other within 4 minutes; and all others within 4.5 minutes.

An additional FAR Part 139.49 ARFF requirement of importance is the mandatory provision of vehicle shelter. This applies to airports located in geographical areas subject to prolonged temperatures below 33 degrees F. MSP and a new airport are clearly subject to this requirement. Accommodating the required equipment dictates that the main station site contain 1.6 acres.

Due to the distance that will exist between the terminal area and the runways at a new airport, at least two satellite stations should be built. A site of 0.7 acres for each satellite station is needed. Thus, a total of 3.0 acres must be reserved for ARFF facilities as follows.

Main Station	1.6 acres
Satellite No. 1	0.7 acres
Satellite No. 2	<u>0.7 acres</u>
Total	3.0 acres

6.10.5 Flight Kitchen

Flight kitchen activity at MSP has been constrained in the past due to the absence of space. At present, only one flight kitchen is located at MSP. It consists of a 78,189-square-foot building on a 3.6-acre site. If space were available, the present operator would occupy another 2 acres, for a total of 5.6 acres. Using this figure as a base in conjunction with an increase of 50 percent for the future, 8.4 acres and a building 183,200 square feet in size is needed in the year 2020.

6.10.6 Federal Functions

This section deals with the requirements of the Federal Aviation Administration (FAA), the U.S. Weather Service, and the U.S. Post Office.

FEDERAL AVIATION ADMINISTRATION

At an air carrier airport, the FAA normally operates an Air Traffic Control Tower and a variety of electronic navigational aids such as instrument landing systems and radar equipment. They also occupy office space from which they provide services to the aviation community. This section examines the control tower and office facilities. Nav aids and related facilities were addressed earlier.

Three (3.0) acres will be required for a freestanding air traffic control tower (ATCT). A site of this size will accommodate the tower structure as well as employee and visitor parking. In addition to the control tower, space must be provided for airport surveillance radar (ASR), very high frequency omni-directional radio range (VOR or VORTAC), and airport surface detection equipment (ASDE). Requirements for these items will be incorporated in subsequent planning studies when the airfield system and control tower location are refined for a specific site layout.

The FAA recently occupied new facilities adjacent to the MAC administrative office at MSP. However, it is assumed that to be strategically located to serve the aviation community, the FAA would relocate to a new airport. The new FAA office, occupied in 1988, is located on a 2.8-acre parcel. The building contains a total of 40,964 square feet on two floors. The FAA functions at this location include: Airport District Office, Flight Standards District Office (formerly GADO), Civil Aviation Security Field Office, and Certificate Management Office (formerly ACDO). The Flight Service Station (FSS) is now located at Princeton. In addition to office space, the FAA also occupies 10,000 square feet of space in Building 16 for storage and maintenance.

Table 6-26

FAA Facility Requirements

Facility	Acres of Land Required in 2020
Air Traffic Control Tower	3.0
Office	4.2
Storage and Shops	<u>1.0</u>
TOTAL	8.2

Source: Ralph White Associates.

U.S. WEATHER SERVICE

The U.S. Weather Service (National Oceanic and Atmospheric Administration) facilities at MSP are located on the second and third floors of the FAA Office Building. They lease 7,971 square feet. This amount of space is sufficient to accommodate their current operation and equipment requirements. No plans are known that would require this amount of space to be greater in the future. As with FAA office space, it is likely that over the 30-year planning period changes will occur; however, at present the magnitude of any changes cannot be anticipated. A total of 2.0 acres was reserved for this agency at a new airport.

U.S. POST OFFICE

The requirement for the Airport Mail Facility (AMF) at a new airport was calculated using a year 2020 forecast of 160,000 tons. Assuming 1.5 tons of mail can be processed per year per square foot, the building should contain 106,700 square feet and be located on a site of 8.6 acres. Since mail is carried on scheduled passenger flights, this site should be located near the terminal area.

6.10.7 Commercial/Public Functions

Commercial/public tenants such as Travelers Express, AT&T, Kavouras, Unisys, Metropolitan Transit Commission, Northern States Power, Aviation Weather Training Service, Medical Center, and the Super America gas station currently occupy approximately 26 acres at MSP. It is appropriate that space be made available for such uses at the new airport. Space made available for these functions should be outside the area required for airfield and passenger/cargo-related services. Once these needs are met, some space may be available and could be set aside for commercial activities. The need for these aviation-related facilities to serve air travelers, airport tenants, and the airport community will depend greatly on the location of a new airport and policy of the governing authorities. A review of other major airports indicates that about 100 total acres is utilized by these types of functions. This amount will be assigned to these users at a new airport.

6.10.8 Utilities

It is not possible at this point in the planning process to predict the amount of space needed for utility-related functions. However, a review of other major airports with operational levels similar to those forecast for MSP in the year 2020 indicates the need for approximately 10 acres for these functions. The sites would be scattered over numerous parts of the airport and would include items such as pump houses, substations, telephone equipment, and various forms of monitoring equipment.

6.10.9 Airline Corporate Offices

At airports where airline corporate headquarters are located, it is desirable to consolidate such facilities. The amount of land needed to accommodate a consolidated facility can best be determined by studying similar situations elsewhere. At Atlanta-Hartsfield International Airport, for example, Delta Air Lines occupies approximately 70 acres on-airport. In this space they have their general offices, computer center, reservations, training center, and flight simulators. If NW corporate offices are to be located at a new airport, approximately 100 acres should be reserved for this function.

6.10.10 Military

Three military facilities are located at MSP. They are the U.S. Air Force (934 TAG IAP); the Minnesota Air National Guard (133D-TAW/CV, MSP/AP); and U.S. Navy. It was assumed that military facilities at and adjacent to MSP will be relocated to a new airport and their existing facilities duplicated in kind. To accomplish this will require 250 acres.

6.10.11 Summary

Table 6-27 provides a summary of the acreage requirements for 2020 for cargo, general aviation, and other facilities.

Table 6-27

Summary of Requirements for Air Cargo,
General Aviation, and Other Facilities

Function/Facility	2020 Requirements (acres)
Air Cargo	109
General Aviation	27
Airport Administration and Maintenance	29
Airline Maintenance Hangars and Operational Support Areas	328
Fuel Storage	7
Aircraft Rescue and Firefighting	3
Flight Kitchen	8
Federal Functions	
• Federal Aviation Administration	8
• U.S. Weather Service	2
• U. S. Post Office	9
Commercial/Public Functions	100
Utilities	10
Airline Corporate Offices	100
Military	<u>250</u>
Total	990

Source: Ralph White Associates.

Chapter 7

Alternative Identification

7.1 INTRODUCTION

Up to now, this Conceptual Design Study has prepared the background material and support data needed to develop a new air carrier airport in the Minneapolis-St. Paul metropolitan area. The purpose of this chapter is to investigate what physical form the new airport should take.

The alternatives presented herein were developed by the project team. At a series of meetings they were presented and comments solicited from representatives of the following groups: the Metropolitan Airports Commission, the Metropolitan Council, the Minnesota Department of Transportation, state legislative staff members, the FAA, the ATA, other airport operators, and the airlines serving the Twin Cities.

Following evaluation of the alternatives in Chapter 8 and a choice of the configuration, a Conceptual Design Plan for the new airport will be developed. This will incorporate surface access, automobile parking, general aviation, airport and airline maintenance facilities, the facilities required by the military, and other support facilities. The location of these latter functions will be responsive to the selected airfield and terminal layouts.

7.2 ALTERNATIVE IDENTIFICATION

The first step in the development of the Conceptual Design Plan is to identify alternative airfield layout and terminal configuration alternatives. The following presents and describes alternatives developed in this study. In Chapter 8 they will be evaluated. Upon selection of an airfield layout and terminal configuration, the two will be integrated to form the basis for the Conceptual Design Plan.

7.2.1 Airfield Layout Alternatives

All of the airfield alternatives should have sufficient capacity to accommodate demand forecast for the year 2020. Since no site for the new airport has yet been identified, neither noise abatement nor terminal area airspace constraints were assumed to exist. The identification of alternative airfield layouts began with the planning parameters from Chapter 3 which relate to the development of an efficient airfield. Similar scale airports located elsewhere were examined to determine how they operate. This examination concentrated on how their layout accommodates demand.

AIRFIELD PLANNING PARAMETERS

To accommodate future demand, at least three runways oriented to the primary wind direction are required. This number of primary runways will keep aircraft delays at cost-effective levels. A fourth runway may be desirable to reduce taxiing distances, depending upon the separations between the three runways. Changes in the direction of the wind over the year and the different types of weather occurring with these winds (i.e., precipitation and blowing snow and ice) suggest that it is also desirable to provide runways in a second direction. If a second direction of operation is provided, at least two runways are needed to maintain acceptable service levels.

The rationale for a second direction of operation depends on the tolerance of aircraft for crosswinds and tailwinds. In this report, crosswinds of up to 20 knots are assumed permissible (excluding snow and ice conditions), but aircraft would not land or take off with strong tailwinds. It is the intent in the development of airfield layout alternatives to utilize the secondary-direction runways as integral parts of the overall airfield operations, to reduce airspace travel distances.

To minimize delays under instrument meteorological conditions, an air carrier airport in the Twin Cities should have at least two, and possibly three, independent instrument approaches. Currently, the FAA is developing runway separation standards for triple independent instrument approaches. At Dallas-Fort Worth International Airport, the FAA has approved triple independent approaches with runway separations of 8,000 feet and 5,000 feet. Studies currently under way are investigating further reductions in separation requirements. While these studies are not yet complete, there are indications that further reductions in runway separation will be possible. Therefore, 5,000-foot and 8,000-foot separations are used in this study.

One important attribute of airfield layout is a "flow-through" capability. This feature provides the ability to have multiple aircraft arrival streams using specific runways, then taxiing into the terminal area. Simultaneously, departure streams may taxi from the terminal area to other runways, with no taxiing aircraft crossing paths or other runways. This is a key characteristic of the new airport currently under construction in Denver. Two other important attributes are the elimination of runway crossings by aircraft and the segregation of arrivals and departures onto their own runways.

EXAMPLES OF AIRFIELD LAYOUTS AT OTHER AIRPORTS

Single-direction airports, such as Atlanta-Hartsfield and Los Angeles International, have a number of runways, all parallel to each other, arranged symmetrically about the terminal area. The runway thresholds are generally not staggered or offset except for minor differences in runway length. Aircraft using the outermost runways must taxi across the inner runway to enter or exit the terminal area. At Travis Air Force Base (near Sacramento, California), where the runways are parallel, the thresholds are offset by a

large distance. This minimizes taxi distances and requires few if any crossings of active runways by taxiing aircraft.

The airfield configuration at Dallas-Fort Worth International Airport expands upon the concept used at Atlanta and Los Angeles. It provides additional runways beyond the four parallel runways. These additional runways are arranged at an approximate 30-degree offset angle to provide crosswind coverage and to add runway capacity. Diverging departure streams help distribute the departing aircraft into the terminal area airspace, while converging arrival streams perform a similar function for arriving airplanes.

At some of the major U.S. airports where wind conditions require runways oriented in two directions, the runways cross. Examples are San Francisco International, La Guardia Airport in New York, Lambert Field in St. Louis, and Minneapolis-St. Paul International. Because the runways cross, there are losses of operating efficiency in calm weather conditions. If they did not cross, runways in both directions could be used independently of each other.

A few other U.S. airports have runways in two directions which do not cross. Kennedy International Airport in New York and Stapleton International Airport in Denver are examples. At each, pairs of parallel runways oriented in two directions do not cross. At each of these airports, however, the runways are aligned in a way that causes flight path conflicts in certain weather conditions.

At O'Hare International in Chicago and Washington National in Washington, D.C., runways are provided in three directions with some runway crossings.

Many of the configurations in other cities result from site-specific wind conditions. The layouts do not necessarily represent the best configuration at a particular site nor recognize the current demand, constraints, and weather conditions.

AIRFIELD LAYOUT ALTERNATIVE IDENTIFICATION

Four runway layout alternatives were identified. These alternatives included a single-direction layout with four runways, and three two-directional layouts, each with five runways. Alternative P-2 is the single-direction concept. It has the shortest distances between the terminal area and the active taxiways for arrivals and departures. Further, its operation does not necessitate any runway crossings.

All four airfield layouts are shown in Figure 7-1. The others include T-1, which is a modification of P-2 that incorporates two crosswind runways. The final two alternatives are designated L-1 and L-2. This is because their runways are laid out in an "L" configuration. The two L-shaped alternatives differ primarily in the placement of the terminal area relative to the runways. All four airfield layout alternatives are described in the following.

- Alternative P-2. See Figure 7-2. All four runways are oriented in the same direction and align with the predominant wind direction.

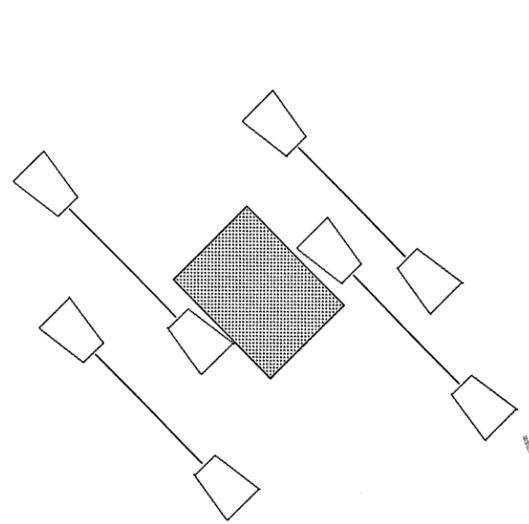
The runways closest to the terminal area are separated by 8,000 feet. The third parallel runway is located 5,000 feet from the nearest runway. This provides triple simultaneous independent instrument approaches. The fourth runway is 2,500 feet from its neighboring runway. This assures independence from wake turbulence concerns, while minimizing taxi distances and providing for simultaneous, independent departures in IFR conditions.

The layout of the runways in P-2 minimizes taxiing distance for arrival and departure aircraft, while allowing them to remain clear of the runway protection zones. The flow-through feature previously described is the foundation of this alternative.

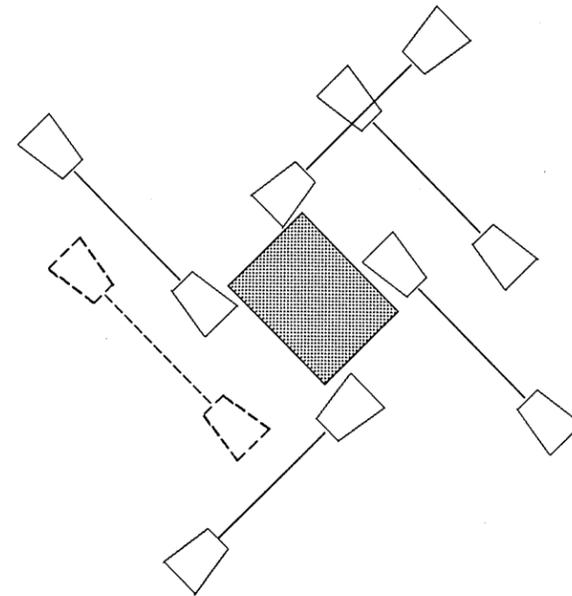
- Alternative T-1. See Figure 7-3. T-1 has five runways located in each of the four different quadrants around the terminal area. The separation between the three runways in the primary direction of operation are again 8,000 and 5,000 feet. The two runways in the secondary direction are located on either side of the terminal area, in a manner that provides maximum flexibility for airspace operation, consistent with minimum taxiing distances.

This alternative builds upon the flow-through feature of P-2 by adding two additional runways, at 90-degree angles, to the principal runways. These runways permit a third independent arrival stream and a third independent departure stream to operate without crossing any of the other four arrival/departure streams. In addition, there is a potential airspace travel distance savings. This occurs by permitting, for example, arrivals from the west in a westerly flow, to land to the south on the northernmost runway instead of flying 10 to 15 miles to the east to line up on a final to the northwest/southeast runways. Finally, the two crosswind runways provide coverage in the northeast/southwest direction, which weather conditions occasionally require.

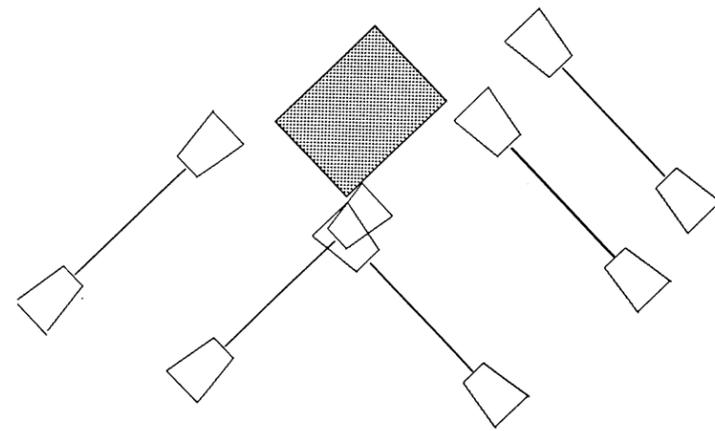
- Alternative L-1. See Figure 7-4. L-1 has the same number of runways as T-1. All runways with the same orientation are located on the same side of the terminal area. This minimizes the stagger (or offset) between the runway thresholds and concentrates aircraft operations in two of the quadrants around the airport. Runway locations again minimize taxiing distance. Many of the features of T-1 are incorporated into this alternative, with one major exception. Since it is not symmetrical in all four quadrants, there are certain inefficiencies with some operating modes.
- Alternative L-2. See Figure 7-5. The layout of Alternative L-2 is similar to that of Alternative L-1. The difference is in the relationship of the runways to the terminal area. By shifting the location of the runways, runway separations and staggers provide a smooth, efficient traffic flow.



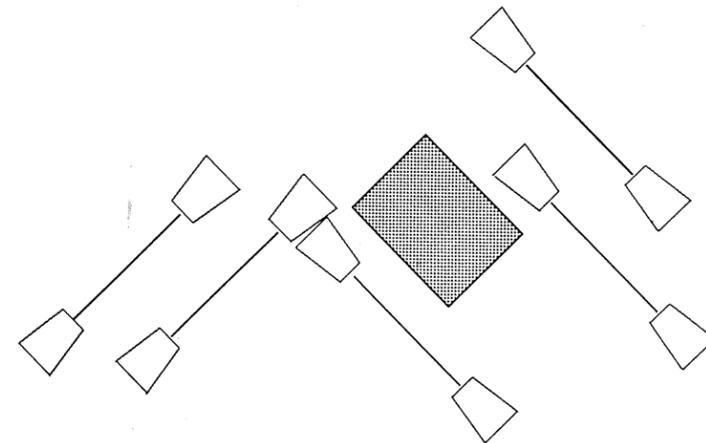
Alternative P-2



Alternative T-1

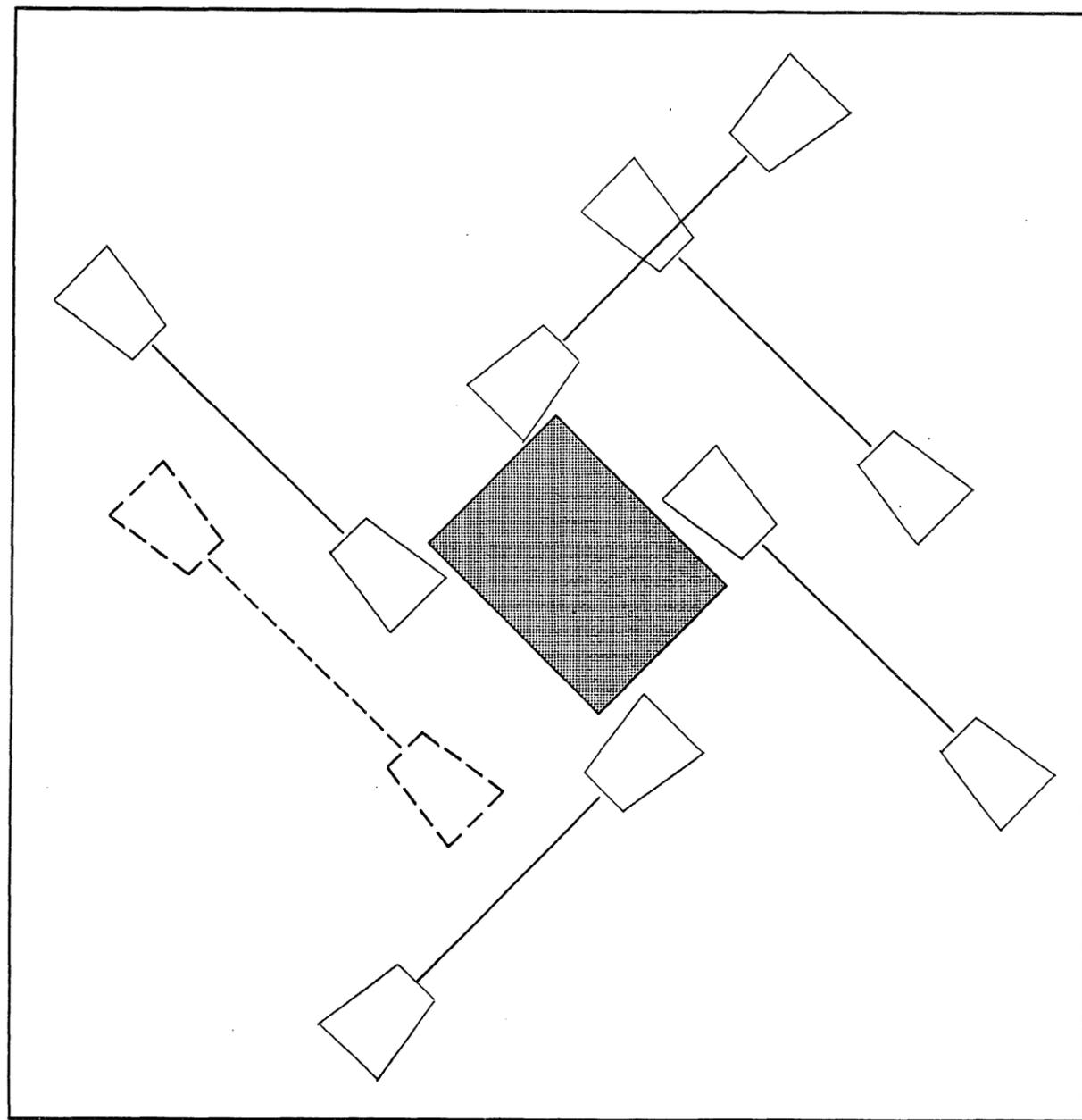


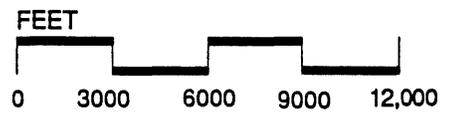
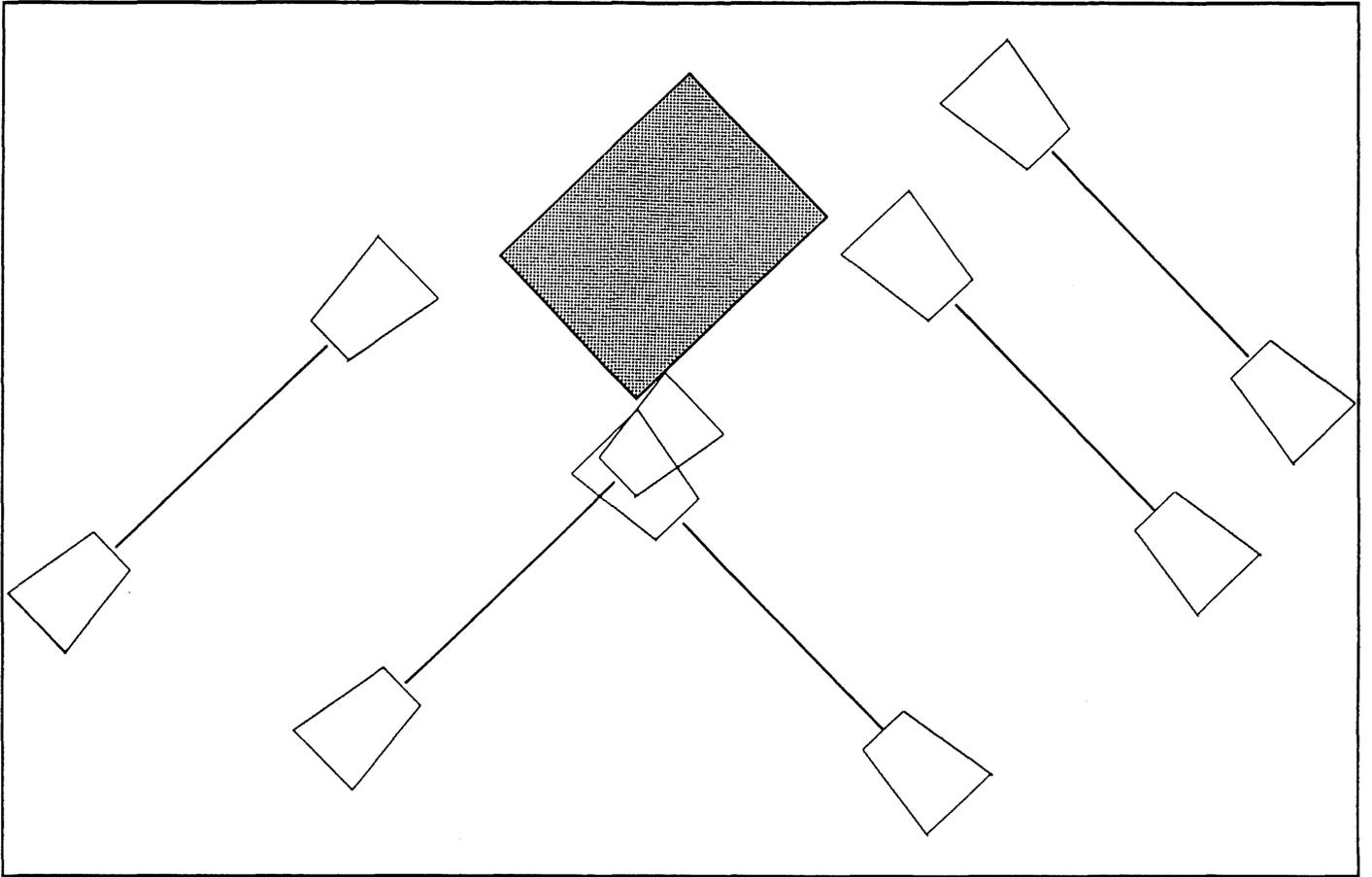
Alternative L-1

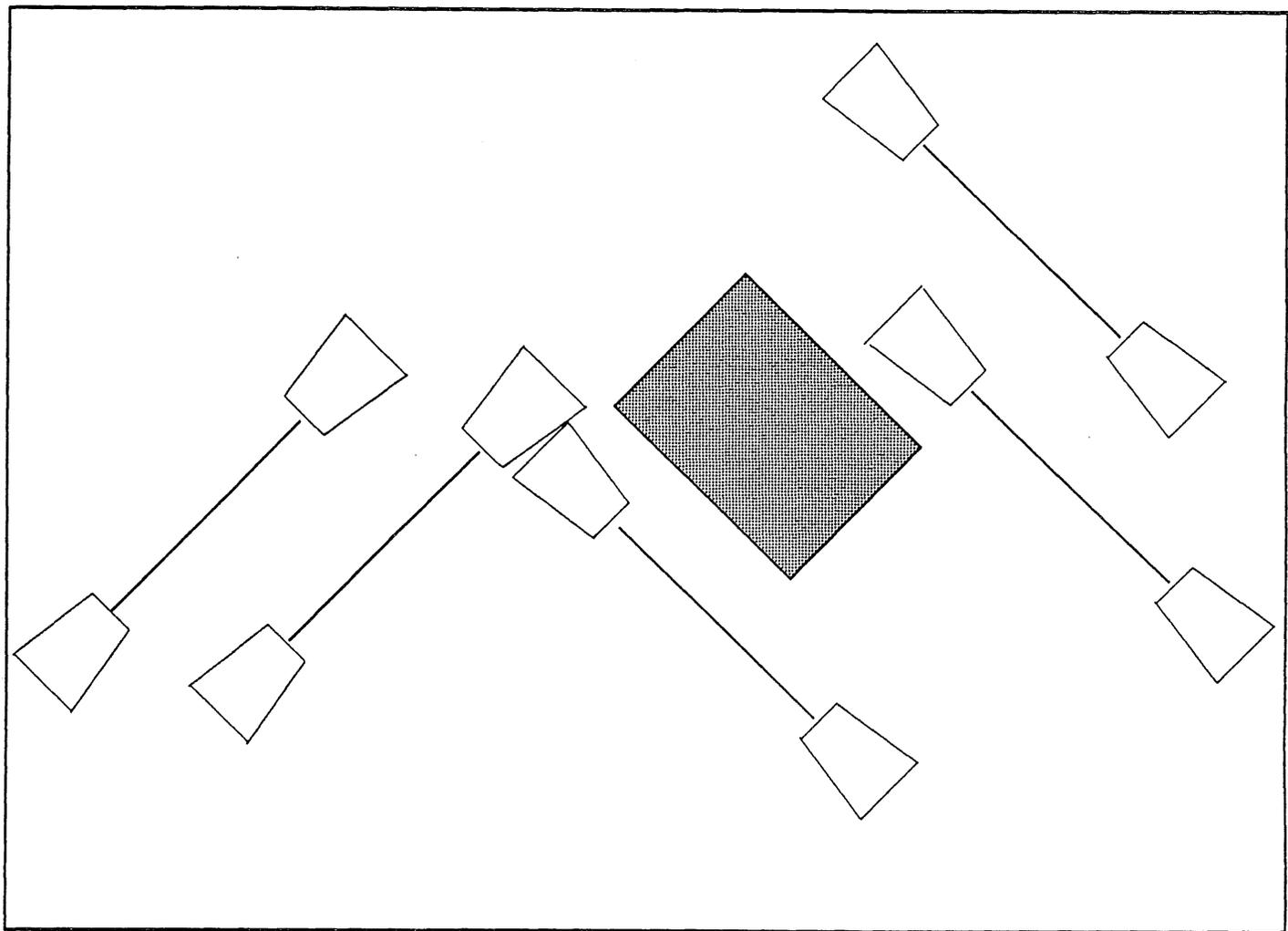


Alternative L-2









7.2.2 Terminal Configuration Alternatives

This section presents and describes the terminal configuration alternatives identified during this study. As with the airfield alternatives, the identification process began with the generation of specific planning parameters related to the terminal building. Then, a number of airports were studied. This focused primarily on plan configuration, overall dimensions of the terminal area, and terminal-building-to-gate and gate-to-apron relationships. From these two steps a number of alternative configurations were identified for a new air carrier airport.

TERMINAL CONFIGURATION PLANNING PARAMETERS

The planning parameters for the terminal area were based on goals and objectives, methodologies, and facilities requirements presented in previous sections of this report. The terminal configuration must be able to accommodate the level of demand forecast in the year 2020. The terminal building, aircraft parking positions, and aircraft apron require an area approximately 6,000 feet by 8,000 feet. It should be centrally located relative to the runways and taxiways. In gross area the terminal will require approximately 2.6 million square feet and must provide approximately 97 domestic, international, and regional air carrier gates. The configuration must strive to integrate domestic, international, and regional air carrier operations. It needs to facilitate the operation of a large domestic air carrier hub and respond to the needs of local origin and destination passengers as well. The terminal building should interface both with the airfield configuration and the surface access system. Additionally, the terminal area configuration should allow for fluctuation in demand, in both the short and long term. Flexibility, expandability, and convertibility should be built into the configuration in order to effectively accommodate changes in passenger processing functions, baggage handling, and ramp operations.

TERMINAL CONFIGURATION ALTERNATIVE IDENTIFICATION

Planning for the terminal area began with a study of the terminal area configurations found in the world's major airports. Six distinctly recognizable configurations were identified. They can be differentiated in several ways: (1) the form that they take in plan, (2) the way passengers move through the processing functions, and (3) the location of the aircraft parking positions relative to passenger processing functions. They also vary in whether passenger processing activities are centralized or decentralized. These six configurations are briefly described in the section that follows. Examples of airports at which each configuration can be found are also provided. Figure 7-6 graphically depicts the six configurations.

Transporter Configuration

The transporter configuration locates the passenger processing functions of ticketing and baggage claim in a central terminal building. This central building is frequently referred to as the central processing unit or CPU. Aircraft are parked on an apron located some

distance from the CPU. Shuttle buses or mobile lounges are used to transport passengers to and from the aircraft. These vehicles act as mobile gate lobbies, eliminating or reducing those spaces in the central building.

This configuration lends itself most appropriately to airports with moderate levels of passenger traffic and situations where that traffic is primarily originating and terminating locally. At airports with a significant volume of transfer passengers, operational characteristics of the transporter concept tend to be cumbersome.

Washington Dulles International Airport in its original configuration is an example. Subsequent modifications have altered the original concept.

Linear Configuration

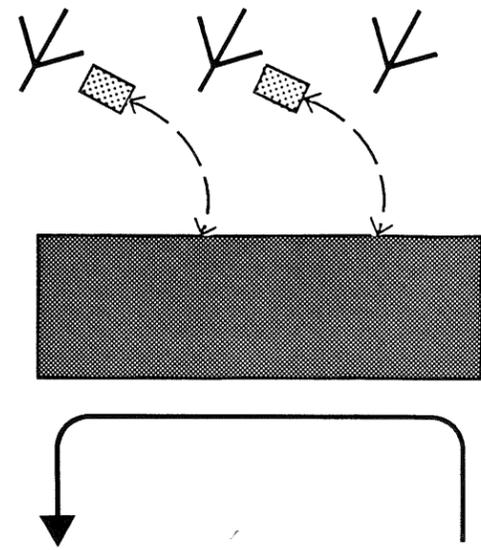
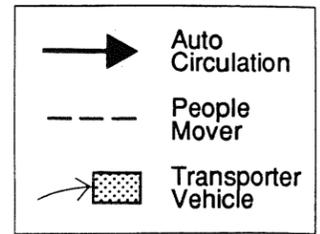
The linear configuration aligns aircraft in a single row along the airside of a passenger terminal building. Ticketing and baggage claim are centralized. Passenger access to aircraft is from holdrooms which are located beyond ticketing and baggage claim. Passenger travel-distance from curb to gate can be kept to a minimum in this type of configuration. This configuration works well for smaller airports or those with a high percentage of originating and terminating passengers.

As the overall level of passenger activity increases, the length of building needed becomes disproportionate to the passenger processing functions in the central building. Walking distances become excessive both between gates and to and from the automobile curb. The distance between gates can be such that transferring between connecting flights becomes impeded.

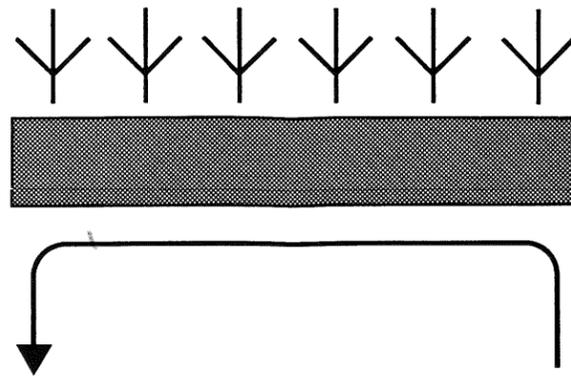
Terminal A at San Jose International Airport and Lexington-Blue Grass Airport are examples of the linear terminal configuration.

Pier Configuration

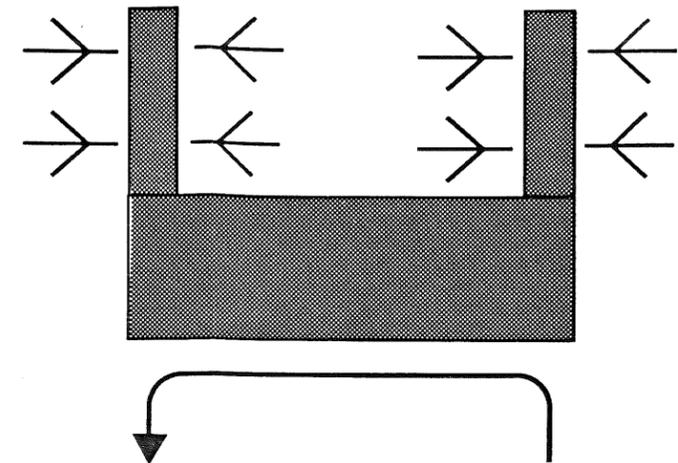
As traffic at an airport increases and more gates and aircraft parking positions are required, a linear terminal configuration may be expanded by the addition of piers. Extended from a central building, the piers allow aircraft parking positions along one or both sides. Passenger holdrooms can be located along one corridor in each pier. This helps maintain reasonable distances between various passenger processing functions.



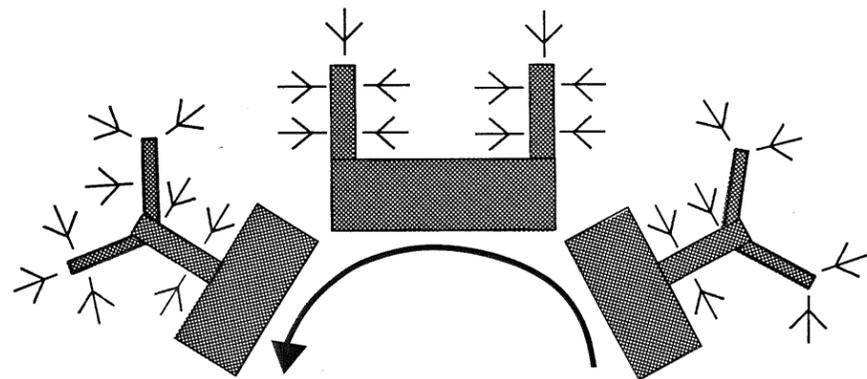
Transporter Configuration



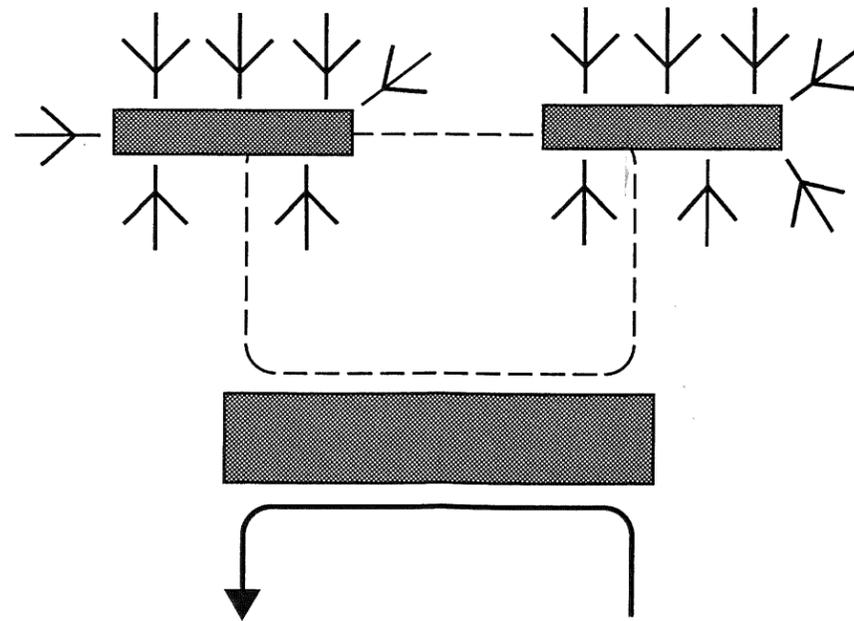
Linear Configuration



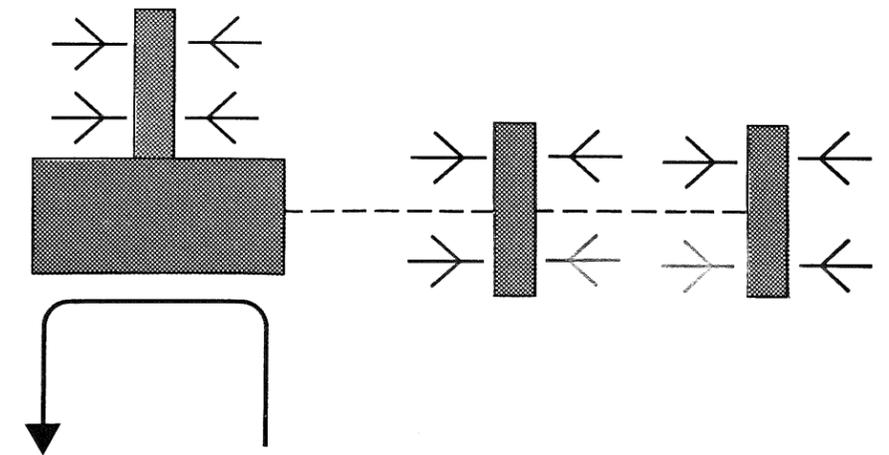
Pier Configuration



Unit Terminal Configuration



Satellite Configuration



Hybrid Configuration

As activity increases, both the number of piers and their length must be increased. Long walking distances and complicated travel routes become a problem. Because pier configurations frequently have dead-end taxilanes, aircraft operations on the ramp can become congested. During periods of high activity, aircraft maneuvering may cause delays. Piers function best in their simplest form. Typical "Y" and "T" configurations have angles and corners that make efficient aircraft parking configurations difficult to achieve.

Minneapolis-St. Paul International Airport is an example of a pier type of configuration, as are Denver-Stapleton, Washington National, and Philadelphia International Airports.

Unit Terminals Configuration

In unit terminals, passenger ticketing and baggage claim are decentralized into two or more individual (i.e., unit) terminal buildings. Typically each unit terminal is anchored by an airline. Aircraft gates assume a variety of configurations, either linear or piers. Unit terminals are typically linked together by a common roadway system. Pedestrian walkways and/or some form of people-mover system are also characteristic.

Unit terminals are typically found at airports served by a number of airlines. Unit terminals serve originating and terminating passengers well, and successfully accommodate on-line connections. Passengers who must connect between unit terminals frequently encounter a more difficult and time-consuming journey.

Los Angeles, Kennedy, Boston-Logan, and Dallas-Fort Worth International airports are examples of the unit terminal configuration.

Satellite Configuration

There is a physical separation between ticketing and baggage claim, and passenger holdrooms and gate positions in satellite configurations. Ticketing and baggage claim are located in the CPU. Holdrooms and aircraft gates are located in satellite concourses. These concourses may be located any distance from the central processor that the site requires or allows.

The form which the satellite concourses take may vary. They can be circular, linear, or have an "H" or "X" configuration. The means by which passengers reach the satellite varies as well. Typical alternatives are a below-grade corridor or an automated people-mover system, which may be located either on an elevated guideway or in tunnels below grade. Transport of passengers by an automated system helps keep passenger walking distances reasonable.

The configuration of satellite concourses relative to a CPU may take several forms. Parallel concourses may be served by a linear people-mover system which has a stop at each one. Alternatively, satellite terminals may be configured around the perimeter of the CPU. People-mover links then emanate radially from the CPU. In either configuration, the satellites may be connected by a people-mover system configured in a loop.

The satellite configuration works well at airports with either a high level of origin/destination traffic or transfer activity. It well serves large airports with a high level of activity. The people-mover technology and the configuration of the satellites are determined by the dominant kind of passenger activity.

Atlanta-Hartsfield International Airport consists of a series of linear satellite concourses linked together via a below-grade people-mover system. The new Denver Airport is similarly arranged. Tampa International Airport has satellite concourses configured in a perimeter fashion around a CPU with people-mover links that radiate out. An X-shaped satellite configuration is used at the new Greater Pittsburgh International Airport with a single people-mover link.

Hybrid Configurations

Over time, airports evolve and change. There are fluctuations in activity levels and changes in the types of traffic. Terminal buildings are required to keep pace. Because of this, it is rare to find any terminal configuration in its pure form. Typically, hybrid configurations develop. These incorporate elements of more than one configuration. Such mixing and matching of elements is so common that hybrids are distinctive.

An airport with a linear configuration may discover that a satellite concourse is the solution to the need for additional gates. Location or expansion of an airline hub can generate both the need for additional gates and the requirement to consolidate the hub airline's operations. This may suggest the development of a new unit terminal or construction of pier or satellite concourses dedicated to that airline.

A hybrid configuration resulting from such a mix of elements can be seen at Seattle-Tacoma International Airport. When pier additions and linear extensions could no longer satisfy the need for additional gates, two satellite concourses were constructed. The transporter configuration at Dulles International Airport has been expanded through the addition of pier concourses. To accommodate an airline hub, midfield satellite concourses are also being considered at Dulles. At Washington National, a temporary unit terminal was recently constructed by an airline because further lengthening of the existing terminal was not possible. The design for the new Denver Airport accommodates two hubbing carriers in side-by-side CPUs connected to a series of satellite concourses.

EXAMPLES OF TERMINAL CONFIGURATIONS AT OTHER AIRPORTS

Terminal configurations at a number of other air carrier airports were studied. The purpose was to learn how they developed and how they function. The airports studied were: Atlanta-Hartsfield, Dallas-Fort Worth, Tampa International, the new Denver Airport, and Greater Pittsburgh. A brief overview of the findings is presented in this section. Figure 7-7 graphically depicts the configuration of the terminal area at each of these airports.

Atlanta-Hartsfield International Airport

The Atlanta-Hartsfield International Airport is located approximately ten miles from downtown Atlanta. It serves as a hub for Delta Air Lines. The terminal complex was completed in 1980 and consists of a multi-level central terminal building which contains the ticketing and baggage claim facilities. Automobile parking is in a garage immediately adjacent to the central terminal building. An international arrivals concourse is connected to the central terminal. Domestic operations are located in four satellite concourses located on the apron, each of which has approximately 30 aircraft positions. A linear, below-grade people-mover system and pedestrian corridor connect the satellite concourses to each other and the central terminal. On the apron, dual taxiways provide unrestricted flow-through for aircraft and unimpeded gate access. This central terminal/satellite concourse flow-through taxi pattern relationship efficiently serves the high volume of passenger and airline activity at Atlanta-Hartsfield. Total passengers at Atlanta were 45.9 million in 1988.

Dallas-Fort Worth International Airport

Dallas-Fort Worth International Airport was built in the early 1970s. It is located midway between Dallas and Fort Worth, Texas, 17 miles from each city. It serves as a hub for American and Delta Air Lines. The terminal configuration consists of a series of semi-circular shaped unit terminals located on either side of a linear vehicular spine. Parking is located within the landside area of the semi-circles. The original objective in this configuration was to minimize the distance a passenger had to walk between car and gate. Ticketing and baggage claim functions stretch out along one level of each unit terminal. A shuttle system connects the terminals. It runs along a lower-level, at-grade roadway. Aircraft gates are located immediately to the airside of each unit terminal. Each terminal accommodates approximately 20 to 25 aircraft parking positions. This terminal configuration functions best when there is a high level of origin-and-destination passenger traffic. The walking distance between widely separated gates can be substantial. Transfer between unit terminals is often inconvenient. The shuttle system, which was not originally designed to handle the volumes of connecting traffic which the airport is now accommodating, has become inadequate. Dallas-Fort Worth had 44.2 million total passengers in 1988.

Tampa International Airport

Tampa International Airport is located approximately four miles west of the city of Tampa, Florida. The existing terminal was completed in the early 1980s. It is primarily an origin-and-destination airport, with 90 percent of the passenger traffic beginning or ending their travel in Tampa. No air carrier operates a hub at Tampa. The terminal area consists of a multi-level central terminal combining automobile parking, ticketing, and baggage claim. This is surrounded by four satellite concourses. Each satellite concourse has 10 to 12 aircraft positions. These satellites are linked to the central terminal by a people-mover system on elevated guideways. This CPU/satellite concourse relationship has the objective of keeping passenger walking distances as short as possible. By limiting the number of gate positions at each satellite, the gates are kept close to the people-mover station.

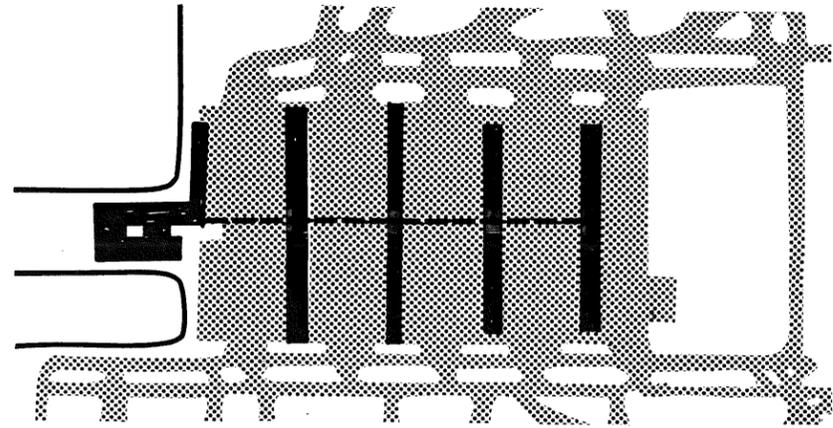
In the CPU, the automobile parking, transfer, ticketing, and bag claim levels are stacked one on top of another. Passenger walking distance is also minimized here. Total 1988 passengers for Tampa were 9.7 million. A fifth satellite concourse is currently under consideration.

New Denver International Airport

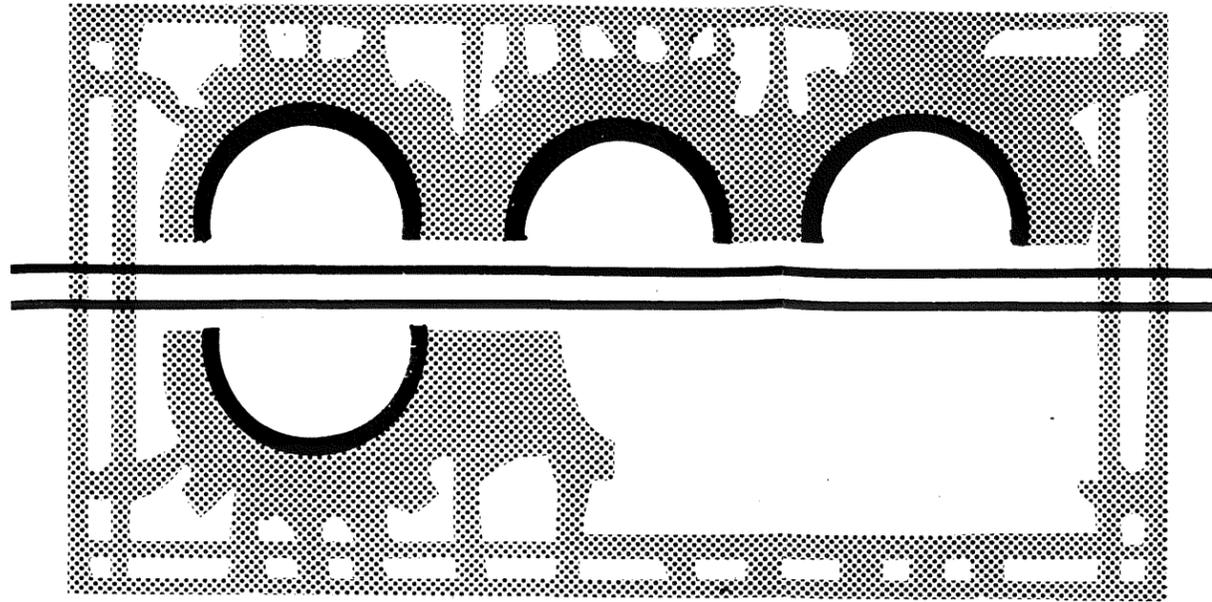
The new Denver International Airport will replace existing Stapleton International Airport. It is intended to accommodate both United and Continental Airlines' hubbing operations, as well as a growing volume of origin-and-destination traffic. Approximately 65 percent of total traffic is expected to consist of connecting passengers. The site for the new airport is northeast of the city of Denver. The Master Plan calls for a pair of multi-level central processing units and three satellite concourses to be built. Each concourse will accommodate 40 to 50 aircraft positions, and will include a central core. This will be the access point to and from the CPU via a linear, below-grade people-mover system. Because at full build-out each satellite concourse is close to 4,000 feet long, a secondary passenger distribution system is planned for the future. It will complement the people-mover system by enhancing gate-to-gate connections within each concourse. Independent apron taxiways provide flow-through aircraft movement between aircraft parking positions and the runways. Stapleton International, the airport presently serving Denver, had 31.7 million passengers in 1988.

Greater Pittsburgh International Airport

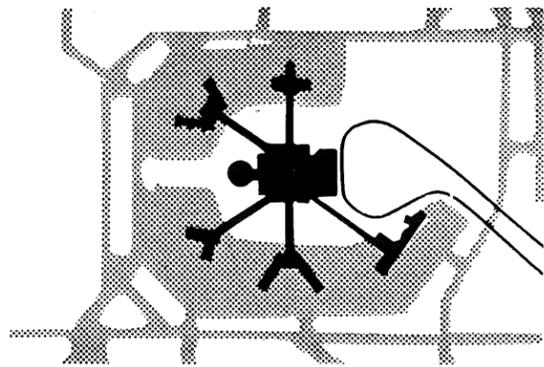
In 1981 Allegheny County selected a configuration for a new terminal for Greater Pittsburgh International Airport. The new terminal is intended to replace the facilities which exist today. The airport is located approximately five miles southeast of the city. Redesigning the terminal area has been made necessary because of USAir's increasing use of the airport as a hub. Seventy-three percent of the traffic through Pittsburgh is associated with USAir. The new configuration has a two-sided, multi-level central terminal. Automobile curbs are located on either side. Ticketing and baggage claim are located on separate levels in the CPU. There is also a level at which passengers gain access to a people-mover system.



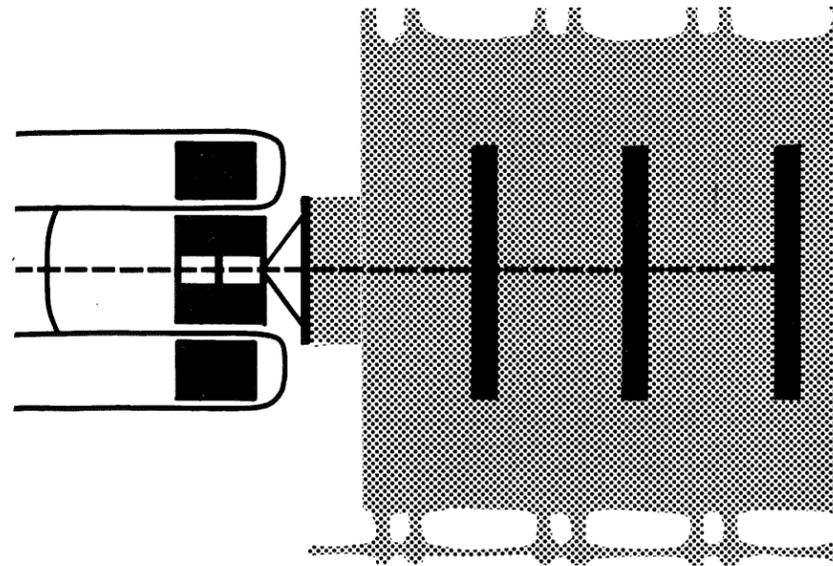
Atlanta



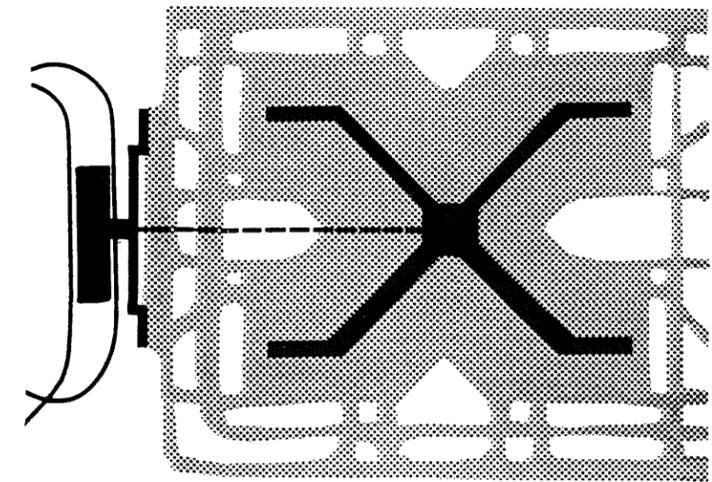
Dallas-Fort Worth



Tampa



Denver (New Airport)



Pittsburgh



Aircraft gates are located at an "X" shaped satellite concourse. The first phase of development will result in 59 gates. At full build-out, there will be approximately 90 gates. International airline gates are located at the satellite. A 30-gate commuter airline pier is located between the satellite concourse and the CPU. A pedestrian corridor connects the commuter pier to the CPU and the people-mover system. This configuration results from the need to accommodate a single large-volume hubbing carrier with a high level of connecting passengers. Most connections between domestic and international air carriers will occur within the satellite. The single people-mover link provides originating/terminating passengers with a convenient connection within the CPU. In 1988, there were 17.9 million passengers at Greater Pittsburgh International Airport.

TERMINAL CONFIGURATION ALTERNATIVE IDENTIFICATION

This section describes the alternative configurations of the terminal area at the new air carrier airport. A total of six were identified. Each terminal configuration was scaled to accommodate the enplanements and passenger connections forecast in the year 2020.

The terminal configuration sought to integrate domestic, regional, and international airline operations. It also had to respond to the unique characteristics of a large hubbing carrier and the particular needs of the local origin-and-destination passenger traffic.

These two configuration requirements were used as exclusionary testing criteria. In other words, if a terminal configuration alternative was unable to satisfy these two criteria, then it was eliminated from further consideration. Application of this evaluation procedure caused three terminal configurations to be eliminated from further consideration.

The transporter alternative was eliminated because it was too cumbersome operationally for an airport with a large number of gates and the present and projected future level of transfer activity.

The linear configuration alternative was eliminated because it is better suited to airports where there is both a lower level of activity and that activity is predominately origin/destination. Aligning approximately 90 gates along a single terminal building would result in very long walking distances between aircraft parking positions. The gate frontage required would also be disproportionate to the size of the CPU. This would create long walking distances for origin/destination passengers as well.

The unit terminal configuration alternative was also eliminated. Separate terminals are appropriate when a limited number of air carriers have significant portions of the overall operations. However, passenger processing functions are common to all types of traffic. Segregating air carriers into separate facilities necessitates duplication. Additionally, decentralization of passenger processing functions and gates makes integration of

domestic, regional, and international airline operations difficult. This can cause problems for both the airlines and the passengers transferring from regional or international airline flights into a domestic carrier's system. Therefore a unit terminal configuration was not considered further.

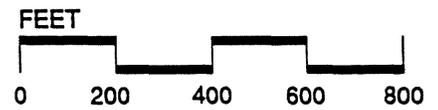
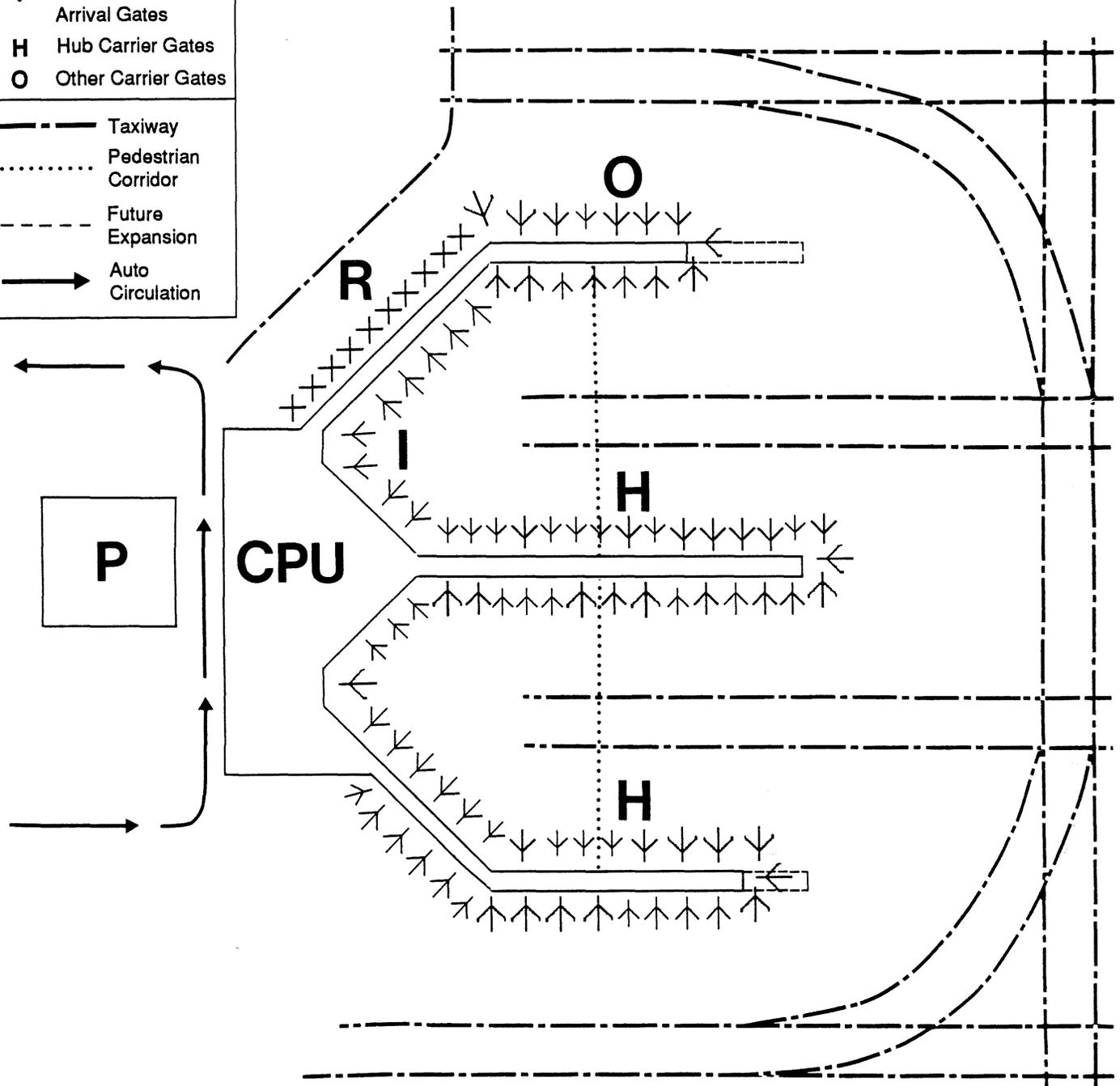
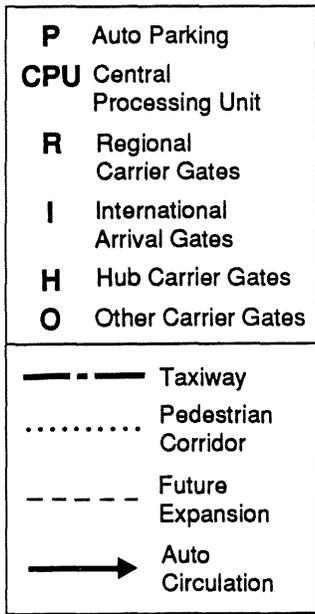
Three configurations remained for further investigation: the pier, the satellite, and the hybrid. From these, five alternatives were identified for inclusion in this study: a pier alternative, two satellite alternatives, and two hybrid alternatives. They are designated as Alternatives A through E and are depicted in Figures 7-8 through 7-12.

Alternative A - The Pier

Alternative A translates the gross facility requirements for the year 2020 into a pier configuration. A two-level central processing unit (CPU) houses the ticketing and baggage claim associated with all domestic, regional, and international airline operations. The CPU has a two-level drive which provides access for public and private vehicles carrying enplaning and deplaning passenger traffic. Automobile parking is centrally located across the drives.

On the airside of the terminal, three piers extend out from the upper level of the CPU. There are approximately 30 aircraft parking positions at each pier. These piers contain the passenger holdrooms. Two of the three piers are needed to accommodate Northwest Airlines. The third pier has sufficient gate positions for all of the other carriers, including international.

To accommodate the number of aircraft parking positions required, the piers are long. Origin/destination passengers must walk between 2,200 and 2,500 linear feet to reach the most distant gates. Passengers connecting between one flight and another may walk as far as 2,500 feet between gates located on one pier, and up to 5,400 feet between gates located on two piers. Because of these walking distances, this alternative relies on moving sidewalks to improve passenger connections within each pier. A below-grade pedestrian corridor with moving sidewalks is also needed to interconnect the piers. Figure 7-8 graphically depicts the pier alternative.

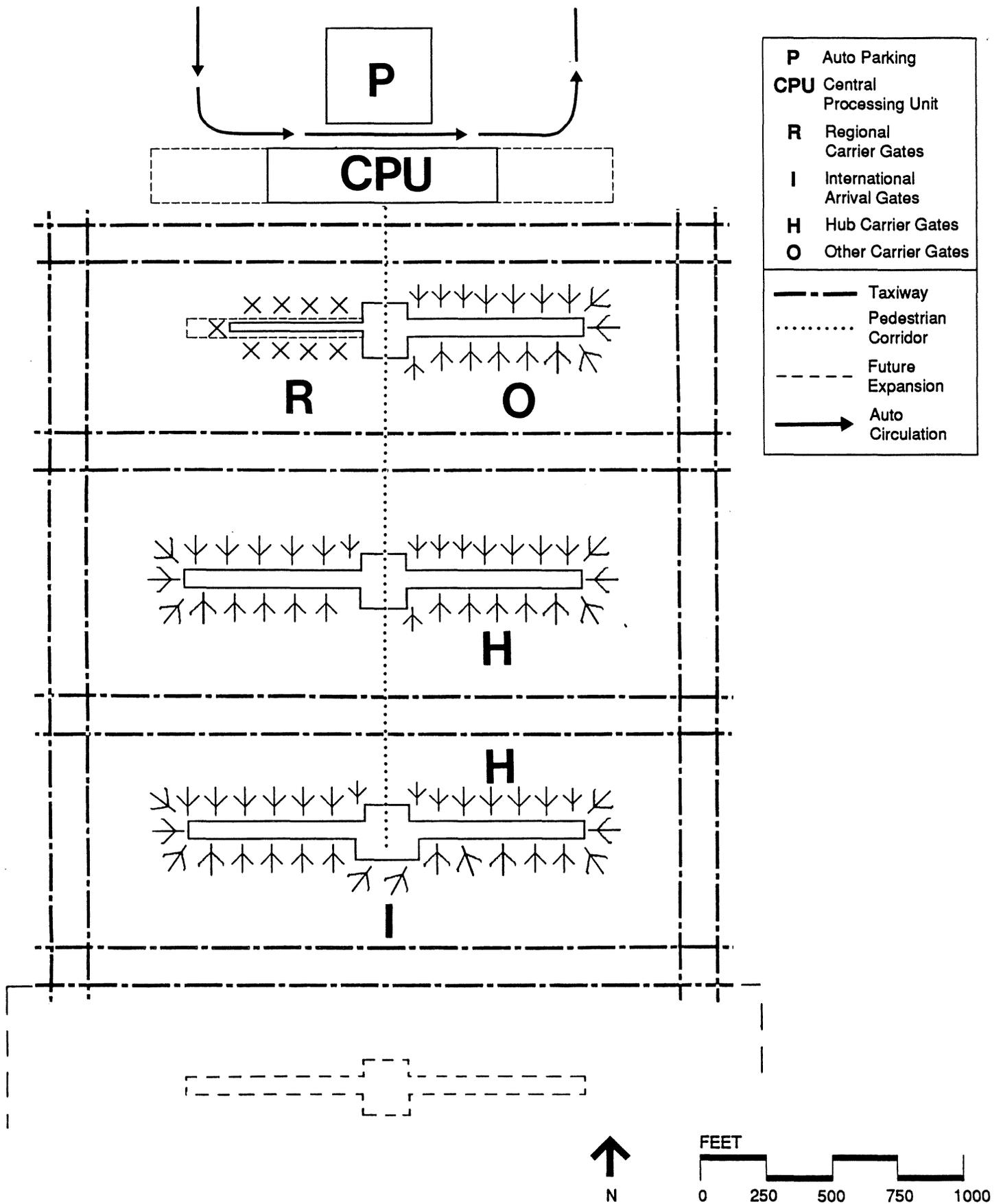


Alternative B - Satellite I

Alternative B accommodates the facility requirements in a satellite configuration. This particular alternative is similar to the terminal configuration at Atlanta-Hartsfield and that which is currently being designed for the new Denver Airport. As in Alternative A, ticketing and baggage claim are located on separate levels of a multi-story CPU. Adjacent to the CPU are the terminal drives and a parking garage. On a third level of the CPU, probably located below grade, is access to a people-mover system. Vehicles would run along guideways below the terminal and apron level to reach the three satellite concourses.

Each satellite concourse has approximately 30 aircraft parking positions. Passenger holdrooms, concessions, other passenger service areas, and airline operations are located in each satellite. Northwest Airlines and international airline arrivals occupy two of the three satellites. The third has positions for the regional and all other domestic air carriers. A fourth satellite, if needed in the future, could be added.

The people-mover takes passengers to a station which is centrally located in each satellite. The longest walking distance for origin/destination passengers to or from this station is approximately 1,000 feet. Connecting passengers would not walk more than 2,000 feet within a satellite concourse. Moving sidewalks in the satellites will shorten the walking distance from the people-mover station to gates, as well as between gates. Facility requirements for this alternative are presented in Figure 7-9.



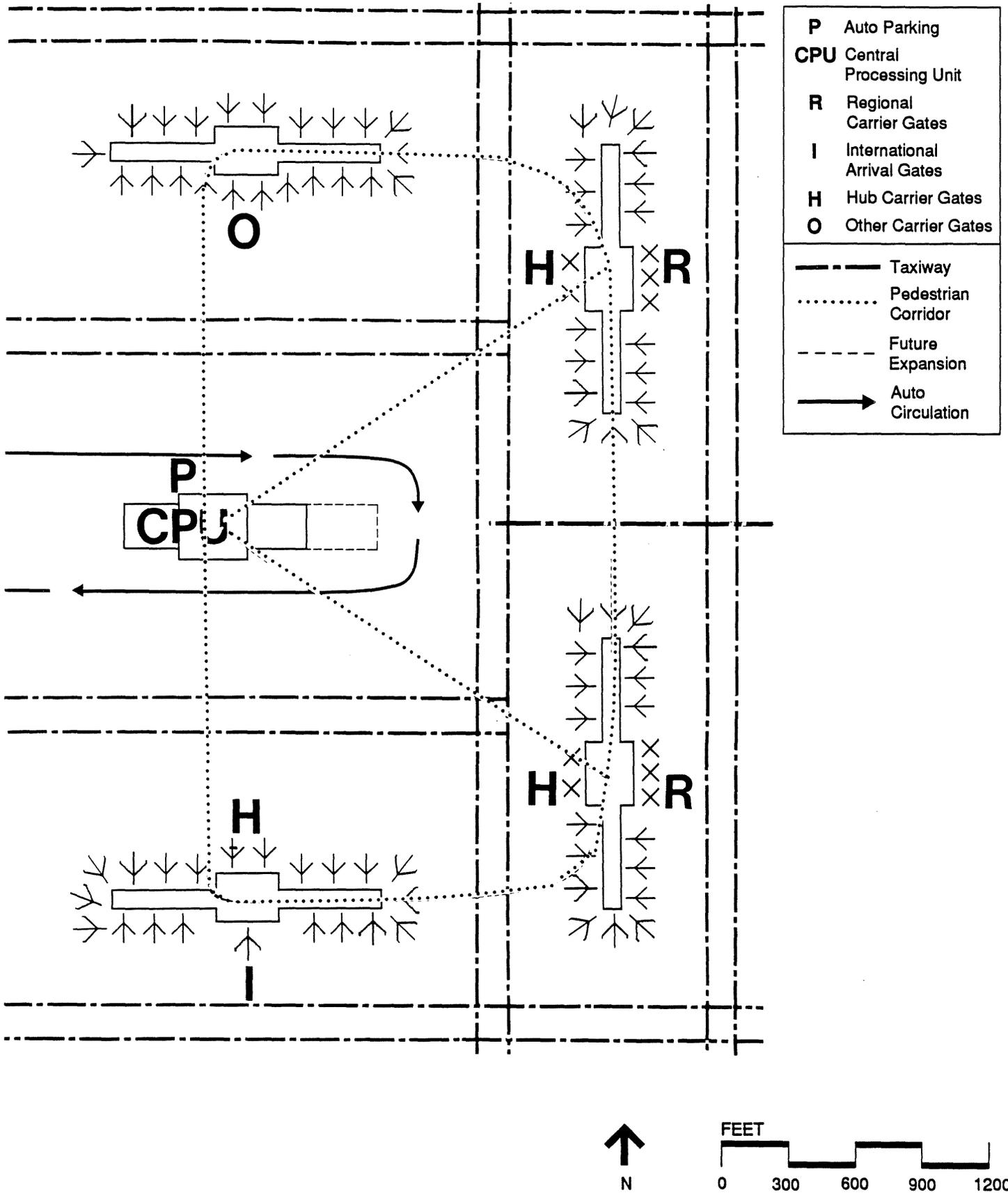
Alternative C - Satellite II

Alternative C also meets the facility requirements with a satellite configuration. This particular alternative is similar to the terminal configuration at Tampa International Airport. A multi-leveled central processing unit (CPU) building contains automobile parking, ticketing, baggage claim, and a people-mover station. Four satellite concourses ring the CPU in a horseshoe configuration. The people-mover system is located below the apron in contrast to Tampa, where it is on an elevated guideway. This variation from the Tampa configuration allows aircraft to circulate on the apron around each satellite.

As configured, each satellite has approximately 23 aircraft parking positions. Passenger holdrooms, concessions, other passenger service areas, and airline operations are located in each satellite. Northwest Airlines and the regional and international airlines occupy three of the four satellites. The fourth has positions for all of the domestic air carriers. Additional satellites can be constructed in the future if needed.

The people-mover system transports passengers to a centrally located station in each satellite. The longest walking distance for origin/destination passengers to or from this station is approximately 650 feet. Excluding the transition to and from the people-mover system, connecting passengers need not walk more than 1,300 feet within a concourse.

The people-mover system required to serve this configuration has right-of-way emanating from a central station in the CPU to stations located in each satellite. This provides nonstop service to and from the CPU for origin/destination passengers. Passengers whose connection requires them to move between satellites would ride to the CPU, where they would change to another people-mover link. The time required to travel between satellites could be reduced by adding a people-mover loop serving only the satellites. Figure 7-10 describes this second satellite configuration.



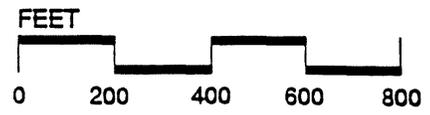
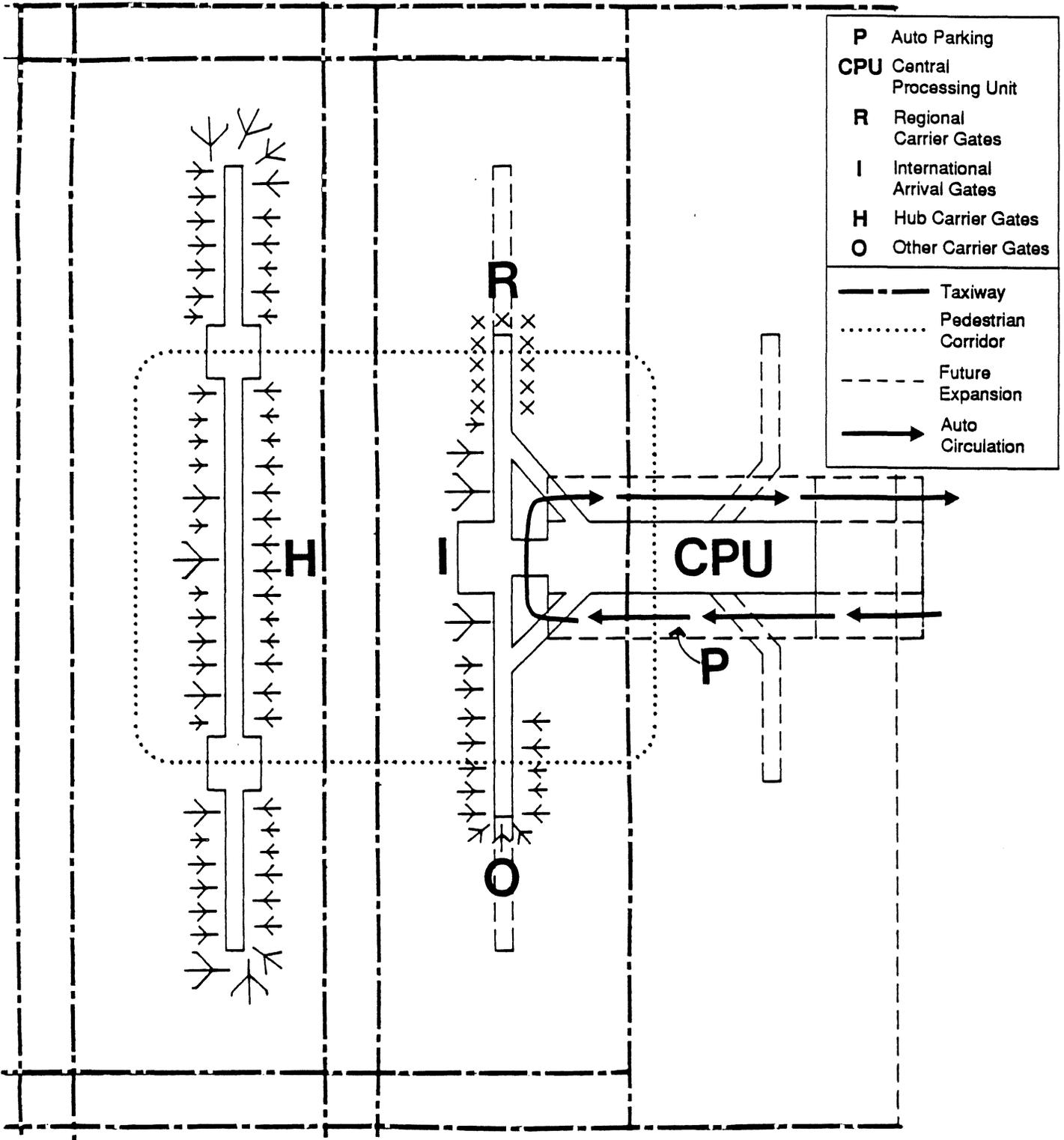
Alternative D - Hybrid I

This hybrid alternative combines elements of the pier and satellite configurations. A CPU contains ticketing and baggage claim. Located above the CPU is a multi-level automobile parking facility. At a lower, level, a people-mover system would provide access to one large satellite concourse.

In this alternative, the regional and non-hubbing domestic air carriers are located in short piers which extend out from either side of the central processing unit. Gates for international arrivals are located here, too. These piers each have approximately 15 aircraft parking positions. The 50 to 60 gates required by Northwest Airlines are located in a satellite concourse. Areas are reserved to extend the length of each pier and to add a new series of piers in the future when more aircraft gates are needed.

A people-mover in a loop configuration transports passengers from the CPU and from pier gates located at the CPU. Passengers transferring between Northwest Airlines flights in the satellite, and passengers transferring to and from areas or gates located in the CPU can both use this system. If the piers are lengthened in the future, additional people-mover stations can be added.

In this configuration, walking distances for origin/destination passengers in either the satellite concourse or the piers are approximately 1,200 feet, excluding transfer to and from the people-mover system. Passengers transferring from one flight to another within the satellite concourse or between the satellite and the pier gates can walk up to a maximum of 2,200 feet. Moving sidewalks in the satellite would shorten the walk to the people-mover station. Passengers can also use these sidewalks to travel between gates as an alternative to riding the people-mover system. Figure 7-11 graphically illustrates this hybrid configuration for the new airport terminal.



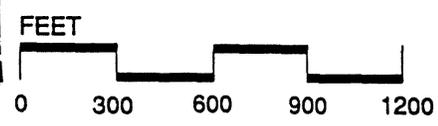
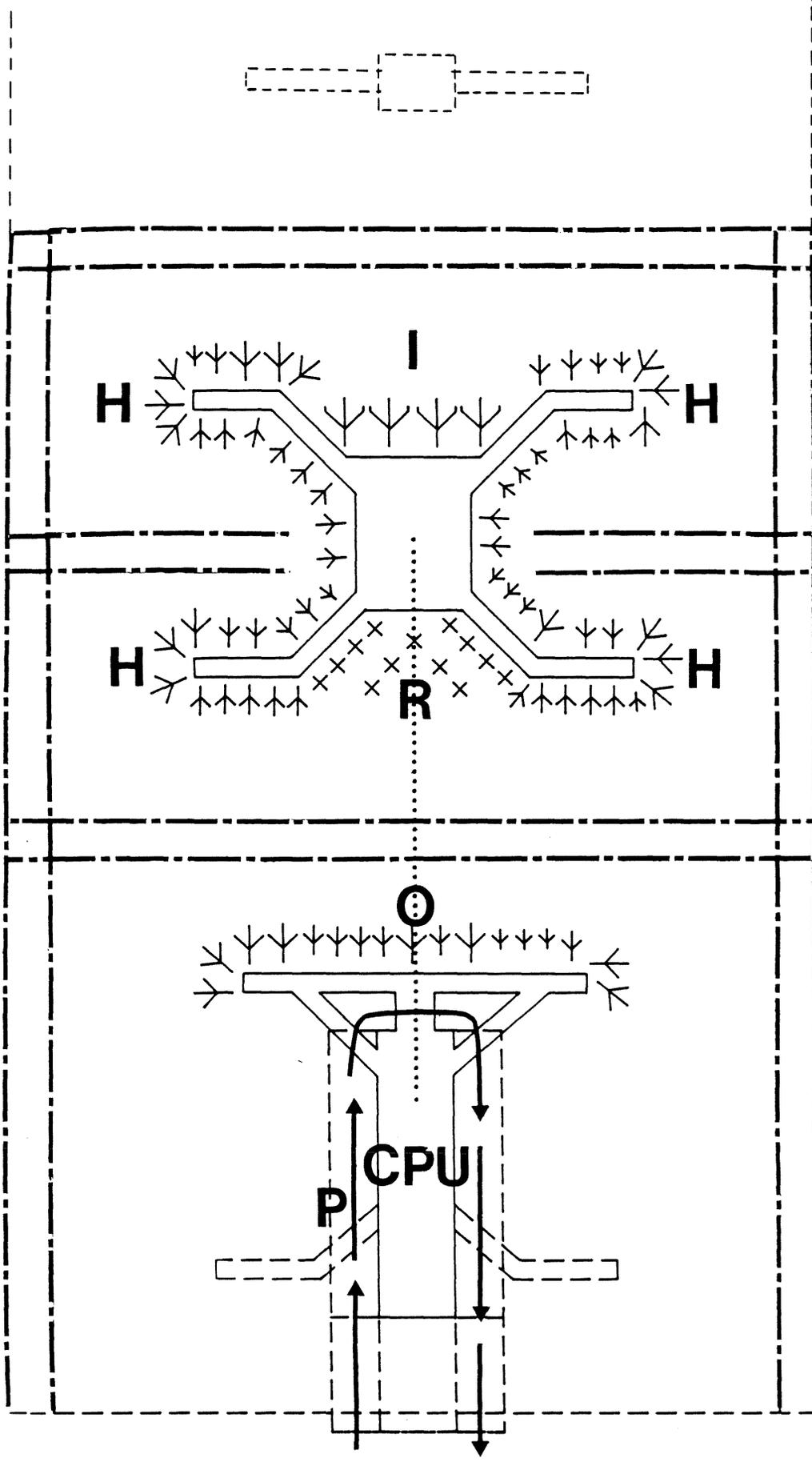
Alternative E - Hybrid II

Alternative D is another hybrid configuration alternative. This hybrid, like the previous one, combines elements from the pier and satellite alternatives. A CPU contains ticketing and baggage claim. Above these functions is a multi-level automobile parking facility. Below, on a passenger-transfer level, is the people-mover station from which passengers gain access to the satellite concourse.

In this alternative, non-hubbing domestic air carriers are located in a short pier which extends from and is parallel to the CPU. This pier accommodates approximately 17 aircraft parking positions. The approximately 70 gates required for the regional and international carriers and Northwest Airlines' hub operations are located in the satellite concourse. This satellite is configured as an "X" and is connected to the CPU by a people-mover. Areas are reserved for the addition of a future satellite and pier if needed.

In this configuration, passengers are delivered to the center of the satellite concourse. Moving sidewalks assist passengers as they travel along the four legs of the "X". Origin/destination passengers using the gates located in the pier concourse connected to the CPU could travel up to 1,300 feet. This distance would lengthen to 1,500 feet when satellite gates and people-mover system are used. All hub carrier connecting passengers, and passengers connecting between the regional and international carrier gates and the hub carrier gates do so within the satellite. Connecting passengers travel up to 3,000 feet to make connections along the four legs of the satellite. Figure 7-12 graphically describes this second hybrid configuration alternative.

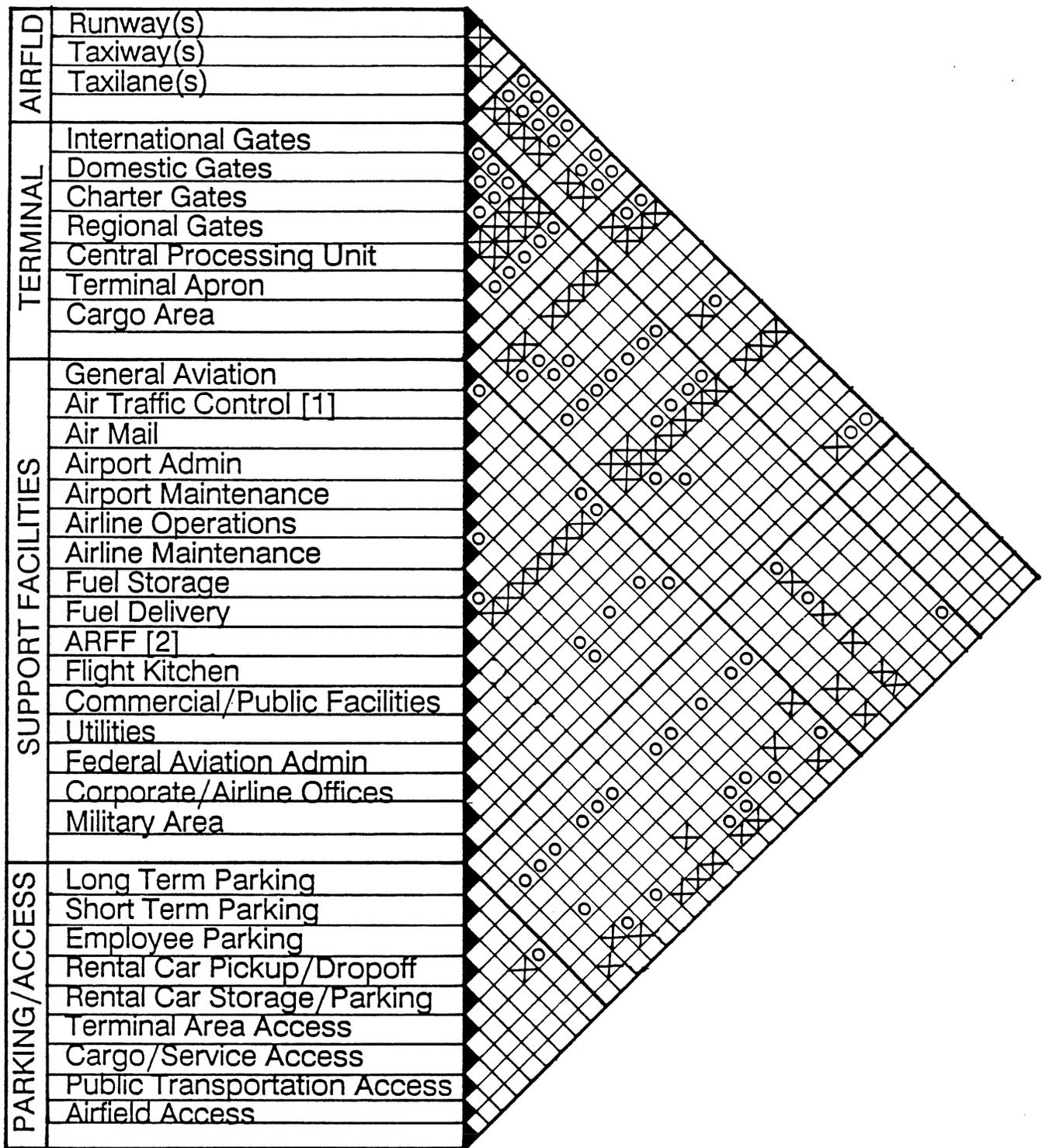
P	Auto Parking
CPU	Central Processing Unit
R	Regional Carrier Gates
I	International Arrival Gates
H	Hub Carrier Gates
O	Other Carrier Gates
	Taxiway
	Pedestrian Corridor
	Future Expansion
	Auto Circulation



7.2.3 Other Facilities

In addition to the airfield and terminal area facilities so far discussed, there are many others that need to be included in the new airport. The layout of most is dependent upon the selected airfield layout and terminal configuration. Many other airport facilities are not site dependent and function equally well with any of the proposed airfield and terminal area alternatives. Thus, they are not critical at this stage of the study.

Rather than rely on an evaluation of alternatives, the analysis of these support facilities will be guided by adjacency requirements. These requirements establish the links that each function has with every other. They also indicate any specific items needed for efficient airport operation. Figure 7-13 presents this information.



[1] Refers to view, not adjacency
 [2] Refers to access, not adjacency

X	Adjacency essential
O	Adjacency desirable
	Adjacency of no concern



Chapter 8

Alternative Evaluation

8.1 INTRODUCTION

Chapter 7 concluded with the identification of airfield layout and terminal configuration alternatives for the new air carrier airport. The objective in this chapter is to develop and apply an evaluation methodology. This evaluation focused on the airfield layout and terminal configuration, with decisions on other facilities hinging on the plan selected for these two primary airport elements.

8.2 EVALUATION METHODOLOGY

8.2.1 Airfield Layout Alternative Evaluation Criteria

Three criteria were employed to evaluate the airfield alternatives. They are: (1) operational efficiency, (2) land impact, and (3) construction cost. Each of the factors was subdivided using the specific criterion described in the following.

CRITERION 1. OPERATIONAL EFFICIENCY

This criterion is used to determine how well the airfield layout functions. It considers ground and airspace operations and wind and weather considerations.

Ground Operations

There are three measures of ground operations: runway delay, the number and character of runway crossings, and taxi distance. These are described as follows.

Runway Delay

Measure:	Average airfield delay.
Methodology:	FAA Capacity and Delay Model.
Reporting:	Average delay per operation and annual delay cost.

Particular attention was paid to this measure during the initial development of the airfield alternatives. One goal was an airfield layout that provides sufficient runway capacity to accommodate projected demand and keeps aircraft delay to a minimum. Runways were added to each airfield alternative to provide the necessary capacity and maintain parity among the alternatives relative to delay.

Runway Crossings

Measure:	Number and character of runway crossings.
Methodology:	Manual calculation.
Reporting:	Subjective.

As the number of runway crossings increases, the efficiency of airfield operations decreases. In normal operating procedures, aircraft on active runways have priority. Taxiing aircraft are subject to delay. Absent ground detection radar, there is the possibility, when visibility is limited, of unauthorized aircraft entering active runways. Consequently, an airfield configuration that minimizes crossings is preferable.

Taxi Distance

Measure:	Weighted average taxi distance.
Methodology:	Manual measurements and calculations.
Reporting:	Average taxi distance per aircraft.

Average taxi distance is calculated by measuring the distance either an arriving or departing aircraft will have to taxi to or from a given runway. For the purpose of this calculation, it is assumed that arriving aircraft exit the runway 6,000 feet from the threshold. All taxi distances were measured to/from the centroid of the terminal area. Aircraft demand was distributed to runways with the least taxi distances in the various operating configurations when capacity permitted. Aircraft taxi distances, the distribution of demand in each operating configuration, and the annual percentage that each operating configuration is used were combined to provide the weighted average taxi distance for each concept.

Airspace Operations

There are two basic measures of airspace operations: flight path distance and the number of flight path interactions. These are described below.

Flight Path Distance

Measure:	Weighted flight path distance.
Methodology:	Manual calculations.
Reporting:	Average flight path distance (in miles) and annual costs.

Aircraft flight path distances depend on the origin and destination airports, the layout of the enroute airspace, the orientation and use of the runways at a new airport, and the configuration of the terminal area airspace.

A four-corner arrival/departure airspace gate system was assumed to measure flight path distances for each airfield layout alternative. The four arrival/departure airspace gates are located 30 miles northeast, northwest, southeast, and southwest of the centroid of the

alternative airfield layouts. The orientation of the airspace gates was established to facilitate traffic flows in the prevailing northwest and southeast wind directions.

Arrival and departure flight paths to and from each runway were established for each airspace gate. Flight paths for arriving aircraft included a seven-mile final approach segment. Where necessary, a ten-mile downwind leg and a five-mile base leg were included. Departure flight paths included a two-mile course segment on runway heading before any turns and, where necessary, a five-mile base leg. Aircraft demand was distributed to each of the flight paths consistent with the runway use distribution employed in the taxiway distance calculations. Aircraft flight distance and the distribution of demand to each flight path in each operating configuration were combined to provide the weighted average flight distance.

Flight Path Interactions

Measure:	The number and character of flight path interactions.
Methodology:	Manual calculation.
Reporting:	Subjective.

Interactions between flight paths possess the potential for conflict. Interactions between the flight paths of aircraft using the terminal area airspace should be avoided. Normally, terminal area airspace arrival and departure routes are separated procedurally from one another, so aircraft using these routes are not in conflict. Both lateral and vertical separation are used to achieve this. At the airport itself, it is desirable to organize the use of the runways so that an aircraft executing a missed approach does not interact with other aircraft using active runways. The purpose of this criterion is to identify operating configurations for a given airfield layout which may require greater flight path distances to resolve potential airspace interactions.

Wind and Weather

Measure:	The ability to accommodate all wind directions and weather conditions.
Methodology:	Wind rose and climatological data analysis.
Reporting:	Subjective.

The wind analysis presented earlier indicated that a southeast-northwest runway alignment provides maximum wind coverage for all weather conditions throughout the metropolitan area, assuming a maximum 20-knot crosswind component. Approximately one percent of the year, prevailing winds out of the northeast combine with snow and/or icy conditions. It is desirable to have crosswind runway capabilities during those times. Otherwise, the airport would be closed for a total of three to four days a year (actually composed of many partial days). The cost of closing for this amount of time is unacceptable for a hub. This criterion analyzed the ability of each airfield layout alternative to operate in all wind and weather conditions.

CRITERION 2. LAND IMPACT

Measure:	The number of acres impacted by each alternative.
Methodology:	INM 3.9 noise model, state safety zones, and manual calculation.
Reporting:	Number of acres impacted.

The number of acres impacted by an airfield layout alternative affects its viability. An airfield configuration should meet all aeronautical requirements and minimize the land impacted. For this evaluation, "land impact" refers to all land required for airfield operations and all property within the Ldn 65 contour and State of Minnesota Safety Zones A and B.

CRITERION 3. CONSTRUCTION COST

Measure:	Costs of construction.
Methodology:	Manual calculations applying unit costs to individual facilities.
Reporting:	Total estimated cost.

Airfield construction cost included all airfield pavement. The more runways and taxiways required for a specific concept, the higher the overall cost.

8.2.2 Terminal Configuration Alternative Evaluation Criteria

Similar to the airfield layout alternative evaluation, a number of criteria which apply to the terminal were identified. When compared, they allow for informed decision-making about the configuration of this facility. Five criteria in all were used. They are: (1) passenger convenience, (2) operational efficiency, (3) implementation, (4) expandability/phasing, and (5) construction cost.

CRITERION 1. PASSENGER CONVENIENCE

Origin and Destination Passenger Walking Distance

Measure:	Distance from the center of the Central Processing Unit (CPU) to the farthest gate.
Methodology:	Measurement by scaling -- excluding any distance covered by major passenger transport system.
Reporting:	The maximum number of linear feet to be traversed.

Maximum walking distance was measured from the center point of the CPU to the farthest gate. Using this distance provided equal consideration of both enplaning and deplaning passengers. In making the measurements, any distance covered by either a people-mover system or other type of passenger conveyance was not counted. Distances along which a

passenger's journey was supplemented by moving sidewalks were included in the measurement.

Origin and Destination Passenger Time

Measure:	The time required to traverse the distance from the center of the CPU to the most distant gate.
Methodology:	Additive process using a combination of distance traveled using various modes and the following factors: Escalators: 1.66 feet per second (fps) People-Movers: Waiting = 90 seconds (avg.) Dwell time = 30 seconds Acceleration/Deceleration = 29.33 fps for 600 feet Speed = 58.67 fps Power Walks: 4.2 fps Walking: 5.3 fps
Reporting:	The number of minutes expended in getting from the CPU to the most distant gate.

Like the previous criterion, this is a level-of-convenience measure for the O&D passenger. In this case it is the time used in getting to or from the aircraft. In making this estimate it was assumed that passengers would use the most convenient available conveyance, even if an option to walk was available. The calculations assumed that people would stand still while using an escalator or walk only half the time while using a moving sidewalk. These assumptions were made to simulate normal usage of these devices, in which uninterrupted use is unlikely.

All of the travel times shown are for originating passengers. The travel time for originating passengers was consistently greater than for terminating passengers. This is because of the need to change one less level in the terminal when deplaning. In every case it was assumed that originating passengers were ticketed and had passed through security.

Connecting Passenger Walking Distance

Measure:	The distance between the hub carrier gates which are separated by the greatest distance.
Methodology:	Measurement by scaling -- excluding any distance covered by major passenger transport system.
Reporting:	The number of linear feet of distance.

This passenger convenience criterion uses the same methodology and assumptions as did origin-and-destination passenger walking distance. The difference is that instead of measuring O&D passenger convenience, it focuses on hub carrier connecting passengers.

Connecting Passenger Time

- Measure: The time required to traverse the distance between the gates of the hub carrier which are the furthest apart.
- Methodology: An additive process. See assumptions under Origin and Destination Passenger Time.
- Reporting: The number of minutes required to connect between the gates of the hub carrier which are most distant from one another.

This criterion is identical to the one for O&D passengers.

Automobile Parking

- Measure: Proximity of automobile parking to passenger processing facilities.
- Methodology: Measurement of the distance between automobile parking and the CPU.
- Reporting: Subjective.

This criterion measures the distance between the automobile parking area and the CPU in order to compare the relative convenience for O&D passengers.

CRITERION 2. OPERATIONAL EFFICIENCY

Hub Compatibility

- Measure: The ability to accommodate the hub carrier in contiguous facilities.
- Methodology: Review of gate configurations for hub carrier and input from airline.
- Reporting: Subjective.

One of the goals for the conceptual design is to provide facilities which are able to accommodate an air carrier hub. All of the alternatives were developed with full consideration of the needs of an airline hub, and each could function as such. This criterion measures the effectiveness of each in accommodating an airline hub.

Hubbing Carrier Gate-to-Gate Baggage Transfer

- Measure: The ease with which the hubbing airline is able to transfer the baggage of connecting passengers from gate to gate.
- Methodology: Review of gate configurations for hub carrier and input from airline.
- Reporting: Subjective.

Where the previous criterion measures each alternative's ability to accommodate a hub carrier, this one measures the effectiveness of the baggage transfer system.

International Airline Integration

Measure:	The location and convenience of international gate positions relative to domestic gates and other passenger facilities.
Methodology:	Review of gate location and airline input.
Reporting:	Subjective.

Another goal is to integrate international and domestic processing facilities. Consequently, all of the alternatives attempt to integrate them. This criterion measures several facets of providing this integration, including accessibility to the hub carrier; potential for providing dual-use gates; and CPU adjacency.

Regional Airline Integration

Measure:	Location of regional airline gate positions relative to their code-sharing airline and other carriers.
Methodology:	Review of the regional airline gate arrangement and the proximity of regional airline gates to other gates.
Reporting:	Subjective.

As with international airline integration, each of the terminal alternatives was designed to meet the goal of regional airline integration. This criterion measures the effectiveness of this integration.

Aircraft Circulation

Measure:	Opportunities for or limitations on aircraft circulation near gates and on taxilanes and taxiways.
Methodology:	Review of terminal configuration.
Reporting:	Subjective.

In designing the airfield layout alternatives, the primary goal was to provide for a smooth and efficient flow of aircraft between the runways and the terminal area. This criterion measures the efficiency with which aircraft can maneuver once they reach the terminal area. Measurements included the identification of impeded gates, the ability to provide independent push-back zones, the provision for dual taxilanes, and ease of connection to the airfield's taxiway system.

Gate Use Flexibility

Measure:	The ability to respond to changes in airline fleet mix and the number of gates with parking or circulation limitations.
Methodology:	Review of the gate configuration.
Reporting:	Subjective; the number of constrained gate positions.

Aircraft gate configurations vary from one alternative to another. The purpose of this criterion is to measure the relative ability of each layout to accommodate both major and minor revisions in the projected aircraft fleet mix. Particular attention was paid to the interchangeability between narrow and wide-bodied aircraft and the ramifications of increased wide-body demand.

Surface Access

Measure:	The ability to provide surface access into and out of the terminal area.
Methodology:	Review of terminal configuration.
Reporting:	Subjective.

The objective of this criterion is to measure each alternative's ability to accommodate the access roadway and curbside requirements.

CRITERION 3. IMPLEMENTATION

Airside Construction

Measure:	Assessment of the complexity and constructability of airside buildings.
Methodology:	Review of the alternatives.
Reporting:	Subjective.

This criterion is intended to serve as an assessment of the relative ease with which the airside buildings may be constructed.

Landside Construction

Measure:	Assessment of the complexity and constructability of landside buildings.
Methodology:	Review of the alternatives.
Reporting:	Subjective.

The purpose of this measure is the same as the previous criterion, but concentrates on the landside buildings -- generally the CPU -- rather than the airside structures.

CRITERION 4. EXPANDABILITY/PHASING

Gates

Measure:	The ability and relative ease of adding five or more gates to an alternative.
Methodology:	Review of the alternatives.
Reporting:	Subjective.

All of the alternatives provide adequate facilities to meet the demand projected. However, as with any future projection, some variations in demand can be expected over the 20-year period. This criterion measures how well each alternative responds to major and minor changes in the number of gates required.

Passenger Processing Facilities

Measure:	The ability and relative ease of expanding passenger processing facilities, parking, and surface access.
Methodology:	Review of the alternatives.
Reporting:	Subjective.

This criterion measures an alternative's ability to adapt to major or minor changes in the passenger demand levels. Combined with the previous criterion, it can be used as a measure of an alternative's overall adaptability.

Phasing

Measure:	Strategy for meeting year 2010 and/or other planning horizons.
Methodology:	Review of airside and landside configuration.
Reporting:	Subjective.

This factor measured the ability of each alternative to provide a phased development strategy for meeting demand for both year 2010 and year 2020. It also examined the ability to phase expansion needed beyond the year 2020.

CRITERION 5. CONSTRUCTION COST

Measure:	Terminal construction cost.
Methodology:	Order-of-magnitude cost estimates for airside building(s) and immediately adjacent apron, and landside building(s) and immediately adjacent roads and drives.
Reporting:	Construction cost in 1990 dollars.

Terminal construction cost includes building construction, specialty systems, roadways, and aircraft terminal apron.

8.2.3 Evaluation of Alternatives for Other Facilities

Other facilities at the new airport also need to be evaluated and decisions made regarding their optimum location. These include, for example, non-terminal-related surface access and parking, general aviation, air cargo, aviation support areas, the military, and airline maintenance facilities. The location of these facilities is dependent on the airfield and terminal alternatives ultimately selected. Decisions on these areas will therefore be made during development of the Conceptual Design Plan in Chapter 9. This step follows airfield and terminal alternative evaluation and selection. The adjacency requirements presented in Figure 7-13 guided this effort.

8.3 INITIAL EVALUATION OF ALTERNATIVES

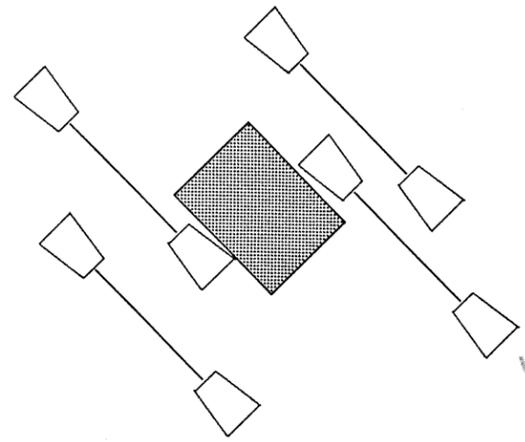
As the first step in evaluating alternatives, an analysis was conducted to determine if any could be eliminated from consideration due to their inability to meet the goals set forth in Chapter 2. This evaluation caused one airfield layout alternative and two terminal configuration alternatives to be eliminated. The following provides details on this process.

8.3.1 Airfield Layout Alternatives

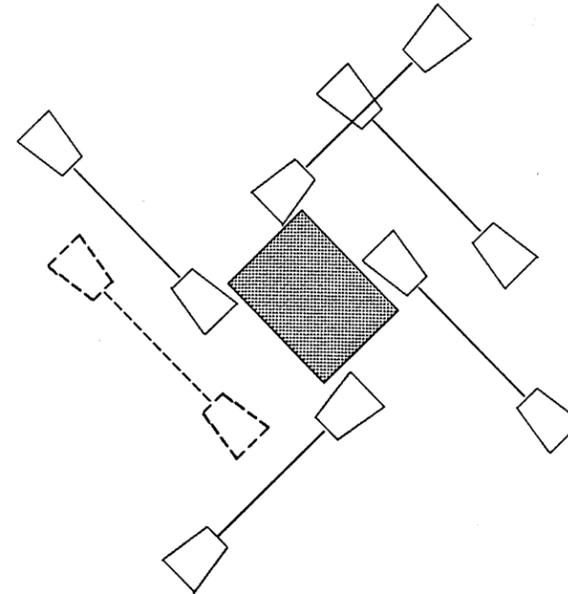
Four airfield layouts were identified. These alternatives, which are shown in Figure 8-1, include a single-direction layout with four runways, and three two-directional layouts with five runways each. Alternative P-2 was included in order to have a single-direction layout. Alternative T-1 is a modification of P-2 that incorporates two crosswind runways. The remaining two airfield alternatives are L-1 and L-2, in which the runways have an L-shaped layout.

The purpose of the initial evaluation was to determine which alternatives to carry forward for detailed evaluation. The "P", "T", and "L" alternatives vary significantly from one another. Each has certain strengths and weaknesses that tend to offset the strengths and weaknesses of the other two. For this reason, it is desirable that at least one "P", "T", and "L" alternative be carried forward for further evaluation. Therefore, the major issue addressed in the initial evaluation was whether or not the two "L" alternatives varied sufficiently to warrant carrying both forward.

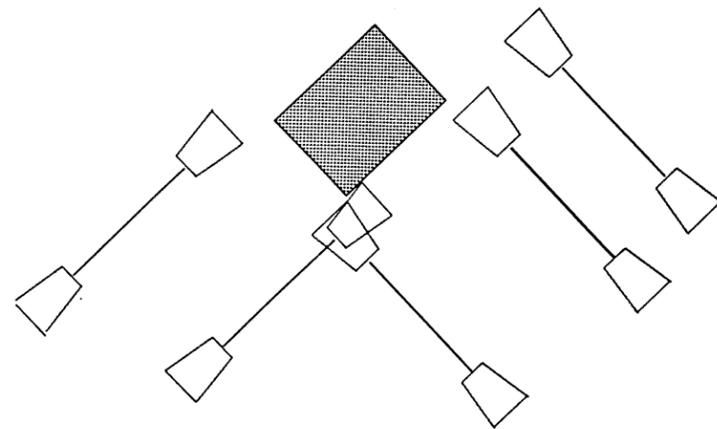
The main difference between the two "L" alternatives is the location of the terminal area. Alternative L-1 locates the terminal area equidistant from the primary and secondary runways and between both. The L-2 alternative locates the terminal area between the primary runways to better integrate terminal area operations with these runways.



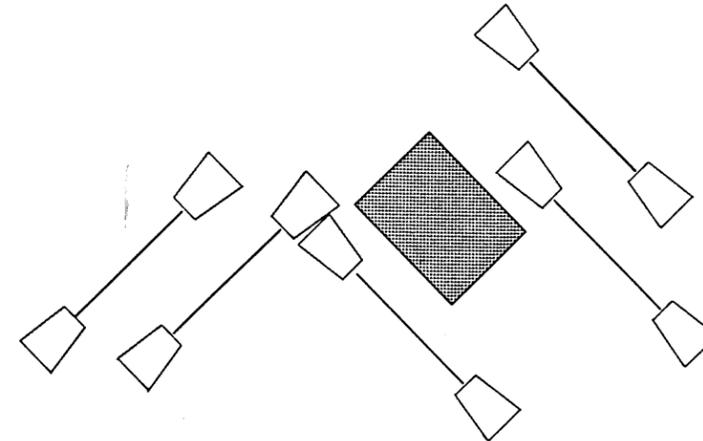
Alternative P-2



Alternative T-1



Alternative L-1



Alternative L-2



Terminal area location affects the distance which aircraft must taxi. Alternative L-2 has an average taxi distance of 12,500 feet per operation. Alternative L-1 has an average taxi distance of 13,800 feet per operation. There is not enough overall difference between Alternatives L-1 and L-2 to carry both forward. Alternative L-2 was selected because of its superior taxiing characteristics.

8.3.2 Terminal Configuration Alternatives

Five terminal configuration alternatives were presented in Chapter 7. These five alternatives, A through E, consisted of a Pier alternative, two Satellite alternatives, and two Hybrid alternatives. They are shown in Figure 8-2. As was the case with airfield layouts, an initial evaluation of these alternatives was undertaken. The evaluation process and the conclusions are described in the following.

ALTERNATIVE A - THE PIER

Evaluation of the Pier alternative indicated that it was deficient in three areas: passenger convenience, operational efficiency, and expandability/phasing.

Walking distance was the first factor considered. For origin/destination passengers this distance ranged from 2,200 to 2,500 linear feet. These distances are roughly equivalent to distances currently experienced today in the Lindbergh Terminal. The walking distance between the hub carrier gates separated by the greatest distance is approximately 5,400 linear feet. This is significantly farther than for passengers connecting between the Gold and Green Concourses at the existing terminal. Additionally, this connecting distance is the longest of the five alternatives, and the Pier does not lend itself to a people-mover system serving either origin/destination or connecting passengers.

In terms of operational efficiency the Pier alternative does not optimize either apron circulation or gate use flexibility. The majority of gates on the piers are served from dead-end taxilanes. These do not provide for a smooth flow of aircraft either to gates or to the runway system. A number of inside corners exist which restrict aircraft maneuvering and limit flexibility in the assignment of parking positions.

Surface access to the terminal was also a problem. The curb requirement is sufficient to require that the curb extend beyond the length of the terminal building. The configuration does not allow development of curbs on both sides of the passenger processing areas.

In the category of expandability, the Pier alternative provided the least clear strategy for expansion beyond the forecast period. Extension of either pier would provide additional gates. However, this would increase the distance passengers have to walk to reach the most distant gates. Providing a significant increase in the number of gates would require adding a midfield satellite and a supplementary people-mover system.

As aircraft gates are added, the size of passenger processing areas must increase as well. It is possible to add on to the ends of the CPU. However, the relationship between the CPU and the piers will eventually become disproportionate. Additionally, the CPU and the piers cannot be expanded independent of each other.

ALTERNATIVE B - SATELLITE I

Alternative B has three satellite concourses parallel to the CPU. This arrangement is similar to Atlanta-Hartsfield and the new Denver airport. This alternative has strengths in a number of areas: passenger convenience, operational efficiency, and expandability. Walking distances for both origin/destination and connecting passengers are less than those at MSP. This is achieved through the distribution of gates to satellite concourses and the use of a people-mover system to transport passengers from the CPU to the satellites.

Operationally there is minimal conflict between aircraft maneuvering on the apron. Gates can be reached through dual taxiways that flow between the satellite concourses. These taxiways are linked to a perimeter taxiway system. Access to the runway system is unrestricted in this configuration. Satellite concourses also provide flexibility in aircraft parking because few corners exist to limit the use of a gate to a specific aircraft type.

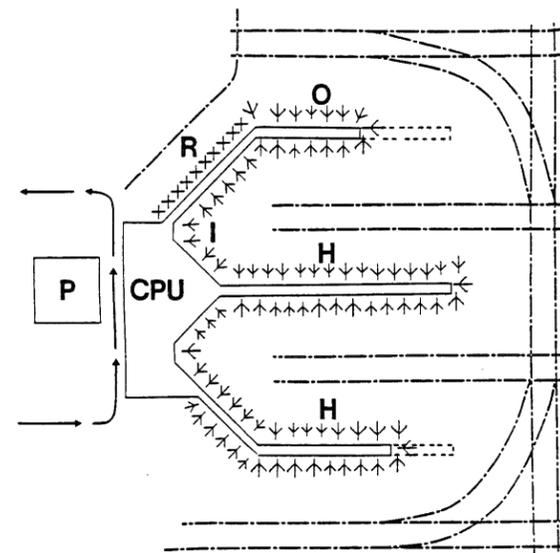
There is an unrestricted relationship between the terminal and the surface access system. Since the CPU stands free from the concourses, surface access can be developed along both sides of the building. This allows curbside functions to occur immediately adjacent to the facilities being served. This independent relationship between landside and airside facilities allows the most opportunity for independent future expansion of the concourses and the CPU.

A criticism of this alternative is the inconvenient location of the international arrival gates. Although their proximity to other gates is good, deplaning international passengers are required to recheck their baggage before returning to the CPU.

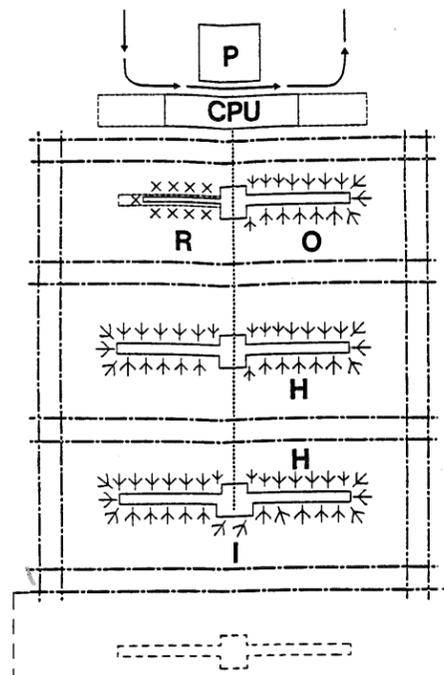
ALTERNATIVE C - SATELLITE II

Alternative C - Satellite II has a CPU with four independent satellite concourses in a "U" configuration. This arrangement is similar to Tampa International Airport. The primary differences between Satellites I and II are the number of satellite concourses, their relationship to the CPU, and the distribution of hub carrier, regional, and international gates. This alternative has some deficiencies, however. These become evident when the operational efficiency and expandability criteria are applied.

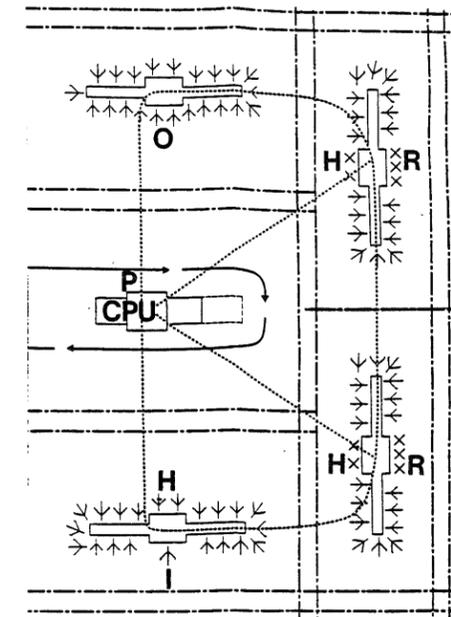
On the plus side, the number of satellites allows each to be modest in size. These small satellites, combined with a people-mover, minimize the walking distances for all passengers. A maximum of 1,300 feet separates the most distant hub carrier gates. One drawback is that aircraft gates are split among three concourse locations rather than two. In Alternative C, improved passenger convenience is obtained at the cost of operational efficiency for the hub carrier.



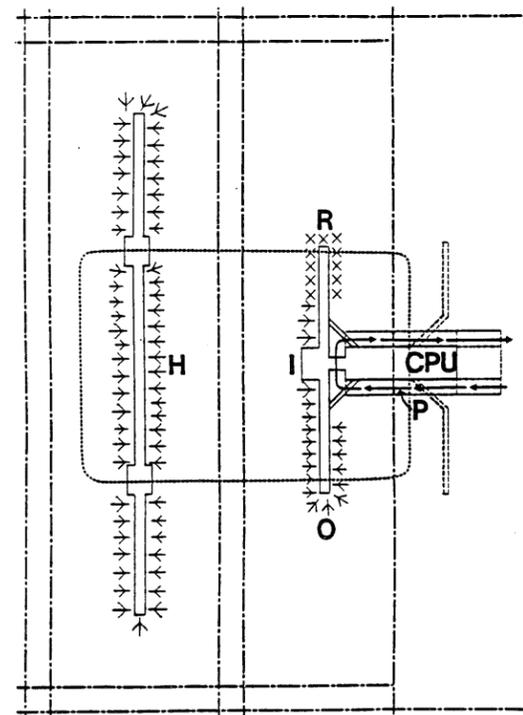
Alternative A - The Pier



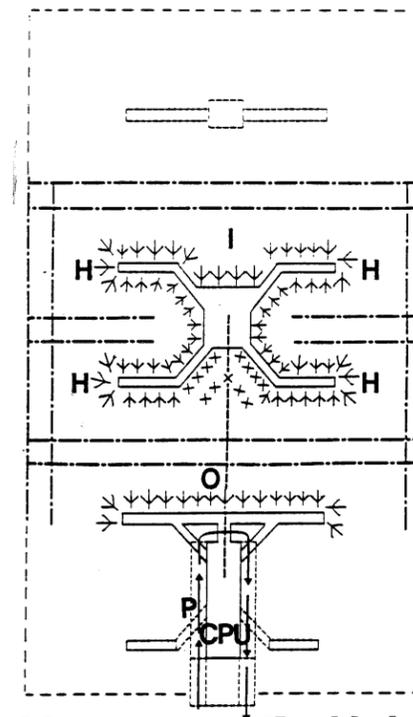
Alternative B - Satellite I



Alternative C - Satellite II



Alternative D - Hybrid I



Alternative E - Hybrid II

P	Auto Parking
CPU	Central Processing Unit
R	Regional Carrier Gates
I	International Arrival Gates
H	Hub Carrier Gates
O	Other Carrier Gates
	Taxiway
	Pedestrian Corridor
	Future Expansion
	Auto Circulation

Alternative C intermingles hub carrier operations with both code-sharing regional and international carrier gates. Review of this alternative with Northwest Airlines produced the feedback that proximity between their domestic gates and the international gates is more important than proximity to the regional carriers.

The CPU in Alternative C is bounded on three sides by satellite concourses. Although provisions can be made for future expansion, this arrangement has limited flexibility because the satellites establish a permanent edge or limit. This constraint limits future expansion of the CPU.

The relationship of the satellites to the CPU also affects the configuration of taxilanes. Alternative B - Satellite I provides an efficient flow-through arrangement with dual taxilanes serving a side of two satellites. The arrangement of the satellites in Alternative C - Satellite II is less conducive to flow-through aircraft movement. It also is less efficient in that the taxilanes serve only one side of one satellite concourse, requiring more apron space to serve the same number of aircraft positions.

Another drawback of Alternative C is the size of the people-mover it requires. To provide one-stop passenger transport for origin and destination passengers and provide connections between all the satellites and the CPU requires a multi-stop, multi-line system. While the system will improve passenger convenience, it will add appreciably to the cost of this configuration.

ALTERNATIVE D - HYBRID I

Alternative D - Hybrid I consists of a CPU with an attached linear concourse, and one satellite concourse. This scheme has strengths in passenger and operational efficiency.

Walking distances for all passengers are kept short either through the use of a people-mover system or the close proximity of gates to the CPU. Origin and destination passengers walk a maximum of 1,200 linear feet, and transfer passengers up to 2,200 linear feet. Both of these distances are less than exist today in the Lindbergh Terminal. International gates, located immediately adjacent the CPU, provide good access to facilities for processing deplaning international passengers. Similarly, carriers whose primary traffic is local origin and destination are also conveniently located adjacent to ticketing, baggage claim, and automobile parking areas.

Alternative D - Hybrid I provides for efficient aircraft movement and plane parking. The satellite is served by dual taxilanes on both sides. This layout facilitates flow-through aircraft movement to and from the runway system. The linear shape of the concourse does not restrict plane parking. The parallel relationship of the two concourses efficiently uses the dual taxilane which runs between them.

The proximity of the CPU to the gates allows for the development of curbside access along both sides of the building. Although future expansion of one end of the CPU is constrained by the location of the satellite, the other sides of the building are not.

Gate expansion beyond the forecast period is possible with this alternative. Piers can be added and the linear concourse can be extended. People-mover stops can be added in these extensions either to shorten walking distances or to provide easy connections to additional hub carrier gates. Significant additions to gate capacity can be achieved by adding another satellite concourse and extending the people-mover.

The primary drawback of this alternative is the separation of hub carrier gates from those used for international arrivals. Neither the proximity of the gates nor the configuration of the people-mover system facilitates convenient passenger transfer.

ALTERNATIVE E - HYBRID II

Alternative E - Hybrid II is similar to Hybrid I in the use of both a satellite concourse and a connected pier. The satellite is configured in an "X", much like the one proposed for Greater Pittsburgh International Airport.

This alternative increases the proximity of the international arrival and hub carrier gates by locating them both in a single satellite concourse. The people-mover system provides a direct connection to the CPU for terminating passengers. Although passenger connections are enhanced by the people-mover, the central stop located in the "X" still creates some long walking distances. The hub carrier gates separated by the greatest distance are 3,000 linear feet apart.

Operationally, flow-through aircraft movement is provided. The taxilane system also efficiently serves gates on either side of the satellite concourse. While the "X" shape allows a central node to be created, it also results in bends and corners that limit or restrict plane parking and creates some dead-end taxilanes.

As with Alternative D - Hybrid I, the CPU is bounded on only one side. This allows the development of curb frontage along both sides of the building. The CPU is consequently left relatively free of constraints on its future expansion.

Piers may be added to this alternative to increase the number of origin/destination carrier gate positions. Adding gates to the hub airline's operation is a problem. Additions to the "X" would increase maximum walking distances beyond a reasonable length. Another satellite concourse and an extension to the people-mover system would be required.

SUMMARY OF INITIAL EVALUATION OF TERMINAL ALTERNATIVES

The initial evaluation of terminal configuration alternatives indicated that Alternative A - the Pier should be eliminated from further consideration. Evaluation of the two satellite

alternatives indicated that three satellite concourses is superior to four. Further, a linear arrangement of satellite concourses is desirable. Also, the international arrival gates should have proximity to both the Central Processing Unit and domestic gates, if possible. Thus, Alternative C - Satellite II was eliminated. Further consideration of Alternative B - Satellite I is appropriate. Further development with the objective of optimizing the location of the international arrival gates is needed, however.

The evaluation suggests that both of the Hybrid alternatives should be further considered. Further development should focus on their merits. For example, hub carrier and international arrival gates can and should be consolidated into a single satellite and connected with a linear people-mover. Alternatively, walking distances for connecting passengers could be shortened through the use of a multiple-stop people-mover. This would also increase proximity to the CPU for originating and terminating passengers.

8.4 ALTERNATIVE EVALUATION

Having narrowed and refined the airfield layout and terminal configuration alternatives, a detailed evaluation was next conducted. This section provides details on the evaluation of the three airfield and five terminal alternatives.

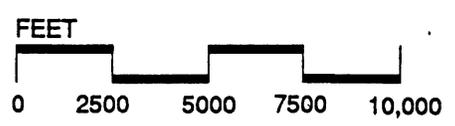
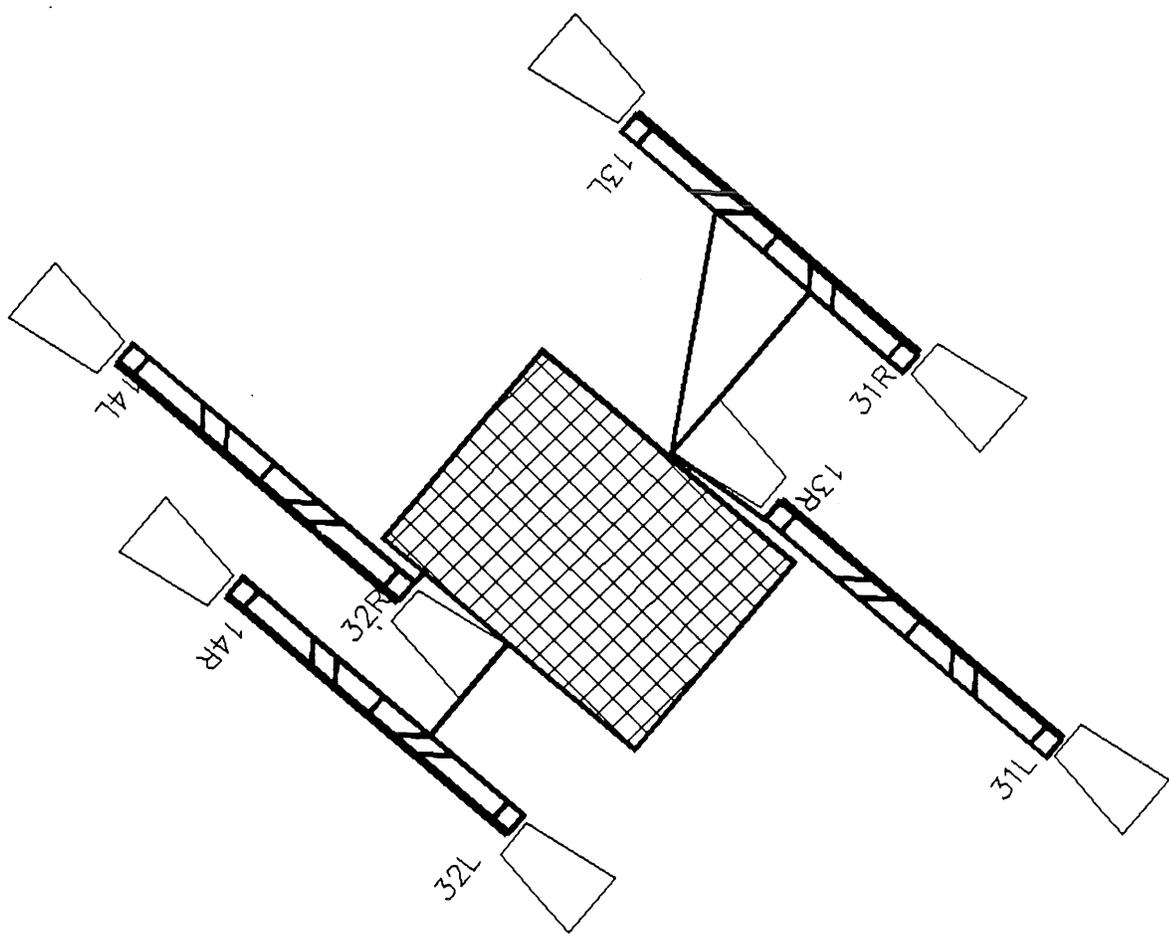
8.4.1 Airfield Layout Alternatives

ALTERNATIVE P-2

Optimization

The optimization of this alternative included the development of a taxiway system and a shifting of the runways to minimize taxi distances. The optimized Alternative P-2 is shown in Figure 8-3.

The primary operating configuration on this airfield is to the southeast, with landings and takeoffs on Runways 13R, 13L, 14R, and 14L. To minimize taxi distances, Runway 13L-31R was shifted to the north and Runway 14R-32L was shifted to the southeast, so their exit taxiways aligned with the crossfield taxiway connecting to the passenger terminal. Runway 14L-32R was shifted as far southeast as possible to move it closer to the crossfield taxiway and still keep the crossfield taxiway out of the Runway Protection Zone (RPZ) for Runway 32R. Runway 13R-31L was relocated to the southeast to keep the crossfield taxiway out of the RPZ for Runway 13R.



Evaluation

CRITERION 1: OPERATIONAL EFFICIENCY

Ground Operations

1. Runway Delays Result: 1.0 minute/operation

The operating configurations used for delay calculations are depicted in Figure 8-4. One benefit of Alternative P-2 is that average annual delays of less than a minute can be achieved with a four-runway system. A disadvantage of Alternative P-2 is that it does not provide the desired free-flowing configuration with independent arrival and departure streams. Alternative P-2 has at least one runway with mixed arrivals and departures in all operating configurations. Although this disadvantage does not significantly impact the capacity of the airfield, the operating efficiency is less than optimal.

2. Runway Crossings Result: No crossings

The runway layout in Alternative P-2 provides a free flow of aircraft on the airfield. Aircraft do not have to cross active runways in any operating configuration.

3. Taxi Distance Result: 8,500 feet/operation

At least one of the outer runways must always be used for either arrivals or departures. This increases the average taxi distances.

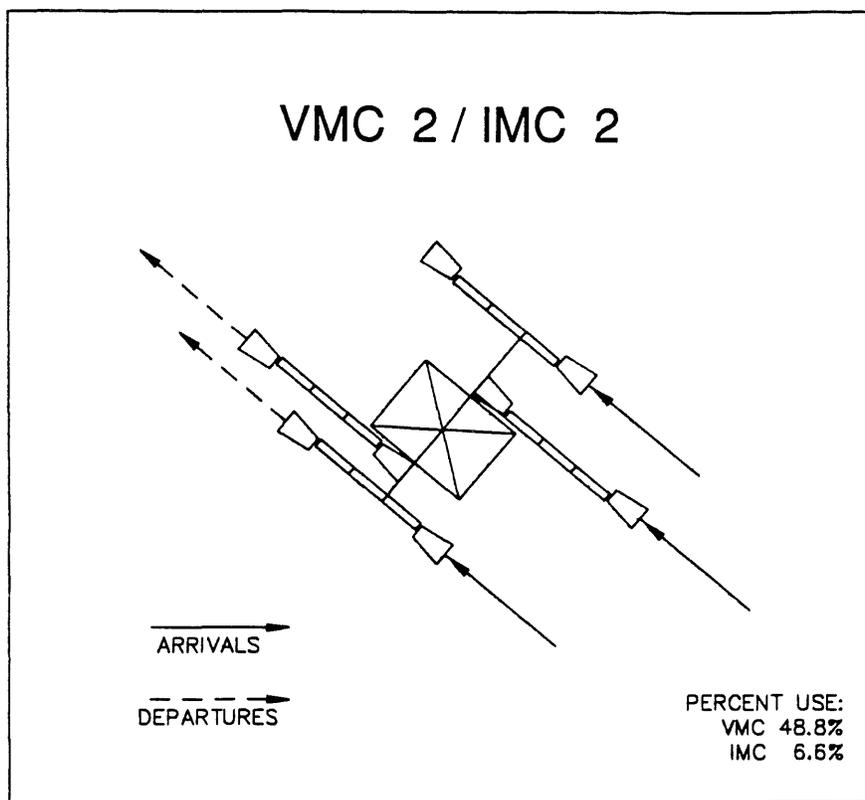
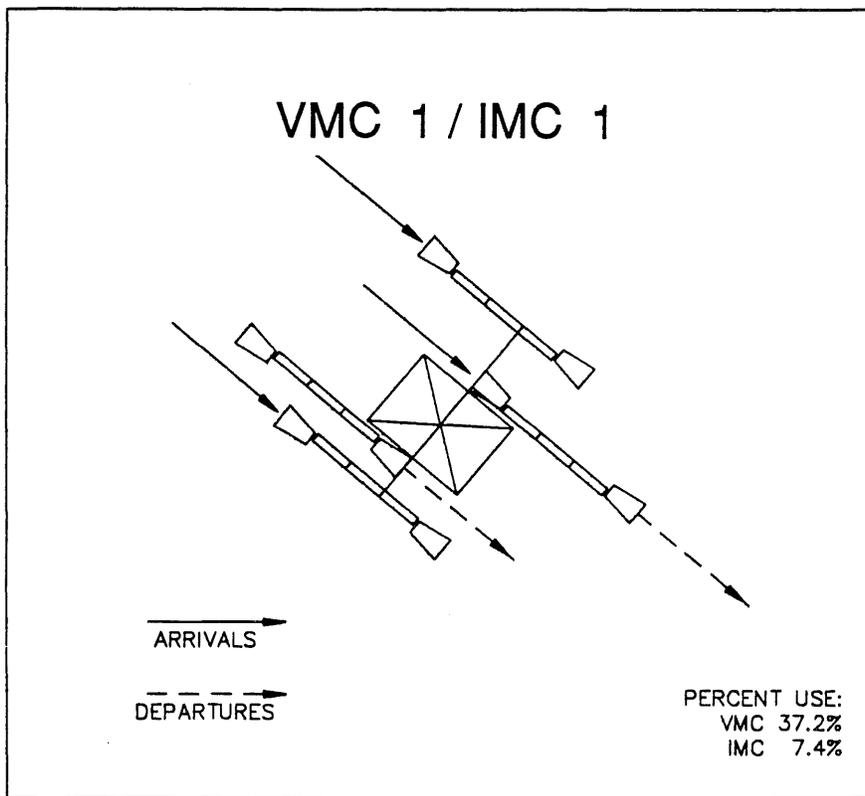
Airspace Operations

1. Flight Path Distance Result: 34 miles/operation

Approximately 45 percent of all traffic is either arriving from the northwest or departing to the southeast. At any given time, 50 percent of this traffic is traversing a large portion of the terminal airspace to reach the opposite airspace gate or runway end.

2. Flight Path Conflicts Result: None

There are no flight path conflicts.



VMC = Visual Meteorological Conditions
 IMC = Instrument Meteorological Conditions
 Numbers refer to operating models



Wind and Weather

Result: Does not cover all conditions

The primary disadvantage of Alternative P-2 is the lack of crosswind coverage. Historical weather data indicate that an airfield with the P-2 layout would be closed for periods of time totaling an aggregate three to four days a year due to a combination of strong crosswinds and snow/icing conditions. The disruption and cost caused by the airport closing for three to four days a year may be unacceptable. These costs must be weighed against the savings realized from reduced land acquisition and airfield construction provided by Alternative P-2.

CRITERION 2: LAND IMPACT

Result: 12,000-26,000 acres

The primary advantage of the four-runway system of Alternative P-2 is that it has the lowest land impact of all the airfield layout alternatives. The land impact is depicted on Figure 8-5. The Ldn contour sets the outer limits for land impact, since it covers a larger area than the state safety zones.

CRITERION 3: CONSTRUCTION COST

Result: \$225 million

The combination of the fewest number of runways to construct and the least land impact results in the lowest construction cost of the three airfield alternatives.

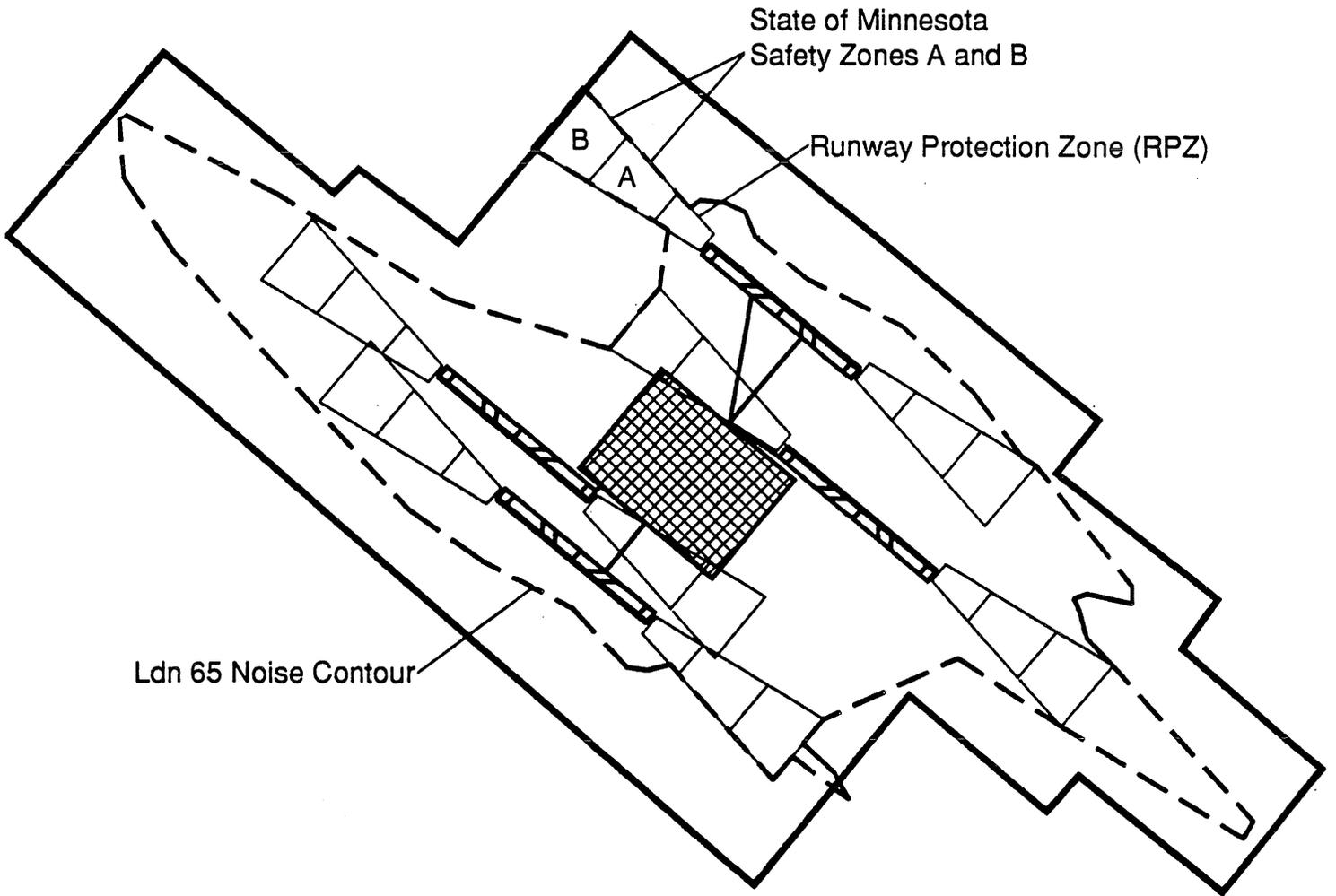
ALTERNATIVE T-1

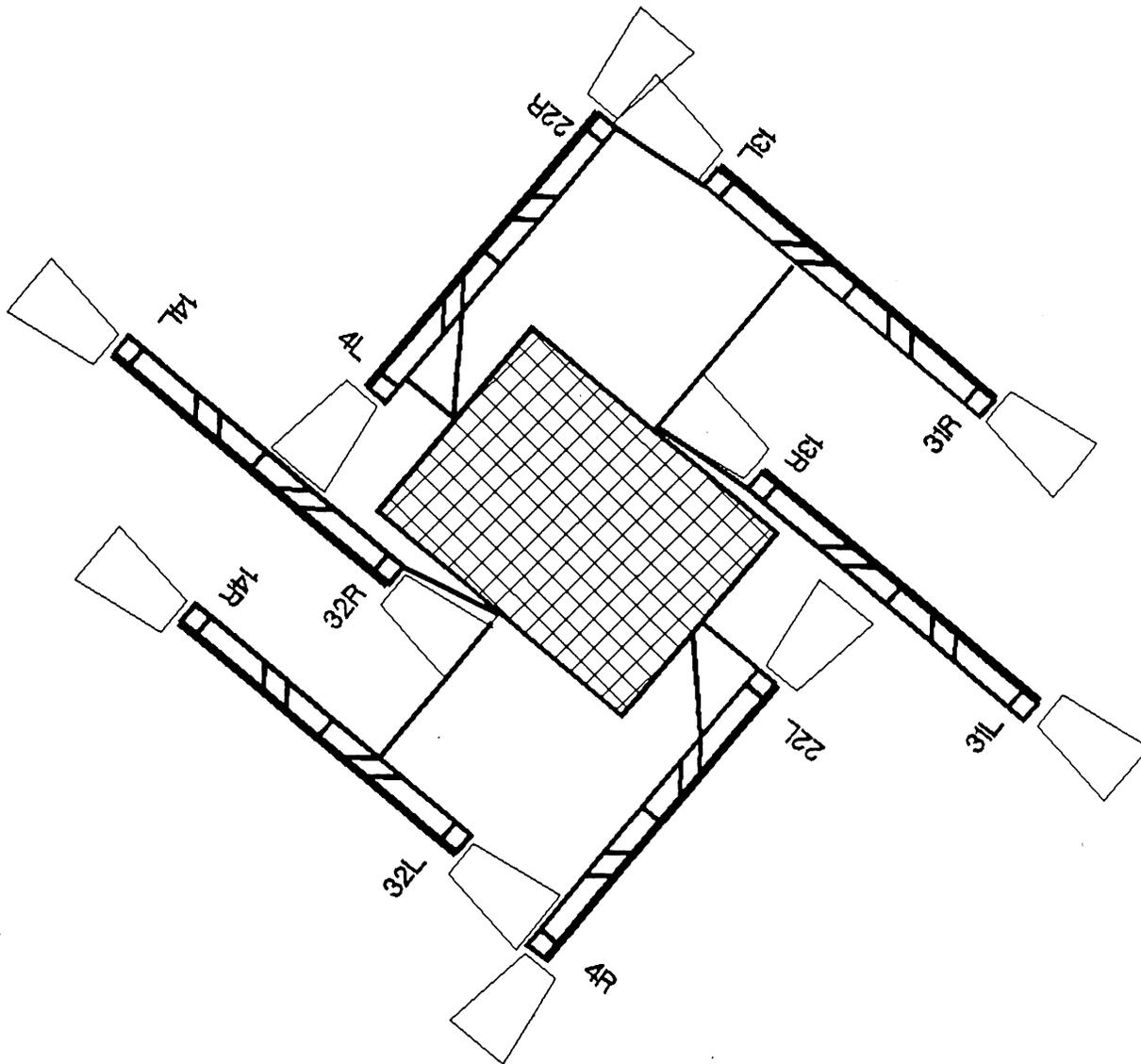
Optimization

The original layout for Alternative T-1 included a five-runway system with the potential to add a sixth runway if necessary. The sixth runway was added in order to maximize operational efficiency. Alternative T-1 in its optimized form is presented in Figure 8-6.

The primary operating configuration in the five-runway layout calls for arrivals on Runways 31L, 31R, and 22R, and departures on Runways 32L, 32R, and 22L. This is the highest capacity operating configuration for Alternative T-1. The same capacity level can be achieved when operating in the opposite direction with arrivals on Runways 14L, 14R, and 22R (which actually provides the best wind coverage), with departures on 13L, 13R, and 22L.

In addition, optimization included development of a taxiway system and a shifting of runways to minimize taxi distances. Runways 13L-31R and 14R-32L, used primarily as arrival runways, were shifted to the northwest and southeast, respectively, so their exit taxiways aligned with the crossfield taxiway. The inner parallels, Runways 13R-31L and 14L-32R, were shifted to the southeast and northwest, respectively, to keep the crossfield taxiways out of their Runway Protection Zones (RPZ).

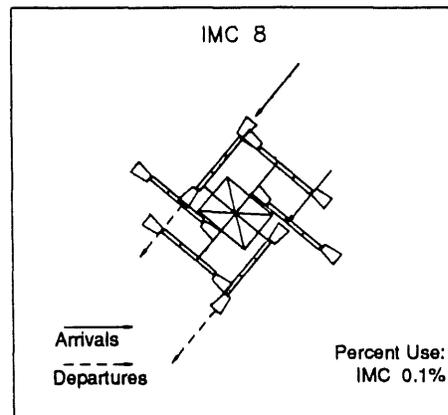
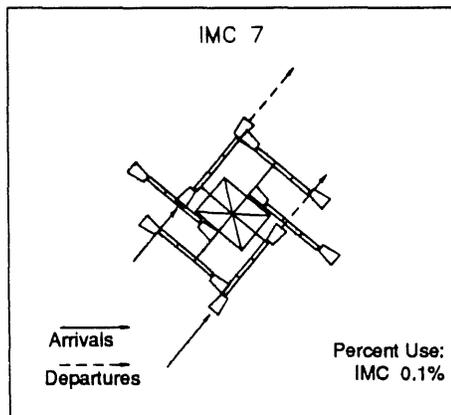
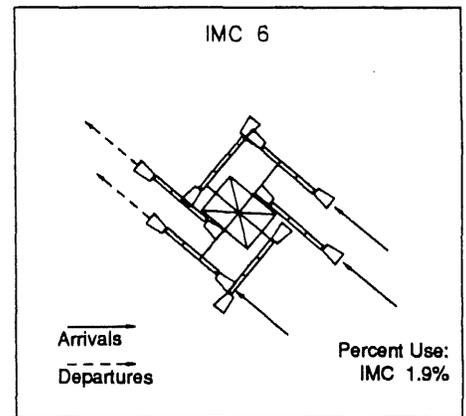
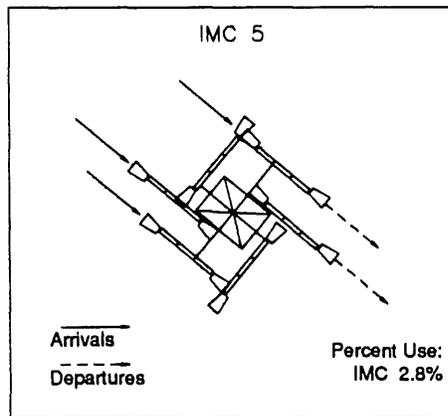
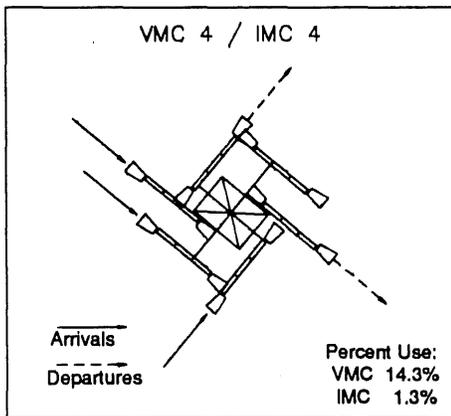
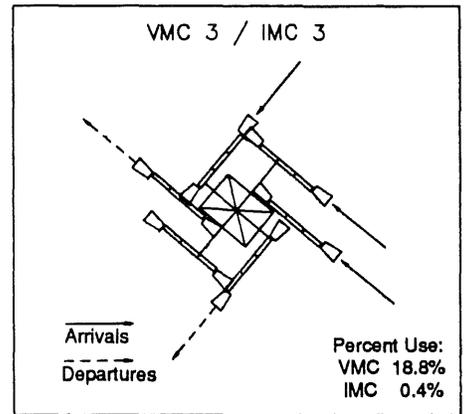
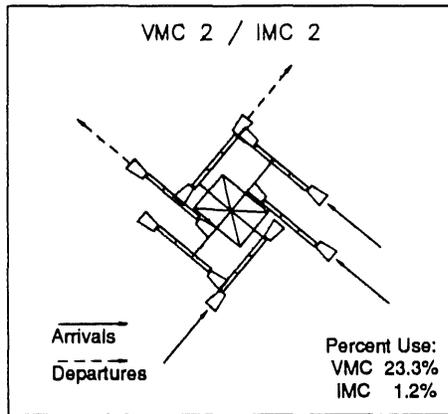
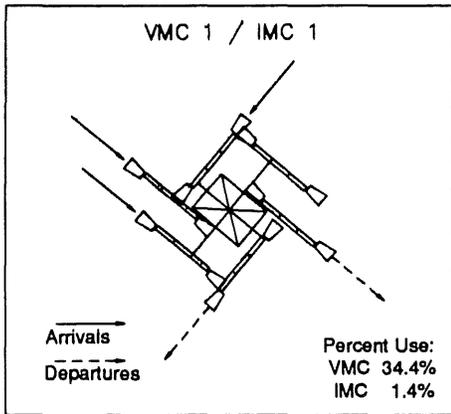




New Air Carrier Airport Conceptual Design



Figure 8-6
Airfield Layout
Alternative T-1



VMC = Visual Meteorological Conditions
 IMC = Instrument Meteorological Conditions
 Numbers refer to operating models



Airspace Operations

1. Flight Path Distance Result: 31 miles/operation

The use of the southwest/northeast runways as primary arrival and departure runways results in the lowest airspace flight distance of the three alternatives. The third independent arrival stream to a crosswind runway permits up to 40 percent of all arrivals to use the crosswind runway instead of flying 10 to 15 miles to line up on a final approach to the northwest/southeast runways.

2. Flight Path Conflicts Result: None

When converging approaches are in use, there is a potential for flight path conflicts. If both aircraft make a go-around (in VMC) or execute missed approaches (in IMC), then the flight paths of the two aircraft may conflict. However, as the points of go-around or missed approach are at least three nautical miles apart, there is sufficient time for the air traffic controller to interact with the pilots of both aircraft to assure safe operations.

- Wind and Weather Result: Full coverage

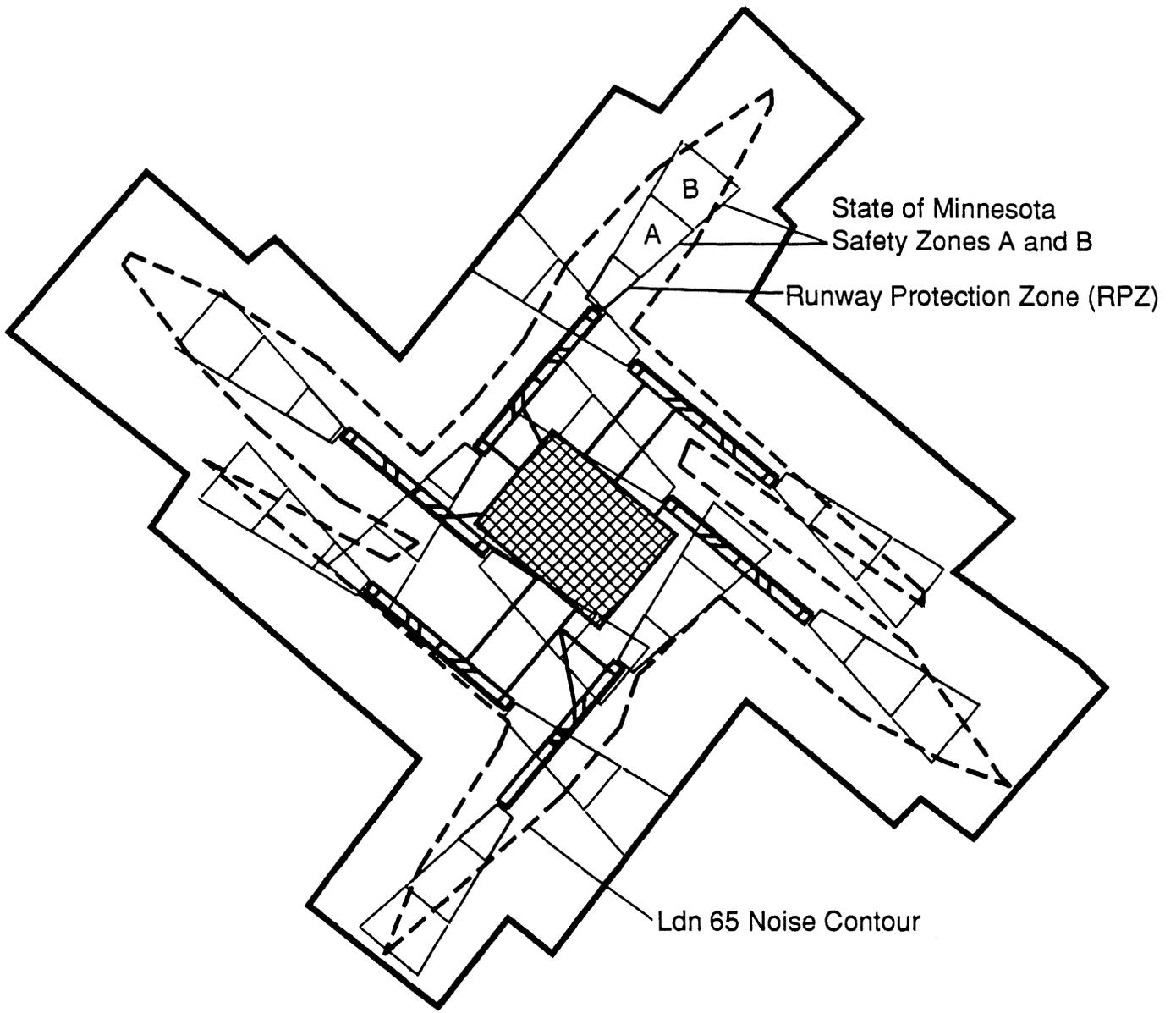
Alternative T-1 provides two parallel crosswind runways in the northeast/southwest direction for use during times of strong crosswinds and snowing/icing conditions.

- CRITERION 2: LAND IMPACT Result: 15,000-28,000 acres

The land impact of Alternative T-1 is not significantly greater than for Alternative P-2. This is because the stagger between the northeast/southwest runways permits the parallel crosswind runways to be located close to the terminal area. Approximately 28,000 acres would be impacted by the Ldn 65 contour. Figure 8-8 shows this impact.

- CRITERION 3: CONSTRUCTION COST Result: \$330 million

Construction of six runways and their supporting taxiway system, which lowers taxi distance and airspace flight distances and improves all-weather capabilities, results in a higher cost than the other two alternatives.



State of Minnesota
Safety Zones A and B
Runway Protection Zone (RPZ)

Ldn 65 Noise Contour



ALTERNATIVE L

Optimization

The layout of Alternative L-2 was refined to allow the operating configuration that provides the greatest capacity to be used the highest percentage of the time. The primary operating configuration for Alternative L-2 features arrivals to the southeast and departures to the southwest. Wind data indicates that this operating configuration can be used approximately 21 percent of the time. Further refinement permits arrivals from the southwest and departures to the northwest for a maximum wind coverage of 28 percent. Alternative L is presented in Figure 8-9.

As with the other two alternatives, Alternative L runway locations were shifted to minimize taxi distances. Runways 13R-31L and 13L-31R are primarily landing runways. They were shifted so the exit taxiways aligned with the crossfield taxiway connecting the runways with the terminal area. Runway 13C-31C was shifted to the southeast to minimize the distance from the Runway 31C threshold to the crossfield taxiway. Runway 4R-22L was shifted to the northeast so the Runway 22R threshold aligned with the threshold to Runway 22L. The thresholds to Runways 22R and 22L were kept southwest of the approach to Runway 31L, so aircraft waiting to depart on Runway 22R or 22L would not be under an approaching aircraft to Runway 31L.

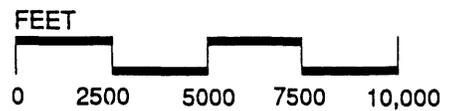
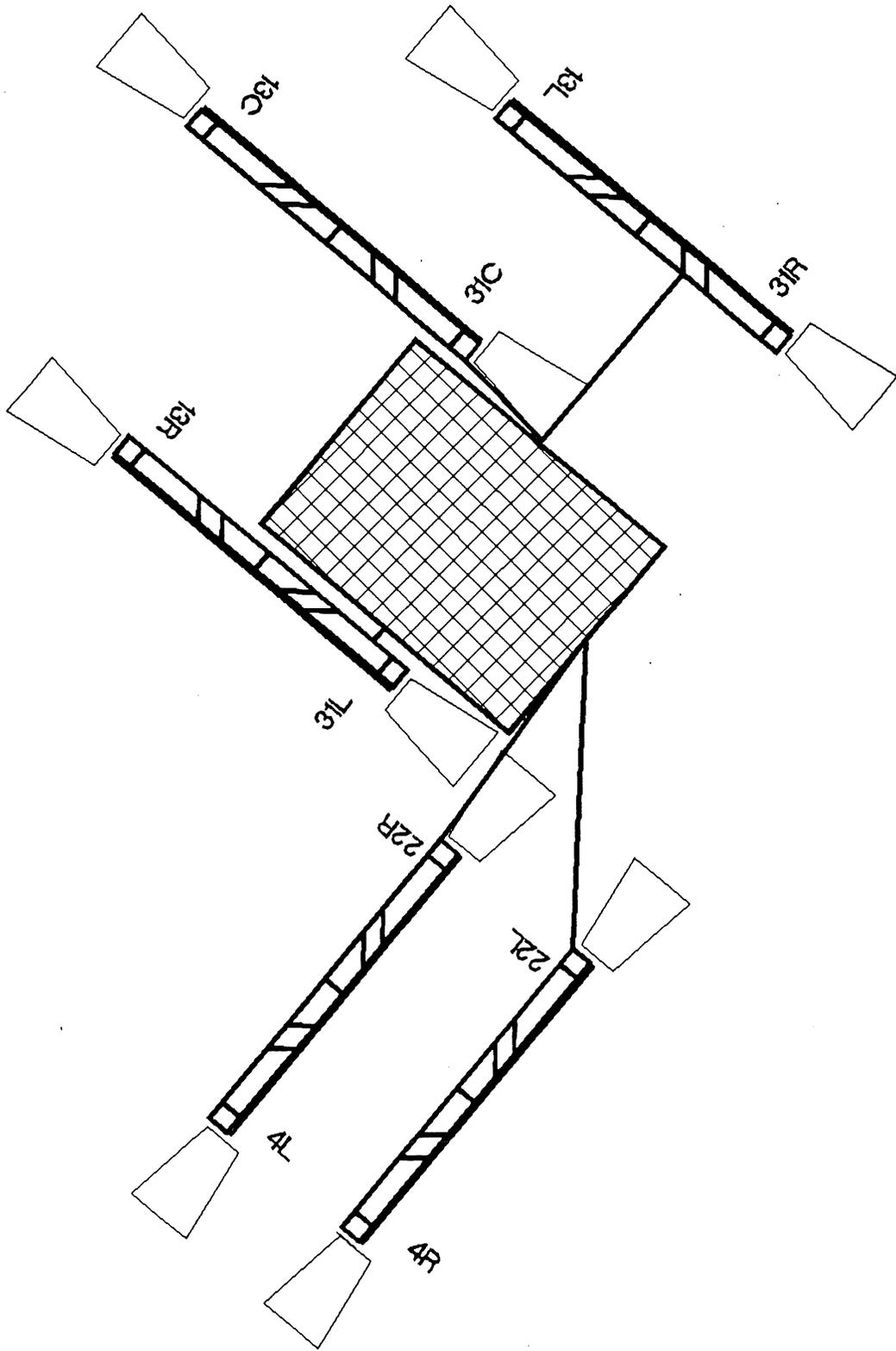
Evaluation

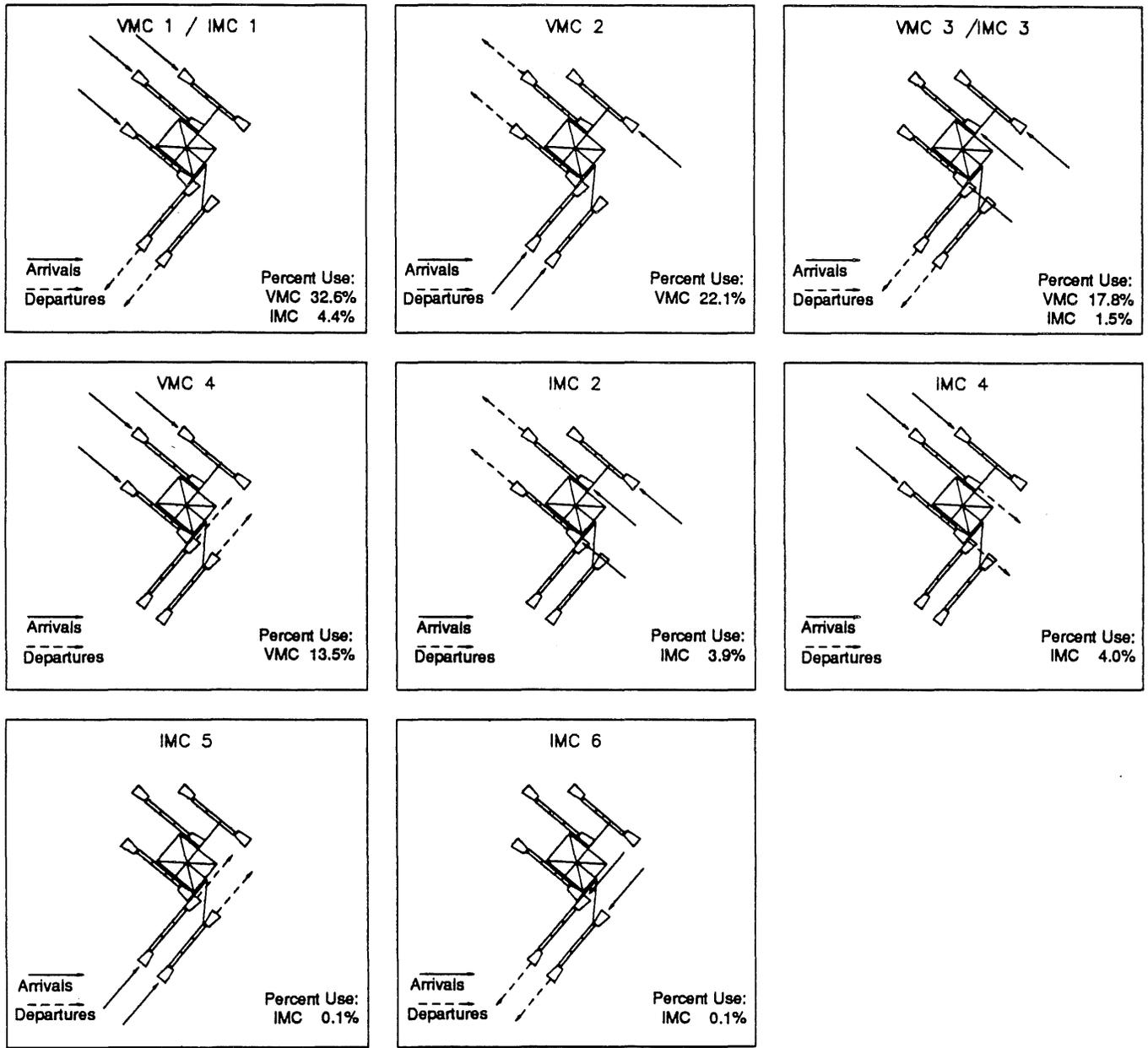
CRITERION 1: OPERATIONAL EFFICIENCY

Ground Operations

- | | |
|------------------|-------------------------------|
| 1. Runway Delays | Result: 0.9 minutes/operation |
|------------------|-------------------------------|

The operating configurations for Alternative L are depicted in Figure 8-10. The primary operating configuration features arrivals to Runways 13R, 13C, and 13L and departures on Runways 22R and 22L. The second VMC operating configuration also takes full advantage of the "L" layout, but has arrivals to Runways 4R, 4L, and 31R with departures on Runways 31L and 31C. There are certain inefficiencies with the remaining operating configurations, since the runway layout is not symmetrical in all four quadrants surrounding the terminal. In IMC, the arrivals to Runways 4R, 4L, and 31R represent potential missed-approach conflicts, and operations must revert to a less efficient single-direction operating configuration. Likewise, the VMC operating configuration of arrivals to Runways 13R, 13C, and 13L with departures on Runways 4R and 4L reverts to a single-direction operation in IMC. Although the inefficiencies occur a relatively small percentage of time (only three to four percent annually), they do result in a less-than-optimal runway layout system.





VMC = Visual Meteorological Conditions
 IMC = Instrument Meteorological Conditions
 Numbers refer to operating models



2. Runway Crossings Result: One

The approach path to Runway 31L crosses an active taxiway connecting the terminal area and Runways 4L-22R and 4R-22L in the VMC and IMC operating configurations of arrivals to 31R, 31C, and 31L and departures on Runways 22R and 22L. Although proper separation is provided between the taxiway and the threshold to Runway 31L, it is undesirable to have an aircraft taxiing underneath an approach path during IMC, and controllers may opt to hold departing aircraft until the arrival has cleared the intersection point. The potential for taxiing delays is an inefficiency inherent within this alternative.

3. Taxi Distance Result: 9,900 feet/operation

The need to keep the thresholds of Runways 22R and 22L southwest of the approach path to Runway 31L and the required use of the "L" in less efficient modes for 40 percent of the time increases the average taxi distance for this alternative over the other two. The taxi distances for aircraft departing on Runways 22R and 22L in the primary operating configuration are 9,500 feet and 12,000 feet, respectively. When combined, they are substantially greater than the taxi distance for departing aircraft in the primary operating configurations of the other two alternatives.

Airspace Operations

1. Flight Path Distance Result: 34 miles/operation

In Alternative L arrivals use the southeast/northwest runways and departures use the southwest/northeast runways. The result is a flight path distance similar to Alternative P-2. However, the ability to depart on Runways 22R and 22L when there are arrivals on Runways 31R, 31C, and 31L results in a somewhat lower average flight path distance for Alternative L relative to the other two alternatives.

2. Flight Path Conflicts Result: One

Runway 22L departures on a flight path leading to the northeast airspace departure gate cross the arrival streams to Runways 31R, 31C, and 31L. Although required separation can be maintained at the point at which the departure stream crosses the three arrival streams, management of three parallel flight paths and one crossing flight close to the airport will be difficult. An alternate route for aircraft departing on Runway 22L to the northeast airspace departure gate may be required. If it is, an increase in flight path distance results.

Wind and Weather Result: Full coverage

Alternative L provides a parallel pair of runways aligned in the northeast/southwest direction for use during times of combined strong crosswinds and snowing/icing conditions.

CRITERION 2: LAND IMPACT

Result: 16,000-29,000 acres

The remote positioning of the southwest/northeast runways relative to the main terminal area results in a land impact for Alternative L with a five-runway system comparable to that of Alternative T-1 with a six-runway system. The land impacted by Ldn 65 is 29,000 acres, as shown in Figure 8-11.

CRITERION 3: CONSTRUCTION COST

Result: \$280 million

Alternative L requires a large number of lengthy taxiways. This results in a relatively high airfield construction cost.

SUMMARY OF AIRFIELD ALTERNATIVE EVALUATION

Alternative P-2

The primary advantages of Alternative P-2 are that average annual delays of less than one minute can be achieved with four runways and land impacts are the least of the three alternatives. The disadvantage of Alternative P-2 is that it does not provide full coverage in all wind and weather conditions. In addition, flight path distances are the highest of the three alternatives.

Alternative P-2 is most viable when located on a site that permits construction of runways in only two directions. The problem with inadequate wind and weather coverage could be overcome by developing runways that intersect the primary runways and are used only in crosswind conditions. With such a solution, however, the cost for the additional runways is incurred but the benefits of reduced average taxi and flight path distances are not achieved.

Alternative T-1

Alternative T-1 has many benefits over the other two airfield alternatives, provided it can be developed on a site that can accommodate a full six-runway layout. The benefits of having the lowest average taxi distance, average flight path distance, and full wind and weather coverage easily offset the costs of the required sixth runway.

Alternative L

Alternative L does not offer many advantages when compared to Alternatives P-2 and T-1. Alternative L works best when the high capacity-high efficiency operating configurations to and from the northwest and to and from the southwest can be used a majority of the time. This is not possible in the Minneapolis-St. Paul area because the distribution of wind and weather patterns requires the use of other less efficient operating modes a high percentage of the time (40 percent annually). The use of these less efficient operating configurations tends to increase average taxi and flight path distances. In addition, the physical layout results in a higher land impact.

8.4.2 Terminal Configuration Alternatives

Based on the initial evaluation, five new terminal configuration alternatives were developed for further evaluation. Four of these park aircraft around satellite concourses. The satellite alternatives differ from one another in their configuration. In all of the satellite alternatives, the satellite concourses are linked to the central terminal (Central Processing Unit or CPU) by an underground people-mover system. In the other alternative, the concourses are linked directly to a central terminal building. These alternatives are referred to by numbers to distinguish them from the initial alternatives. Satellite configurations dominate because of their effectiveness in meeting goals for the project. They facilitate flow-through operations. They serve hub carrier connecting operations well. Further, they allow minimum walking distances for both O&D and connecting passengers. Future expansion is also readily possible with this configuration.

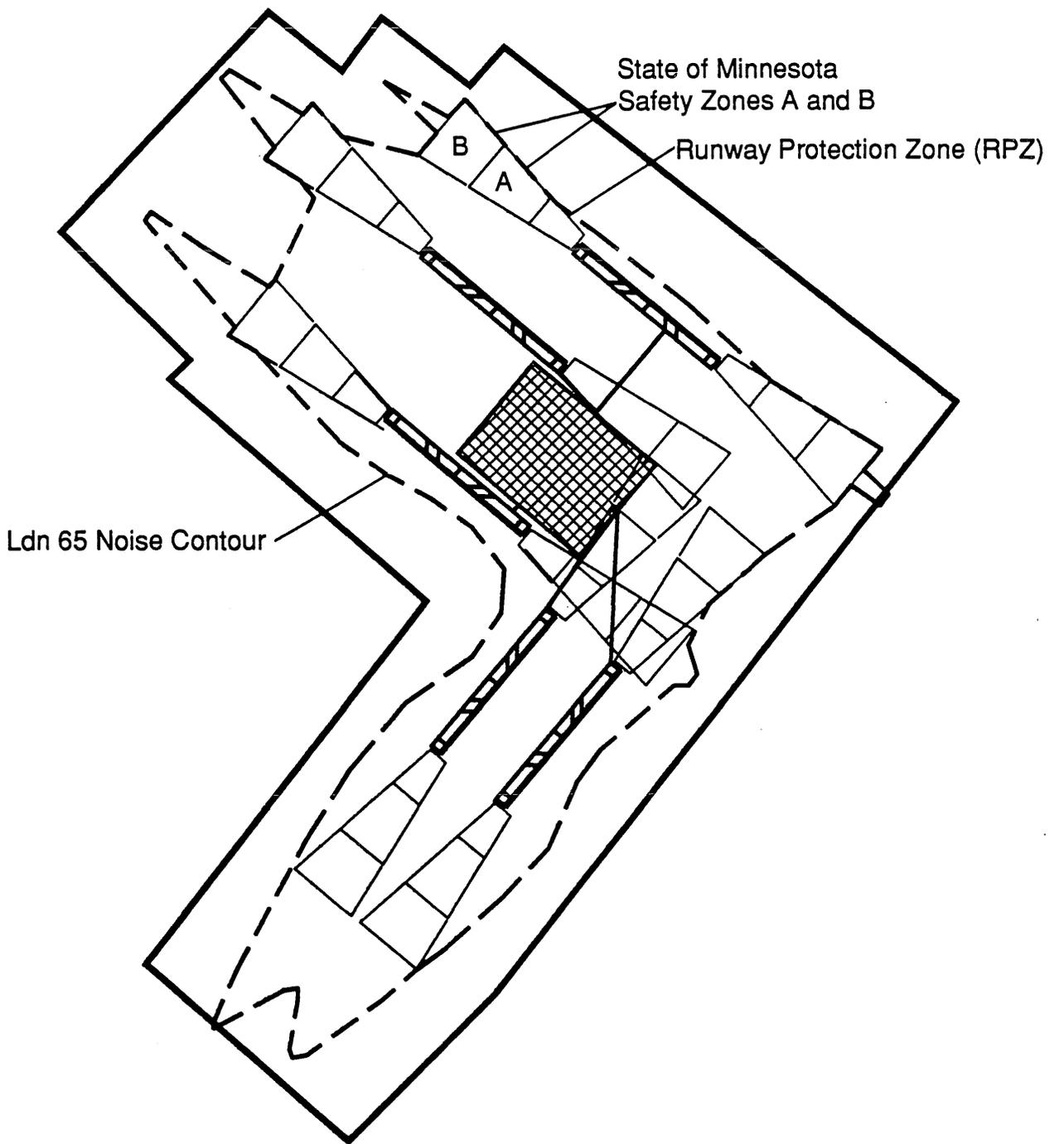
ALTERNATIVE 1

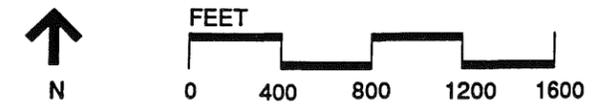
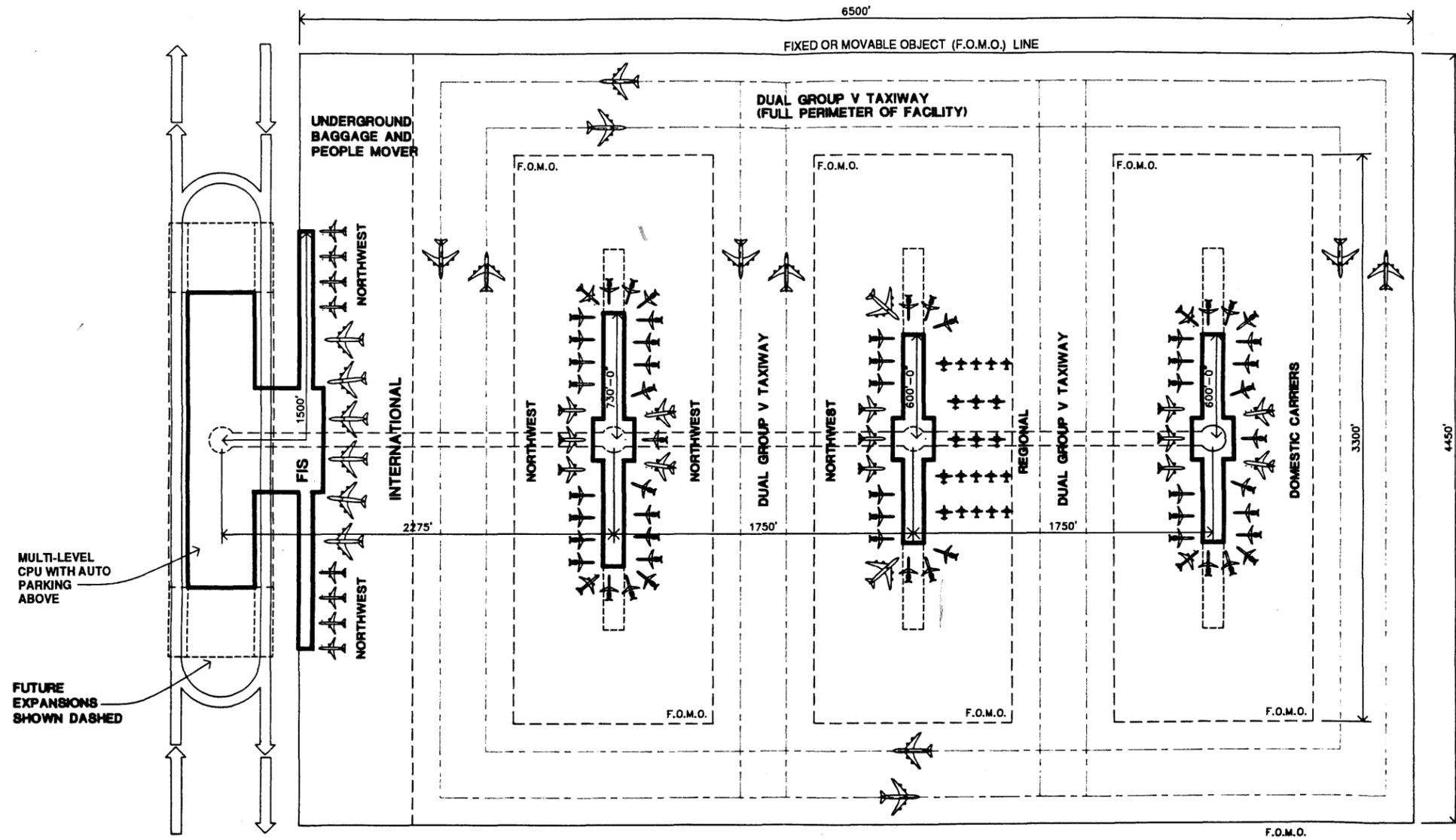
Description

Alternative 1 consists of a CPU which contains ticketing, bag claim, and a limited number of gates in an attached linear concourse, and three satellite concourses where the majority of the aircraft gates are located. This configuration is similar to Atlanta-Hartsfield International Airport in that it consists of a series of satellite concourses aligned parallel to one another and connected to a central terminal via a below-grade people-mover system. The new Denver airport has this configuration. Figure 8-12 shows Alternative 1.

The satellite concourses have independent push-back zones for aircraft. These allow aircraft to enter and exit gate positions without their movements conflicting with one another. Dual taxiways between satellites and on the perimeter allow flow-through aircraft circulation. In other words, aircraft can taxi from the arrival runways to the gate and then out to the departure runways without having to backtrack or detour.

To accommodate the required number of aircraft positions, a linear concourse parallel to the CPU and the three satellite concourses is needed. This concourse contains the international arrivals gates and a limited number of domestic gates for Northwest Airlines. This location provides easy access to landside facilities for international passengers terminating their travel in Minneapolis-St. Paul. It also provides close-in aircraft parking that can be used by Northwest Airlines. All other aircraft gates are located at the three satellite concourses. The remainder of Northwest Airlines gates are assigned to the two satellite concourses closest to the CPU. The regional carriers are centrally located, where they are close to both their code-sharing carrier and other domestic positions. The remaining domestic gate positions are located in the third satellite concourse.





The satellite concourses are connected to each other and the central processing unit by a below-grade people-mover system. The system operates as a shuttle with stops at the center of each satellite concourse and one stop at the CPU. Baggage moves below grade between buildings. The CPU is multi-leveled, with ticketing, baggage claim, ground transportation, and parking located on separate levels. Federal Inspection Services (FIS) would be separate, but integrated along one side.

The ticketing and baggage claim levels of the CPU are served by auto drives located along both sides of the building. This maximizes curbside access and access to the ticketing and baggage claim lobbies. This configuration has the potential to allow access to and from the terminal drives from more than one direction.

Airside and landside terminal facilities in Alternative 1 can be constructed independent of one another. In addition, the CPU can be expanded on either end, as can the FIS area. Gate positions may be added to the satellite concourses by extending them on either or both ends. Additional satellite concourses can also be constructed.

Evaluation

The following is a detailed evaluation of Alternative 1.

CRITERION 1: PASSENGER CONVENIENCE

Origin/Destination Passenger Walking Distance

The longest distance a passenger has to walk is 1,500 linear feet. This is the journey from the CPU to the end of the linear concourse which is attached to it.

Origin/Destination Passenger Time

The following times were calculated for enplaning passengers whose air travel originated in Minneapolis-St. Paul. All times have been rounded up to the nearest 30 seconds.

	<u>Walking Time</u>	<u>Automated People-Mover Time</u>	<u>Total Time</u>
Originating passengers using the 2nd satellite (Hub Airline)	5 min. 30 sec.	4 min. 30 sec.	10 min.
Originating passengers using the 3rd satellite (Other Airlines)	4 min. 30 sec.	6 min.	10 min. 30 sec.

This compares to an unassisted walking time today at MSP for the same journey of 8 minutes.

Connecting Passenger Walking Distance

The longest walking distance for a connecting passenger is 2,230 linear feet from the end of the longest satellite concourse to the end of the pier attached to the CPU.

Connecting Passenger Time

To get from the end gate at the second satellite concourse to the end gate at the attached linear concourse, passengers walk to the people-mover station, ride the people-mover through an intermediate stop at the first satellite concourse, and then walk to the gate from the people-mover station. The time required for this journey is 15 minutes and 30 seconds. This compares to an unassisted walking time today at MSP of 15 minutes.

Automobile Parking

Automobile parking is located directly above the passenger processing level in the CPU. Deplaning passengers ride elevators from the parking floors to the ticketing level or proceed directly to the people-mover station level. When deplaning, passengers ride elevators to automobile parking from either the baggage claim or people-mover levels of the CPU.

CRITERION 2: OPERATIONAL EFFICIENCY

Hub Compatibility

The hub carrier's operations are split into three parts. Two parts are located in the satellite concourses and the third is in the linear concourse attached to the CPU. The hub carrier can, however, develop strong corporate identity in the satellite concourse because it is the sole occupant.

Baggage Transfer

Because hub operations are not concentrated in one location, some gate-to-gate transfer of baggage is required. Bag carts must therefore cross taxilanes unless a below-grade service road is provided. Below-grade baggage transfer lanes can be built along the same alignment as the people-mover system.

International Airline Integration

Passengers (and their baggage) who connect from an international arrival to a domestic departure must proceed via the people-mover to gates not located immediately adjacent to the international gates and the FIS facility. Alternative 1 does not necessarily require these passengers to exit and re-enter the secure area of the airport. International passengers who terminate their travel in Minneapolis exit the secure area immediately adjacent to the CPU.

Regional Airline Integration

Passengers connecting to or from regional flights are required to transfer from one satellite concourse to another. Alternative 1 does not require these passengers to exit and re-enter the secure areas of the airport.

Aircraft Circulation

Independent push-back zones and dual taxiways provide unrestricted aircraft access to all gates. Flow-through aircraft circulation is provided on the apron from the arrival runways to the departure runways. Below-grade service roads will keep the apron area free of baggage handling vehicles. Dimensional guidelines for Group V aircraft were used to size the perimeter and interior taxiways.

Gate Use Flexibility

The satellite concourses in this alternative do not impose any restrictions on aircraft parking. Taxiway sizing does not limit gate capacity.

Surface Access

The CPU is bounded by airside development on only one side. Thus, development of access and egress roads from two directions is possible.

CRITERION 3: IMPLEMENTATION

Airside Construction

Three identical satellite concourses comprise the airside facilities. The people-mover must be integrated into the satellite concourses and the CPU. Most likely, cut-and-cover construction can be used for the below-grade systems. Tunneling, which is more expensive, is the alternative. The linear concourse attached to the CPU must be integrated with this structure. Airside satellite concourse construction can proceed independent of CPU construction.

Landside Construction

Landside construction consists of a multi-level CPU which includes automobile parking on its upper levels. People-mover and baggage handling systems may require significant below-grade construction. Location of passenger ticketing on the second level of the CPU dictates elevated drives. Construction is based on 50-foot by 55-foot bay spacing. This matches the dimensions of the automobile parking. Structural systems that support portions of the CPU which overhang the terminal drives need to be integrated with the layout and structure of the drives.

CRITERION 4: EXPANDABILITY/PHASING

Gates

Hub carrier gates can be added by extending either end of the first two satellite concourses. Domestic carrier gates can be added by extending either end of the third satellite. International arrival gate positions can be added to either end of the international arrival area. Even more gates can be added through construction of another satellite concourse and an extension of the people-mover and baggage transfer systems.

Passenger Processing Facilities

Passenger processing facilities and automobile parking can be expanded by extending the length of the CPU. Additions at either end are possible. An increase in the length of the CPU allows curb frontage to be extended. FIS facilities can expand on either end.

Phasing

The satellite concourses can be constructed independent of one another. The central processing unit and its associated automobile parking can be constructed in modular units or bays and include the people-mover station.

CRITERION 5: CONSTRUCTION COST

The cost of constructing Terminal Configuration Alternative 1 is \$601,588,000. The breakdown of this cost is shown in Table 8-1.

Table 8-1

Terminal Configuration Alternative 1: Construction Cost

Element	Project Cost (1990 Dollars)
TERMINAL BUILDING	
Central Processing Unit (CPU)	\$210,000,000
Concourses	51,525,000
Satellites	137,700,000
Other	<u>97,000,000</u>
Subtotal	\$496,225,000
AUTOMATED PEOPLE-MOVER	\$105,363,000
TOTAL TERMINAL COST	\$601,588,000

Source: TRA Airport Consulting and The Alliance.

ALTERNATIVE 2**Description**

Alternative 2 is the same as Alternative 1 except that satellite concourses are configured differently. In Alternative 2, there are two X-shaped satellite concourses. As in Alternative 1, they are connected to the CPU via below-grade people-mover and baggage systems. This alternative is similar to the proposed USAir terminal at Pittsburgh. See Figure 8-13.

The aircraft gates are divided between the two satellite concourses. All NW gates and the international arrival gates are located in the building closest to the CPU, as are the FIS facilities. The remainder of the domestic and regional carrier gates are located in the second satellite concourse. This configuration has independent push-back zones as well as dual taxiways in and around the airside buildings.

The two satellite concourses are connected to each other and to the central processing unit by below-grade people-mover and baggage systems. The people-mover system operates as a shuttle with a stop at the center of both satellite concourses and the CPU. As with Alternative 1, the CPU is a multi-story building with separate levels for ticketing, baggage claim, ground transportation, and automobile parking. Curbside frontage and drives can be located on both sides of the building on both the baggage claim and ticketing levels. The alternative also allows roadway access and egress from more than one location.

The landside and airside buildings in this alternative can be constructed independent of one another. Future expansion of the CPU will be possible at either end. The smaller satellite concourse can be expanded by extending any or all of its four legs. Once this is done, additional gate capacity requires the construction of another satellite and an extension of the people-mover system.

Evaluation

The following is a detailed evaluation of Alternative 2.

CRITERION 1: PASSENGER CONVENIENCE

Origin/Destination Passenger Walking Distance

The longest walking distance for an O&D passenger is 1,450 linear feet. This is from the CPU to the gate located at the end of any leg of the large satellite.

Origin/Destination Passenger Time

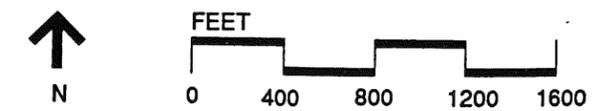
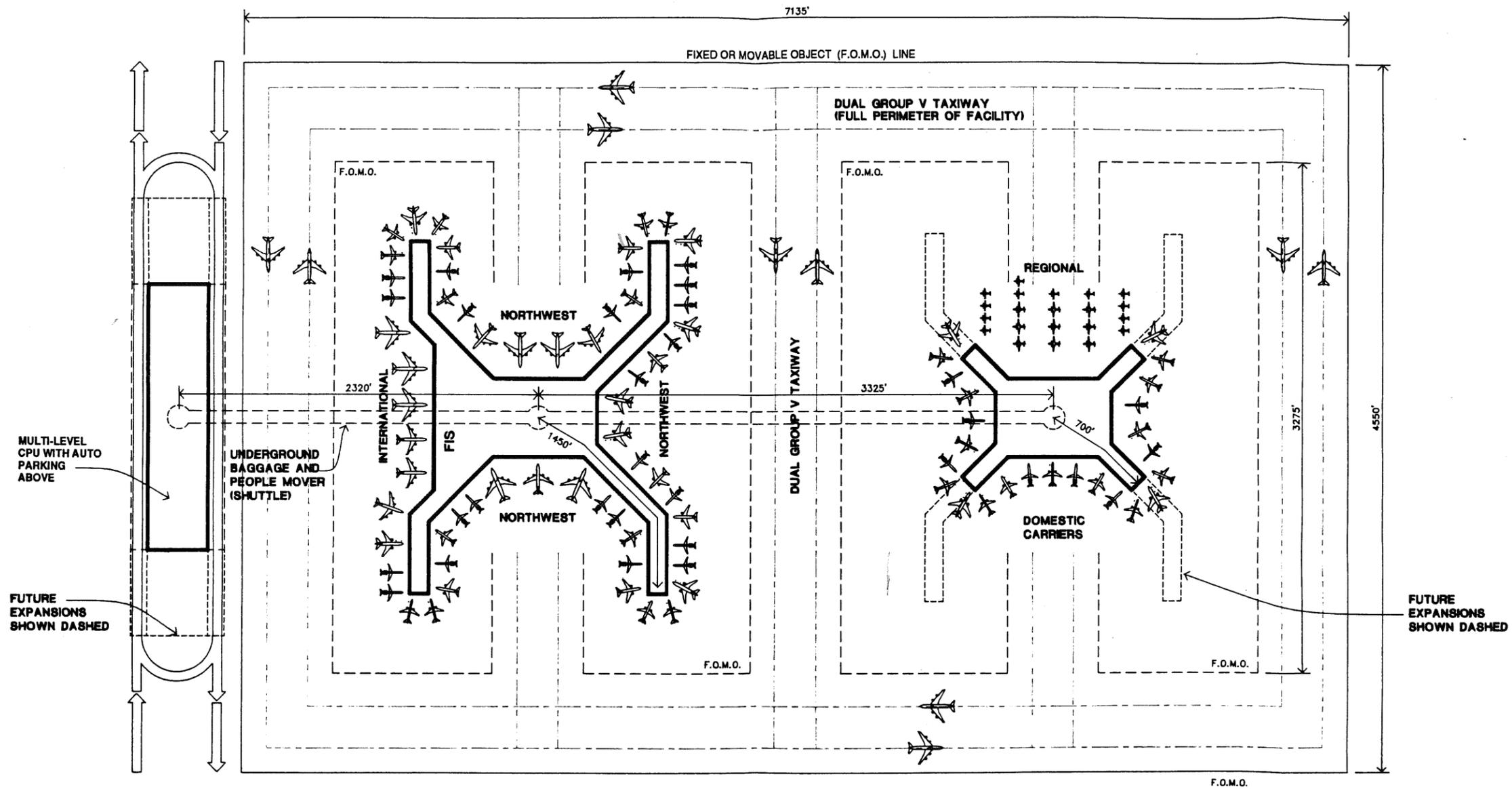
The following times were calculated for enplaning passengers whose air travel originated in Minneapolis-St. Paul.

	<u>Walking Time</u>	<u>Automated People-Mover Time</u>	<u>Total Time</u>
Originating passengers using the end gate of the large satellite (Hub Airline)	7 min.	3 min. 30 sec.	10 min. 30 sec.
Originating passengers using the end gate of the small satellite (Other Airlines)	5 min. 30 sec.	4 min. 30 sec.	10 min.

This compares to an unassisted walking time today at MSP of 8 minutes.

Connecting Passenger Walking Distance

The longest unassisted walk is 2,900 linear feet. This is from the end gate of any leg of the large satellite concourse to the end gate of the opposite leg.



Connecting Passenger Time

The longest connecting passenger walk is from the end of one satellite concourse leg to the end of another. This path is as follows: from a regional carrier gate located at the end of the small satellite concourse, a passenger would walk to the people-mover station, ride the people-mover to the large satellite concourse, and then walk to the gate located at the end of any leg. The time required is 15 minutes, 30 seconds, which is slightly more than is required today at MSP. Passengers making connections within the hub carrier satellite concourse can walk or use moving sidewalks, which will be installed the length of each satellite.

Automobile Parking

Automobile parking is located directly above the passenger processing functions in the CPU. Passengers ride elevators down from the parking floors to the ticketing level or lower to the people-mover station level. From here, they proceed to their gates to enplane. Deplaning passengers, once they reach the CPU, ride elevators up to automobile parking from either the baggage claim or people-mover levels.

CRITERION 2: OPERATIONAL EFFICIENCY

Hub Compatibility

The X configuration of the satellite concourses allows the gates used by the hub carrier to be centralized in one location. In addition to being efficient, this configuration allows the hub carrier to develop a discrete corporate identity in its satellite concourse. Centralization of operations avoids airline duplication of either facilities or personnel and keeps walking distances for connecting passengers to a minimum.

Baggage Transfer

An apron service road accommodates baggage connecting between domestic flights and baggage moving from international arrivals to domestic departures. Baggage transfer between a regional and a domestic flight requires bag carts to cross taxilanes unless a below-grade service road is provided. Below-grade baggage transfer lanes are possible along the same alignment as the people-mover system.

International Airline Integration

Terminating international passengers proceed from the FIS area via the people-mover system to deplaning passenger facilities located in the CPU. These passengers must re-check their baggage prior to boarding the people-mover system. International passengers connecting with Northwest Airlines domestic flights may do so within the satellite. International passengers connecting with regional airline flights or other airlines would do so via

the people-mover system. Alternative 2 does not require passengers to exit and re-enter the secure area of the airport.

Regional Airline Integration

Alternative 2 does not require passengers connecting to or from regional carrier flights to exit and re-enter the secure area of the airport.

Aircraft Circulation

Independent push-back zones and dual taxiways provide unrestricted access to all aircraft gates. The X configuration means that some gates can only be reached via dead-end taxilanes. Flow-through aircraft circulation on the apron from the arrival runways to the departure runways is provided. A below-grade service road is required to keep the apron area free of vehicles carrying baggage. Guidelines for Group V aircraft were used to determine the dimensions of perimeter and interior taxiways.

Gate Use Flexibility

The size of the taxiways in this alternative does not limit gate capacity. However, the X configuration of the satellite concourses results in a number of corners and bends in the buildings. These impose a limit on the size aircraft which may park at a number of gate locations, specifically at some interior corners. Wingtip and tail clearances of parked aircraft may require that aircraft maneuvering into parking positions receive special assistance from ground crews.

Surface Access

The CPU is bounded by airside development on only one side. Thus, access and egress roads from more than two directions is possible.

CRITERION 3: IMPLEMENTATION

Airside Construction

Two X-shaped satellite concourses comprise the airside facilities. The people-mover system must be integrated into the satellites and the CPU. Cut-and-cover construction or tunneling will be required for the below-grade people-mover and baggage transfer systems. Airside satellite concourse construction can proceed independent from construction of the CPU.

Landside Construction

The landside facilities consist of a multi-level CPU which includes automobile parking located on its upper levels. People-mover and baggage handling systems may require

significant below-grade construction. Location of passenger ticketing on the second level of the CPU requires elevated drives. Construction is based on 50-foot by 55-foot bay spacing. This matches the dimensions of the automobile parking. Structural systems that support portions of the CPU which overhang the terminal drives would need to be integrated with the layout and structure of the drives.

CRITERION 4: EXPANDABILITY/PHASING

Gates

Hub carrier gates can be added by extending the length of the satellite concourses. This change will increase the walking distance from the end of a satellite concourse to the people-mover station. The smaller satellite can be expanded the same way. If Northwest Airlines used gates in both satellite concourses, their hub operation would be split. Connecting domestic passengers could be required to ride the people-mover system. Gates for arriving international flights can be added to either end of the international arrival concourse. Even more gates can be added through construction of an additional satellite concourse. This would also require an extension of the people-mover and baggage transfer systems.

Passenger Processing Facilities

Passenger processing facilities and automobile parking can be expanded by extending the length of the CPU. Additions at either end are possible. An increase in the length of the CPU allows curb frontage to be extended. FIS facilities can expand on either end.

Significant increases to the FIS area could alter the plane parking arrangement. This could reduce the total number of aircraft parking positions at the satellite concourse.

Phasing

Satellite concourses, or portions thereof, can be constructed independent of one another. Alternative 2 provides two options for phasing. In one, both satellite concourses could be built with shortened legs during the first phase. In the other, one complete satellite concourse could be built along with only a portion of the second. The central processing unit and its associated automobile parking can be constructed in modular units or bays, and include the people-mover station.

CRITERION 5: CONSTRUCTION COST

The cost of constructing Terminal Configuration Alternative 2 is \$732,253,000. The breakdown of this cost is shown in Table 8-2.

Table 8-2

Terminal Configuration Alternative 2: Construction Cost

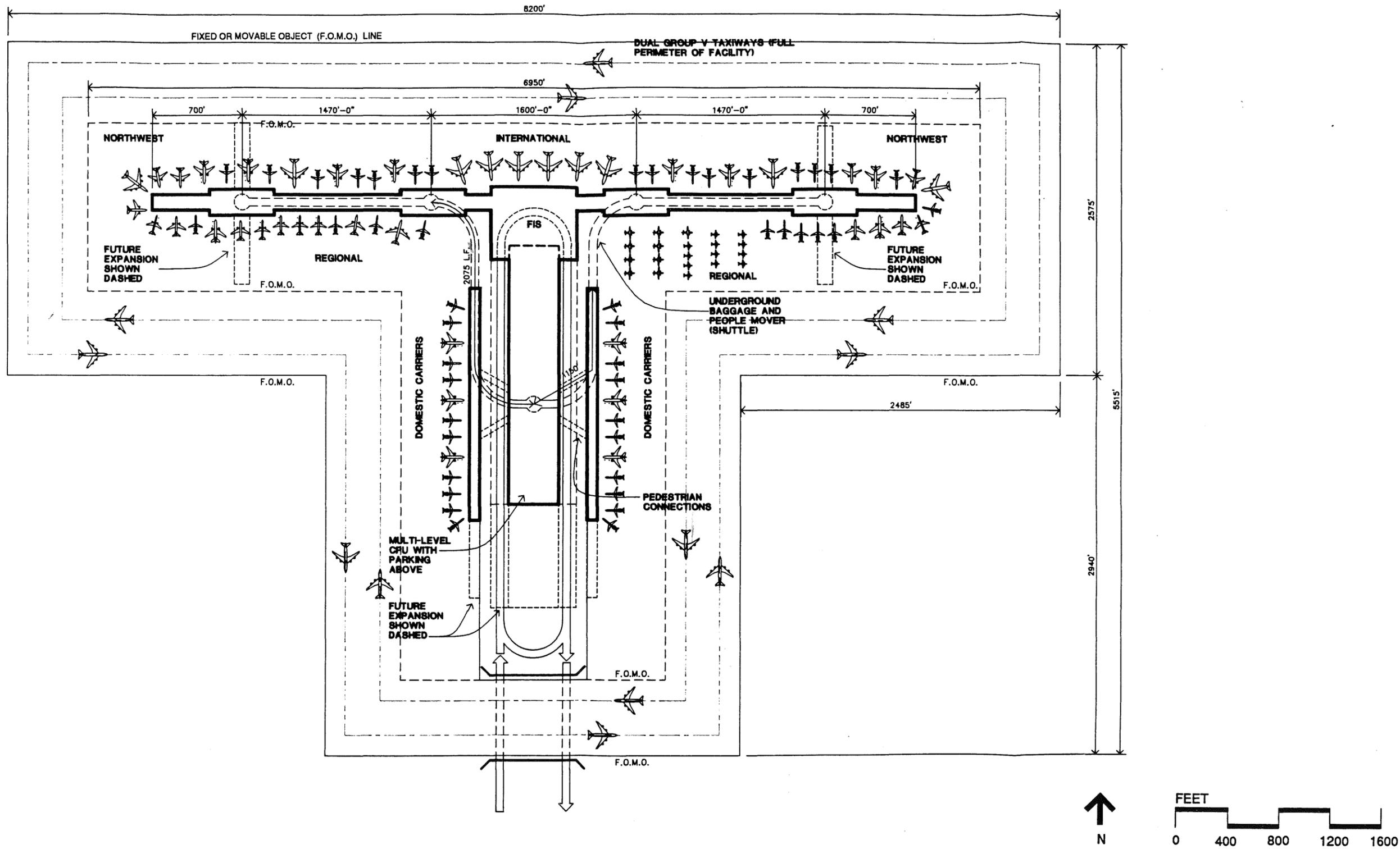
Element	Project Cost (1990 dollars)
TERMINAL BUILDING	
Central Processing Unit (CPU)	\$210,000,000
Satellites	322,875,000
Other	<u>105,250,000</u>
Subtotal	\$638,125,000
AUTOMATED PEOPLE-MOVER	\$94,128,000
TOTAL TERMINAL COST	\$732,253,000

Source: TRA Airport Consulting and The Alliance.

ALTERNATIVE 3**Description**

Alternative 3 is derived from the earlier hybrid alternatives. The configuration consists of two single-sided concourses connected to a CPU by above-grade pedestrian corridors, and a long double-sided concourse which is directly attached to the CPU. A below-grade people-mover system also links the CPU to the long double-sided concourse. Alternative 3 is shown in Figure 8-14.

In this alternative all of the gates for Northwest Airlines and the regional and international carriers are located along a single concourse. The concourse is physically attached to the Central Processing Unit. The concourse is symmetrically arranged around the FIS facility. This configuration provides direct access to the CPU for arriving international passengers who terminate their travel in Minneapolis-St. Paul. Gates along the concourse can be reached either by walking or via a below-grade people-mover shuttle. This shuttle transports passengers to their gates from the CPU or between gates for connecting flights. The same below-grade corridor would be used for baggage transfer as well. The remaining domestic gates, which are likely to accommodate predominantly origin-and-destination flights, are located in two single-sided concourses which are parallel to the CPU. Passengers would reach these gates from the CPU via the above-grade pedestrian corridors.



Sufficient space is provided around all of the concourses so that the aircraft push-back zone is unrestricted. There is a dual taxiway system around the perimeter of the terminal area. Aircraft circulate around the terminal area as they arrive from or depart to the runway system.

In this alternative, the CPU would again be a multi-level structure, with the various passenger processing areas located on separate levels. The ticketing and baggage claim areas have curbs on either side. Because the airside concourse connects to the CPU, surface access and egress is limited to one end of the CPU.

The CPU and the satellite concourses are physically connected in this alternative. Because they are, careful coordination will be required during construction. Once constructed, however, the various terminal components can be expanded independent of one another. Each of the single-sided concourses can be extended on one end. Extensions can be made to the double-sided concourse at the people-mover nodes. The CPU can be extended to provide additional ticketing, baggage claim, parking facilities, or other needed support areas. Significant additions to the overall number of gates can be achieved by construction of: (1) an additional satellite concourse, or (2) a concourse remote from but parallel to the double-sided concourses.

Evaluation

Following is a detailed evaluation of Alternative 3.

CRITERION 1: PASSENGER CONVENIENCE

Origin/Destination Passenger Walking Distance

The longest walking distance which an O&D passenger must walk is 1,150 linear feet. This is the distance from the CPU to the domestic gates located at the end of either of the single-sided concourses that are parallel to the CPU.

Origin/Destination Passenger Time

The following times were calculated for enplaning passengers whose travel originated in Minneapolis-St. Paul.

	<u>Walking Time</u>	<u>Automated People-Mover Time</u>	<u>Total Time</u>
Originating passengers using the end gate of the double-sided concourse (Hub Airline)	5 min.	4 min. 30 sec.	9 min. 30 sec.
Originating passengers using the end gate of either single-sided concourse (Other Airlines)	5 min.	NA	5 min.

This compares with 8 minutes at MSP today.

Connecting Passenger Walking Distance

The longest unassisted walking distance for a connecting passenger is 1,470 feet. This is from the gate located at the midpoint of one of the double-sided concourses to the gate at the midpoint of the other double-sided concourse.

Connecting Passenger Time

The most time-consuming trip through the airport for a connecting passenger is from the domestic gate position located at the end of the double-sided concourse to the domestic gate at the opposite end. To make this connection, a passenger must walk to the people-mover station, ride the people-mover four stops, and then walk to the end gate. The passenger has two choices: (1) ride the people-mover or (2) make the entire connection by walking and/or using the moving sidewalks.

Connecting passenger using the people-mover = 14 min.

Connecting passenger walking = 23 min. 30 sec.

These times compare with 15 minutes at MSP today.

Automobile Parking

Automobile parking is located above the passenger processing level in the CPU. Passengers ride elevators from the parking floors to the ticketing level or proceed directly to the people-mover station level to reach the gates of either the regional carriers or the hub carrier to enplane. To reach pedestrian connectors to all other domestic gates, passengers ride elevators from the parking floors to ticketing, and then to a passenger transfer level. When deplaning, passengers ride elevators to auto parking from one of three levels in the CPU: baggage claim, people-mover, or passenger transfer.

CRITERION 2: OPERATIONAL EFFICIENCY

Hub Compatibility

The double-sided concourse configuration allows hub carrier gates to be centralized. All of the other advantages previously described for Alternative 2 are also available with this configuration. The extended length of the concourse allows immediate proximity to code-sharing regional carriers as well as international arrivals.

Baggage Transfer

An apron service road can accommodate gate-to-gate transfer of baggage transfer between domestic, regional, and arriving international flights. Service road penetrations through the concourse at a number of locations would facilitate the transfer of baggage between gates on opposite sides of the building. Baggage transfer in this alternative does not require bag carts to cross taxilanes. Thus, a below-grade service road is unnecessary. Below-grade baggage transfer lanes could be built along the same alignment as the people-mover system to expedite baggage transfer for originating and terminating passengers.

International Airline Integration

Gates for arriving international flights are immediately adjacent to the deplaning passenger facilities located in the CPU. Deplaning international passengers transferring to Northwest Airlines domestic flights do so within the concourse by walking or by riding the people-mover system. Deplaning international passengers transferring to regional airline flights do the same. Alternative 3 does not require passengers to exit and re-enter the secure area of the airport during this transfer process.

Regional Airline Integration

Passengers connecting to or from regional airline flights ride the people-mover system to connect with flights at gates not located immediately adjacent to those of the regional carriers. Alternative 3 does not require passengers to exit and re-enter the secure area of the airport during this transfer process.

Aircraft Circulation

Independent push-back zones and dual taxiways provide unrestricted access to all gates. Flow-through aircraft taxiing is not possible due to the perpendicular arrangement of the concourses relative to each other and the CPU. Guidelines for Group V aircraft were used to establish the dimensions of the perimeter and interior taxiways.

Gate Use Flexibility

Neither the double-sided nor the single-sided concourse configuration restricts aircraft parking to any specific aircraft type. Taxiway dimensions do not impose any limits on gate capacity.

Surface Access

The CPU is bounded by airside development on three sides. This, plus the fact that one end of the CPU is attached to the airside building, means that there is only one point of access for surface vehicles. Further, the access road must pass beneath a cross taxiway.

CRITERION 3: IMPLEMENTATION

Airside Construction

Concourses in Alternative 3 are physically attached to the CPU building either directly or via pedestrian connectors. The people-mover system, which runs the length of the concourse, must be carefully integrated into this alternative to avoid conflict with the building's structural system.

Landside Construction

A multi-level CPU with automobile parking located on its upper floors is the major land-side facility. People-mover and baggage handling spaces require significant below-grade construction. Location of passenger ticketing facilities on the second level of the CPU requires that the drive system be elevated. Construction is based on 50-foot by 55-foot bay spacing. This matches the dimensions of the automobile parking on the upper floors. Structural systems which support any portion of the facility that overhangs the terminal drives must be integrated with the layout and structure of the drives. Airside and landside facility development will require close coordination.

CRITERION 4: EXPANDABILITY/PHASING

Gates

Gates for the hub carrier can be added by perpendicular extensions to the main concourse. These would be located at the people-mover station nodes. Gates for other domestic carriers can be added by extending one end of the single-sided concourses. Gates for international arrivals can be added to either side of the international arrival area. A greater number of gates than any of these proposals will provide can be obtained through the construction of satellite concourses. These would be located parallel to the main double-sided concourse. An extension of the people-mover system would be required.

Passenger Processing Facilities

Passenger processing facilities and automobile parking can be added by extending the length of the CPU. Any increase in the length of the CPU allows curb frontage to be extended. FIS facilities can expand to either side of the facility. Significant increases to the FIS area could alter the aircraft parking arrangement.

Phasing

The full length of the single- or double-sided concourses needed to meet the year 2010 forecast of demand can be constructed as a first phase. The central processing unit and automobile parking can be constructed by bays, to include the people-mover station, starting from the center bay. A temporary connection to the FIS facility is necessary. Another option for first-phase development of the CPU is construction of the bays necessary to support permanent connections to both the people-mover station and the FIS facility.

CRITERION 5: CONSTRUCTION COST

The cost of constructing Terminal Configuration Alternative 3 is \$712,655,000. The breakdown of this cost is shown in Table 8-3.

Table 8-3

Terminal Configuration Alternative 3: Construction Cost

Element	Project Cost (1990 Dollars)
TERMINAL BUILDING	
Central Processing Unit (CPU)	\$210,000,000
Concourses	270,000,000
Other	<u>104,800,000</u>
Subtotal	\$584,800,000
AUTOMATED PEOPLE-MOVER	\$127,855,000
TOTAL TERMINAL COST	\$712,655,000

Source: TRA Airport Consulting and The Alliance.

ALTERNATIVE 4A

Description

Alternative 4A satisfies year 2020 facility requirements through another satellite concourse configuration. This alternative consists of two parallel, satellite concourses, one long and one short. They are connected to a central processing unit by a below-grade people-mover system. There are also gate positions in a pier attached to the central processor. Figure 8-15 shows the configuration of Alternative 4A.

Each satellite concourse has independent push-back zones to facilitate aircraft movement to and from the gate positions. There are dual taxiways between the satellite concourse and at the perimeter. These allow flow-through aircraft circulation on the apron. Aircraft can maneuver from the arrivals runway to the gate and then out to the departures runway without having to backtrack or detour.

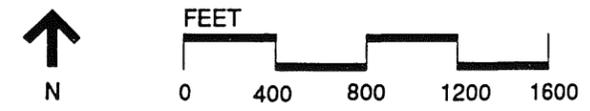
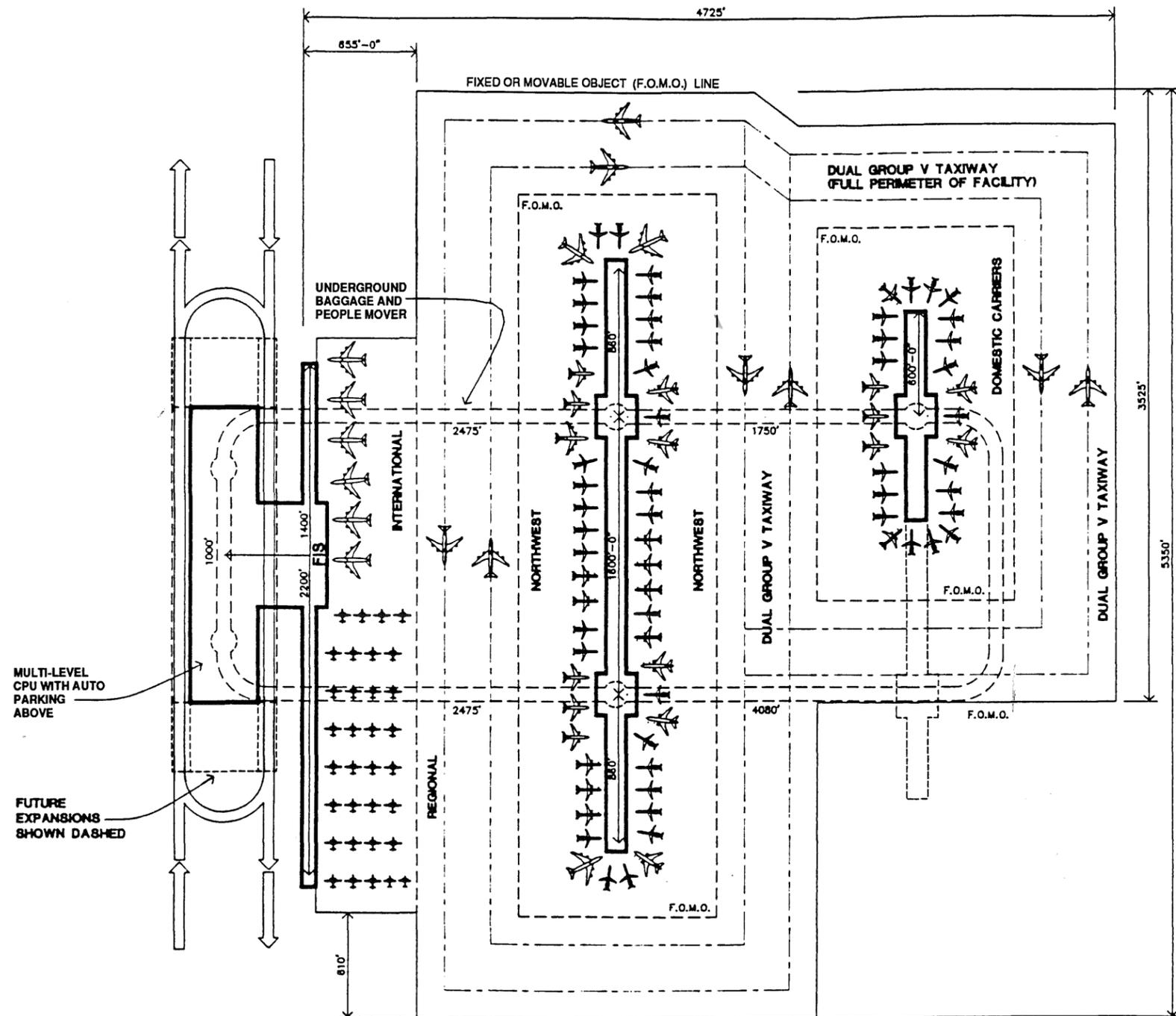
Gates are distributed as follows. International arrival and regional airline gates are located along a linear concourse parallel and attached to the CPU. The satellite concourse located closest to the CPU contains all of Northwest Airlines' domestic gates. This provides a close-in location for Northwest Airlines origin-and-destination traffic. It also locates all of Northwest Airlines' operations in one facility, which is convenient for a hub operation. The remaining domestic positions are located in the other, smaller satellite concourse.

The two satellite concourses are linked to each other and the CPU by below-grade people-mover and baggage handling systems. The people-mover system facilitates passenger movements to and from the CPU as well as between gates. The system has two stops at both the CPU and the long satellite concourse.

The CPU is multi-leveled. Baggage handling, baggage claim, ticketing, ground transportation, and parking are located on separate levels. Federal Inspection Services (FIS), while separate, are also integrated along one side of the CPU, adjacent to the international arrival gates.

The ticketing and baggage claim levels of the CPU would have curbs on either side. This provides the maximum amount of curbside access and maximizes access to the ticketing and baggage claim lobbies. Surface access to and from the terminal drives from more than one direction is possible with this alternative.

The CPU and the satellite concourses can be constructed independent of one another in this alternative. In addition, the CPU can be expanded on either end, as can the FIS area. Gates can be added to the satellite concourses by extending their length on either or both ends. Further, additional satellite concourses can be constructed. Extensions to the baggage and people-mover systems would link them to the existing facilities.



Evaluation

The following is a detailed evaluation of Alternative 4A.

CRITERION 1: PASSENGER CONVENIENCE

Origin/Destination Passenger Walking Distance

The longest walking distance for an origin-and-destination passenger is 2,200 feet. This is from the CPU to the end of the regional airline pier.

Origin/Destination Passenger Time

The following times were calculated for enplaning passengers whose air travel originated in Minneapolis-St. Paul.

	<u>Walking Time</u>	<u>Automated People-Mover Time</u>	<u>Total Time</u>
Originating passengers using the 1st satellite (Hub Airline)	5 min. 30 sec.	3 min. 30 sec.	9 min.
Originating passengers using the 2nd satellite (Other Airlines)	4 min. 30 sec.	4 min. 30 sec.	9 min.

Presently 15 minutes is required to make the equivalent journey on foot at MSP.

Connecting Passenger Walking Distance

A distance of 3,560 feet is the longest unassisted walk for connecting passengers. This is from the gate located at the end of the long satellite concourse to the regional gate located at the end of the pier attached to the CPU.

Connecting Passenger Time

To get from the gate position located at the end of the long satellite concourse to the gate at the opposite end, passengers have a choice. They can walk to the people-mover station, ride the people-mover and then walk to the other end gate; or the entire connection could be made by walking and/or using the moving sidewalks. The times required to complete these journeys are as follows.

Connecting passenger using the people-mover = 14 min.

Connecting passenger walking = 12 min. 30 sec.

These times compare with 15 minutes at MSP today.

Automobile Parking

Automobile parking is located directly above the passenger processing levels in the CPU. Passengers would ride elevators down from the automobile parking floors to the ticketing level or further down to the people-mover station level to proceed to the gates for enplaning. To reach regional or international airline gates, passengers ride elevators from the parking floors to the ticketing levels, and then walk to the gates located in the attached pier. When deplaning, once passengers reach the CPU, they ride the elevators up to the auto parking levels from the baggage claim or people-mover levels.

CRITERION 2: OPERATIONAL EFFICIENCY

Hub Compatibility

The long, double-sided satellite concourse is sufficiently large to accommodate all of the hub carrier's gates. All of the previous stated advantages for a hub operation are available with this alternative configuration. Connections from international or regional airline gates to gates accommodating domestic flights require use of the people-mover system.

Baggage Transfer

Transferring domestic baggage from gate to gate is accomplished via an apron service road. Several service road penetrations through the ground level of the satellite concourse facilitate the transfer of baggage between gates on opposite sides. Baggage being transferred between regional and international airline arrivals and domestic airline departures requires baggage carts to cross taxilanes. This can be avoided if a below-grade service road is provided. Below-grade baggage transfer lanes can be built along the same alignment as the people-mover system.

International Airline Integration

Gates for arriving international flights are located immediately adjacent to the deplaning passenger facilities in the CPU. Deplaning international passengers connecting to domestic airline flights use the people-mover system. Deplaning international passengers connecting to regional airline flights remain within the concourse attached to the CPU. Alternative 4A does not require passengers to exit and re-enter the secure area of the airport during this process.

Regional Airline Integration

All passengers connecting to or from regional airline flights ride the people-mover system to reach the domestic airline gates. Alternative 4A does not require passengers to exit and re-enter the secure area of the airport during this transfer process.

Aircraft Circulation

Independent push-back zones and dual taxiways provide unrestricted aircraft access to all gates. Flow-through aircraft circulation is provided on the apron from the arrival runways to the departure runways. Below-grade service roads keep the apron free of vehicles carrying baggage.

Gate Use Flexibility

Concourse configuration in Alternative 4A inflicts no restrictions on parking of any aircraft type. Gate capacity is in no way limited by the dimensions of the taxiways or taxilanes.

Surface Access

The CPU is bounded on only one side by airside development. This configuration allows the development of access and egress roads from two directions.

CRITERION 3: IMPLEMENTATION

Airside Construction

Airside construction consists of two similar, but independent, satellite concourses. The people-mover must be integrated into both the satellite concourses and the CPU. Either cut-and-cover or tunneling construction will be required for all below-grade systems. The linear concourse attached to the CPU must be integrated with its structure. Satellite concourse construction can be independent from construction of the CPU.

Landside Construction

Landside facilities consist of a multi-level CPU with automobile parking located on its upper floors. People-mover and baggage handling systems require significant below-grade construction. Location of passenger ticketing facilities on the second level of the CPU requires that the drive system be elevated. Construction is based on 50-foot by 55-foot bay spacing. This matches the dimensions of the automobile parking located on the upper floors. Structural systems which support any portion of the facility that overhangs the terminal drives must be integrated with the layout and structure of the drives.

CRITERION 4: EXPANDABILITY/PHASING

Gates

A small number of future hub carrier gates can be added by extending the ends of the long satellite concourse. A large number of gates for either the hub airline or other domestic carriers can be added by extending the small satellite concourse. Additional gates for arriving international flights can be constructed on either side of the international arrival

area. Gates can also be added by building an additional satellite concourse. This would be aligned parallel to the other satellites. An extension of the people-mover system would also be required.

Passenger Processing Facilities

Passenger processing facilities and automobile parking can be added by lengthening the CPU at either end. Any increase in the length of the CPU will allow a longer curb frontage. FIS facilities can expand on either side.

Phasing

Satellite concourses sufficient in number and size to meet the year 2010 forecast of demand can be constructed as a first phase. The central processing unit and automobile parking can be constructed by bays, to include the people-mover station, starting from the center bay.

CRITERION 5: CONSTRUCTION COST

The cost of constructing Terminal Configuration Alternative 4A is \$685,735,000. The breakdown of this cost is shown in Table 8-4.

Table 8-4

Terminal Configuration Alternative 4A: Construction Cost

Element	Project Cost (1990 Dollars)
TERMINAL BUILDING	
Central Processing Unit (CPU)	\$210,000,000
Concourses	62,325,000
Satellites	144,000,000
Other	<u>97,000,000</u>
Subtotal	\$513,325,000
AUTOMATED PEOPLE-MOVER	\$172,410,000
TOTAL TERMINAL COST	\$685,735,000

Source: TRA Airport Consulting and The Alliance.

ALTERNATIVE 4B

Description

Alternative 4B is a variation on Alternative 4A. There is only one difference, but it is significant. Regional airline gates are now located in the satellite concourse located furthest from the CPU. The satellite has been lengthened on one end to accommodate these gates. Figure 8-16 illustrates Alternative 4B.

As in Alternative 4A, each satellite concourse has an independent push-back zone to facilitate aircraft movement to and from the gate positions. There are dual taxiways between the satellites and at the perimeter. These allow flow-through aircraft circulation on the apron. Aircraft can maneuver from the arrivals runway to the gate and then out to the departures runway without having to backtrack or detour.

The required number of gates is distributed as follows. International arrival gates are located along a linear concourse parallel and connected to the CPU. The satellite closest to the CPU contains all of the domestic gates for Northwest Airlines. This provides a close-in location for all of Northwest Airlines' local origin-and-destination traffic. It also consolidates all of Northwest Airlines' operations in one facility, which is convenient for a hub operation. The second satellite contains the remaining domestic airline gates, as well as those of the regional airlines.

The satellite concourses are linked to each other and the CPU by below-grade people-mover and baggage handling systems. The people-mover facilitates passenger movements to and from the CPU as well as between satellite gates for connecting passengers. The system would have two stops at both the CPU and the longer satellite concourse.

The CPU is multi-leveled. Ticketing, baggage claim, ground transportation, and parking would be handled on separate levels. Federal Inspection Services (FIS) would be separate, but integrated along one side, immediately adjacent to the international arrival gates.

The ticketing and baggage claim levels of the CPU have an automobile curb on either side. This provides the maximum amount of convenient curbside access that is possible and maximizes access to the ticketing and baggage claim lobbies. This alternative allows access to and from the terminal drives from more than one direction.

The CPU and the satellite concourses can be constructed independent of one another in this alternative. In addition, the CPU can be expanded on either end, as can the FIS area. Gate positions may be added to the satellites by extending their length from either or both ends. Additional satellite concourses can also be constructed. The baggage and people-mover systems would need to be extended to serve them.

Evaluation

The following is a detailed evaluation of Alternative 4B.

CRITERION 1: PASSENGER CONVENIENCE

Origin/Destination Passenger Walking Distance

The longest walking distance is 1,200 feet. This is from the CPU to the international gate positions. From the CPU to a gate at the end of the longest satellite, the longest walk would be 1,360 linear feet.

Origin/Destination Passenger Time

The times required for originating passengers using the hub and other airlines are the same as those for Alternative 4A -- that is, 9 minutes total time for each. This compares to 8 minutes today at MSP.

Connecting Passenger Walking Distance

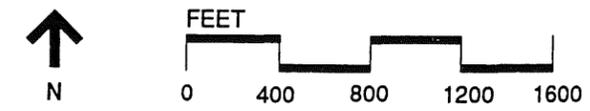
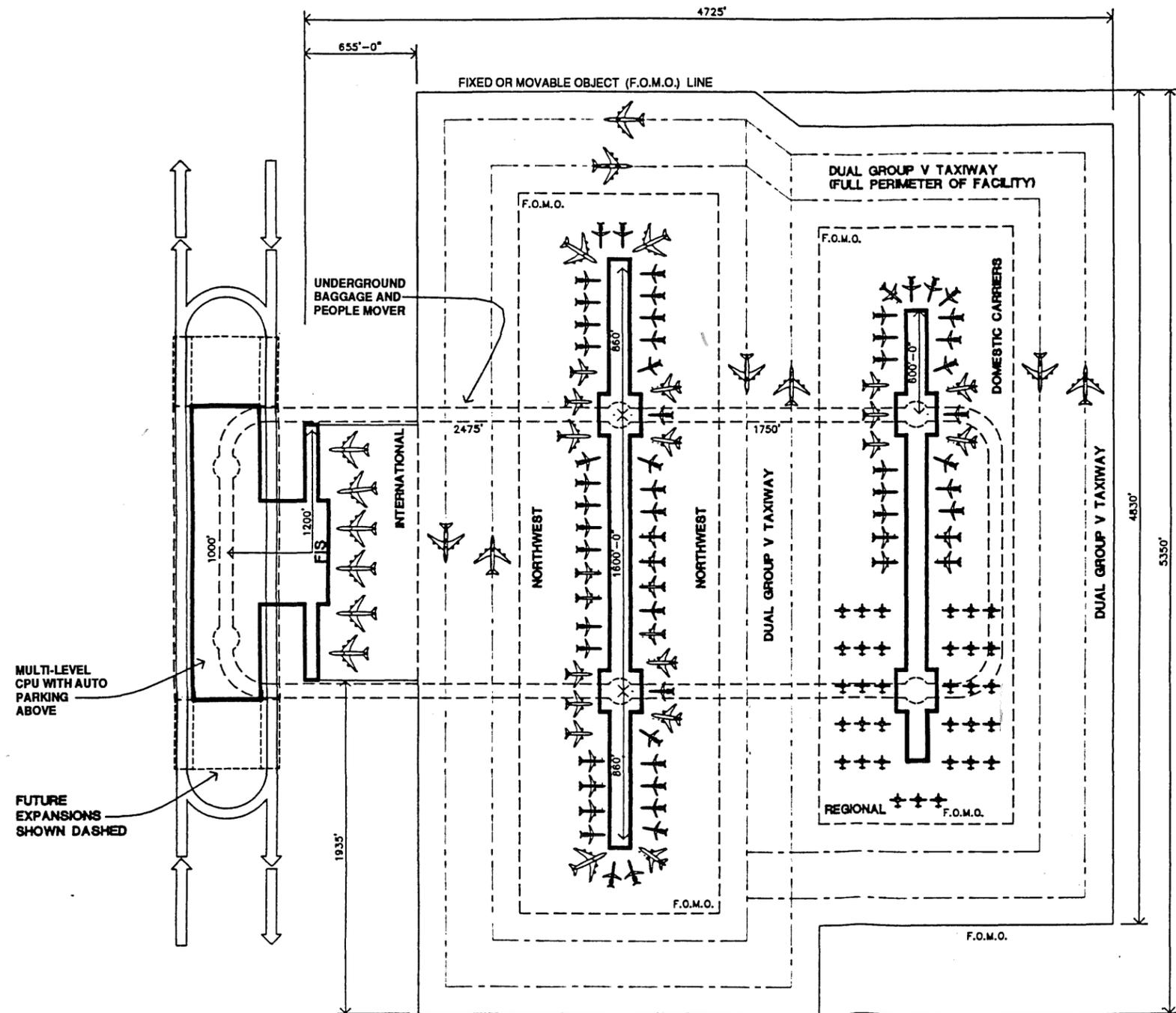
A distance of 3,320 linear feet is the longest unassisted walk for connecting passengers. This is from the gate located at one end of the long satellite concourse to the other end. However, connecting passengers would be encouraged to use the people-mover system. This would shorten their walk to 1,720 linear feet.

Connecting Passenger Time

The longest walk is from the domestic airline gate position located at the end of the long satellite concourse to the domestic airline gate at the opposite end. This trip requires a passenger to walk to the people-mover station, ride the people-mover, and then walk to the end gate. Passengers have two choices. In one, they ride the people-mover. In the other, the entire connection is made by walking and/or using the moving sidewalks. Regional airline passengers transferring to/from Northwest Airlines flights use the people-mover system and ride one or two stops, depending on the gate. The times required are the same as those for Alternative 4A. The comparable time at MSP today is 15 minutes.

Automobile Parking

Automobile parking is located directly above the passenger processing levels in the CPU. Banks of elevators are located throughout the garage. Passengers ride these elevators down to the ticketing level or further down to reach the people-mover station level. To reach regional or international airline gates, passengers ride the elevators from parking down to the ticketing level, then walk to the gates located in the attached pier. When deplaning, passengers ride the elevators up to automobile parking from either the baggage claim or people-mover level.



CRITERION 2: OPERATIONAL EFFICIENCY

Hub Compatibility

The long, double-sided satellite concourse is sufficiently large to accommodate all of the hub carrier's gates in one location. The hub carrier can develop a discrete corporate identity in this area. Passengers connecting from international or regional airline flights to domestic flights must use the people-mover system.

Baggage Transfer

Transferring domestic baggage from gate to gate is accomplished via a perimeter service road. Several service road penetrations at ground level through the satellite concourse will facilitate the transfer of baggage between gates on opposite sides of the concourse. Baggage being transferred between regional and international airline arrivals to domestic airline departures requires baggage carts to cross taxilanes. This can be avoided if a below-grade service road is provided. Below-grade baggage transfer lanes can be built along the same alignment as the people-mover system.

International Airline Integration

Gates for arriving international flights are located immediately adjacent to the deplaning passenger facilities in the CPU. Deplaning international passengers connecting to Northwest Airlines domestic flights must ride the people-mover system. Alternative 4B does not require passengers to exit and re-enter the secure area of the airport during this transfer process.

Regional Airline Integration

Most passengers connecting to or from regional airline flights ride the people-mover system to connect to other domestic gates. Alternative 4B does not require passengers to exit and re-enter the secure area of the airport during this transfer process.

Aircraft Circulation

Independent push-back zones and dual taxiways provide unrestricted aircraft access to all gates. Flow-through aircraft circulation is provided on the apron from the arrival runways to the departure runways. Below-grade service roads keep the apron area free of vehicles carrying baggage. Guidelines for Group V aircraft were used to determine the dimensions of the perimeter and interior taxiways.

Gate Use Flexibility

Neither the double-sided nor single-sided concourse configuration restricts aircraft parking in Alternative 4B in any way. Gate capacity is in no way limited by the dimensions of the taxiways or taxilanes.

Surface Access

The CPU is bounded by airside development on only one side. This configuration allows the development of access and egress roads from more than one direction.

CRITERION 3: IMPLEMENTATION

Airside Construction

Airside construction consists of two similar, but independent, satellite concourses. The people-mover must be integrated into both the satellite concourses and the CPU. Either cut-and-cover or tunneling construction will be required for the below-grade systems. The pier concourse attached to the CPU must be integrated with its structure. Satellite concourse construction can be independent from construction of the CPU.

Landside Construction

Landside facilities consist of a multi-level passenger processing CPU with automobile parking located above. People-mover and baggage handling systems require significant below-grade construction. Location of passenger ticketing facilities on the second level of the CPU requires elevated drives. Construction is based on 50-foot by 55-foot bay spacing. This matches the parking dimensions stated previously. Structural systems which support any portion of the facility that overhangs the terminal drives need to be integrated with the layout and structure of the drives.

CRITERION 4: EXPANDABILITY/PHASING

Gates

A small number of hub carrier gates can be added by extending the ends of the long satellite concourse. Additional gates for international arrivals can be built on either side of the international arrival area. Gates can also be added by constructing an additional satellite concourse. This would be aligned parallel to the other satellites. An extension of the people-mover system would also be required.

Passenger Processing Facilities

Passenger processing facilities and automobile parking can be added by lengthening the CPU at either end. Either of these can be expanded independently. Any increase in the

length of the CPU will allow a longer curb frontage. FIS facilities can expand on either side.

Phasing

Satellite concourses sufficient in number and size to meet the year 2010 forecast of demand can be constructed as a first phase. The central processing unit and automobile parking can be constructed by bays, to include the people-mover station, starting from the center bay.

CRITERION 5: CONSTRUCTION COSTS

The cost of constructing Terminal Configuration Alternative 4B is \$706,085,000. The breakdown of this cost is provided in Table 8-5.

Table 8-5

Terminal Configuration Alternative 4B: Construction Cost

Element	Project Cost (1990 Dollars)
TERMINAL BUILDING	
Central Processing Unit (CPU)	\$210,000,000
Concourses	34,875,000
Satellites	180,675,000
Other	<u>98,125,000</u>
Subtotal	\$523,675,000
AUTOMATED PEOPLE-MOVER	\$182,410,000
TOTAL TERMINAL COST	\$706,085,000

Source: TRA Airport Consulting and The Alliance.

Chapter 9

Conceptual Design Plan

9.1 INTRODUCTION

Chapter 8 presented the evaluation of airfield layout and terminal area configuration alternatives. The purpose of this chapter is to select an alternative for each and combine them to create a unified airport conceptual design plan. The final step in completing the conceptual design plan is to integrate all of the required airline, maintenance, military, and other facilities. This is done as follows. First, the airfield layout and terminal configuration alternatives were adjusted and optimized to complement each other. After this, the factors limiting or impacting land development were identified. This was done to determine the best location for the variety of support facilities required to create a fully functional international airport serving as headquarters for a major airline. Several support facility layouts were examined and the optimum identified and integrated with the airfield and terminal layouts.

9.2 AIRFIELD LAYOUT

Chapter 8 evaluated the airfield layout alternatives. Table 9-1 shows a summary of the evaluation.

The information presented in Table 9-1 indicates that Alternative T-1 is superior in all operational categories except cost. Offsetting this higher cost are several important assets. Alternative T-1 provides excellent capacity in all four directions. Converging runways result in the least air travel and taxi distances of all the alternatives. During winter weather conditions the runway layout in Alternative T-1 provides full coverage. Finally, the theory underlying the operation of this alternative is similar to that which the FAA has approved for the new international airport in Denver which is currently under construction. For these reasons, Alternative T-1 has been recommended as the airfield configuration to be used in the preparation of the conceptual design plan.

Table 9-1

Summary of Airfield Layout Alternative Evaluation

Factor	Alternative P-2	Alternative T-1	Alternative L
1. Operational Efficiency			
A. Ground Operations			
- Runway Delays	1.0 min./op.	0.9 min./op.	0.9 min./op.
- Runway Crossings	None	None	One
- Taxi Distance	8,500 ft./op.	7,400 ft./op.	9,900 ft./op.
B. Airspace Operations			
- Flight Path Distance	34 mi./op.	31 mi./op.	34 mi./op.
- Flight Path Conflicts	None	None	One
- Wind and Weather	No crosswind coverage	Full coverage	Full coverage
2. Land Impact	12,000-26,000 acres	15,000-28,000 acres	16,000-29,000 acres
3. Construction Cost	\$225 million	\$330 million	\$280 million

Source: HNTB.

9.3 TERMINAL CONFIGURATION

As with the airfield alternatives, Chapter 8 presented an evaluation of the terminal configuration. Table 9-2 is a summary of this evaluation, which includes a comparison with conditions as they exist today at Minneapolis-St. Paul International Airport. Based on the information contained in Table 9-2, Alternative 4B was recommended for incorporation in the conceptual design plan. Alternative 4B has the following characteristics:

- Convenient passenger access between automobile parking and passenger processing facilities.
- Reasonable travel times between passenger processing functions and the aircraft gates.
- Passenger walking distances which are reasonable in their absolute.
- Logical and direct routes for passengers between gate positions for domestic, regional, and international airlines.

Table 9-2

Summary of Terminal Configuration Alternative Evaluation

Factor	Alternative 1	Alternative 2	Alternative 3	Alternative 4A	Alternative 4B	Minneapolis-St. Paul Int'l. Airport
Passenger Convenience						
A. Maximum O&D Passenger Walking Distance	1,500 ft.	1,450 ft.	1,150 ft.	2,200 ft.	1,700 ft.	2,400 ft.
B. O&D Passenger Time	10 min. 30 sec.	10 min. 30 sec.	9 min. 30 sec.	9 min.	9 min.	8 min.
C. Maximum Connecting Passenger Walking Distance	2,230 ft.	2,900 ft.	1,750 ft.	3,560 ft.	3,060 ft.	4,650 ft.
D. Connecting Pax Time	15 min. 30 sec.	15 min. 30 sec.	23 min. 30 sec.	12 min. 30 sec.	12 min. 30 sec.	15 min.
E. Automobile Parking	Above CPU	Above CPU	Above CPU	Above CPU	Above CPU	Adjacent to CPU
Operational Efficiency						
A. Hub Compatibility	Yes, but not efficient	Yes	Yes	Yes	Yes	NA
B. Baggage Transfer	Below grade	Below grade	Below grade	Below grade	Below grade	NA
C. International Integration	Yes	Yes	Yes	Yes	Yes	NA
D. Regional Integration	Yes	Yes	Yes	Yes	Yes	NA
E. Aircraft Circulation	Flow through	Some dead-ends	Dead-ends	Flow through	Flow through	NA
F. Gate Use Flexibility	No restrictions	Limited	Limited	No restrictions	No restrictions	NA
G. Surface Access	Two directions	Two directions	One direction	Two directions	Two directions	NA
Implementation						
A. Airside Construction	No problems	No problems	No problems	No problems	No problems	NA
B. Landside Construction	No problems	No problems	No problems	No problems	No problems	NA
Expandability/Phasing						
A. Gates	Expandable	Expandable	Expandable	Expandable	Expandable	NA
B. Pax Processing Facilities	Expandable	Expandable	Expandable	Expandable	Expandable	NA
C. Phasing	No problems	No problems	No problems	Expandable	Expandable	NA
Construction Cost	\$602 million	\$732 million	\$713 million	\$686 million	\$706 million	NA

Source: TRA Airport Consulting.

- Full accommodation of the requirements of a large single carrier airline hub. These include: all connecting passenger processing in a single consolidated facility, simplified baggage transfer, and a gate layout that can respond to a changing fleet mix.
- Unconstrained aircraft movement to and from the aircraft gates.
- Separate airside/landside facilities, allowing phased implementation and incremental construction packaging.

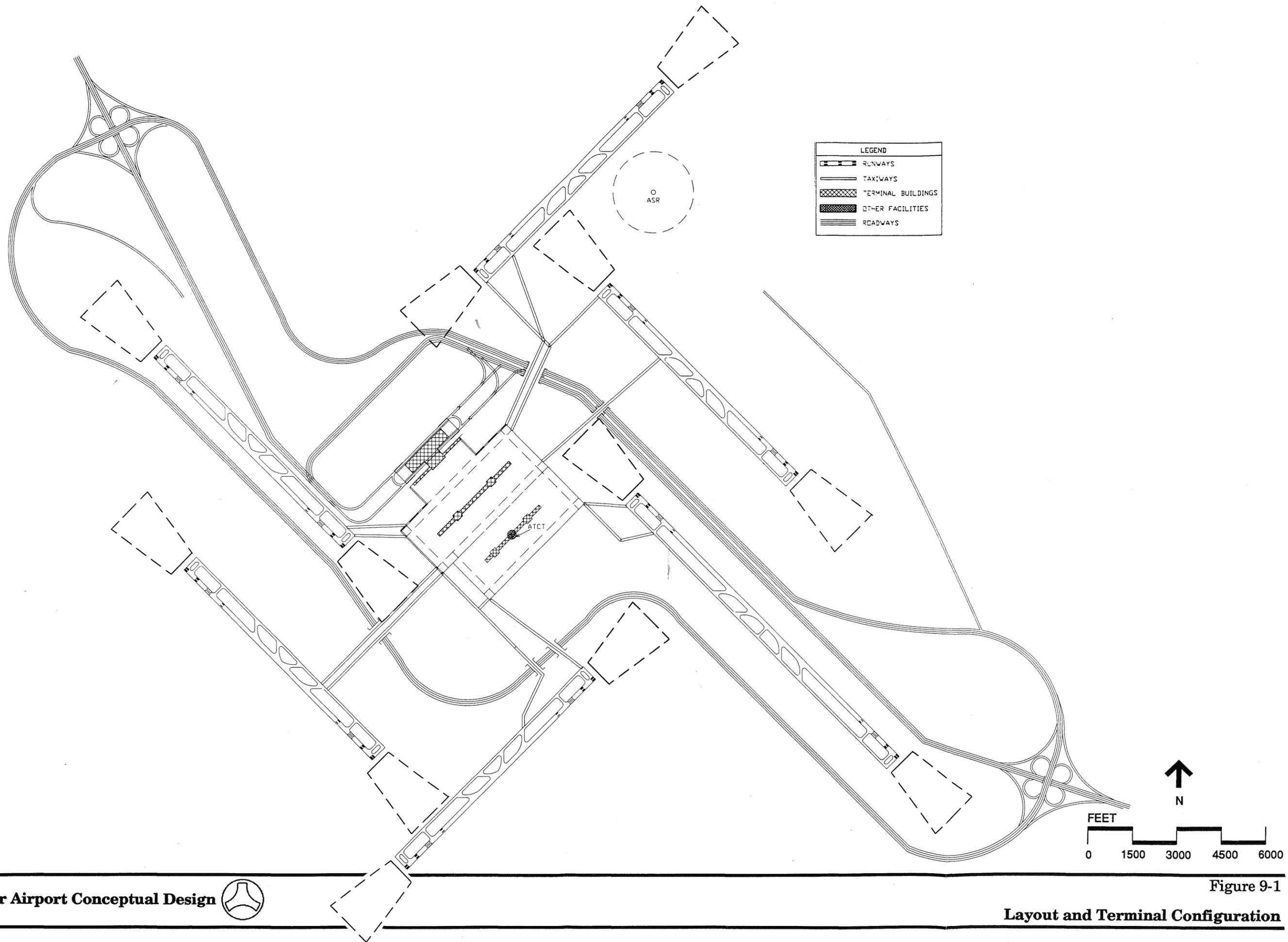
9.4 INTEGRATION OF AIRFIELD LAYOUT AND TERMINAL CONFIGURATION

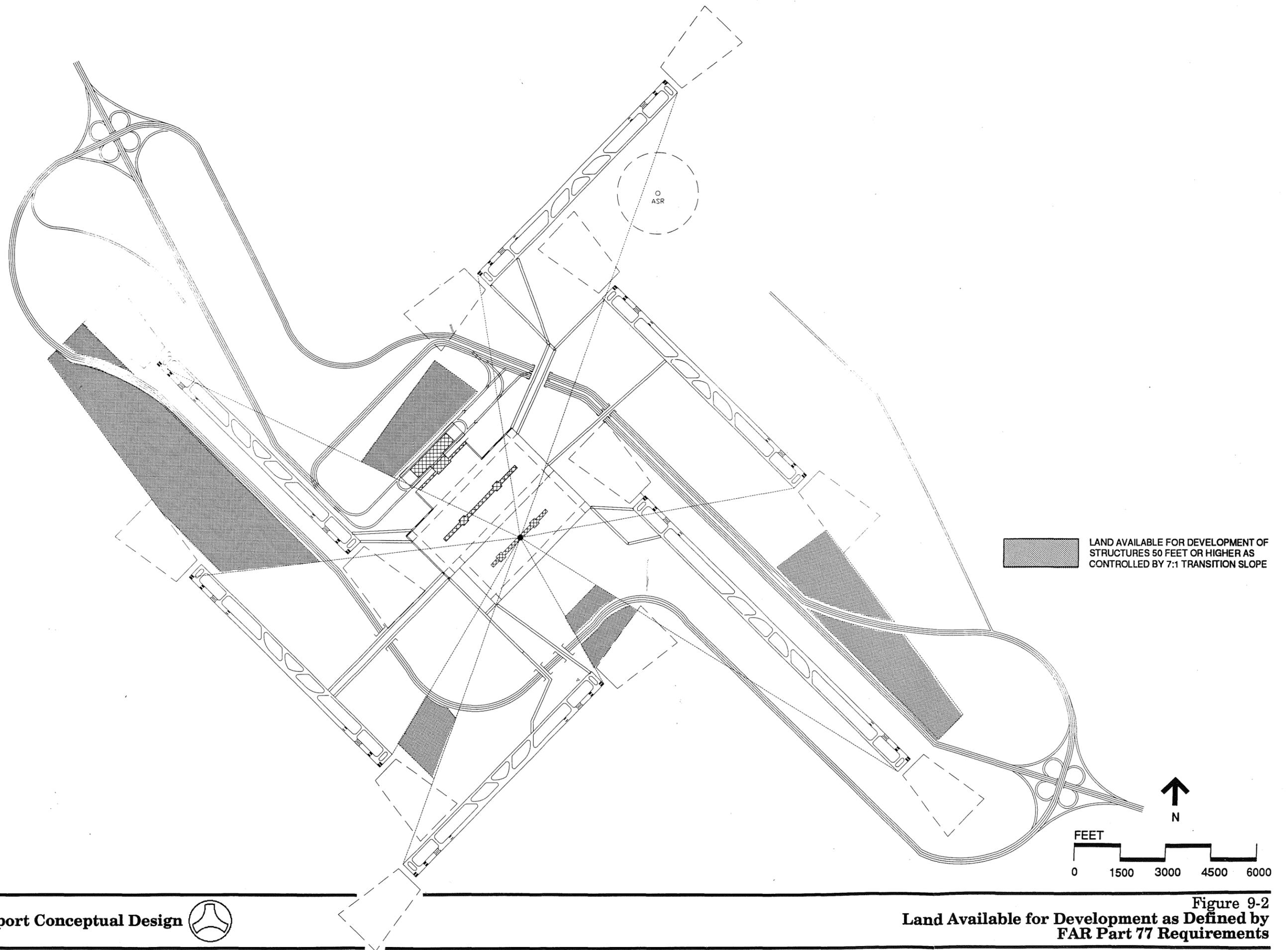
As the preceding sections show, the evaluation of airfield layout and terminal configuration alternatives has resulted in the recommendation of one of each for use in the Conceptual Design Plan. This recommendation was endorsed by the Metropolitan Airports Commission. Figure 9-1 shows the integration of these two alternatives. The location of some runways has been adjusted slightly in order to accommodate full terminal area build-out and two-directional surface access. Several taxiway bridges were needed and are shown in the plan.

It is important that the Conceptual Design Plan be flexible enough to respond to changes in the level and character of forecast demand. Further, it must be able to conform to the characteristics of the site for the new airport that is eventually selected. This plan is capable of both of these.

9.5 OTHER FACILITIES

This section deals with the location of the other facilities that are required to complete the Conceptual Design Plan. A brief review of these facility requirements is provided in Table 9-3.





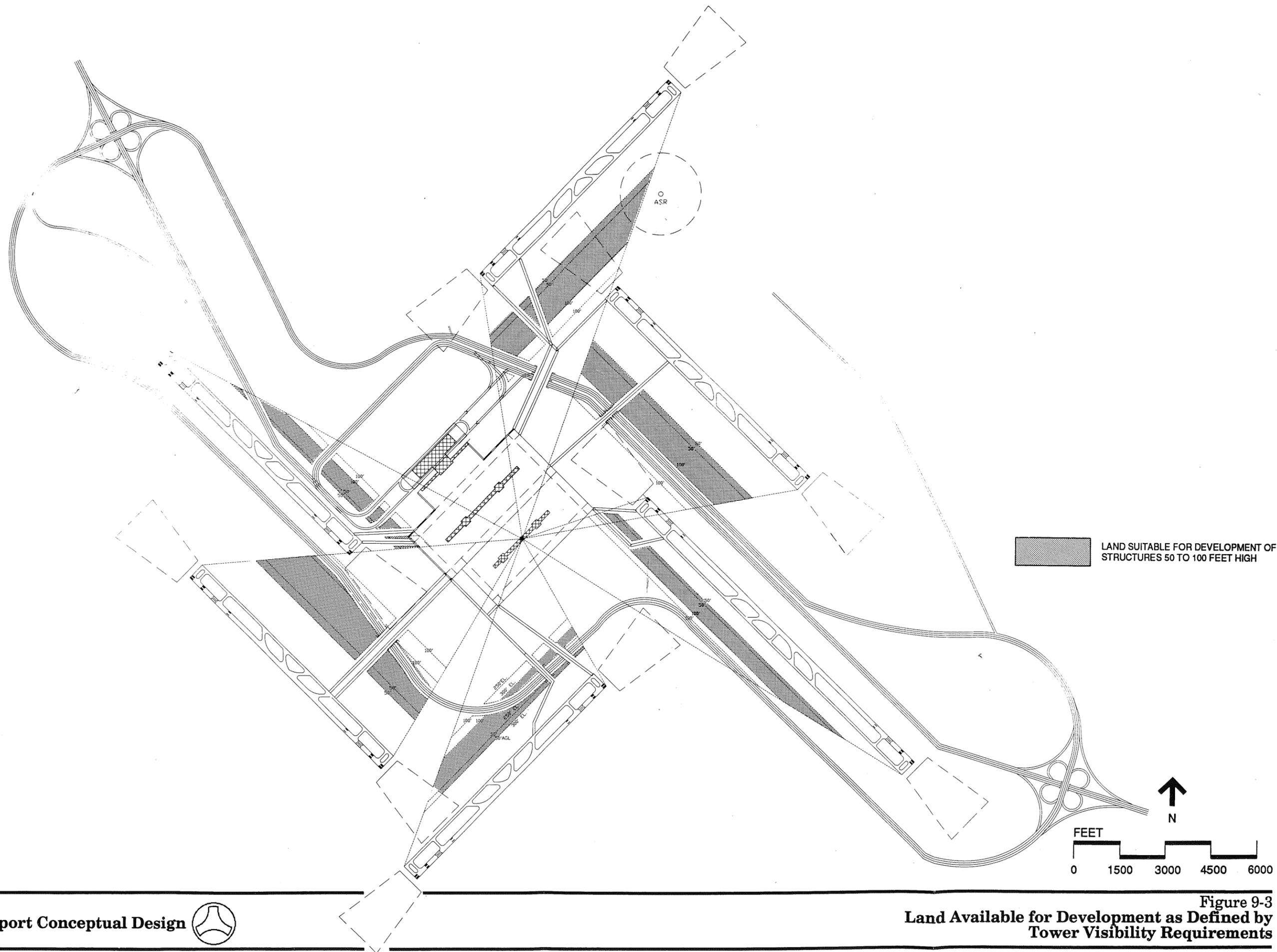
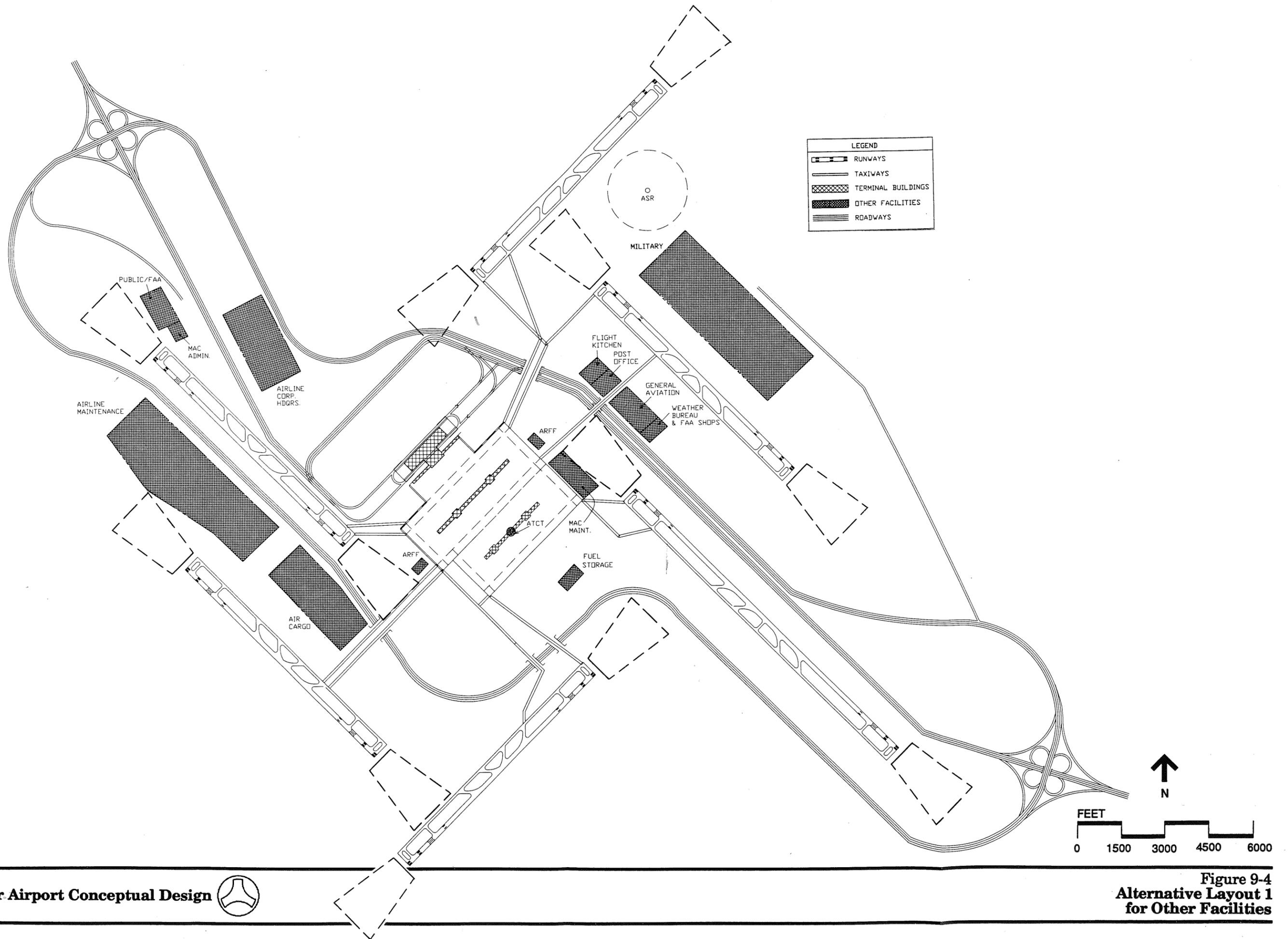
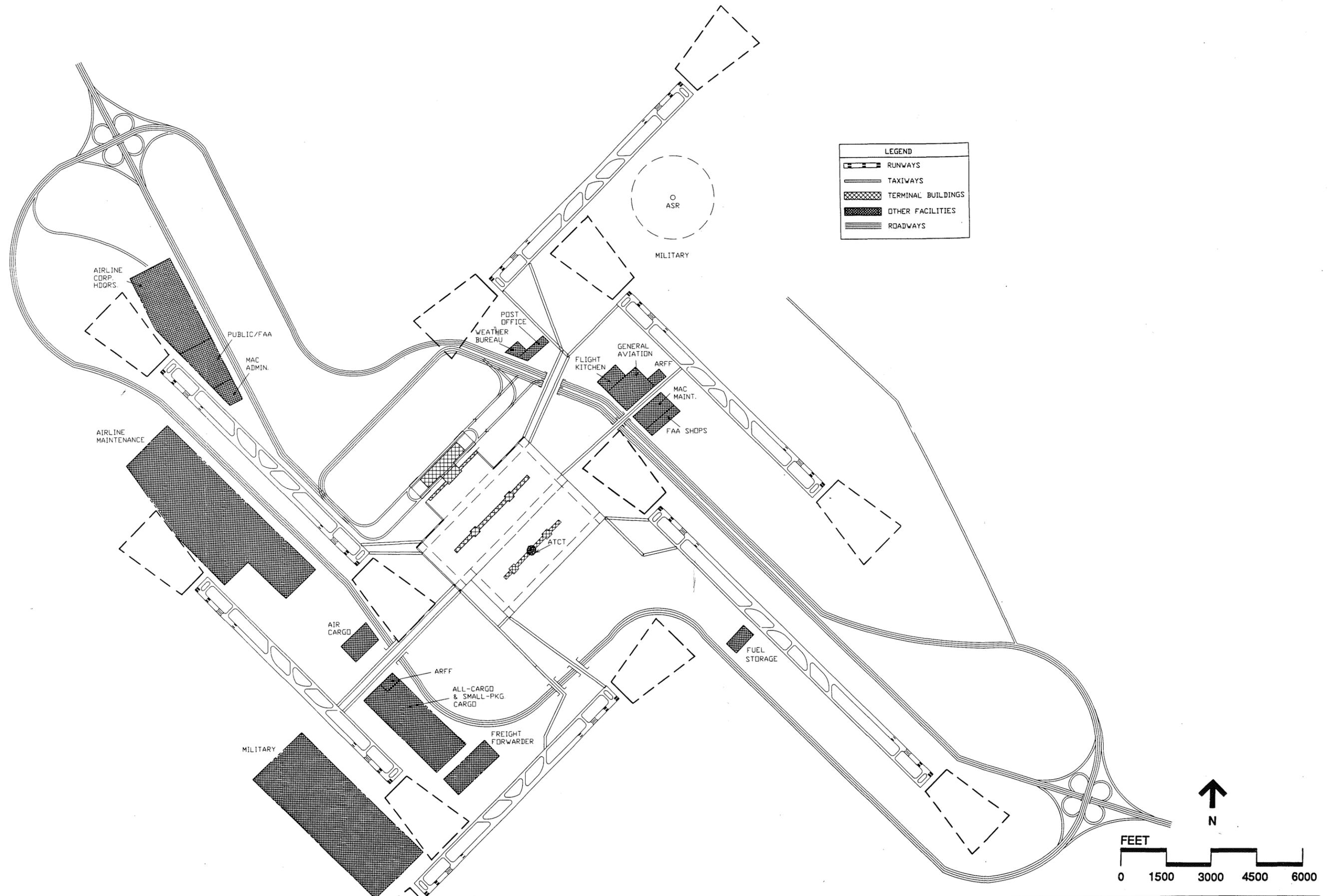
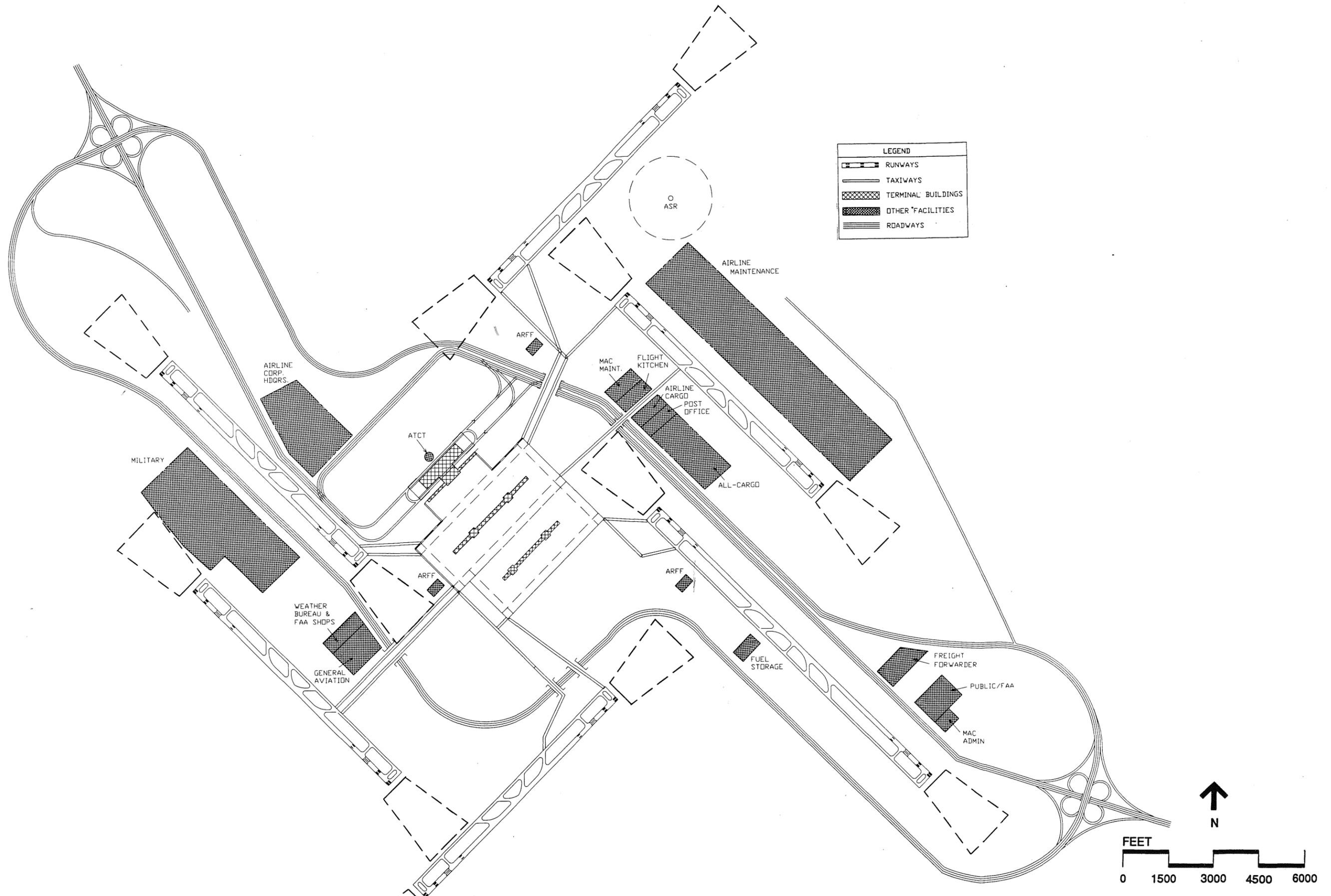


Figure 9-3
 Land Available for Development as Defined by
 Tower Visibility Requirements







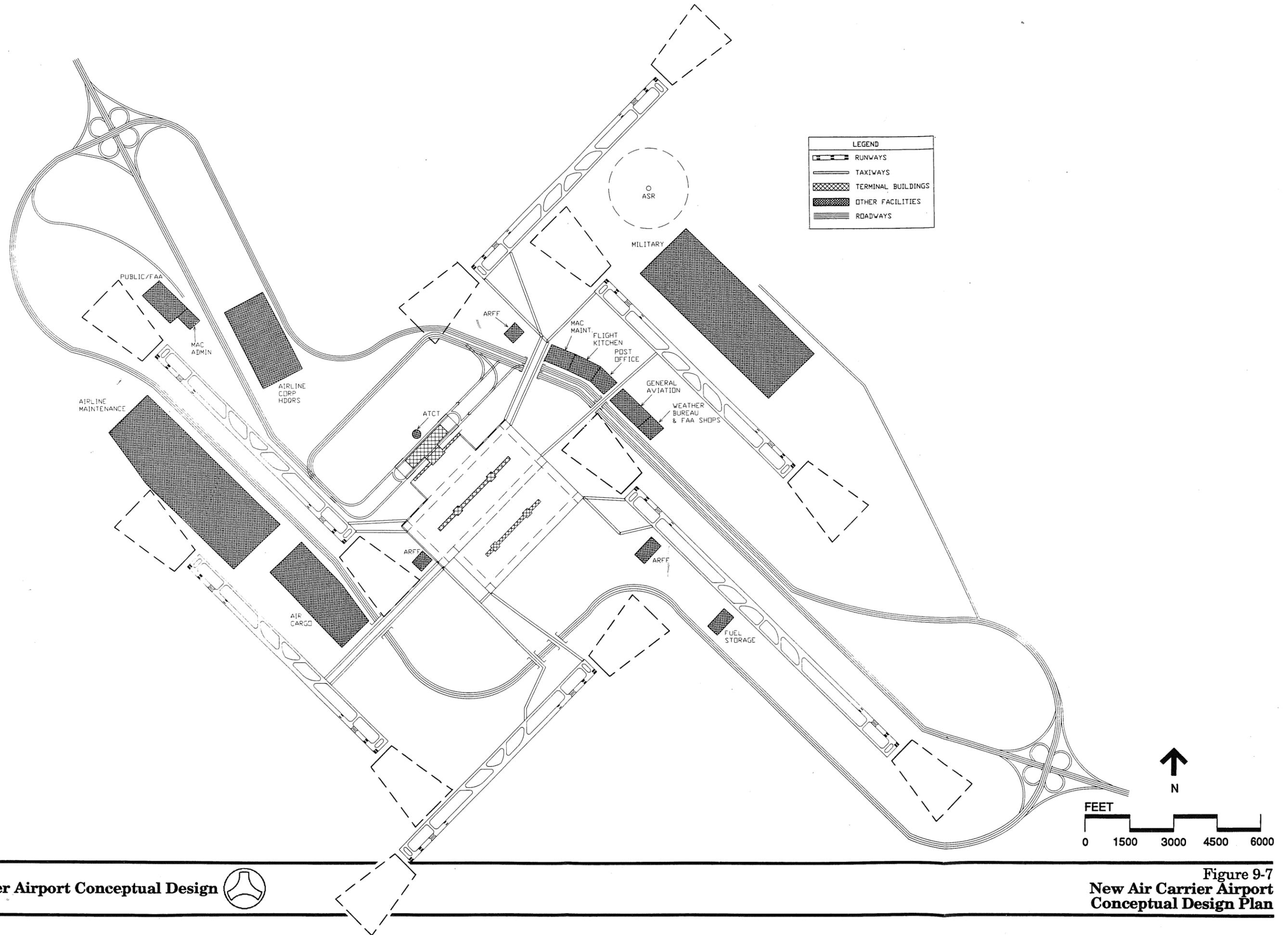


Table 9-3
Requirements for Other Facilities

Function/Facility	2020 Requirements (acres)
Air Cargo	109
General Aviation	27
Airport Administration and Maintenance	29
Airline Hangars and Operational Support	328
Fuel Storage System	7
Aircraft Rescue and Firefighting	3
Flight Kitchens	8
Federal Facilities (FAA only)	8
Federal Facilities (other)	
- U.S. Weather Service	2
- Air Mail Field	9
Commercial/Public	100
Utilities	10
Corporate Airline Offices	100
Military	<u>250</u>
Total	990

Source: Ralph White Associates.

The following process was utilized to integrate all other required facilities into the Conceptual Design Plan. An adjacency requirement matrix was prepared (see Figure 9-4). For each function, this showed which other functions it should be next to as well as those functions to which it did not relate. Next, potential building areas were identified. This was accomplished by considering Air Traffic Control Tower (ATCT) sight-line requirements, safety zones, and FAR Part 77 surfaces that control the height of objects affecting navigable airspace. A number of layouts were then prepared. These sought to optimize adjacency priorities, consolidate similar functions, avoid the juxtaposition of functions which conflict with one another, and provide for operational efficiency and safety as well as long-range expandability. Alternative layouts were then evaluated. Details on how this process was implemented are provided in the following.

9.5.1 Adjacency Requirements

Table 9-4 is a list of all of the other facilities required. With each, the first and second priority for adjacency is shown, along with access considerations. These were used in developing and evaluating the alternative layouts.

9.5.2 Identification of Areas Available for Other Facilities

Determining the location of building areas for other facilities was accomplished through the application of a frequently used planning methodology. This identifies all of the land dedicated to other uses. What remains is then the land available.

A review of the integrated airside layout and terminal configuration indicated that the air traffic control tower (ATCT) must be located near the center of the terminal area in order to meet FAA visibility requirements. Two locations were examined: one on top of the smaller satellite concourse and the other directly in front of the CPU. The minimum height of the controller's eye level was determined to be 173 feet and 198 feet, respectively, for these two locations. This was calculated from the FAA requirement that there be a minimum angle of 0°35' for the controller sight line with the horizon at the end of each runway, on a level surface.

As is intuitively obvious, the higher the tower, the greater the area visible and hence available for development. To provide the amount of land needed to meet the facility requirements, a tower height of 250 to 300 feet is necessary. Thus, for this study, a tower controller eye level of 300 feet was adopted. Shaded areas in Figure 9-2 are those available. This work assumes that airline hangars are 50 to 100 feet in height and air cargo buildings 25 to 35 feet. As long as buildings are no taller than this, air traffic controllers in the tower cab will be able to see over the structures and maintain visibility to the edge of the closest parallel taxiway or runway end.

In addition to line-of-sight requirements, there are airport areas on which development is limited or restricted due to the requirements of Part 77 of the Federal Air Regulations. Part 77 requires that no object penetrate a 7:1 transitional surface. This surface starts at the edge of the primary surface surrounding a runway and projects outward until it intersects the 150-foot horizontal surface. Using Part 77 and the information in Figure 9-2, the potential building areas were further defined. See Figure 9-3.

9.5.3 Alternative Layouts for Other Facilities

In developing the three alternatives shown in Figures 9-4, 9-5, and 9-6, prime consideration was given to reducing the travel time and distance between airline maintenance, air cargo, and ARFF areas. The height of airline hangars is such that there are only three areas that are both large enough and have sufficient height allowances to accommodate them. One area is between the westernmost parallel northwest/southeast runways and the other two are east of the easterly northwest/southeast runway.

Similarly, two areas close to the terminal apron are available for air cargo. Both are located between the parallel northwest/southeast runways, one northeast and the other southwest of the satellite concourses. Both are evaluated.

FAA siting requirements were used to locate the ARFF stations. These call for ARFF vehicles to be able to reach the midpoint of the furthest runway in a set period of time. The travel distance with two stations is marginal, so a third station was added on one alternative.

Military facilities were located in three different sites. The objective was to keep these facilities somewhat remote and provide access to the least used runways for their day-to-day operations.

Several alternative locations for general aviation were identified. Each alternative met several tests. The sites permit hangar heights of 35 to 50 feet. Interaction with air carrier operations was kept to a minimum, but the need to be convenient to local corporations and users was respected. General aviation is particularly sensitive to where the airport is ultimately located, and its facility requirements should be reviewed later.

MAC administration, MAC airfield maintenance, airline offices, flight kitchens, FAA shops, and Weather Bureau offices can be located at a number of sites. Several locations are shown in the alternatives.

When possible, the U.S. Post Office Airport Mail Facility (AMF) was located close to the air cargo area, near the terminal apron for tugs and near local access roads for customer convenience.

9.5.4 Evaluation of Alternative Layouts for Other Facilities

Table 9-5 contains a comparison of the priorities listed Table 9-4, Adjacency Requirements. This information was evaluated and the findings are presented in the next section.

Table 9-4
Adjacency Requirements

Function/Facility	Adjacency: 1st Priority	2nd Priority	Access Considerations
AIR CARGO			
Airline	Midpoint of terminal apron	Regional highway system	Separate roads -- avoid terminal roadways
All-Cargo	Regional highway system	Airfield system	Separate roads -- avoid terminal roadways
Freight Forwarders	Other air cargo areas	Regional highway system	Separate roads -- avoid terminal roadways
GENERAL AVIATION			
	Regional highway system	Airfield system	Separate roads -- avoid terminal roadways
AIRLINE MAINTENANCE			
	Terminal gate positions	Regional highway system	Employee shift change, peaking, avoid terminal roadways
AIRPORT ADMINISTRATION & MAINTENANCE			
Administrative Offices	Regional highway system	Airport service road	Access for visitors. access to operations area
Field Maintenance & Shops	Airfield system	Administrative offices	Access for suppliers
ARFF	Airfield system*	Terminal, cargo airline maintenance	Low-volume employee access. Provide easy access for ARFF equipment to airfield and service roads.

* Provide station location to respond to midpoint of furthest runway in 3 minutes for Quick Response Vehicle (QRV) and 4 minutes for all other required vehicles.

(continued)

Table 9-4
Adjacency Requirements
(continued)

Function/Facility	Adjacency: 1st Priority	2nd Priority	Access Considerations
FUEL STORAGE	Supply source	Terminal apron	Access for employees. Access to terminal apron for hydrant trucks.
FEDERAL			
Offices	Aviation community	Local highways	Access for employees and visitors. Avoid terminal area.
ATCT**	Airfield system and approaches	Local highways	Access for employees, security desirable. Avoid terminal area.
Maintenance and Storage	Access to nav aids	Service road	Equipment deliveries. Avoid terminal area.
AMF (Post Office)	Terminal apron	Air cargo area	Regional highway access.
FLIGHT KITCHEN	Terminal apron	Regional highways	Employee access and deliveries. Avoid terminal area.
COMMERCIAL/ PUBLIC	Aviation-oriented users	General public	Mixed general access.
AIRLINE CORPORATE HEADQUARTERS	Regional highways, employee functions	Hangars and other training and support areas	Employees and visitors. Avoid terminal area.
MILITARY	Airfield system	Local roads	Staff and employees -- secured.

Source: Ralph White Associates.

** Provide location to: (1) be able to see all paved operating surfaces under tower responsibility and (2) have eye level meet 0°35' angle criteria with runway and horizon.

Table 9-5

Evaluation of Layout Alternatives for Other Facilities

Function/Criteria	Alternative 1	Alternative 2	Alternative 3
AIR CARGO			
Tug/truck distance from terminal apron to cargo building:			
- Airline	6,000'	5,900'	6,000'
- All Cargo/Freight Forwarder	8,600'	8,200'/10,400'	8,800'/17,400'
All cargo aircraft taxi distance to closest takeoff runway:			
- VMC1/IMC1 Mode	14,000'	14,000'	10,200'
- VMC2/IMC2 Mode	10,200'	10,200'	11,700'
Segregation from terminal operation:			
- Access Road	Yes	Yes	Yes
- Taxiways	Some taxiing on perimeter of terminal apron	Some taxiing on perimeter of terminal apron	Some taxiing on perimeter of terminal apron
AIRLINE MAINTENANCE			
Taxi/tow distance from terminal apron to maintenance facility	16,000'	15,300'	10,500'
Runway crossings	0	0	1
Convenient access for employees	Yes	Yes	Yes

(continued)

Table 9-5

Evaluation of Layout Alternatives for Other Facilities
(continued)

Function/Criteria	Alternative 1	Alternative 2	Alternative 3
GENERAL AVIATION			
Segregation from air carrier operations:			
- Facilities	Yes	Yes	Yes
- Taxiing	Some taxiing through terminal area required	Some taxiing through terminal area required	Some taxiing through terminal area required
Convenient access for users	Yes	Yes	Yes
ATCT			
Convenience for tower personnel:			
- Walking/Ride Distance	4,000'	4,000'	Negligible
- Parking	Remote	Remote	Adjacent
Sight distance to furthest runway	17,000'	17,000'	19,400'
Controlled minimum eye-level height (0°35' with horizon)	173'	173'	198'

(continued)

Table 9-5

Evaluation of Layout Alternatives for Other Facilities
(continued)

Function/Criteria	Alternative 1	Alternative 2	Alternative 3
ARFF			
Response distance to midpoint of each runway (ranked from shortest to longest)	6,700'	3,000'	4,800'
	7,500'	6,300'	6,300'
	8,500'	8,500'	6,700'
	8,700'	11,000'	8,400'
	10,700'	11,500'	8,500'
	11,100'	12,500'	8,700'
Number of Stations	2	2	3
POST OFFICE (AMF)			
Distance of facility from terminal apron	5,600'	7,000'	6,400'
Convenience to public users	Yes	Yes	Yes
MILITARY			
Separation from other operations	Good	Best	Least acceptable

Source: Ralph White Associates.

Of the airline maintenance hangar alternatives, the layout shown in Figure 9-6 provides the shortest taxi/tow distance from the terminal apron. This layout does require taxiing aircraft to cross a runway. However, these crossings normally occur in early morning or late evening hours when air traffic is light. Thus, it appears that either alternative is workable. Both sites provide a southwestern exposure of the hangar door openings.

The location for the military facility should be selected contingent on the area selected for airline maintenance.

The location of fuel storage is flexible. It is highly dependent on the location of supplier pipelines and the on-site distribution system. A suitable location for fuel storage can be identified on any alternative once an airport site is determined. Similarly, locations for all other support functions can be identified once the final locations of the most critical functions have been determined.

9.5.5 Layout Plan for Other Facilities

Based on the evaluation of support facility alternatives, it was concluded that a combination of the best features of each should be used in completing the Conceptual Design Plan. The choices that result are as follows.

Location of the ATCT near the front of the CPU slightly expands the area available for support facilities that is located between the westerly parallel northwest/southeast runways. In addition, it eliminates the need for an intermediate level in the tower from which to see the aircraft gates and apron around the base of the structure. This location provides for visibility over a potential third satellite concourse, with a similar building-to-building spacing as those proposed.

The three-station ARFF option alternative best meets the response time criteria established by the FAA. It is thus adopted for the Conceptual Design Plan.

9.6 CONCEPTUAL DESIGN PLAN

Completion of the support facilities alternative evaluation makes development of the Conceptual Design Plan for the new air carrier airport possible. The Conceptual Design Plan, which is shown in Figure 9-7, was created by combining Airfield Layout Alternative T-1 and Terminal Configuration Alternative 4B. Surface vehicle access is from two directions. Support facilities are shown in the Conceptual Design Plan and are located according to the analysis contained in this chapter.

FIG 9-2
THRU 9-7

Chapter 10

Financing Methods and Sources

10.1 INTRODUCTION

Typically, airport sponsors rely on multiple sources of funding for major airport development -- principally, bond financing (debt), federal grants-in-aid, and internally generated cash flow. In addition, tenant financing can be an important source of funding for certain types of airport facilities, and other agencies of the federal government (such as the Federal Highway Administration and Urban Mass Transit Administration) can be important sources of funding for access facilities and services. Finally, local agencies and private utility companies are likely to play a role in financing some of the infrastructure of a new airport, such as extension of utilities (gas, electric, water, and sewer lines) to the new airport site and upgrading of local roads to provide airport access.

New sources of funding that may play a more significant role in the financing of airport development projects in the future include passenger facility charges (PFCs), the use of private capital (privatization¹), direct contributions from sponsoring political jurisdictions (public investment), and designated locally imposed aviation taxes (primarily on the sale of aviation fuel). Proceeds from the sale, lease, or other disposition of the existing airport site are also important equity contributions in the financing plan for a new airport project. These funding sources are discussed in this chapter.

In most cases, no single financing source can satisfy the funding requirements of a large-scale airport development project. Development of a new air carrier airport will require a credible, balanced financing plan that incorporates a number of the funding sources described below.

10.2 BOND FINANCING

Various debt instruments have been used successfully to provide capital for airport development, including:

- General obligation bonds secured by a pledge of the full faith, credit, and taxing power of the sponsoring jurisdiction.
- General obligation bonds additionally secured by a formal pledge of the revenues of the airport.

1. The term "privatization" as employed herein refers to the use of private capital for airport development.

- General-purpose revenue bonds payable only from, and secured by, the net revenues of the airport.
- Special facility revenue bonds payable from and secured by a net lease with a particular tenant.

Airport bonds can be issued as either fixed- or variable-rate debt. In addition, the sponsors of several airports with large capital funding needs (such as those in Miami and Houston) have established successful commercial paper programs to provide interim funding of projects in anticipation of periodic fixed-rate financings.

10.2.1 General Obligation Bonds

General obligation (G.O.) bonds are backed by the full faith, credit, and ad valorem taxing power of the issuer. It is the unconditional pledge by the issuing government to levy taxes that provides security to bondholders that the bonds will be repaid.

While general obligation bonds are secured by the full faith and credit of the issuer, most G.O. bonds issued for airport purposes are paid from airport revenues, thereby eliminating the need to levy additional ad valorem taxes. These bonds are typically referred to as self-liquidating general obligation bonds. For example, in the Commonwealth of Pennsylvania, municipal issuers can go to court to have G.O. bonds declared self-liquidating if the revenues of the facility or enterprise can be shown to be adequate to repay the bonds. Once so determined, the bonds do not count against the jurisdiction's statutory debt limit. The City of Philadelphia has issued over \$250 million of self-liquidating G.O. bonds for airport purposes. Allegheny County, the owner and operator of Greater Pittsburgh International Airport, has also issued self-liquidating general obligation bonds for airport purposes. Many other jurisdictions have issued G.O. bonds for airport purposes that are essentially self-liquidating from airport revenues without the necessity of a court approval process.

In other jurisdictions, the issuer has pledged the revenues of the project or enterprise to the repayment of bonds that are otherwise secured by the full faith and credit of the jurisdiction. These bonds are referred to as "double-barrel" general obligation revenue bonds. The Metropolitan Airports Commission has made widespread use of this type of bond financing over the years, obtaining very favorable bond ratings and lower interest costs by providing a backup pledge of its ad valorem taxing power (in the metropolitan area) to what are, in essence, general purpose revenue bonds. The use of revenue bonds backed by a general obligation tax pledge has afforded MAC greater control over the

financing of capital improvements since it is not subject to majority-in-interest² airline approval procedures typically found at airports that rely on revenue bond financing.

While general obligation bonds and G.O.-backed revenue bonds remain a source of funding for some airports, most public airport sponsors in the United States today rely on pure revenue bonds for financing airport projects. The trend away from the use of general obligation debt for airport development reflects (1) limitations on the total debt capacity of many governmental jurisdictions coupled with the large financing needs of airport projects, (2) the desire to avoid the necessity of voter approval of airport bonds, and (3) the ready marketability of airport revenue bonds. Most airport operators in the United States do not have the authority to issue bonds secured by a pledge of tax revenues of the sponsoring jurisdiction. Nonetheless, those airport operators that have the opportunity to issue such bonds are able to enjoy the advantages of lower interest rates and greater financing flexibility.

10.2.2 General Purpose Airport Revenue Bonds

Revenue bonds are payable solely from and secured by a pledge of the net revenues (total revenues less operating and maintenance expenses) of an airport.

Since revenue bonds are not backed by the taxing power of the issuing entity, the capital markets require, as a precondition to the issuance of such bonds, a study demonstrating the prospective feasibility of the project. The feasibility study must typically demonstrate that projected airport revenues are sufficient to meet all of the annual funding requirements of the airport (e.g., operating and maintenance expenses, debt service on the bonds, funding/replenishment of required reserve accounts). Other factors taken into consideration in the rating of airport revenue bonds include the strength of the local air service market, the mix of local versus connecting traffic, the amount of debt in relation to the size of the market, the earnings history of the airport, provisions of airline-airport use and lease agreements, quality of management, and legal structure (rate covenant, reserve funds, additional bonds tests, etc.).

Revenue bonds are issued under the terms of an ordinance or resolution adopted by the sponsoring jurisdiction. The bond ordinance provides the framework for the financial operation of the airport (or airport system) by defining the rate covenant, the structure of

2. "Majority-in-interest" is a term used to describe the provisions whereby airlines are afforded some measure of control over airport capital improvements, particularly if they affect airline costs. As typically outlined in airline lease agreements, approval of a majority of the signatory airlines is required at many airports before large capital projects can be undertaken. However, what constitutes a "majority" varies by airport and can be calculated using a combination of a number of different methods (departures, landed weight, number of carriers, etc.).

funds and accounts to be used by the airport sponsor, and the application of revenues to those funds and accounts. The rate covenant requires the airport sponsor to establish rates, fees, and charges so as to generate sufficient net revenues (after paying operating and maintenance expenses) to provide a fixed margin of coverage of annual debt service requirements. The typical coverage requirement is 1.25 times the base (1.25x), but can range from 1.00x to 1.35x. Airport bond ordinances typically require the maintenance of debt service reserve accounts (usually in an amount equal to the maximum annual principal and interest requirements on the bonds), which are typically funded from bond proceeds.

There is an established market for general purpose airport revenue bonds, and this type of debt has been used successfully to finance large airport development projects. In 1988, Allegheny County issued \$524 million of airport revenue bonds to finance the new midfield terminal project at Greater Pittsburgh International Airport, and in 1990, the City and County of Denver issued \$700 million of airport revenue bonds to finance a portion of the new Denver airport project. There has been no instance of default on any airport revenue bond issue in the history of the U.S. airport industry.

10.2.3 Special Facility Revenue Bonds

Special facility revenue bonds are tax-exempt bonds issued by an airport sponsor (or perhaps by another governmental entity such as an industrial development authority) to finance construction or acquisition of airport facilities for use by an airline or group of airlines. Debt service on the bonds is covered from payments received by the airport sponsor from the airline under a financing agreement (such as net lease or loan agreement). The airport sponsor is not liable for payments on the bonds beyond the amount of revenues received under the financing agreement. The airport sponsor does not use any of its own funds to pay principal, interest, or other costs incurred in connection with the financing.

The facilities financed with the bonds are owned by the issuer (usually the airport sponsor); title vests with the issuer immediately upon completion of construction. The security for the bonds is the tenant airline's credit rather than the airport sponsor's credit. The tenant usually enjoys exclusive use of the facilities for the term of the lease, with control over the facility reverting back to the airport sponsor upon expiration of the lease. The lease is typically coterminous with the term of the bonds (20 to 30 years).

Special facility bond financing has played an important role in several recent, large airport development projects:

- Chicago-O'Hare International Airport. As part of the financing plan for the \$1.5 billion O'Hare Development Program, in 1984 the City of Chicago issued \$320 million of special facility revenue bonds on behalf of United Airlines to finance portions of United's new Terminal One at O'Hare International Airport. These bonds were used to finance the exclusive-space component of the project as

well as all of United's tenant finishes, baggage systems, loading bridges, and other equipment.

- Raleigh-Durham International Airport. In 1985, the Raleigh-Durham Airport Authority issued \$114 million of tax-exempt special facility revenue bonds to finance a passenger terminal facility, fueling and freight facilities, a flight catering kitchen, and other furnishings and equipment for American Airlines.
- Hartsfield-Atlanta International Airport. In 1989, the City of Atlanta issued \$327 million in tax-exempt special facility revenue bonds on behalf of Delta Air Lines to finance improvements to Delta's Technical Operations Center, maintenance and training facilities, and international cargo facilities at Hartsfield-Atlanta International Airport.
- Alliance Airport. In 1990, American Airlines and the Alliance Airport Authority issued \$350 million in tax-exempt special facility revenue bonds to finance a portion of the acquisition, construction, and equipping of aircraft maintenance facilities adjacent to the airfield at Alliance Airport in Fort Worth, Texas.

From experience at other airports, it appears that special facility revenue bonds can be used to finance a variety of project elements:

- Unit terminals for hubbing carriers
- Terminal building space finishes and equipment, such as loading bridges and baggage transfer systems
- Fuel storage and distribution systems
- Support facilities, such as cargo buildings, inflight kitchens, and maintenance hangars

In general, special facility revenue bond financing has been used primarily at large connecting hub airports because of the major investments in terminal and support facilities often required at those airports. The use of special facility revenue bonds to finance portions of major terminal expansion projects is a relatively recent phenomenon; over the last 10 years, major terminal improvements have been financed by this method at Chicago-O'Hare International, Dallas/Fort Worth International, LaGuardia, and Los Angeles International airports. In each instance, the airlines requesting the financing were tenants of their own unit terminals under long-term lease arrangements with the airport sponsor.

The principal economic advantages of special facility revenue bonds to an airport sponsor (relative to using general purpose revenue bonds) are:

- Diversification of Debt Structure. Use of special facility revenue bonds diversifies the debt structure of the airport operator and helps to broaden the market for the issuer's debt.
- Transfer of Risk. Since the credit behind a special facility revenue bond is the tenant's, not the airport sponsor's, the underlying risk inherent in debt issuance is transferred to the tenant, thereby strengthening the airport's credit standing.

The principal economic advantages of special facility revenue bonds to an airline are:

- Low Tax-Exempt Interest Rates. The major advantage is the lower interest rate that can be achieved by the airline(s) because of the tax-exempt status of interest on the bonds -- perhaps 2 or 3 percent below the interest rate on conventional borrowings.
- Alternative Source of Capital. Tax-exempt bonds provide an alternative source of capital for financing airline facilities. Since the most active purchasers of tax-exempt bonds are financial institutions (such as insurance companies) and the public, less reliance is placed on an airline's traditional lending sources (such as commercial banks).
- Fewer Restrictions. In contrast with common practice for taxable financings, tax-exempt financings usually do not place restrictions on working capital, debt-equity ratios, dividends, or the incurrence of other indebtedness. Tax-exempt bond financing also typically provides 100 percent of the funds required for the project.

10.2.4 Federal Tax Law Relating to Airport Revenue Bonds

The issuance of airport revenue bonds is governed by provisions of the 1986 Tax Reform Act, as amended by the Omnibus Budget Reconciliation Act of 1988.

In general, tax-exempt municipal bonds are divided into two categories:

1. Governmental purpose bonds -- bonds used to finance facilities exclusively for public purposes, such as schools, hospitals, water and sewer, roadways, and public parking facilities. Under current law, few airport projects other than roadway and parking facilities qualify as "governmental purpose."
2. Private-activity bonds -- bonds used to finance facilities that primarily benefit or financially involve private persons. Under current law, bonds are considered private activity if more than 10 percent of bond proceeds is used by a nongovernmental entity and 10 percent of the principal or interest is secured from revenues derived from a private concern. Since airport runways and

terminals are principally used by or leased to airlines, almost all airport revenue bonds are considered to be private-activity bonds.

The Tax Reform Act of 1986 imposed limitations on the use of tax-exempt bonds and on private-activity bonds in particular.

The designation of airport revenue bonds as private-activity bonds results in certain restrictions and requirements that must be met to preserve the tax-exempt status of the bonds, as follows:

1. Governmental Ownership. Projects financed by tax-exempt bonds must be governmentally owned. Property leased or operated pursuant to a management or operating agreement by a nongovernmental entity (such as an airline) is treated as governmentally owned only if all of the following apply:
 - a. The lessee makes an irrevocable election (binding on the lessee and all successors in interest under the lease) not to claim depreciation or an investment credit with respect to such property.
 - b. The lease term is not more than 80 percent of the reasonably expected economic life of the property.
 - c. The lessee has no option to purchase the property other than at fair market value (as of the time such option is exercised).
2. Qualifying Property/Definition of Qualifying Airport Facilities. At least 95 percent of net bond proceeds must be used for qualifying property. Qualifying airport facilities are generally defined to include:
 - a. Facilities directly related and essential to (1) servicing aircraft or enabling aircraft to take off and land, or (2) transferring passengers or cargo to or from aircraft.
 - b. Facilities functionally related and subordinate to an airport, such as inflight kitchens, ground transportation parking areas, and land for noise protection.

Net proceeds are defined as gross proceeds less amounts invested in a reasonably required reserve or replacement fund. No reduction is made for amounts paid for costs of issuance. Amounts used to pay costs of issuance must therefore be paid from the so-called 5 percent "bad money"³ portion of an issue.

3. "Bad money" is a term used to describe the portion of net bond proceeds that can be used for "nonqualifying property" (such as issuance costs) under federal tax law. To preserve the tax-exempt status of the bonds, current law limits to 5 percent the percentage of net bond proceeds that can be applied toward nonqualifying property.

3. Ineligible Facilities. The 1986 Tax Reform Act also provided that certain types of airport facilities would no longer qualify for tax-exempt financing, such as:
 - a. Airport hotels
 - b. Office buildings (other than those required for airport administrative purposes)
 - c. Industrial parks
 - d. Manufacturing facilities
 - e. Retail facilities in excess of the size necessary to serve passengers and employees of the airport
 - f. Rental car facilities that are not part of the terminal complex
4. Alternative Minimum Tax. Current law requires bondholders to include 50 percent of interest income on private-activity bonds for purposes of calculating the alternative minimum tax (AMT).⁴ Because interest on private-activity bonds is subject to the AMT, the market assesses an interest rate penalty on private-activity AMT bonds generally estimated to be about 25 basis points (one quarter of one percent).
5. Issuance Expenses. Issuance expenses funded from bond proceeds cannot exceed 2 percent of the principal amount of the issue.
6. Reserve Funds. Reserve funds funded from bond proceeds cannot exceed 10 percent of the principal amount of the issue.
7. Advance Refunding. Private activity bonds may not be advance refunded. Advance refunding is a procedure whereby outstanding bonds are refinanced prior to their call date to achieve interest rate savings.

These restrictions have led some airport sponsors (such as the City of Albuquerque and Wayne County, the owner and operator of Detroit Metropolitan Wayne County Airport) to issue revenue bonds for large projects in two or more separate series: one for the private-purpose elements of the project (terminals and airfield facilities) and one for the

4. The Alternative Minimum Tax is a separate income tax system that parallels the regular income tax system and levels a flat federal tax (23 percent for individuals and 20 percent for corporations) on a broader base of income. As indicated herein, the effect of private-activity bonds that are subject to the AMT has been to increase the interest rates on debt issued for airport development by as much as 25 basis points (equal to one quarter of one percent).

governmental purpose elements (parking facilities and roadways). In addition to exemption from the AMT, governmental purpose bonds can be advance refunded, providing some additional flexibility to the issuer. The City of Albuquerque has already advance refunded its 1987 series of governmental purpose airport system revenue bonds, which were originally issued to finance a new parking structure at Albuquerque International Airport.

The Supreme Court has ruled that local governments do not have a constitutional right to issue tax-exempt debt. The current rules for issuing tax-exempt airport revenue bonds reflect the result of extensive debate in the Congress and are not likely to change in the near future. While it is unlikely that basic public-use airport facilities, such as runways, terminals, and roadways, would be denied tax exemption, it is possible that, as a result of budgetary pressures, Congress may further tighten the rules for issuing tax-exempt bonds.

10.2.5 MAC's Authority to Issue Bonds

Under Minnesota statute 473.608, MAC is empowered to:

... borrow money and issue bonds for the purposes of acquiring property ... constructing and equipping new airports, acquiring existing airports, equipping them and making additions thereto and improvements thereon, and making capital improvements to any airport constructed or acquired by the corporation, or for the purpose of making payments on principal or interest of bonds heretofore issued ... and redeem any such bonds ...

Over the years, MAC has issued two types of bonds: Airport Improvement Bonds and General Obligation Revenue Bonds. Both types of bonds are considered self-liquidating general obligation bonds in that they are payable primarily from pledged revenues derived by MAC from the operation of its airport system. However, the bonds are also secured by the full faith and credit of MAC, which is obligated under Minnesota statutes to levy ad valorem taxes on all taxable property in the metropolitan area as may be required to pay interest and principal on the bonds when due and maintain the required debt service reserve. Airport Improvement Bonds are secured by a mortgage on certain MAC property at Minneapolis-St. Paul International Airport.

MAC no longer issues Airport Improvement Bonds. Seven series of General Obligation Revenue Bonds have been issued in the total principal amount of \$155,950,000. As of December 31, 1989, there were outstanding \$27,255,000 of Airport Improvement Bonds and \$134,440,000 of General Obligation Revenue Bonds.

Minnesota statutes provide a debt limit of \$150,000,000 over and above the amount of bonds outstanding as of January 15, 1988. The Series 7 Bonds were issued in July 1988 in

the principal amount of \$51,150,000, reducing MAC's current bonding authority to \$98,850,000. However, this authority can be increased by law.

Minnesota statutes require that MAC establish a debt service fund and maintain on deposit in that fund an amount equal to two years of debt service -- debt service becoming due in the current year and the next following year. Minnesota statutes also contain a rate covenant that obligates MAC to establish, revise from time to time, and collect rates, fees, charges, and rentals from its tenants and users so as to produce revenues at all times sufficient to meet debt service requirements on MAC's outstanding bonds and to pay all of its operating and maintenance expenses.

Current statutes do not authorize MAC to issue either general or special facility revenue bonds.

10.3 FEDERAL FUNDING/AIRPORT IMPROVEMENT PROGRAM

The Airport and Airway Improvement Act of 1982 (reauthorized and amended in 1987 and again in 1990) created the Airport Improvement Program (AIP), an airport grant program administered by the Federal Aviation Administration and funded from the Airport and Airways Trust Fund. Moneys in the Trust Fund are generated from an 8 percent ticket tax, a 5 percent cargo tax, a \$10.00 international arrivals and customs fee, a \$0.12 and \$0.14 per gallon tax on aviation gasoline and jet fuel, respectively, and other aviation-related user fees. Effective December 1, 1990, the Omnibus Budget Reconciliation Act of 1991 increases many of these taxes, including the ticket tax to 10 percent, the cargo tax to 6.25 percent, and aviation gasoline and jet fuel to \$0.15 and \$0.175, respectively. Revenues generated from these tax increases are to go into the General Fund for deficit reduction in Federal Fiscal Year (FFY) 1991 and FFY 1992, and thereafter into the Aviation Trust Fund.

Under the AIP, each commercial service airport is entitled to its share of a total amount appropriated for entitlement grants, apportioned annually based on numbers of enplaned passengers. In addition to entitlement funds, the AIP also makes available discretionary funds administered by the FAA and allocated on a national priority system. Discretionary funds are divided among several set-aside programs guaranteeing that a certain percentage will be allocated to reliever airports, general aviation airports, noise abatement, capacity enhancement, and other purposes.

During FFY 1982-FFY 1990, MSP was allocated an average of approximately \$5,172,000 per year in AIP grants. For all of its airports, including MSP, MAC receives approximately \$7 million per year in entitlement funds and is eligible to receive additional discretionary funds for a variety of purposes (primarily noise mitigation and reliever airport development).

Concern over the amount of moneys available for airport capacity issues led Congress to include a provision in the 1987 reauthorization of the Airport and Airway Improvement Act guaranteeing 75 percent of discretionary funds (after allowing for set-asides) to projects related to capacity, security, or noise abatement. This amount was reported to be approximately \$124.5 million in FFY 1989 and approximately \$47 million in FFY 1990. As discussed later, the FAA has developed project selection criteria to help make decisions on the relative priority of competing capacity projects.

For FFY 1991 and FFY 1992, the amount of money appropriated for the AIP will increase to \$1.8 billion and \$1.9 billion, respectively, from \$1.4 billion in FFY 1990. The increase in authorized funding levels, if continued beyond FFY 1992 as currently expected, should result in substantially more funding available for discretionary grants throughout the 1990s, particularly for high priority, capacity-enhancing projects such as new airports.

In recent years, the FAA has created a procedure by which an airport sponsor can request a Letter of Intent (LOI) from the FAA. An LOI is a formal indication of the level of funding the FAA intends to commit to that sponsor in the form of federal grants (entitlement and discretionary) over a number of future fiscal years. Issuance of an LOI is subject to Congressional review and, since AIP funds are appropriated on a year-by-year basis and the program itself is only authorized through FFY 1992, does not constitute a binding appropriation or commitment of funds by the FAA. LOIs have been awarded primarily for large capacity-enhancing projects, the construction of which is expected to extend over a number of years. Several recent examples are described below:

- Denver -- The City and County of Denver has received an LOI for \$351 million of federal funding over the nine-year period, FFY 1991 through FFY 1999, for the new Denver airport project, which, when coupled with grants received in FFY 1989 and FFY 1990, brings the total amount of federal funds for that project to \$501 million, about 25 percent of the estimated cost of the project.
- Austin -- In 1988, the City of Austin received an \$87 million LOI for its new airport project, all but \$7 million of which is discretionary money. An additional discretionary grant of \$10 million in 1988, coupled with future entitlement moneys, brings the total federal commitment for the project to \$114 million, about 20 percent of the estimated cost of the original project. (The Austin project has been delayed as the City is now considering the possibility of redeveloping Bergstrom Air Force Base in lieu of developing a completely new airport.)
- Detroit -- On September 28, 1990, the FAA issued an LOI to Wayne County, owner and operator of Detroit Metropolitan Wayne County Airport. The LOI provides \$185 million of entitlement and discretionary funds over a nine-year period, FFY 1991 through FFY 1999, for a major airfield development program at that airport. The program includes development of two new air carrier

runways and the apron and taxiway system for a proposed midfield terminal complex.

As currently established, the AIP and the Aviation Trust Fund are subject to constraints arising from federal budget considerations; in recent years, spending levels appropriated by Congress have lagged behind authorized funding levels. Although it is likely the AIP will be reauthorized in 1992, there is no assurance it will be in place or be adequately funded in the late 1990s. However, given the recent major LOI commitments made for Denver, Austin, and Detroit, and assuming no major changes in the AIP over the next decade, MAC can reasonably anticipate receiving substantial federal funding if a decision is reached to build a new air carrier airport.

10.4 INTERNALLY GENERATED CASH FLOW

The ability of airport sponsors to generate and accumulate discretionary cash flow is often a critical element of the financing plan for a major development project such as a new airport. The amount of money an airport can generate is often a function of the particular business arrangements negotiated with the airlines and contained in the airport use and lease agreements. MAC uses a compensatory methodology for calculating rates and charges at MSP, enabling it to generate and retain excess revenues from concession activities. During the six-year period, 1985 through 1990, MAC applied approximately \$87 million in discretionary cash flow to meet its ongoing capital needs. In addition, the airports operated by MAC will generate an estimated \$81 million for the period 1991 through 1997 that will be available for construction, as indicated in Table 10-1. These funds have been applied to meet ongoing capital needs. (MAC has a policy to use bond proceeds, internally generated cash flow, and grants at MSP; only internally generated cash flow and grants are used to finance capital improvements at the general aviation airports operated by MAC.)

Both Denver and Austin have relied to a great extent on internally generated cash flow for the initial funding of their new airport projects -- moneys to fund such front-end costs as master planning, environmental assessment, and preliminary design and land acquisition costs, as well as to pay debt service on bonds issued for land acquisition.

Table 10-1

HISTORICAL AND PROJECTED SURPLUS NET REVENUES
Metropolitan Airports Commission
1985-1996
(in thousands)

HISTORICAL SURPLUS NET REVENUES (a)	Historical				
	1985	1986	1987	1988	1989
Operating revenues	\$49,757	\$56,054	\$59,556	\$59,909	\$62,000
Interest income	9,827	7,589	8,283	9,587	9,921
Total revenues	\$59,584	\$63,643	\$67,839	\$69,496	\$71,921
less:					
Operating expenses	(26,935)	(26,757)	(29,289)	(31,595)	(35,695)
Debt service	(13,892)	(13,930)	(15,422)	(16,672)	(19,010)
Surplus net revenues	\$18,757	\$22,956	\$23,128	\$21,229	\$17,216

PROJECTED SURPLUS NET REVENUES (b)	Estimated 1990	Projected						
		1991	1992	1993	1994	1995	1996	1997
Operating revenues	\$62,675	\$65,994	\$69,143	\$71,391	\$74,278	\$77,763	\$80,621	83,670
Interest earnings	1,393	1,160	1,464	1,465	1,486	1,527	1,536	1,549
Self-liquidating payments	9,216	8,989	8,121	12,117	16,439	15,741	15,385	13,830
	\$73,284	\$76,143	\$78,728	\$84,973	\$92,203	\$95,031	\$97,542	\$99,049
Operating expenses	(40,854)	(43,406)	(45,535)	(47,774)	(50,129)	(52,605)	(55,211)	(57,952)
Sinking fund transfers	(20,300)	(16,613)	(15,831)	(25,649)	(28,694)	(31,234)	(29,261)	(27,536)
Equipment purchases	(1,980)	(2,980)	(2,000)	(2,000)	(2,000)	(2,000)	(2,000)	(2,000)
Surplus net revenues	\$10,150	\$13,144	\$15,362	\$9,550	\$11,380	\$9,192	\$11,070	\$11,561
					\$81,259			

Note: A substantial portion of these projected funds
is budgeted for proposed Construction Fund projects.

- a. Source: Metropolitan Airports Commission, Minneapolis-St. Paul Minnesota, Comprehensive Annual Financial Report Year Ended December 31, 1989.
b. Metropolitan Airports Commission staff estimates.

Under a recent court ruling in Denver, no costs attributable to a new replacement airport can be charged to the airlines through rates and charges at MSP prior to the opening of the new airport.⁵ Therefore, the only source of funds available to pay debt service on bonds issued for a new airport is the surplus cash flow generated from non-airline sources at MSP. The implication of this ruling is that the vast majority of debt service on bonds issued for new airport acquisition and development must be capitalized and paid from bond proceeds.

- Since the new Denver airport project began in 1987, the City has invested approximately \$80 million in Stapleton International Airport capital and operating funds for the new airport project. In addition, the City is paying debt service on approximately \$200 million in bonds sold for land acquisition that cannot be included in the airline rate base. The decision to dedicate large amounts of existing funds and cash flow toward the new airport project was facilitated by a moratorium that was declared on further capital improvements at Stapleton in 1987.
- Prior to issuing \$30 million in revenue bonds for its new airport project in 1989, the City of Austin funded \$6.5 million in planning and administration costs from capital and operating funds. In addition, the City has committed \$5 million a year from cash surplus generated at Robert Mueller Municipal Airport toward the new airport project and to pay debt service on the 1989 bonds from internal cash flow without charging the airlines.

The application of internally generated cash surpluses to front-end planning, design, and land acquisition costs can reduce the financing costs associated with a new airport by deferring the need to issue debt and thereby reducing the amount of capitalized interest (the interest costs during construction that are usually paid from bond proceeds). As discussed later, capitalized interest is often a significant portion of the total financing costs.

10.5 TENANT FINANCING

Another source of financing for certain elements of major airport development projects is direct tenant investment. This source is typically used for the finishing and equipping of terminal concession space, the construction of rental car service facilities, and the acquisition of depreciable equipment, such as loading bridges and baggage conveyors, when tenants elect to obtain the tax benefits of ownership. Third-party developers also provide an alternative means of financing multi-tenant facilities, such as cargo buildings, bringing private sources of capital to the funding of airport development projects. Third-party

5. It should be noted that MAC has obtained a commitment from the airlines serving MSP to fund a portion of the front-end costs of planning, design, and environmental assessment for the new airport directly from revenues at MSP by including such costs in the rate base for calculating airline rates and charges.

developer financing can be advantageous to the airport sponsor by (1) preserving the sponsor's bonding capacity for other public-use facilities, (2) offering specialized knowledge and professional management in facility planning and leasing, and (3) avoiding the coverage and reserve requirements of traditional airport revenue bonds. Nonetheless, many airport sponsors prefer to finance their own cargo facilities in order to retain financial and operational control.

10.6 OTHER FUNDING SOURCES

10.6.1 Direct Federal Investment

New airport projects require investment in a control tower, weather monitoring facilities, and other navigational aids which are typically the responsibility of the federal government. The FAA plans a direct investment of nearly \$200 million in federal facilities at the new Denver airport.

10.6.2 Grants from Federal Agencies

In addition to FAA grants and direct investment, potential sources of federal funding for new airport development include the Federal Highway Administration (for major access roadways and interchanges with interstate highways) and the Urban Mass Transit Administration (for public transportation and rail access).

As mentioned earlier, other state and local entities can be expected to provide funding for certain off-airport infrastructure improvements in connection with a new airport project.

10.7 PASSENGER FACILITY CHARGES

On October 27, 1990, Congress approved a significant new funding source for airports -- the passenger facility charge (PFC) -- by repealing the legislative prohibition against PFCs, which were previously prohibited by Congress under the Anti-Head Tax Act of 1973. PFCs are fees imposed on enplaned passengers by airport sponsors for the purposes of generating revenues for airport projects that increase capacity or mitigate noise impacts. The Airport Safety and Capacity Expansion Act of 1990 (the 1990 Act) links PFCs with the establishment of a national noise policy and full funding of certain federal grant programs. The Secretary of Transportation (the Secretary) has until May 3, 1991, to issue regulations pertaining to implementation of PFCs.

According to the new law, airport sponsors can apply to the Secretary for the right to levy a PFC (in the amount of \$1.00, \$2.00, or \$3.00 per enplaning originating and connecting passenger), and the Secretary must approve or disapprove the request within 120 days. Any PFC so approved is to be a separate charge printed on each passenger ticket and

collected by the airlines. Passengers are limited to two such charges per one-way trip. Revenues generated from PFCs have certain prescribed uses, specifically:

1. PFC revenue can only be used for identified, eligible airport-related projects that (a) preserve or enhance airport capacity, security, or safety, (b) furnish opportunities for enhanced airline competition, or (c) mitigate noise.
2. PFC-funded portions of capital costs cannot be included in the airline rate base, with the exception of terminal or other facilities used on an exclusive or preferential basis. Likewise, PFC revenues cannot be credited to the airlines in the calculation of airline rates, fees, and charges. Airport sponsors must give airlines written notice of proposed PFC-supported projects and meet with the airlines regarding the projects. While the airlines cannot veto the project, they can issue a "certificate of agreement or disagreement" expressing their support or disapproval of the project.
3. PFC revenues can be used to pay debt service on eligible projects but not operating and maintenance expenses.
4. PFC revenues must be spent at the airport generating them or at another airport within the airport sponsor's system. The law preempts state or local laws preventing airports from imposing PFCs and overrides any airline agreement that may prohibit PFCs.

In return for the right to assess PFCs, large- and medium-hub airports will forego up to 50 percent of their AIP entitlement funds, and such foregone entitlements are to be deposited into an AIP discretionary fund to be used for projects at small-hub, nonhub, and general aviation airports, and for capacity enhancement.

The approval of individual PFCs for airport sponsors is linked to establishment of a national noise policy and compliance with certain noise provisions set forth by the individual airport sponsors. Specifically, the Secretary must issue regulations establishing a National Noise Policy by July 1, 1991, providing for the phasing out of 85 percent of the Stage 2 aircraft fleet by July 1, 1999, and limiting any noise-related operating restrictions placed on Stage 2 and Stage 3 aircraft by airport sponsors. Noncompliance with the noise provisions of the law at an airport could result in termination of the airport sponsor's authority to levy PFCs and its eligibility to receive AIP funding.

In addition, the Secretary must initiate a rulemaking to study capacity allocation at the four slot-controlled airports (John F. Kennedy International, LaGuardia, Chicago-O'Hare International, and Washington National airports).

Finally, the authority of airport sponsors to levy PFCs is linked to the full funding of certain federal grant programs. In particular, the Secretary's authority to approve new PFCs will expire on September 30, 1992, unless the AIP and Essential Air Service (EAS) Program are funded to their fully authorized levels for FFY 1991 and FFY 1992. The AIP funding levels are \$1.8 and \$1.9 billion, respectively, and the EAS Program funding levels are \$26.6 million and \$38.6 million, respectively, for those years.

PFCs would provide MAC with a significant source of revenues for airport development purposes. Assuming 12 million annual enplaned passengers at MSP, a \$3.00 PFC would generate approximately \$32.4 million a year (after collection costs are deducted), which, if dedicated to airport development -- either expansion of MSP or development of a new airport -- could generate a substantial amount of seed capital over the period of time it will take to acquire land and design and construct the new airport. (In fact, a major impetus for repeal of the prohibition against PFCs was provided by the City of Chicago and the Secretary of the U.S. Department of Transportation, who have publicly stated the desire that a PFC be used to help finance a third air carrier airport in the Chicago area.)

Under the new law, PFCs can also be used to leverage debt. Given the assumptions outlined in Table 10-2, a \$3.00 PFC levied at MSP would support between \$139 million and \$222 million in new PFC-secured revenue bonds which, in turn, could be dedicated to new airport development.

The financing capacity of PFC income will be a function of the particular debt service coverage requirement prescribed in the rate covenant. Preliminary discussions with bond rating agencies have suggested that a connecting hub airport (such as Minneapolis-St. Paul International) will likely require higher debt service coverage for PFC-secured bonds, perhaps in the 1.50x-2.00x range. Higher debt service coverage requirements effectively reduce the leveraging capacity of a given level of PFC income.

Table 10-2 also shows the available net proceeds of bonds leveraged with PFC income after accounting for likely funding requirements, issuance costs, and interest earnings. Assuming that interest on the bonds is not capitalized (PFC revenues used to pay debt service during construction), a 1.75x coverage requirement would produce approximately \$168 million of net bond proceeds, which could be used for new airport project costs.

Table 10-2

POTENTIAL FINANCING CAPACITY OF PFC INCOME
Metropolitan Airports Commission

KEY ASSUMPTIONS:	
Enplaned passengers	12,000,000
Amount of PFC charge	\$3.00
PFC collection fee	10.0%
Interest rate on bonds	8.0%
Investment yield	7.0%
Amortization period (years)	15
Construction period (years)	5

FINANCING CAPACITY OF PFC INCOME	Rate Covenant Requirement			
	1.25x	1.50x	1.75x	2.00x
Assumed enplaned passengers	12,000,000	12,000,000	12,000,000	12,000,000
x PFC charge	\$3.00	\$3.00	\$3.00	\$3.00
= Gross PFC income	\$36,000,000	\$36,000,000	\$36,000,000	\$36,000,000
- Collection fee (@10%)	(3,600,000)	(3,600,000)	(3,600,000)	(3,600,000)
= Net PFC income to MAC	\$32,400,000	\$32,400,000	\$32,400,000	\$32,400,000
/ Rate covenant	1.25	1.50	1.75	2.00
= PFC income required for debt service	\$25,920,000	\$21,600,000	\$18,514,286	\$16,200,000
/ Debt service factor	0.1168	0.1168	0.1168	0.1168
= FINANCING CAPACITY -- Principal amount of Airport Revenue Bonds	\$221,861,688	\$184,884,740	\$158,472,634	\$138,663,555
AVAILABLE NET PROCEEDS--INTEREST NOT CAPITALIZED FROM BOND PROCEEDS				
Principal amount	\$221,861,688	\$184,884,740	\$158,472,634	\$138,663,555
- Issuance expenses (@1%)	(2,218,617)	(1,848,847)	(1,584,726)	(1,386,636)
- Reserve fund (level principal and interest)	(25,920,000)	(21,600,000)	(18,514,286)	(16,200,000)
+ Interest income--construction funds	32,886,565	27,405,471	23,490,404	20,554,103
+ Interest income--reserve funds	8,294,400	6,912,000	5,924,571	5,184,000
= Net proceeds available for project costs [A]	\$234,904,036	\$195,753,363	\$167,788,597	\$146,815,022
Total PFC income available during construction period	\$162,000,000	\$162,000,000	\$162,000,000	\$162,000,000
- Interest during construction to be paid with PFC income	(70,995,740)	(59,163,117)	(50,711,243)	(44,372,338)
= Excess PFC income available for project costs [B]	\$91,004,260	\$102,836,883	\$111,288,757	\$117,627,662
= Total funds available for project costs [A+B]	\$325,908,296	\$298,590,246	\$279,077,354	\$264,442,685
ANNUAL CASH FLOW AFTER COMPLETION OF PROJECT CONSTRUCTION				
Net PFC income to MAC	\$32,400,000	\$32,400,000	\$32,400,000	\$32,400,000
- Debt service on PFC bonds	(25,920,000)	(21,600,000)	(18,514,286)	(16,200,000)
= Remaining PFC income available "equity" capital for other eligible projects	\$6,480,000	\$10,800,000	\$13,885,714	\$16,200,000

During the period of new airport construction, PFC income not required for payment of debt service on PFC-secured bonds would be available as equity capital for other eligible elements of the project. After completion of the project, excess PFC income would be available for other eligible projects.

10.8 PRIVATIZATION

A growing number of initiatives are under way in the United States to evaluate the potential for the privatization of air carrier airports. While airport management has traditionally been a function of local government, this view is being increasingly challenged by developments in airport management overseas and the general trend in the United States to seek greater private involvement in the management of public facilities. However, the issue to be addressed is what role the private sector can play in developing a new airport.

One difficulty in evaluating privatization as a method and source of funding is its different meanings and interpretations. While the term "airport privatization" is becoming synonymous with the transfer of an entire air carrier airport to private operation, this is only one form of public-private approach available to airports. The most significant forms of privatization are outlined below:

- Contract Services -- This is the most common form of privatization, in which the airport sponsor contracts with a private entity to manage and staff particular airport functions. This can range from one specific function (e.g., parking) to management of the entire airport, as at Burbank-Glendale-Pasadena Airport. The main characteristic of this type of privatization is that risk and control over quality and quantity of service remain with the public sponsor.
- Developer Financing -- Developer financing involves an airport sponsor entering into a contract with a private corporation, partnership, or other private entity for the planning, financing, and (sometimes) operation of specific facilities. One unique example of this form of privatization is the private consortium selected to finance, design, build, and operate a new \$300 million, 24-gate terminal in Toronto, Canada. As described previously, the main characteristics are that the airport sponsor (1) retains some control over at least the planning and design of the facility, and (2) resumes control of the facility at its residual value at the end of the financing agreement.
- Long-Term Lease/Transfer of Existing Airports -- This form of privatization involves the transfer of the planning, financing, developing, and operating responsibilities of an airport sponsor to a private organization that operates the airport as a commercial enterprise. The public sponsor retains a limited role in policy direction and management. Examples include the government sale of the British Airports Authority to a private entity and a proposal by the County of

Albany to lease Albany County Airport to Lockheed Air Terminal/British American (subsequently rejected by the FAA).

- Development of Private Airport Facilities – The ultimate public-private partnership strategy for airports would be the development and operation of completely new airport facilities exclusively by private enterprises for public use. The closest example of this in the United States is Alliance Airport near Fort Worth, Texas, a commercial air cargo facility constructed and partially financed by a private developer (although \$31 million of FAA grants and additional public funds were used to finance a significant portion of the airfield development cost).

Clearly, there are opportunities for private involvement in the financing of a new airport. However, because of the outstanding issues surrounding the turning of what has historically been a public function into a private enterprise, the level of private involvement is a policy decision that can only be made by MAC in the context of specific proposals that may emerge. Of course, it is important to recognize that privatization usually involves raising capital in taxable markets. It is likely that privatization proposals will result in a higher cost of capital than general purpose airport revenue bonds. The potential advantages of privatization in terms of efficient design, construction, and operation of public airport facilities will have to be weighed against the inherent disadvantage in terms of capital cost.

10.9 PUBLIC INVESTMENT AND STATE AVIATION PROGRAMS

10.9.1 Public Investment

Public investment occurs when state and local governments make direct financial contributions toward the cost of an airport project in recognition of future benefits such as job creation and additional tax revenues brought about by the economic development that follows. Investment by the public sector can be through grants from a general fund or dedicated aviation fund, or grants from the proceeds of economic development bonds issued by state or local governments supported by taxing authority. Several examples of state and local public investment programs are described below.

- County of Allegheny/Commonwealth of Pennsylvania. The major impetus behind the development of the midfield terminal complex now under construction at Greater Pittsburgh International Airport was the decision by the Commonwealth of Pennsylvania and the County of Allegheny in 1987 to provide \$127.5 million of public investment on a 2:1 state/county basis. The Commonwealth's share was provided from the proceeds of economic development bonds; the County's share was provided from the proceeds of tax-supported general obligation bonds.
- Cities of Dallas and Fort Worth. In the late 1960s, the Cities of Dallas and Fort Worth provided \$57 million of funding for land acquisition for the Dallas/Fort

Worth Regional Airport, which represented the equity contribution of the Cities to the project. By agreement, the DFW Board has committed to repay \$27 million of this investment over a period of years, leaving a net public investment of \$30 million. This equity financing was the principal catalyst that allowed the new airport project to proceed and greatly enhanced the posture of the Board in negotiations with the airlines. The land contribution also reduced the initial requirement for revenue bond financing and, by evidencing a commitment of the Cities to the project, enhanced the marketability of the Board's initial series of revenue bonds.

- State of Florida. In some instances, public investment takes the form of low interest loans. Through a Land Acquisition Loan Program, the State of Florida is providing \$30 million in loans to the Greater Orlando Aviation Authority for land acquisition in connection with the planned fourth runway project at Orlando International Airport. The Authority expects to repay the loans, which are interest free with a bullet 10-year maturity,⁶ once federal grants for land acquisition become available. This program is funded through a state aviation fuel tax.
- Commonwealth of Kentucky. The Regional Airport Authority of Louisville and Jefferson County received a major assist from the Commonwealth of Kentucky in the financing of its recently completed new terminal complex at Standiford Field. In 1983, the Commonwealth issued \$10.5 million of economic development bonds on behalf of the Authority to finance parking and roadway elements of the project. The Authority leased the ground area required by these elements to the Commonwealth, which, in turn, leased back the completed facilities to the Authority. The Authority makes lease payments each year in amounts sufficient to pay debt service on the bonds. More importantly, the lease payments did not commence until completion of construction; interest on the bonds during the construction period was paid from general fund revenues of the Commonwealth, thereby reducing the overall borrowing costs borne by the Authority.

10.9.2 State Aviation Programs

In addition to public investment, state aviation programs can be a source of local government equity funding for major airport development projects. While many states have airport funding programs (typically funded from a per gallon or ad valorem tax on aviation fuel), most of these programs are relatively small in terms of the capital provided and typically are directed to small airline airports and general aviation airports. The State of Minnesota currently assesses a \$0.05 per gallon tax on aviation fuel purchased in the

6. A bullet maturity on a loan means the entire amount of the principal is repaid at the end of the loan period, with the borrower making interest payments only during the loan term. The example used above was an interest-free loan so, in effect, airports in Florida simply repaid the total amount loaned to them by the State in 10 years.

State. Based on a 1988 survey by the National Association of State Aviation Officials (NASAO), the State of Minnesota spent \$2.89 per capita on State aviation programs (eighth in the United States).

The State of Minnesota has an airport grant program that is administered by the Department of Transportation -- Office of Aeronautics. The Office of Aeronautics typically distributes approximately \$9 million to \$10 million annually from the State Aviation Trust Fund, which is funded by a tax on aviation fuel, aircraft registration fees, and the aircraft flight property tax. Eligible projects are funded on a two-thirds State/one-third local airport sponsor basis. While eligible projects are usually safety-related (airfield improvements, navigational aids, etc.), funding can be applied by individual airport sponsors to non-AIP-eligible projects. The State Aviation Trust Fund also supports a revolving loan program to finance hangar development, mostly at the State's smaller, general aviation airports.

Historically, MAC has generally received approximately 13 percent to 15 percent of the total grants made available to State airports annually. In Fiscal Year 1991, MAC received \$1.3 million in State grants for a variety of airport projects. MAC generally directs much of this State funding to its six general aviation airports to fund projects that did not receive federal funding.

The State of Florida has an airport grant program (funded in the same manner as the loan program described above) that provides funding of up to 50 percent of the non-federal share of AIP projects (equaling 12.5 percent of the total cost).

10.10 LOCALLY IMPOSED AVIATION FUEL TAX

Another potential source of funding for new airport development is a fuel tax levied and administered by the airport sponsor. This funding source is being used by the City and County of Denver in a rather unusual way for the new Denver airport project.

In 1989, the City of Denver doubled an existing aviation fuel tax to \$0.04 per gallon with the intention of dedicating the \$0.02 increase to the new airport project. (The remaining \$0.02 has traditionally been a general fund revenue source for the City.) However, the City subsequently decided to use the fuel tax increase to provide another important element in the over-all financing plan for the new airport -- retirement of Stapleton debt. A separate account has been created to accumulate proceeds of the fuel tax increase, and these moneys will be applied toward retirement of outstanding Stapleton debt at the call dates in 1994. Thereafter, the proceeds of the fuel tax increase will be used to pay costs at the new airport.

If a decision is reached to build a new airport, consideration could be given to increasing the fuel tax and dedicating the proceeds of the increase (or, perhaps, a portion of the current tax) to the funding of the new airport. Such revenues could provide an additional source of equity capital for the project.

10.11 PROCEEDS FROM THE DISPOSITION OF MSP

Another potential source of funding for new airport development is the proceeds from the sale, lease, or other disposition of Minneapolis-St. Paul International Airport. The City and County of Denver has established a separate organization, the Gateway/Stapleton Reuse Group, to administer the planning and marketing aspects of the Stapleton redevelopment effort now under way.

It is important to recognize, however, that while MSP represents a large source of equity capital in a new airport project, the benefits of that equity cannot be counted as a source of funding for new airport construction since the proceeds will probably not be realized until well after financing of a new airport is completed, as will be discussed in Chapter 11.

Chapter 11
Financing Issues

11.1 INTRODUCTION

The prospect of developing a new air carrier airport raises a number of important issues that need to be considered in developing an appropriate, credible financing plan. These issues include (1) determining the optimal debt structure (the types of debt instruments to be used and the structure of that debt), (2) maximizing the availability of federal aid, (3) realizing the equity in Minneapolis-St. Paul International Airport (MSP), and (4) funding front-end costs. These issues are discussed in this chapter.

11.2 OPTIMAL DEBT STRUCTURE

As discussed in Chapter 10, under current Airport Law, MAC is empowered to issue only General Obligation Revenue Bonds -- bonds secured by a back-up pledge of ad valorem taxes in the metropolitan area. A new air carrier airport will cost between \$2 billion and \$3 billion, exclusive of the cost of replacing maintenance base facilities for Northwest Airlines. MAC will probably not be able to rely solely on any one type of funding source for financing a new airport. Consequently, some combination of general obligation revenue bonds and pure revenue bonds will be needed.

11.2.1 General Requirements of Pure Revenue Bonds

If the new revenue bonds are to be similar to those commonly used in the airport industry today, they would have the following characteristics:

1. Rate covenant -- a covenant to set rates, fees, and charges sufficient to generate net revenues (total revenues less operating and maintenance expenses) at least equal to 1.25x debt service requirements each year.
2. Debt service reserve -- a reserve, funded from the proceeds of each bond issue and replenished (if necessary) from net revenues in the amount of the maximum annual debt service on the bonds (in effect, a one-year reserve, not two years).
3. Additional bonds test -- the demonstrated ability to generate net revenues for the first three to five years after completion of a project at least sufficient to meet the rate covenant.
4. Other reserves -- an operating and maintenance (working capital) reserve equal to at least three months of budgeted operating and maintenance expenses and a

renewal and replacement (contingency capital) reserve of some fixed dollar amount, perhaps \$5 million.

11.2.2 Potential for a Combined Debt Structure

Even though there is likely to be a greater role than in the past for pure revenue bond debt in the financing plan for a new airport, there could be an important role for limited use of tax-supported revenue bond debt. Such bonds, if issued in combination with pure revenue bonds, would continue to enjoy a strong credit rating and lower the overall average cost of borrowing for the project. Two observations can be made:

- Twin Cities taxpayers have traditionally been willing to support airport development in the region by lending their credit (back-up tax support) even though not requiring the actual levying of any tax dollars. Continuation of this public posture toward lending credit support to the financing of regional airport infrastructure would provide a material assist in accomplishing a new airport project at the lowest possible cost.
- Building a new airport would probably require the early retirement of bonds issued for MSP, thereby (in theory) freeing up debt capacity that could be used for a new airport with no increase in taxpayer exposure.

A combined debt structure of pure revenue bonds and general obligation revenue bonds could have another important advantage -- the ability to demonstrate coverage of the senior lien revenue bond debt without having to fund coverage. Specifically, if MAC were to (1) issue pure revenue bond debt and general obligation revenue bond debt in the approximate ratio of 4:1, (2) subordinate the general obligation revenue bond debt to the pure revenue bond debt, and (3) assess rates, fees, and charges to at least cover all the operating and debt service costs of a new airport, it would generate sufficient net revenues to provide approximately 1.25x coverage of its pure revenue bond debt without having to fund coverage in the calculation of its rates, fees, and charges. (Many airport sponsors have to charge the airlines 1.25x debt service in the rate base each year in order to meet their rate covenants.) This type of debt structure could have an important benefit of reducing airline costs and keeping those costs in a reasonable range.

To illustrate this concept, consider a new airport project requiring the issuance of \$1,250 million of debt (at approximately 8 percent) and with annual operating expenses of \$100 million. If all of the debt were pure revenue bonds, the airport sponsor would be required to raise \$239 million in revenues to meet the rate covenant:

Revenues		\$239	million
Operating and maintenance expenses		<u>100</u>	
Net revenues	A	\$139	million
Debt service (8 percent over 30 years)	B	111	
Coverage	A/B	1.25x	

However, if \$250 million of subordinate general obligation revenue bonds were issued along with \$100 million of pure revenue bonds, the airport sponsor would only require \$211 million of revenues to meet the rate covenant on the senior lien revenue bond debt:

Revenues		\$211	million
Operating and maintenance expenses		100	
Net revenues	A	\$111	million
Debt service--pure revenue bonds	B	89	
Debt service--g.o. revenue bonds		22	
Coverage	A/B	1.25x	

These savings could either be passed along entirely to the users, or retained in part by the airport sponsor as an annual profit margin negotiated with the airlines for ongoing capital needs.

11.2.3 Fixed- Versus Variable-Rate Debt

One strategy for reducing overall borrowing costs and increasing flexibility is to use a combination of fixed- and variable- rate revenue bond debt. Fixed-rate debt minimizes interest exposure by locking in a known interest rate, thereby providing some assurance with regard to overall borrowing costs. Variable-rate debt has the advantages of lower interest rates and immediate "call provisions," which permit the issuer to repurchase outstanding bonds at par virtually at any time, should resources become available for such purpose. Fixed-rate bonds permit optional redemption (i.e., "calling" the bonds) only after 10 years from the date of issue.

Using a combination of fixed- and variable-rate bonds to finance a new airport project would serve two important purposes:

1. Reduced borrowing costs. Historically, in the tax-exempt securities market, short-term variable interest rates have been lower than long-term fixed rates. However, the savings in financing costs to the issuer from lower interest rates is accompanied by increased risk -- exposure to higher interest rates. Because of this risk, bond insurers and rating services generally prefer issuers to limit the

amount of variable-rate debt to no more than 25 percent of total outstanding debt.

2. Accelerated debt retirement. Depending upon the interest rate environment, it may be financially advantageous to the issuer after completion of the new airport to use surplus revenues and/or other funding sources not available during the early phases of new airport development (e.g., lagging federal grants under an LOI and proceeds from the disposition of the existing airport site) to retire variable-rate debt, and thereby reduce total debt service costs. By reducing the debt burden in this way, user fees and charges can be lowered and the issuer's exposure to interest-rate risk reduced.

The financing plan for the new airport in Denver includes a mix of fixed- and variable-rate bonds. Given the current cost estimates, construction schedule, and timing of non-debt funding sources, the City of Denver plans to issue a total of \$2.4 billion in tax-exempt airport revenue bonds in eight series from 1990 to 1992 -- four series of fixed-rate bonds and four series of variable-rate bonds. The financing plan calls for the City of Denver to gradually pay down the principal amount of variable-rate bonds from two sources:

1. Federal grants to be received under the FAA's LOI after completion of the new airport, and
2. 75 percent of the net proceeds from the disposition of Stapleton International (the remaining 25 percent dedicated to additional new airport capital improvements).

Thus, by utilizing variable-rate debt as a component of its financing plan, the issuer can enjoy the advantages of lower borrowing costs in the short term and greater flexibility over the long term.

11.2.4 Funding of Reserve Funds and Debt Service Coverage

As discussed previously, the 1986 Tax Act limits to 10 percent the amount of bond proceeds that may be applied toward funding reserve funds, effectively limiting the use of bond proceeds to funding a debt service reserve. As a result, airport sponsors need to develop alternative strategies for funding other reserve funds typically required in a revenue bond financing program (e.g., an operating and maintenance reserve and a renewal and replacement reserve).

One alternative is to fund such reserve requirement accounts through the airline rate base, either (1) in advance, prior to the completion of the project, or (2) after completion of the project. Another alternative is to fund reserve requirements from cash on hand or surplus revenues.

Debt service coverage is another funding requirement accompanying the use of general revenue bond debt. From the airport sponsor's point of view, it is advantageous to fund debt service coverage each and every year, since such funded coverage represents surplus cash flow that the sponsor can use to pay for further capital development. However, many airport sponsors negotiated arrangements with the airlines whereby the required coverage amount is funded only once, placed in a coverage account, and rolled over (i.e., counted as revenue each year thereafter) to meet the coverage requirement of the rate covenant. This latter technique has been used at several airports that have undertaken large development programs, such as Chicago-O'Hare International, Denver-Stapleton International, Charlotte-Douglas International, and Greater Pittsburgh International airports. As with reserve requirements, the source of funding for the coverage account is typically either (1) airline rates and charges, or (2) surplus revenues generated prior to the completion of the new facility.

These funding methods are illustrated by the following recent examples:

- Pittsburgh -- In conjunction with the financing of the midfield terminal at Greater Pittsburgh International Airport, the debt service reserve fund was funded from the net proceeds of bonds issued in 1988 and 1990. The operation and maintenance reserve fund and 50 percent of the required balance in the renewal and replacement fund are being funded prior to the date of beneficial occupancy (DBO) of the project through charges to the airline rate base. The remaining balance of the renewal and replacement fund will be funded over a five-year period following DBO through airline rates and charges. Debt service coverage is also being funded through charges to the airline rate base prior to DBO.
- Denver -- The financing plan for Denver's new airport provides for funding of debt service reserves from bond proceeds and required increases in the operating and maintenance reserve from Stapleton net revenues prior to completion of the new airport. Denver also is funding a debt service coverage account from Stapleton net revenues over a five-year period (1989-1993) prior to completion of the new airport.

11.2.5 Single vs. Multiple Issues

The decision to issue debt for a large project (either once in a single large issue or in several series over the construction timeframe) is related to risk and the cost of carrying debt. Issuing debt once in a single series (the strategy used in Pittsburgh) locks in the cost of borrowing and provides the airport sponsor with some insulation against market uncertainties, such as higher interest rates. However, the certainty associated with single debt issuance comes with the higher costs of (1) marketing a very large issue and (2) capitalizing more interest during the construction period. Given the general inability to

arbitrage unspent bond proceeds under current tax laws, there is usually a cost ("negative carry") associated with issuing debt well in advance of actual cash need.

Conversely, spreading bond issues over the new airport development timeframe, in a manner generally timed to actual cash needs, can significantly lower overall financing costs by reducing capitalized interest. Again, the advantages of lower financing costs and greater refunding flexibility are balanced by the inherent interest-rate risks of returning to the market to issue debt. As discussed previously, Denver plans to issue several series of bonds over the 1990-1992 timeframe to finance its new airport. The issues are timed to meet project funding requirements and should result in lower capitalized interest costs if market conditions remain stable.

For major new airport projects, the magnitude of the financing need will generally preclude single-issue financing from a marketability standpoint, and the longer construction period will usually result in the need to spread the financing over several issues to minimize negative carry.

11.2.6 Funding of Capitalized Interest

As a general rule, both case law and prevailing practice preclude airport sponsors from charging the costs of a major capital project to the users until the users have "beneficial occupancy" of the facilities. As a result, airports typically capitalize interest on bonds issued for major capital projects through the Date of Beneficial Occupancy (DBO) of the project. For a major project such as a new airport, capitalized interest will account for a significant portion of the total financing need -- perhaps as much as 30 percent of the principal amount of bonds.

The issuance of variable-rate debt, with the intent to convert the debt to fixed rate at the completion of the construction period, is a strategy that was used by the Sarasota-Manatee Airport Authority to reduce capitalized interest costs for its recently completed new terminal project.

The newly passed Airport Safety and Capacity Expansion Act of 1990 permits the use of PFC revenues to pay debt service on bonds issued for approved projects. A \$3.00 PFC dedicated to pay interest on debt prior to DBO could also reduce capitalized interest costs.

Another possible strategy for reducing capitalized interest costs might be to levy ad valorem taxes to pay interest on the general obligation revenue bonds during the period of construction of a new airport. The Airport Law states that any tax levies assessed for airport purposes be repaid from future revenues with an annual interest rate of 6 percent.

By virtue of its taxing authority, and with the support of the Legislature and the seven counties in the metropolitan area, MAC could levy taxes for a limited period (four to five years) to pay all or a portion of the interest during construction associated with the new

airport. The tax-generated revenues used to pay capitalized interest could be considered an outright "grant" (i.e., public investment) or preferably, upon DBO, the tax revenues could be repaid with interest over some period of time, say, 10 years. This approach would lower overall financing costs and thereby improve the economics of the new airport.

This approach was used by the Charleston County Aviation Authority (Charleston, South Carolina) in financing the new terminal complex at Charleston International Airport that was completed in 1985. In 1979, the Authority issued \$15.5 million of general obligation bonds for the project. The Authority committed to servicing the debt entirely from airport revenues after DBO of the terminal and properly structured the airline agreements to guarantee adequate revenues.

However, for the five-year period prior to DBO, Charleston County agreed to levy ad valorem taxes to pay interest on the bonds. Thus, the Authority and, in turn, the airline users of the airport were relieved of the obligation to fund interest during construction, thereby reducing overall borrowing costs. Charleston County agreed to be repaid over 20 years, beginning in FY 1986, from surplus airport revenues.

As previously mentioned, any ad valorem taxes assessed to help pay for new airport costs would, under the Airport Law, be considered as "advances" that must be repaid. Therefore, MAC could include the repayment cost in the airline rate base and recover this cost from the airlines after DBO.

11.2.7 Special Facility Revenue Bond Financing

Chapter 10 presented certain elements of a new airport project that might be financed with special facility bonds. This method of financing is particularly advantageous at airports which are used as hubs by financially strong carriers. The use of special facility revenue bonds allows the airport sponsor to further diversify its debt structure (thereby enhancing the creditworthiness of its general purpose revenue bonds) and insulate itself from the risk inherent in financing hubbing facilities (as opposed to facilities required to serve the origin-destination market).

However, with the declining financial health of the airline industry in general, there has been a recent trend toward using general purpose revenue bonds to finance facilities that otherwise might be considered "special facilities." Allegheny County recently financed nearly \$100 million of facilities for USAir, including a baggage transfer system and construction of various support facilities, at Greater Pittsburgh International Airport. The City and County of Denver has committed to finance up to \$100 million of bonds for support facilities (cargo building, maintenance hangar, and inflight kitchen) for Continental Airlines. The City of Houston is committed to issuing new third lien revenue bonds to help finance a new maintenance complex for Continental at Houston Intercontinental Airport.

Important issues for further consideration are the suitability of airline credits for airport tax-exempt financing in the future and the criteria to be used by airport sponsors in deciding between general purpose and special facility revenue bonds as a financing vehicle for certain types of projects.

- Suitability of Airline Credits. During the late 1980s, the wave of actual or threatened leveraged buyouts in the airline industry raised concerns as to the future costs and marketability of special facility revenue bonds. Investors in this type of debt were concerned with both the credit standing of the airlines and the liquidity of airline debt in secondary markets. These concerns continue as rising fuel costs and sluggish domestic traffic place financial strains on the airline industry and threaten the demise of several of the weaker airlines. The generally high level of indebtedness and the need to finance large numbers of new aircraft currently on order raise further questions regarding the acceptance of airline credits in the tax-exempt securities market in future years.

- Criteria for Using Special Facility Revenue Bonds. In general, airports enjoy higher credit ratings (and, therefore, lower financing costs) than airlines. Therefore, in the event a decision is made to proceed with a new airport, MAC can expect pressure from its airline tenants to provide financing for virtually all airline facilities at the new airport through general purpose revenue bonds (either pure revenue bonds or general obligation revenue bonds). However, the magnitude of financing needs associated with a new airport project argues for careful choices among financing options. Criteria for making such choices might include:
 1. Seek to diversify debt structure in order to preserve and enhance the creditworthiness of senior lien revenue bonds.
 2. Use general purpose revenue bonds only for facilities required to serve the local O&D market.
 3. Use special facility revenue bonds (or, as in the Houston example, a new type of subordinate-lien general-purpose revenue bonds) to finance (a) hubbing facilities (terminal gates, baggage transfer systems, etc.); (b) systemwide maintenance, training, and administrative facilities; and (c) exclusive-use support facilities (cargo buildings, inflight kitchens, equipment maintenance facilities, etc.).
 4. Consider use of general purpose revenue bonds for the purposes identified previously in (3) on a case-by-case basis if market conditions for special facility bonds limit market access or impose prohibitive costs on the particular airline.

In summary, MAC has previously set the precedent of using general purpose bonds for what are traditionally "special facilities" with the financing of Northwest's maintenance complex and hub terminal facilities at MSP. However, with the substantial amount of debt financing that would be required for a new airport, MAC may have to reconsider this practice and seriously consider using special facility revenue bonds for these types of facilities at the new airport.

11.3 MAXIMIZING FEDERAL AID

11.3.1 Multi-Year Letter of Intent

Securing a multi-year letter of intent (LOI) will be an important step in the financing of the new airport. The LOI will demonstrate a significant federal commitment to the project and, in turn, help to legitimize the project when MAC is ready to go to the bond market.

Historically, the ability of the FAA to issue multiple-year LOIs has been limited by continued appropriation of AIP funds at less than authorized levels, leading to limitations on the amount of discretionary funds remaining after allocation of appropriated moneys for entitlements and other set-asides. Provisions in the Airport Safety and Capacity Expansion Act of 1990, if extended to the new reauthorization bill in 1992, should correct these deficiencies over the longer term.

In 1989, the FAA Office of Airport Planning and Programming issued selection criteria to assist in prioritizing competing applications for capacity enhancement projects and allocation of discretionary funding through the LOI process. The purpose of developing and assigning numerical scores to criteria was to allow the FAA to rank-order projects according to (1) their effect on the overall national air transportation system, (2) the project benefit and cost, and (3) the financial commitment of the sponsor or other nonfederal funding sources to capacity enhancement. Because every capacity project is unique, a high numerical score does not necessarily guarantee a commitment of discretionary funding.

Under the ranking system, new airport projects receive the highest score under the benefit and cost criterion. Several airport sponsors have recently secured sizable LOIs for large-scale airport projects. These were previously reviewed in Chapter 10.

Several generalizations about the terms of an LOI can be noted:

1. The FAA takes into consideration the financial commitment of the airport sponsor in terms of public investment and other forms of local equity contributions in making long-term commitments through the LOI process. Most LOIs involve the multi-year commitment of the sponsor's entitlement funds to the project in return for the FAA's commitment of discretionary funds.

2. The period of the LOI is likely to extend well past the period of construction of the project, so as to reduce the FAA's annual commitment of discretionary dollars. This will require the airport sponsor to develop a specific strategy for using the lagging grants, such as paying down debt or phasing construction of some elements of the project over a longer period of time.
3. The sponsor will likely be required to assess a PFC as a condition of receiving the LOI, so a strategy for using PFC proceeds will be required.
4. An LOI will not be awarded until the record of decision is filed, in effect approving the Airport Layout Plan (ALP) and the final EIS.
5. The projects funded with LOIs will conform to the FAA's selection criteria priority rankings, with an emphasis on capacity enhancement projects. New airport projects can expect the highest consideration for LOI funding.
6. Although substantial in absolute terms, overall federal participation in large-scale new airport projects will probably not exceed 25 percent of the total project costs. This level of federal aid is generally far less than will be required for purely AIP-eligible project components. As a result, a larger portion of typically federal-funded costs (such as runways, taxiways, aprons) will have to be financed from other sources.
7. The success of an airport sponsor in obtaining an LOI is, in part, a function of the effectiveness of its lobbying efforts with Congress and the FAA. Once a commitment to proceed with a new airport is made, a lobbying strategy for federal funds should be given immediate priority.

A credible financing plan for a large project such as a new airport must be based on a long-term commitment of federal funds through an LOI, thereby providing assurance to the bond market at the outset that this important source of funding will be available in reasonably predictable amounts.

11.3.2 Future AIP Funding Levels and LOI Commitments

As mentioned earlier, the Airport Safety and Capacity Expansion Act of 1990 mandates full appropriation of authorized AIP funding levels of \$1.8 billion in FY 1991 and \$1.9 billion in FY 1992. Although the AIP or some similar program will likely be reauthorized in FY 1992, it is uncertain at this time what funding levels will be authorized by Congress.

Also, as the FAA continues to award multi-year LOIs to other airport sponsors, the capacity for new LOIs will be reduced, regardless of appropriation levels. This would argue for

moving ahead as quickly as possible with the project once a consensus is reached that a new airport is the appropriate long-term development strategy.

11.4 EQUITY FROM MSP

So that the return on the future disposition of MSP is maximized, the disposition should be accomplished over a relatively long period of time to allow market absorption at fair market value. It is unlikely, therefore, that MAC could realize all of the equity it has in MSP until many years after the opening of a new airport. One difficult aspect of the financing plan, therefore, is to devise a strategy to take into consideration as much of the equity of the existing site as possible even though these funds would not be available at the time a new airport is constructed.

The issue of disposing of airport property involves a trade-off between immediate access to capital (by selling property all at once at whatever the market will bear) and maximizing total return (by leasing/selling parcels over time as can be absorbed by the market at fair market rates). Because airports involve relatively large land areas, attempts to sell the entire parcel at one time could flood the real estate market and result in significantly lower overall return.

The strategy to be used in disposing of an existing airport must be incorporated into the financing plan for a new airport. Denver has agreed to sell, lease, or otherwise dispose of Stapleton at fair market value, subject to existing deed restrictions, and to apply 75 percent of the net proceeds to pay off variable-rate bonds issued for the new airport. (The remaining 25 percent will be reserved for capital improvements at the new airport.) A combined fixed-rate/variable debt structure was built into the financing plan for this purpose.

Another complication is that airport land may have been acquired from the federal government and be encumbered with deed restrictions. Also, FAA grant agreements often include certain restrictions that limit the application of proceeds of land purchased with federal funding. In many instances, however, land purchased with AIP grants can be disposed of at fair market value so long as the proceeds are applied to airport system projects. Two such cases involve the cities of Denver and Atlanta.

- Denver -- Approximately 37 percent of the property at Stapleton International Airport was deeded to the City and County of Denver by the federal government to be used for airport purposes. The deeds contained a reverter clause, which requires that land no longer needed for airport purposes would revert to the federal government. Denver, through federal legislation, has been given conditions of release from the reverter clause in the deeds. The release provides that the land must be sold or leased at fair market value and all proceeds from the disposition of Stapleton property be used for airport purposes at the new airport.

- Atlanta -- In 1984, the City of Atlanta entered into a Memorandum of Agreement with the FAA regarding the resale of land acquired with federal participation for noise compatibility or approach protection. Terms of the Agreement require the City to (1) receive fair market value for the property, (2) use net proceeds from sale of such land on a non-matching fund basis for an FAA-approved noise compatibility program or other AIP-eligible airport development, and (3) include in all deeds FAA-approved covenants restricting development of land in a manner consistent with airport purposes. The FAA also reserved the right to review and approve any transfer.

Minnesota statute 473.621, Subdivision 5, requires special treatment of land no longer used for airport purposes:

In the event that airport land owned by either city [Minneapolis or St. Paul] should no longer be used for airport purposes, the corporation's [MAC's] control thereof shall cease, and title to the land and all improvements shall be and remain in the city, but the city shall become liable to the corporation for the repayment, without interest, of an amount of the taxes so paid which is proportionate to its own share of the cities' original investment . . . [60 percent for Minneapolis and 40 percent for St. Paul]

Minnesota statutes state that income from the disposal of other land or improvements owned or controlled by MAC no longer used for airport purposes shall continue to be used for purposes of the metropolitan airports system. Given the restrictions of this section, the ownership of all MSP land and improvements should be reviewed to accurately assess MAC's ability to obtain the use of the proceeds from any future disposition of the airport.

11.5 MAXIMIZING INTERNAL CASH FLOW

As demonstrated in other new airport development projects, the ability of the airport sponsor to generate and accumulate internally generated cash flow (revenues in excess of operating expenses and debt service requirements) is very important in getting the project off the ground. Once a policy decision is made to construct a new airport, several strategies may become important:

- Limit further capital investment at Minneapolis-St. Paul International in order to preserve funds for new airport development.
- Reassess rate policies and accelerate amortization of existing assets, if possible, to recover costs as quickly as possible and enhance cash flow prior to DBO.
- Develop a plan for retiring existing debt on or before DBO, if necessary.

- Dedicate internal cash flow to front-end costs of new airport development so as to defer debt issuance as long as possible (thereby minimizing capitalized interest costs).

Table 10-1 (in Chapter 10) presents projections of MAC surplus net revenues for the seven-year period, 1991-1997. The projections indicate that as much as \$81 million in surplus net revenues may be generated after the payment of operating expenses and debt service prior to commencement of development of a new airport. Additional surplus revenues would be available during construction of the new airport in the late 1990s. If development of a new airport is selected, some portion of these surplus revenues should be reserved each year to build up a capital fund for new airport development.

11.6 FUNDING FRONT-END COSTS

If a decision is made to move forward with a new airport, MAC will require substantial funding for initial program management and scheduling, preliminary engineering and design, land acquisition, and administrative expenses. MAC will have to incur these front-end costs in order to define the scope and cost of the project, obtain a federal funding commitment, acquire the site, and otherwise position itself to go to the bond market to finance final design and construction.

As discussed previously, because of the sizable funding requirements of these elements, MAC should anticipate the need to have a funding strategy in place. The likely sources of funds for such front-end costs are:

- Internally generated cash flow
- Revenues generated from a PFC
- Bonds (for land acquisition) that can be paid from net revenues at MSP (not through airline rates and charges)

11.7 FUNDING LAND ACQUISITION

If a decision is made to proceed with a new airport, MAC should move expeditiously to acquire the site in order to freeze land costs and minimize speculation. However, the timing of this crucial element early in a new airport project presents two funding problems:

- Federal grants cannot be obtained for land acquisition until the FAA's Record of Decision on the EIS is filed.

- MAC will likely be precluded from including new airport land acquisition costs in the airline rate base at MSP.

If MAC were to elect to begin land acquisition prior to the Record of Decision, it is likely that bonds would have to be issued for that purpose, with debt service on the bonds carried from surplus net revenues at MSP prior to DBO (and from new airport revenues thereafter). Upon approval of the EIS and the filing of the Record of Decision, MAC would be able to apply immediately for federal reimbursement for land already acquired, and then use those funds for the initial phase of design and construction. This is the approach used by the City and County of Denver for its new airport project.

If MAC were to wait until after the Record of Decision to begin land acquisition, it could use federal grant moneys to fund most of the land acquisition costs, with matching funds provided from internal cash flow and/or PFC revenues. However, the cost of the land could be higher under this scenario because of the delay in proceeding.

The timing and financing of the land acquisition program will be an important issue to be addressed in the overall financing plan for the project.

Chapter 12

Cost and Funding

12.1 COST

Following the development of the Conceptual Design Plan, a cost estimate was prepared. Many of the new airport costs are very uncertain. Since this study is being carried out without definition of a specific site, costs such as land acquisition, utilities, and off-site access cannot be accurately determined. For this reason, a range of costs was developed in these areas. Estimates of the costs for airfield and terminal facilities are more accurate; however, even here, the level of detail in the Conceptual Design Plan is very general and costs must be viewed in this context. After a specific site has been selected, and a development plan for that site has been prepared, a level of detail will exist that allows a cost estimate with a greater degree of accuracy to be prepared.

Since the cost estimate is expressed in 1990 dollars, project costs will be subject to inflation from 1990 to the actual period of construction. For the purposes of this analysis, it was assumed that land acquisition would begin in 1998 and that the project would be completed during the 1999-2003 period, with a date of beneficial occupancy of January 1, 2004.

If a decision is reached to proceed with a new airport, it is important to plan the construction of the project over a short time frame in order to minimize financing costs. The cost of capitalizing interest during construction of a major project is a significant element of the financing cost. For example, the estimated cost of capitalizing interest on bonds for the new Denver airport project is forecast to exceed the entire cost of the Dallas/Fort Worth International Airport built 20 years earlier. Therefore, if a decision to proceed is made, it is in MAC's interest to carry out the financing and construction of the project over the shortest possible time frame.

Project costs shown in Table 12-1 do not include inflation during the 1995-2003 period. When inflation is considered, the resultant total cost estimates are summarized as follows:

<u>Rate of inflation</u>	<u>Low cost estimates (in millions)</u>	<u>High cost estimates (in millions)</u>
0%	\$3,735	\$4,128
2	4,619	5,094
4	5,690	6,262

Table 12-1
Cost Estimate

	Costs ¹
Site Acquisition:²	\$94,400,000 - \$288,600,000
Site Preparation:	\$300,000,000
Airside Facilities:	
Runways	\$120,000,000
Taxiways	200,000,000
Aprons	200,000,000
Navigational Aids	40,000,000
Perimeter Road	<u>15,000,000</u>
Total	\$575,000,000
Landside Facilities - Terminal Area:	
Terminal Building ³	\$341,900,000
Automated People-Mover System	<u>182,400,000</u>
Total	\$524,300,000
Landside Facilities - Surface Access:	
Public Access Roadways ⁴	\$287,100,000 - \$387,200,000
Service Roads	<u>45,300,000</u>
Total	\$332,400,000 - \$432,500,000
Landside Facilities - Parking:	
Public and Employee Parking ⁵	\$137,600,000 - \$196,400,000
Public Transportation Parking ⁶	<u>23,500,000</u>
Total	\$161,100,000 - \$219,900,000
Support Facilities:	
Airline Maintenance and Support ⁷	\$694,800,000
Air Cargo ⁸	57,700,000
Military ⁹	100,000,000
Fuel Storage and Distribution	23,100,000
General Aviation	15,400,000
Rental Car Storage and Service	13,800,000
Airport Support ¹⁰	23,100,000
Federal Services ¹¹	<u>26,900,000</u>
Total	\$954,800,000

(continued)

Table 12-1

Cost Estimate
(continued)

		Costs ¹
Utility Infrastructure: ¹²		
Water Supply and Distribution		\$20,000,000
Wastewater Collection and Treatment		20,000,000
Stormwater Retention and Treatment		<u>25,000,000</u>
Total		\$65,000,000
Total (excluding Site Acquisition)	\$2,912,600,000 - \$3,071,500,000	
Total plus Fees and Contingency at 25%	\$3,640,700,000 - \$3,839,400,000	
Site Acquisition	\$94,400,000 - \$288,600,000	
TOTAL PROJECT COST ¹³	\$3,735,100,000 - \$4,128,000,000	

Notes:

1. Costs based on Runway Layout Alternative T-1 and Terminal Configuration Alternative 4B.
2. Preliminary cost estimates for land acquisition were prepared by Robert Boblett Associates, Inc., based upon an analysis of land sales and generalized land uses in townships located within the proposed Metropolitan Council search areas. The large range represents uncertainties regarding the following factors: (1) acreage requirements (15,000-30,000 acres); (2) differing land values in northern vs. southern areas; (3) presence or absence of residential, commercial, or industrial developments; (4) relocation requirements; (5) valuation uncertainties, legal fees, and other costs potentially associated with condemnation proceedings; and (6) inability to prevent land speculation occurring between now and the ultimate date of acquisition. There has been no attempt to factor inflation into the analysis.
3. Includes new Central Plant sized to serve Terminal Building(s). Excludes automobile parking and curbside circulation roads.
4. The lower cost alternative assumes upgrading of one major connection to the regional surface transportation system. The higher cost alternative assumes upgrading of two such connections.
5. The lower cost alternative assumes a freestanding parking structure; the higher cost alternative assumes auto parking is located above the CPU. The only employee parking requirements included in this cost are for terminal building employees.
6. Public transportation loading and queuing area assumed to be located on the third level of the terminal building.

Table 12-1
Cost Estimate

Notes (continued):

7. Includes ground service equipment, cabin service, flight kitchens, and aircraft maintenance.
8. Includes scheduled airlines, all-cargo carriers, small-package carriers, and freight forwarders. Required taxiways and taxiway connections are also included.
9. Includes on-airport Navy Marine Corps Reserve, Air Force, Air National Guard, and officers' mess and firing range. Excludes off-airport Army and Navy facilities.
10. Includes Aircraft Rescue and Firefighting (ARFF) building and equipment, MAC administrative offices, MAC airport maintenance facilities, monitoring equipment for air, water, and noise, and a public safety facility.
11. Includes air traffic control tower (ATCT) and space for the Weather Bureau, FAA administrative offices, FAA shops, and the U.S. Post Office.
12. Assumes electric and gas service and telecommunication infrastructure will be provided by the respective suppliers.
13. Project cost equals construction cost plus fees and contingencies.

12.2 SOURCES OF FUNDS

The assumptions underlying the sources of funds for the new airport are presented in Table 12-2. Tables 12-3 and 12-4 present projections of potential sources of funding for a new airport. Table 12-3 summarizes the low cost estimate and Table 12-4 summarizes the high cost estimate. These tables and the discussion which follows illustrate one potential approach (i.e., set of assumptions) for funding a new airport. They are not a specific recommended strategy. The major sources of funding include:

- AIP grants-in-aid
- Passenger facility charge (including the net proceeds of bonds secured by PFC revenues)
- Net cash flow from the existing airport system during the 1995-2003 period
- The net proceeds of special facility revenue bonds issued for the airline maintenance facilities element of the project
- Tenants
- The federal government
- Other state and local agencies, particularly for access improvements
- The net proceeds of additional general obligation revenue bonds by MAC
- The net proceeds of new airport system revenue bonds issued by MAC

The major assumptions and annual cash flows associated with certain of the funding sources are summarized in Table 12-2. Each is discussed in the following paragraphs.

12.1.1 AIP Grants-in-Aid

The estimated amount of AIP grants-in-aid represents both entitlement funds and discretionary funds (assumed to be received under a Letter of Intent) during the 1998-2003 period. It is assumed that all AIP funds during the 1991-1997 period would be used for projects at MSP and elsewhere in the airport system operated by MAC. Beyond 1997, it was assumed that 80 percent of MAC's entitlement funds will be reserved for the new airport. (As discussed subsequently, it was assumed that MAC will assess a passenger facility charge as of January 1, 1998, and therefore lose 50 percent of its entitlement funds as required under current law.)

Table 12-2

FUNDING AND CASH FLOW ASSUMPTIONS
(dollar amounts in thousands)

Economic -----		Federal Grants-in-Aid -----	
Rate of inflation	0.0%	AIP Letter of Intent--annual discretionary grants (1999-2003)	\$40,000
Schedule milestones -----		MAC Resources -----	
Decision to proceed and environmental approval (Record of Decision)	January 1, 1998	Principal amount of G. O. Revenue Bonds authorized for New Airport	\$500,000
Land acquisition completed	January 1, 1999	Annual cash flow from Existing Airport System	
Date of Beneficial Occupancy (DBO)	January 1, 2004	Total	
Passenger Facility Charges (PFCs) -----		1991-1994	\$10,000
PFC rate	\$3.00	1995-1998	10,000
PFC collection fee	10.0%	1999-2005	15,000
PFC bond rate covenant	1.75 x	Amount reserved for New Airport Project:	
PFC bond interest rate	8.0%	1991-1994	0% of cash flow
PFC bond term	15 years	1995-1998	50% of cash flow
		1999-2005	100% of cash flow
			\$ --
			5,000
			15,000

(continued)

Table 12-2 (Page 2 of 2)
 FUNDING AND CASH FLOW ASSUMPTIONS
 (in thousands)

	Estimated 1990	Projected									
		1995	1996	1997	1998	1999	2000	2001	2002	2003	
Cash Flow from Operations											
Net cash flow from Existing Airport System	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	
less: amount spent for Existing Airport System	10,000	5,000	5,000	5,000	5,000	--	--	--	--	--	
Amount reserved for New Airport development	\$ --	\$5,000	\$5,000	\$5,000	\$5,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	
Cumulative total--1995 through 1998					\$20,000						
Cumulative total--1999 through 2003										\$75,000	
AIP grants-in-aid											
Entitlements											
Existing Airport System	4% increase	\$7,000	\$8,517	\$8,857	\$9,212	\$958	\$996	\$1,036	\$1,078	\$1,121	\$1,166
Reserved for New Airport (a)		--	--	--	--	3,832	3,985	4,145	4,310	4,483	4,662
Discretionary (LOI) for New Airport		--	--	--	--	--	40,000	40,000	40,000	40,000	40,000
Cumulative total--1998-2003											\$225,418
Passenger Facility Charges											
Enplaned passengers (b)	8,500	12,357	12,848	13,358	13,888	14,440	15,013	15,263	15,517	15,775	
Average growth rate		7.77%					3.97%			1.66%	
PFC amount (effective 1/1/92)		--	--	--	\$3.00	\$3.00	\$3.00	\$3.00	\$3.00	\$3.00	
Gross PFC income		--	--	--	41,665	43,319	45,039	45,788	46,550	47,324	
less: Collection fee of 10%		--	--	--	(4,166)	(4,332)	(4,504)	(4,579)	(4,655)	(4,732)	
Net PFC income to Commission		\$ --	\$ --	\$ --	\$37,498	\$38,987	\$40,535	\$41,209	\$41,895	\$42,592	
PFC bonding capacity											
Assumed PFC bond rate covenant					1.75 x						
PFC income available for debt service					21,427						
Debt service factor					0.1168						
PFC bonding capacity in 1998					\$183,408						
less: issuance expenses					(1,834)						
less: debt service reserve					(21,427)						
Available net proceeds					\$160,147						
Interest income on PFC reserve fund		\$ --	\$ --	\$ --	\$1,500	\$1,500	\$1,500	\$1,500	\$1,500	\$1,500	
Annual debt service on PFC bonds		--	--	--	(21,427)	(21,427)	(21,427)	(21,427)	(21,427)	(21,427)	
Remaining net PFC income available for Project		--	--	--	17,571	19,059	20,608	21,282	21,967	22,664	
Cumulative total--1998-2003 for New Airport										\$123,151	

- a. Assuming 80% of entitlement moneys dedicated to new airport development.
 b. Annual enplaned passenger projections interpolated from 5 year forecasts presented in Chapter 5, Table 5-4.

Source: KPMG Peat Marwick.

Inflation rate: 0.0%
 Years to midpoint:
 Land acquisition 8 1.000
 Site development 9 1.000
 Construction 11 1.000

Table 12-3
 COST AND SOURCES OF FUNDING
 LOW COST ESTIMATE
 (in thousands)

Project Element	Years to Midpoint of Construction	Base-Year Cost Estimate	Reallocate Fees and Contingencies	Restated Base-Year Cost Est	Escalated Cost Estimate	Sources of Funding									Total	
						AIP Grants-in-Aid	Passenger Facility Charges	Airport System Cash Flow	Special Facility Rev Bonds	Direct Tenant Funding	Direct Federal Funding	Other State & Local Agencies	General Obligation Rev Bonds	Airport System Rev Bonds		
SITE ACQUISITION	8	\$94,400	\$ --	\$94,400	\$94,400		\$94,400								\$0	\$94,400
CONSTRUCTION																
Site development	9	300,000	75,000	375,000	375,000	\$112,709	28,945	\$14,557						\$45,609	173,180	375,000
Airfield																
Runways	11	\$120,000	\$30,000	\$150,000	\$150,000											
Taxiways	11	200,000	50,000	250,000	250,000											
Aprons	11	200,000	50,000	250,000	250,000											
Navigational aids	11	40,000	10,000	50,000	50,000											
Perimeter road	11	15,000	3,750	18,750	18,750											
		\$575,000		\$718,750	\$718,750	112,709	55,479	27,901						87,417	\$435,244	\$718,750
Terminal																
Terminal building	11	\$341,900	\$85,475	\$427,375	\$427,375											
Automated people mover system	11	182,400	45,600	228,000	228,000											
Public transportation parking/queuing	11	23,500	5,875	29,375	29,375											
		\$547,800		\$684,750	\$684,750		52,854	26,581						83,282	\$522,032	\$684,750
Access and parking																
Public access roadways	11	\$287,100	\$71,775	\$358,875	\$358,875		27,701	13,931				179,438	43,648	94,158	\$358,875	
Service roads	11	45,300	11,325	56,625	56,625		4,371	2,198					6,887	43,169	56,625	
Public and employee parking	11	137,600	34,400	172,000	172,000		13,276	6,677					20,919	131,127	172,000	
		\$470,000		\$587,500	\$587,500											
Support facilities																
Airline maintenance and support	11	\$694,800	\$173,700	\$868,500	\$868,500				\$868,500						\$0	\$868,500
Air cargo	11	57,700	14,425	72,125	72,125										72,125	72,125
Military	11	100,000	25,000	125,000	125,000						\$125,000			0	125,000	
Fuel storage and distribution	11	23,100	5,775	28,875	28,875										28,875	28,875
General aviation	11	15,400	3,850	19,250	19,250										19,250	19,250
Rental car storage and service	11	13,800	3,450	17,250	17,250										17,250	17,250
Airport support	11	23,100	5,775	28,875	28,875										28,875	28,875
Federal services	11	26,900	6,725	33,625	33,625						33,625			0	33,625	
		\$954,800		\$1,193,500	\$1,193,500											
Utility infrastructure																
Water supply and distribution	11	\$20,000	\$5,000	\$25,000	\$25,000											
Wastewater collection and treatment	11	20,000	5,000	25,000	25,000											
Stormwater retention and treatment	11	25,000	6,250	31,250	31,250											
		\$65,000		\$81,250	\$81,250		6,272	3,154						9,882	61,942	81,250
Subtotal--construction		\$2,912,600	\$728,150	\$3,640,750	\$3,640,750	\$225,418	\$188,898	\$95,000	\$868,500	\$0	\$158,625	\$179,438	\$297,645	\$1,627,228	\$3,640,750	
Fees and contingencies at 25.0%		728,150	(728,150)	0	0											
Total project cost (excluding land acquisition)		\$3,640,750	\$0	\$3,640,750	\$3,640,750	\$225,418	\$188,898	\$95,000	\$868,500	\$0	\$158,625	\$179,438	\$297,645	\$1,627,228	\$3,640,750	
Total project cost (including land acquisition)		\$3,735,150		\$3,735,150	\$3,735,150	\$225,418	\$283,298	\$95,000	\$868,500	\$0	\$158,625	\$179,438	\$297,645	\$1,627,228	\$3,735,150	
Percent of total sources of funding						6.0%	7.6%	2.5%	23.3%	0.0%	4.2%	4.8%	8.0%	43.6%	100.0%	

Source: KPMG Peat Marwick.

Inflation rate:	0.0%	
Years to midpoint:		
Land acquisition	8	1,000
Site development	9	1,000
Construction	11	1,000

Table 12-4
COST AND SOURCES OF FUNDING
HIGH COST ESTIMATE
 (in thousands)

Project Element	Years to Midpoint of Construction	Base-Year Cost Estimate	Reallocate Fees and Contingencies	Restated Base-Year Cost Est	Escalated Cost Estimate	Sources of Funding								Total	
						AIP Grants-in-Aid	Passenger Facility Charges	Airport System Cash Flow	Special Facility Rev Bonds	Direct Tenant Funding	Direct Federal Funding	Other State & Local Agencies	General Obligation Rev Bonds		Airport System Rev Bonds
SITE ACQUISITION	8	\$288,600	\$ --	\$288,600	\$288,600		\$283,298	\$5,302						\$0	\$288,600
CONSTRUCTION															
Site development	9	300,000	75,000	375,000	375,000	\$112,709	0	12,713					42,185	207,393	375,000
Airfield															
Runways	11	\$120,000	\$30,000	\$150,000	\$150,000										
Taxiways	11	200,000	50,000	250,000	250,000										
Aprons	11	200,000	50,000	250,000	250,000										
Navigational aids	11	40,000	10,000	50,000	50,000										
Perimeter road	11	15,000	3,750	18,750	18,750										
		\$575,000		\$718,750	\$718,750	112,709	0	24,366					80,855	500,820	718,750
Terminal															
Terminal building	11	\$341,900	\$85,475	\$427,375	\$427,375										
Automated people mover system	11	182,400	45,600	228,000	228,000										
Public transportation parking/queuing	11	23,500	5,875	29,375	29,375										
		\$547,800		\$684,750	\$684,750	0	0	23,214					77,030	584,506	684,750
Access and parking															
Public access roadways	11	\$387,200	\$96,800	\$484,000	\$484,000	0	0	16,408				242,000	54,447	171,145	484,000
Service roads	11	45,300	11,325	56,625	56,625	0	0	1,920					6,370	48,335	56,625
Public and employee parking	11	196,400	49,100	245,500	245,500	0	0	8,323					27,617	209,560	245,500
		\$628,900		\$786,125	\$786,125										
Support facilities															
Airline maintenance and support	11	\$694,800	\$173,700	\$868,500	\$868,500				868,500					0	868,500
Air cargo	11	57,700	14,425	72,125	72,125									72,125	72,125
Military	11	100,000	25,000	125,000	125,000						125,000			0	125,000
Fuel storage and distribution	11	23,100	5,775	28,875	28,875									28,875	28,875
General aviation	11	15,400	3,850	19,250	19,250									19,250	19,250
Rental car storage and service	11	13,800	3,450	17,250	17,250									17,250	17,250
Airport support	11	23,100	5,775	28,875	28,875									28,875	28,875
Federal services	11	26,900	6,725	33,625	33,625						33,625			0	33,625
		\$954,800		\$1,193,500	\$1,193,500	0	0	0						0	
Utility infrastructure															
Water supply and distribution	11	\$20,000	\$5,000	\$25,000	\$25,000										
Wastewater collection and treatment	11	20,000	5,000	25,000	25,000										
Stormwater retention and treatment	11	25,000	6,250	31,250	31,250										
		\$65,000		\$81,250	\$81,250	0	0	2,754						9,140	69,355
Subtotal--construction		\$3,071,500	\$767,875	\$3,839,375	\$3,839,375	\$225,418	\$0	\$89,698	\$868,500	\$0	\$158,625	\$242,000	\$297,645	\$1,957,490	\$3,839,375
Fees and contingencies at 25.0%		767,875	(767,875)	0	--	--	--	--	--	--	--	--	--	--	--
Total project cost (excluding land acquisition)		\$3,839,375	\$0	\$3,839,375	\$3,839,375	\$225,418	\$0	\$89,698	\$868,500	\$0	\$158,625	\$242,000	\$297,645	\$1,957,490	\$3,839,375
Total project cost (including land acquisition)		\$4,127,975			\$4,127,975	\$225,418	\$283,298	\$95,000	\$868,500	\$0	\$158,625	\$242,000	\$297,645	\$1,957,490	\$4,127,975
Percent of total sources of funding						5.5%	6.9%	2.3%	21.0%	0.0%	3.8%	5.9%	7.2%	47.4%	100.0%

Source: KPMG Peat Marwick.

It was further assumed that MAC will be successful in obtaining a multi-year Letter of Intent from the FAA in the total amount of \$200 million over the five-year construction period, 1999-2003, and that all of these funds will be committed to the new airport. This results in total AIP grants-in-aid of \$225 million available for a new airport during the 1998-2003 period. It was assumed that these federal funds will be used to fund the project elements that have the highest priority for federal funding under the AIP, namely airfield and site development.

12.2.2 Passenger Facility Charge

It was assumed that MAC will assess a passenger facility charge (PFC) effective January 1, 1998, in the amount of \$3.00 per enplaned passenger. The projection of PFC revenue in Table 12-2 is based on the forecasts of passenger traffic presented in Chapter 5. In the projection of annual PFC income, it was assumed that a 10 percent collection fee will be assessed by the airlines for administering the collection of the PFC.

It was then assumed that, as of January 1, 1998, coincident with a decision to proceed with the development of a new airport, MAC will issue bonds secured by PFC income to finance front-end costs of the project. The second page of Table 12-2 shows the projected net proceeds of such PFC bonds that might be made available.

It was assumed that PFC bond financing would require a rate covenant of 1.75 times. As a result, each year MAC will generate PFC income in excess of the debt service requirements on its PFC bonds. It was assumed that this remaining net PFC income during the 1998-2003 period will be available for new airport development.

Under these assumptions, the total amount of PFC income potentially available for the project was estimated to be approximately \$283 million over the 1998-2003 period. It was assumed that priority will be given to the use of PFC funds for site acquisition. Thereafter, PFC income will be prorated among all of the other elements of the project, except for support facilities.

12.2.3 Special Facility Revenue Bonds

A major cost of new airport development is the airline maintenance facilities required to replace existing ones at MSP. Because of the magnitude of these costs, it is unlikely that MAC will pledge its general revenue bonding credit for such facilities. Consequently, in Tables 12-3 and 12-4, it was assumed that the airline maintenance facilities will be financed in their entirety with the net proceeds of special facility revenue bonds. These will be issued on the basis of net leases with particular airline tenants.

12.2.4 Tenants

While it is possible that some elements of the new airport (such as concession space in the terminal, rental car service and storage facilities, and certain air cargo facilities) might be developed directly by tenants, it was assumed that all such facilities will be financed by MAC as part of the overall bond financing program. Therefore, no funding from tenants was assumed in Tables 12-3 and 12-4.

12.2.5 The Federal Government

It was assumed that all federal and military facilities located at the new airport will be funded and paid for directly by the federal government.

12.2.6 Other State and Local Agencies

The public access roadway element of the project includes the development of access roads from major arterial highways to the new airport site. It was assumed that these off-airport access costs will be funded by other State and local (and perhaps federal) agencies as part of the regional highway network. In Tables 12-3 and 12-4, it was assumed that these off-airport highway costs will amount to 50 percent of the total cost for public access roadways.

12.2.7 General Obligation Revenue Bonds

It is unlikely that the State of Minnesota and the political jurisdictions in the metropolitan area will lend their general obligation credit to the entire financing requirements of a project as large as a new air carrier airport. However, as described earlier, there are considerable financing advantages to MAC if a portion of the overall financing requirements of the project were met with general obligation revenue bonds. It was assumed that the State and local jurisdictions will authorize up to \$500 million of new general obligation revenue bonds to pay for a new airport (with the understanding that all existing or outstanding general obligation revenue bonds associated with MSP will be refunded or defeased on or before the Date of Beneficial Occupancy (DBO) of the new airport).

It is envisioned that the new general obligation revenue bonds will be issued early in the overall financing program to provide funding for front-end costs. As a result, it will be necessary to capitalize interest on these bonds for a fairly extensive period of time, perhaps as much as four years. Assuming the issuance of \$500 million of general obligation revenue bonds on January, 1998, and allowing for payment of issuance expenses, funding of a one-year sinking fund reserve, and funding of four years capitalized interest, approximately \$298 million of net proceeds will be provided for the project. In Tables 12-3 and 12-4, it

was assumed that these net proceeds will be allocated on a pro rata basis to all elements of a new airport other than support facilities.

12.2.8 Airport System Revenue Bonds

On the basis of the assumptions described previously and in Table 12-2, MAC will have to raise approximately \$1,627 million of net proceeds of airport system revenue bonds in order to finance the remaining portion of a new airport under the low cost estimate, and \$1,957 million under the high cost estimate. Again, in Tables 12-3 and 12-4 no inflation is assumed during the nine-year projection period.

12.3 USE OF FINANCIAL INFORMATION

Once again, the preceding discussion and the projections in Tables 12-3 and 12-4 illustrate only one possible approach for funding a new airport. If a decision is reached to construct a new air carrier airport, it will be appropriate to develop a funding and financing plan and to assess the implications of the funding requirements on future airline rates and charges and overall airport cash flow and debt service coverage. The assumptions used in this chapter and the projections of funding sources are consistent with those used in Denver for the new airport under construction there. It is, however, not possible at present to assess the potential feasibility of the project or the reasonableness of the resultant fees and charges to the airlines. Those judgments can only be based on further analysis after the scope, costs, schedule, and potential funding sources for the project are further defined.

Glossary

AAAE - American Association of Airport Executives.

AC - Advisory Circular.

ACTIVITY - Used in aviation to refer to any kind of movement, e.g., cargo flights, passenger flights, or passenger enplanements. Without clarification it has no specific meaning.

ADF - Automatic Direction Finder.

AGL - Above Ground Level.

AIP - Airport Improvement Program.

AIR CARGO - All commercial air express and air freight with the exception of air mail and air parcel post.

AIR NAVIGATION FACILITY (NAVAID) - Although generally referring to electronic radio wave transmitters (VOR, NDB, ILS), it also includes any structure or mechanism designed to guide or control aircraft involved in flight operations.

AIR ROUTE TRAFFIC CONTROL CENTER (ARTCC) - FAA-manned facility established to provide air traffic control services to aircraft operating in controlled airspace, en route between terminal areas. Although designed to handle aircraft operating under IFR conditions, some advisory services are provided to participating VFR aircraft when controller work loads permit.

AIR TAXI - An air carrier certificated in accordance with FAR Part 135 and authorized to provide, on demand, public transportation of persons and property by aircraft. Generally operate small aircraft "for hire" for specific trips.

AIR TRAFFIC HUB - Air traffic hubs are not airports; they are the cities and Metropolitan Statistical Areas requiring aviation services and may include more than one airport. Communities fall into four classes as determined by each community's percentage of the total enplaned passengers by scheduled air carriers in the 50 United States, the District of Columbia, and other U.S. areas designated by the Federal Aviation Administration. Hub designations are determined by the following criteria.

1. Large Hub: 1.00 percent.
2. Medium Hub: 0.25 percent to 0.999 percent.
3. Small Hub: 0.05 percent to 0.249 percent.
4. Nonhub: Less than 0.05 percent.

AIRCRAFT GATE POSITION - An aircraft operational stand close to the terminal building and related to a specific passenger loading gate.

AIRCRAFT MIX - The classification of aircraft into groups which are similar in size, noise, and operational characteristics. (See also FLEET MIX.)

AIRCRAFT OPERATIONS - The airborne movement of aircraft. There are two types of operations: local and itinerant.

1. LOCAL OPERATIONS are performed by aircraft which:
 - (a) operate in the local traffic pattern or within sight of the airport;
 - (b) are known to be departing for or arriving from flights in local practice areas located within a 20-mile radius of the airport;
2. ITINERANT OPERATIONS are all aircraft operations other than local operations.

AIRCRAFT TYPE - A distinctive model of aircraft, as designated by the manufacturer.

AIRFIELD - A defined area on land or water including any buildings, installations, and equipment intended to be used either wholly or in part for the arrival, departure, and movement of aircraft.

AIRLINE OPERATIONS AREA - An area close to the aircraft gate position(s) required for the airline operations personnel and equipment.

AIRPORT, BASIC UTILITY: STAGE I - This type of airport serves about 75 percent of the single-engine and small twin-engine airplanes used for personal and business purposes. Precision approach operations are not usually anticipated. This airport is designed for small airplanes in Airplane Design Group I.

AIRPORT, BASIC UTILITY: STAGE II - This type of airport serves all the airplanes of Stage I, plus some small business and air taxi-type twin-engine airplanes. Precision approach operations are not usually anticipated. This airport is also designed for small airplanes in Airplane Design Group I.

AIRPORT, GENERAL UTILITY: STAGE I - This type of airport serves small airplanes. Precision approach operations are not usually anticipated. This airport is also designed for small airplanes in Airplane Design Group I.

AIRPORT, GENERAL UTILITY: STAGE II - This type of airport serves large airplanes in Aircraft Approach Category A and B and usually has the capability for precision approach operations. This airport is normally designed for airplanes of Airplane Design Groups I and II. It may also be designed to serve Aircraft Approach Category A large airplanes in Airplane Design Group III. While runways serving or expected to serve large airplanes may be built to utility airport standards, they are considered as other than utility runways in aeronautical studies.

AIRPORT ROADS - A network of public and non-public roads within the airport boundary providing access to the various airport buildings or areas.

AIRPORT SERVICE AREA - The geographic area that generates demand for aviation services at an airport.

AIRPORT SURVEILLANCE RADAR (ASR) - Radar providing position of aircraft by azimuth and range data without elevation data. It is designed for a range of approximately 50 miles. Also called ATC Terminal Radar.

AIRPORT TRAFFIC AREA - Unless otherwise specifically designated, that airspace with a horizontal radius of five statute miles from the geographical center of any airport at which a control tower is operating, extending from the surface up to but not including 3,000 feet above the surface.

AIRSIDE - That portion of the airport facility where aircraft movements take place, airline operations areas, and areas that directly serve the aircraft (taxiway, runway, maintenance, and fueling areas). See LANDSIDE.

AIRSPACE - The area above the ground in which aircraft travel. It is divided into corridors, routes, and restricted zones for the control and safety of traffic.

- **Highly Restricted Airspace:** Defined as one common path out of an airport where aircraft must follow one another for from one to five miles.
- **Normal Airspace:** Where aircraft can be "fanned out" over three basic directions.
- **Unrestricted Airspace:** Implies that no restrictions in use are present.

ALL-CARGO CARRIER - An air carrier certificated in accordance with FAR Part 121 to provide scheduled air freight, express, and mail transportation over specified routes, as well as the conduct of nonscheduled operations which may include passengers.

ALP - Airport Layout Plan.

ALS - Approach Light System.

ALTERNATE AIRPORT - An alternate destination airport if flight to the original destination cannot be completed. Selection of an alternate airport is required for IFR operations (FAR Part 91.83) if weather reports and forecasts for the first airport of intended landing indicate that for one hour before and one hour after the estimated time of arrival, the ceiling will be less than 2,000 feet above the airport elevation and the visibility will be less than three miles.

AMBIENT NOISE LEVEL - Background noise level, exclusive of the contribution made by aircraft.

AMOS - Automatic Meteorological Observation Station.

ANNUAL SERVICE VOLUME - The upper band of annual aircraft operations that an airfield can be expected to accommodate. Annual service volume does not take into account reductions in volume due to specific levels of delay.

APPROACH CONTROL SERVICE - AIR TRAFFIC CONTROL service provided by a terminal area traffic control facility for arriving and departing IFR aircraft, and, on occasion, VFR aircraft.

APPROACH SURFACE - An imaginary surface longitudinally centered on the extended runway centerline and extending outward and upward from each end of the primary surface. It is applied to each end of a runway based on the type of available or planned approach.

APRON - A defined area on the airside of the terminal building where aircraft are maneuvered and parked and where activities associated with the handling of flights can be carried out. (Also known as RAMP.)

ARFF - Aircraft Rescue and Fire Fighting (see CFR).

ARP - Airport Reference Point.

ARRIVING (Passenger, Baggage, Cargo, Mail) - A passenger (baggage, cargo, mail) arriving at the terminal by air, whether terminating, transit, or transfer.

ASV - Annual Service Volume.

ATA - Air Transport Association.

ATC - Air Traffic Control.

ATCT - Air Traffic Control Tower. (See CONTROL TOWER.)

AVGAS - AViation GASoline. Fuel used in reciprocating (piston) aircraft engines. Avgas is manufactured in the following grades: 80/87, 100LL, 100/130, and 115/145.

AVIGATION EASEMENT - A form of limited property right purchase that establishes legal land-use control prohibiting incompatible development of areas required for airports or aviation-related purposes.

BAGGAGE - The personal property or other articles of a passenger transported in connection with his journey. Unless otherwise specified, it includes both checked and unchecked baggage.

BAGGAGE CLAIM AREA - An area provided in the terminal building for the claiming of checked baggage from the airlines by passengers on arrival.

BAGGAGE MAKE-UP AREA - The area where checked baggage for departing flights is loaded into containers or onto baggage carts.

BAGGAGE STRIPPING AREA - The area where checked baggage from arriving flights is unloaded from baggage containers or baggage carts. (Also referred to as BAGGAGE BREAKDOWN AREA.)

BASED AIRCRAFT - An aircraft permanently stationed at an airport, usually by some form of agreement between the aircraft owner and airport management.

BASELINE - With respect to an environmental factor, the amount of pollution or impact present in the ambient. With respect to forecasts, the probable level of activity if unusual shifts in trend do not occur.

BEACON - See Rotating Beacon.

BRL - Building Restriction Line. A clearance restriction which is usually parallel to runway and taxiway centerlines, at varying distances depending on the type of approach to the individual runway or the type of aircraft to use the taxiway.

B.S. - Broadcast Station. Public or private radio broadcasting station (AM or FM).

BSL - Building Setback Line.

CAPACITY - The maximum volume which an airport element can accommodate without saturation.

CAROUSEL - A mechanically driven rotating baggage claim or sorting device which is oval or circular in shape and on which baggage remains until physically removed.

CAT I (one) - Category I ILS approach procedure which provides for approach to a height above touchdown of not less than 200 feet, except in unusual terrain, and with **RUNWAY VISUAL RANGE (RVR)** of not less than 1,800 feet.

CAT II (two) - Category II ILS approach procedure which provides for approach to a height above touchdown of not less than 100 feet and with **RUNWAY VISUAL RANGE** of not less than 1,200 feet.

CAT III (three) - Category III ILS approach which provides for approach with no decision height minimum and a **RUNWAY VISUAL RANGE (RVR)** of not less than 700 feet.

CBD - Central Business District.

CEILING - The height above the ground of the base of the lowest layer of clouds or obscuring phenomena aloft that is reported as broken or overcast and not classified as scattered, thin, or partial. Ceiling figures in aviation weather reports may be determined as measured, estimated, or indefinite.

CERTIFICATED ROUTE AIR CARRIER - One of a class of air carriers holding certificates of public convenience and necessity. These carriers are authorized to perform scheduled air transportation over specified routes and a limited amount of non-scheduled operations.

CFR - Crash-Fire-Rescue (e.g., facilities, equipment, station). (See ARFF.)

CHARTER - A non-scheduled flight offered by either a supplemental or certificated airline.

CIP - Capital Improvement Program.

CIRCLING APPROACH - An instrument approach procedure in which an aircraft executes the published instrument approach to one runway, then maneuvers visually to land on a different runway. Circling approaches are also used at airports that have published instrument approaches with a final approach course that is not aligned within 30 degrees of any runway.

CLEAR ZONE - The ground areas beneath the inner end of the runway approach surface. Height restrictions are involved.

CLEARWAY - A clearway is an area available for the continuation of the take-off operation which is above a clearly defined area connected to and extended beyond the end of the runway. The area over which the clearway lies need not be suitable for stopping aircraft in the event of an aborted take-off clearway are applicable for use only in the take-off operations of turbine-engined airplanes.

COMMERCIAL AIR CARRIER - An air carrier certificated in accordance with FAR Parts 121 or 127 to conduct scheduled services on specified routes. These air carriers may also provide nonscheduled or charter services as a secondary operation. Four carrier groupings have been designated for statistical and financial data aggregation and analysis.

1. **MAJORS:** Air carriers with annual operating revenues greater than \$1 billion.
2. **NATIONALS:** Air carriers with annual operating revenues of between \$100 million and \$1 billion.
3. **LARGE REGIONALS:** Air carriers with annual operating revenues of between \$10 million and \$99,999,999.
4. **MEDIUM REGIONALS:** Air carriers with annual operating revenues of less than \$10 million.

COMMUTER AIR CARRIER - An air carrier certificated in accordance with FAR Part 135 which operates aircraft with a maximum of 60 seats, and provides at least five scheduled round trips per week between two or more points, or carries mail.

COMMUTER/AIR TAXI OPERATIONS - Those arrivals and departures performed by air carriers certificated in accordance with FAR Part 135.

CONCESSIONAIRE - An individual firm, company, or organization permitted by the airport governing board to locate or carry on business at the airport for the convenience of its users.

CONCOURSE - The landside part of a departure and/or arrival facility, which usually includes circulation space and departure lounges.

CONDEMNATION - Proceedings under which a property interest may be forcibly acquired; government may condemn land through the power of eminent domain; an individual may apply inverse condemnation to obtain just compensation for a property interest taken by government without prior agreement.

CONICAL SURFACE - An imaginary surface extending outward and upward from the periphery of the horizontal surface of an airport at a slope of 20 to 1 for a horizontal distance of 4,000 feet.

CONSTRAINED OPERATIONAL ACTIVITY - Present or forecast aircraft activity which is limited due to economic, environmental, operational, or physical factors. Unconstrained forecasts assume no such limits but express the demand that would exist in an absence of supply-side problems.

CONTROL AREAS - These consist of the airspace designated as Federal Airways, additional Control Areas, and Control Area Extensions, but do not include the Continental Control Area.

CONTROL TOWER - A central operations facility in the terminal air traffic control system consisting of a tower cab structure (including an associated IFR room if radar-equipped) using air/ground communications and/or radar, visual signaling, and other devices to provide safe and expeditious movement of terminal air traffic. (See ATCT.)

CONTROL ZONES - Areas of controlled airspace which extend upward from the surface and terminate at the base of the Continental Control Area. Control zones that do not underlie the Continental Control Area have no upper limit. A control zone may include one or more airports and is normally a circular area with a radius of five statute miles and any extensions necessary to include instrument departure and arrival paths. (See also CONTROL AREAS.)

CONTROLLED AIRSPACE - Airspace designated as continental control area, control area, control zone, or transition area within which some or all aircraft may be subject to air traffic control.

CRITICAL AIRCRAFT - The user aircraft which requires the most sophisticated facilities at the airport; the aircraft for which facilities are designed. Also referred to as the design aircraft.

CYCLIC MAINTENANCE - Repair or reconstruction projects using CIP funds which are performed at selected pre-defined intervals, usually several years apart.

dba - Decibel(s), measured on the A-weighted scale to factor out anomalies.

DECIBEL (dB) - The standard unit of noise measurement relating to a logarithmic scale in which 10 units represents a doubling of acoustic energy.

DEPARTURE LOUNGE - A common area used for assembling originating passengers who have passed ticket and baggage check-in and the necessary security controls, together with transfer and transit passengers. (See Concourse.)

DEPLANEMENT - A passenger disembarkation from a commercial flight.

DESIGN HOUR - The design hour is an hour close to peak but not absolute peak, which is used for airport planning and design purposes. It is usually the peak hour of the average day of the peak month or the 37th busiest hour of the year (90th percentile).

DH - Decision Height. During a precision approach, the height (or altitude) at which a decision must be made to either continue the approach or execute a missed approach.

DISPLACED THRESHOLD - Actual touchdown point on specific runways designated due to obstructions which make it impossible to use the actual physical runway end.

DME - Distance Measuring Equipment. An airborne instrument which indicates the distance the aircraft is from a fixed point, usually a VOR station.

DOMESTIC FLIGHT - A flight within a single country.

DOMESTIC PASSENGER (Baggage, Cargo, Mail) - A passenger (baggage, cargo, mail) transported wholly on a domestic flight.

DOT - Department of Transportation.

EAS - See Essential Air Service.

EFFECTIVE RUNWAY GRADIENT - The maximum difference between runway centerline elevations divided by the runway length, expressed as a percentage.

EMINENT DOMAIN - Right of the government to take property from the owner, upon compensation, for public facilities or other purposes in the public interest.

ENPLANEMENT - A passenger boarding of a flight.

EN ROUTE - The route of flight from point of departure to point of destination, including intermediate stops.

EN ROUTE AIRSPACE - Controlled airspace above and/or adjacent to terminal airspace.

EN ROUTE AIRWAYS - The route a flight follows from departure point to destination.

EN ROUTE HIGH ALTITUDE SYSTEM - Includes the controlled airspace (control zones, transition areas, federal victor airways, continental control area, and positive control airspace) in the high-altitude stratum which is generally defined as the airspace from 18,000 to 45,000 feet.

EN ROUTE LOW ALTITUDE SYSTEM - Includes the controlled airspace (control zones, transition areas, federal victor airways, and continental control area) in the low-altitude stratum, which is generally defined as the airspace between 700 feet or 1,200 feet above ground level (AGL) up to 18,000 feet above sea level (ASL).

EP - Enplaned Passenger.

EPA - U.S. Environmental Protection Agency.

ESSENTIAL AIR SERVICE - Derives from Section 419 of the Airline Deregulation Act of 1978 which bears this name and relates to points having certificated service at the time of the Act or being on a carrier's certificate between July, 1968, and October, 1978.

EXPRESS - Property transported under published air express tariffs.

FAA - Federal Aviation Administration.

FACILITY - A term commonly employed when referring to an area or areas and/or system(s) where particular handling functions take place.

FAR - Federal Air Regulations, administered by FAA. Some of the most common are FAR 121 (creating rules for certificated carriers), FAR 135 (operating rules for air taxis and most commuters), and FAR 36 (noise rules).

FBO (FIXED BASE OPERATOR) - An operator of one or more aircraft who has a permanent fixed aviation service facility at an airport. FBOs usually engage in aviation activity such as flight instruction, fuel sales, repairs, aircraft rental and sales, and air charter.

FEEDER SYSTEM - This usually involves air taxi and/or commuter (regional) air carriers operating short to medium haul flights into larger air terminals. Passengers and freight can then connect with the larger carriers for a longer flight. Most carriers have interline agreements to ensure that this service be provided with minimum inconvenience to the customer.

FINAL APPROACH IFR - The flight path of an aircraft which is inbound to the airport on an approved final instrument approach course, beginning at the point of interception of that course (Final Approach Fix) and extending to the airport or the point where circling for landing or missed approach is executed.

FIS - Federal Inspection Service.

FLEET MIX - The proportion of aircraft types or models at an airport. (See also Aircraft Mix.)

FLIGHT PLAN - A description or outline of a planned flight which a pilot submits to the FAA, usually through a flight service station. The flight plan includes information on aircraft type, identification, airspeed and altitude to be flown (initially), time of departure, origin and destination airports, estimated time en route, number of passengers and amount of fuel on board, aircraft's color and equipment, and name of the pilot. Flight plans are optional for all VFR flights, but are required for IFR flights in controlled airspace, including all scheduled passenger flights.

FLIGHT SERVICE STATION (FSS) - An FAA-manned facility designed to provide airmen with assistance and information regarding flight operations. Primary focus is on collection, dissemination, and distribution of weather information. Other functions include airport and air traffic advisory services, flight planning services, and aid to lost aircraft. FSS personnel also operate and maintain airport lighting and navigation aids. Flight plans for general aviation flights are filed with the FSS.

FLOW - Direction of activity (see Outbound, Inbound).

FLYBY - A usually low-altitude flight past a predesignated place by one or more airplanes.

FLYOVER - A low-altitude flight over a public gathering or place by one or more airplanes.

FOREIGN FLAG AIR CARRIER - An air carrier other than a U.S. flag air carrier in international air transportation. "Foreign air carrier" is a more inclusive term than "foreign flag air carrier," presumably including those non-U.S. air carriers operating solely within their own domestic boundaries. In practice, the two terms are used interchangeably.

FSS - See FLIGHT SERVICE STATION.

FY - Fiscal Year.

GATE - A point of passenger access to the apron/aircraft from the terminal building and vice versa.

GATE LOUNGE - An area adjacent to a gate used for assembling departing passengers for a flight departure.

GENERAL AVIATION (GA) - All civil aviation activity except that of air carriers certificated in accordance with FAR Parts 121, 123, 127, and 135. The types of aircraft used in general aviation activities cover a wide spectrum from corporate multi-engine jet aircraft piloted by professional crews to amateur-built single-engine piston acrobatic planes, balloons, and dirigibles.

GENERAL AVIATION AIRCRAFT - All civil aircraft except those owned and classified as air carrier.

GENERAL OBLIGATION BOND - A form of public indebtedness backed by the full faith and credit of the municipality or other appropriate public body.

GLIDE SLOPE - The electronic component that provides vertical guidance (by instrument reference) during ILS approaches.

GROUND SERVICE EQUIPMENT - Equipment used for servicing aircraft on the apron.

HAA - Height Above Airport. Indicates the height of the minimum descent altitude (MDA) above the published airport elevation.

HAT - Height Above Touchdown. Indicates the height of the decision height (DH) or minimum descent altitude (MDA) above the highest runway elevation in the touchdown zone (first 3,000 feet of runway).

HIGH-SPEED TAXIWAY - An exit taxiway with design geometrics allowing use at high speeds.

HIRL - High Intensity Runway Lighting.

HORIZONTAL SURFACE - An imaginary surface consisting of a horizontal plane 150 feet above the established airport elevation, the perimeter of which is constructed by swinging arcs of specified radii from the center of each end of the primary surface of each runway and connecting the adjacent arcs of lines tangent to those arcs.

HUB - See AIR TRAFFIC HUB.

HUB-AND-SPOKE SYSTEM - System used by airlines in which air traffic is routed to a major airport (HUB) from markets (shorter routes within the airline's system or served by other carriers) and consolidated for longer flights with higher load factors.

HUD - U.S. Department of Housing and Urban Development.

HVOR - High-altitude VOR.

IFR (Instrument Flight Rules) - Operating procedures that govern flight under instrument meteorological conditions (IMC) caused by limited visibility or other operational constraints.

IMAGINARY SURFACE - Any of several surfaces established with relation to an airport and each runway for the purpose of determining whether an object is an obstruction to air navigation. (See also Approach Surface, Conical Surface, Horizontal Surface, Primary Surface, Transitional Surface).

IMC - Instrument Meteorological Conditions.

INBOUND - Activity originating beyond the study area or location under discussion and terminating there.

INM - Integrated Noise Model.

INSTRUMENT APPROACH - An approach conducted with guidance provided by radar and/or radio nav aids.

INSTRUMENT LANDING SYSTEM (ILS) - A precision landing aid consisting of localizer (azimuth guidance), glide slope (vertical guidance), marker beacons (range and approach fix information), and approach light system. Establishes a course and a descent path to align an aircraft with a runway for final approach.

INSTRUMENT OPERATION - The arrival at or departure from an airport of an aircraft operating in accordance with an IFR Flight Plan or the provision of IFR separation from other aircraft by a terminal traffic control facility.

INTERLINE TRANSFER - The transfer of passengers, baggage, cargo, or mail between flights of different airlines.

INTERNATIONAL - International flights involve an origin in one country and a destination in another. U.S. carriers require FAA and Presidential approval for international flights.

INTERREGIONAL - Activity involving an origin in one region and a destination in another.

INTERSTATE - Activity with an origin in one state and a destination in another.

INTERSTATE AIR CARRIER - An air carrier which conducts operations across state boundaries.

INTRALINE TRANSFER - The transfer of passengers, baggage, cargo, or mail between flights of the same airline. Also known as on-line.

INTRAREGIONAL - Activity entirely within regional boundaries.

INTRASTATE - Activity entirely within state boundaries.

INTRASTATE AIR CARRIER - An air carrier which conducts operations solely within the boundaries of a state.

ITINERANT OPERATION - Any aircraft arrival and/or departure other than a local operation.

JET BLAST - The high-velocity movement of air behind a jet engine in operation.

JOINT-USE FACILITY - An airport terminal building used by more than one passenger or cargo operator.

KHz - Kilohertz.

LANDSIDE - That portion of the airport utilized for all activities except aircraft movement (see AIRSIDE). The landside generally includes the following elements: vehicular access roads and parking, passenger terminal, cargo terminal, aircraft hangars, FBOs, fuel storage area, CFR equipment, and maintenance facilities.

L_{dn} (DAY-NIGHT AVERAGE SOUND LEVEL) - The 24-hour equivalent sound level (Leq) with a 10-decibel penalty applied to nighttime (10:00 p.m. to 7:00 a.m.) levels.

Leq (EQUIVALENT SOUND LEVEL) - The equivalent A-weighted sound level for a specified period of time.

LIRL - Low Intensity Runway Lights.

L/MF - Low to Medium Frequency.

LOAD - Any item carried in an aircraft other than those included in the basic operating weight.

LOADING BRIDGE - An adjustable protected passageway bridging the space between a terminal building or a pier and an aircraft passenger door.

LOCAL OPERATION - Any operation performed by an aircraft which: (a) operates in the local traffic pattern or within sight of the tower; (b) is known to be departing for, or arriving from, flight in local practice areas located within a 20-mile radius of the control tower; or (c) executes a simulated instrument approach or low pass at the airport.

LOCALIZER (LOC) - The component of an ILS which provides course guidance to the runway. The localizer may be used as part of a complete ILS, or by itself.

LONG HAUL - Flights greater than 1,500 miles.

LORAN - Long Range Navigation aid operating in the 1750-1950 KHz (LORAN A) or 110-110 KHz (LORAN C and D) frequency band.

LVOR - Low-altitude VOR.

MAGNETOMETER - A device which permits the identification of metallic substances on passengers.

MALS - Medium (intensity) Approach Light System.

MARKER BEACON - A VFR navigational aid which transmits a narrow directional beam. It is associated with an airway or an instrument approach.

MASTER PLAN - A long-range comprehensive plan to guide airport development.

MEDIUM HAUL - Flights between 500 and 1,500 miles.

MGW - Maximum Gross (take-off) Weight of an aircraft or type of aircraft.

MIDDLE MARKER - A marker beacon that refines a point along the glide slope of an ILS. It is usually located approximately 3,500 feet from the runway threshold.

MILITARY OPERATION - An operation by military aircraft.

MINIMUM DESCENT ALTITUDE (MDA) - The lowest altitude, expressed in feet above mean sea level, to which descent is authorized on final approach or during circling-to-land maneuvering in execution of a standard instrument approach procedure where no electronic glide/slope is provided.

MIRL - Medium Intensity Runway Lighting.

MISSED APPROACH - A prescribed procedure to be followed by aircraft that cannot complete an attempted landing at an airport.

MLS - Microwave Landing System. Precision approach aid providing much wider and more flexible horizontal and vertical approach guidance than the ILS, including curved approach paths and steeper approach angles.

MOA - Military Operations Area.

MODAL SPLIT - Division of travel between modes of transport, often expressed as a percentage.

MOVEMENT - Usually synonymous with the term operation (i.e., a take-off or a landing).

MSA - Metropolitan Statistical Area.

MSL - Mean Sea Level.

NAVAID - See AIR NAVIGATION FACILITY.

NDB - Non-Directional Beacon. An electronic ground station transmitting in all directions in the low and mid-range frequency spectrum; provides azimuth guidance to aircraft equipped with direction finder receivers. These facilities are often established with ILS outer markers to provide transition guidance to the ILS system.

NEF - Noise Exposure Forecast.

NOAA - National Oceanic and Atmospheric Administration.

NOISE ABATEMENT - A procedure for the operation of aircraft at an airport which minimizes the impact of noise on the environs of the airport.

NOISE CONTOUR - A line on a map connecting points of equal noise exposure.

NON-PRECISION APPROACH PROCEDURE - A standard instrument approach procedure in which no electronic glide slope is provided.

NON-SCHEDULED - See Charter.

NOS - National Ocean Survey.

NPI - Non-Precision Instrument.

NPIAS - National Plan of Integrated Airport Systems.

NTSB - National Transportation Safety Board. An agency of the U.S. government established to investigate accidents involving all modes of transportation. The Board also makes recommendations on safety measures and practices and is the repository of aviation accident statistics.

NWS - National Weather Service.

O & D - Origin and Destination.

OAG - Official Airline Guide. Publishes all scheduled airline flights, whether for passengers or cargo.

OC - Obstruction Chart.

OFAW - Obstacle-Free Area Width. Pertains to a runway or a taxiway.

OPBA - Operations Per Based Aircraft.

OPERATIONAL MAINTENANCE - Airport maintenance performed on a regular basis as required throughout the year.

OPERATIONS - See AIRCRAFT OPERATIONS.

ORIGINATING FLIGHT - A flight, designated by a flight number, commencing at the airport in question.

ORIGINATING PASSENGER (Baggage, Cargo, Mail) - A passenger (baggage, cargo, mail) commencing transport by air at the airport in question.

OUTBOUND - Activity originating at the study area or location under discussion and terminating outside it.

OUTER MARKER - One component of an ILS, one of two marker beacons used for an ILS approach, normally four to seven miles from the runway threshold. It provides the pilot with an audio and visual signal. See also MIDDLE MARKER.

PAPI - Precision Approach Path Indicators.

PAR - Precision Approach Radar. Equipment that may be used to monitor certain non-radar approaches, but is primarily used to conduct precision approaches where the radar controller issues specific verbal instructions to the pilot.

PART 77 - The applicable portions of Federal Aviation Regulations which define obstructions to air navigation.

PASSENGER BOARDING - The checking and entry of passengers into an aircraft prior to its departure.

PASSENGER DISEMBARKATION - Exit of passengers from an aircraft after its arrival.

PASSENGER LOAD FACTOR - The ratio of passenger seats occupied to the total seat capacity of the aircraft.

PASSENGERS - The sum of enplanements plus deplanements.

PATWAS - Pilots Automatic Telephone Weather Answering Service. A recorded telephone weather briefing service. In some locations, pilots using touch-tone telephones may obtain weather information for specific routes.

PAX - An abbreviation for "passengers."

PAYLOAD - The weight of passengers, baggage, cargo, and mail, including both revenue and non-revenue items.

PEAK - A defined period during which the highest traffic activity occurs (or is expected to occur) at an airport or in an airport terminal. See also DESIGN HOUR.

PEAK-DAY ACTIVITY - That level of activity, existing or forecast, which is representative of typical peak-hour conditions; demand levels in excess of the peak-day value may occasionally occur as atypical highs.

PEAK-HOUR DEMAND - That level of activity, existing or forecast, which is representative of typical peak-day conditions; demand levels in excess of the peak-hour value may occasionally occur as atypical highs.

PEAK MONTH - The month of the year during which the highest traffic activity occurs.

PEOPLE MOVER - A mechanical system for assisting the horizontal or vertical movement of people over relatively long distances, usually within passenger terminals and piers (e.g., moving sidewalks, escalators, etc.).

PIER - A terminal building extension protruding into the apron area, giving protected passenger access to aircraft gate positions.

PLASI - Pulsating Light Approach Slope Indicators.

POSITIVE CONTROL AREAS - Airspace wherein aircraft are required to be operative under Instrument Flight Rules.

PRECISION APPROACH - An instrument approach utilizing both vertical and horizontal guidance.

PRIMARY RUNWAY - That runway which provides the best wind coverage, etc.; this runway receives the most usage at an airport.

PRIMARY SURFACE - An imaginary surface longitudinally centered on a runway. When the runway is paved, the primary surface extends 200 feet beyond each end of the runway.

RACETRACK - A mechanized baggage or sorting system consisting of belts or plates which operates continuously in a variety of closed-circuit layouts.

RADAR BEACON - A radar transmitter that upon receiving a radar signal emits a signal which reinforces the normal reflected signal or which introduces a code into the reflected signal, especially for identification purposes.

RADAR SEPARATION - Radar spacing of aircraft in accordance with established minima.

RAIL - Runway Alignment Indicator Light

RAMP - See APRON.

REGISTERED AIRCRAFT - Aircraft registered by FAA (required for all U.S. active aircraft). FAA records of registered aircraft are by address of owner as opposed to based aircraft, which are classified by the physical location of the airplane.

REIL - Runway End Identifier Lights.

RELIEVER AIRPORT - A metropolitan area general aviation airport with facilities and services suitable for attracting and diverting general aviation activity away from major air carrier airports. The immediate benefit is reduced congestion and additional capacity at the air carrier facility.

REVENUE BONDS - A form of public indebtedness backed by the revenue generated by the facility for which the debt was incurred.

RNAV - Area Navigation.

ROTATING BEACON - A visual navaid displaying flashes of white and/or colored light used to indicate the location of an airport.

ROTOR - Horizontal airfoils and their hub on a helicopter.

RPM - Revenue Passenger Miles.

RUNWAY SAFETY AREA - A cleared, drained, graded, and preferably turfed area symmetrically located about the runway. Under normal conditions, the runway safety area is capable of supporting snow removal, fire fighting and rescue equipment, and of accommodating the occasional passage of aircraft without causing major damage.

RVR - Runway Visual Range.

RW - Runway.

SATELLITE - A building surrounded by aircraft gate positions, separated from the terminal building, and reached by surface, underground, or above-ground connection.

SCHEDULED AIR CARRIER - See COMMERCIAL AIR CARRIER.

SDF - Simplified Directional Facility. Used for nonprecision approaches, the SDF provides a final approach similar to that of an ILS localizer except that the SDF course may be offset from the runway (usually not more than 3 degrees).

SECTION 401 (of the Federal Aviation Act of 1958 as amended by the Airline Deregulation Act of 1978) - Provides for the issuance of a certificate of public convenience and necessity by the CAB, to carriers engaged in scheduled or charter, interstate and overseas air transportation. The certificate previously had stated the regular defined routes and destinations to be served by a fixed level of service. However, beginning January 1, 1982, carriers with 401 certificates received freedom to enter new markets without CAB approval.

SECTION 406 (of the Federal Aviation Act of 1958 as amended by the Airline Deregulation Act of 1978) - Provides for the compensation (subsidy) of regional air carriers. Rates paid are subject to the conditions peculiar to air transportation and to the particular air carrier or class of air carrier.

SECTION 419 (of the Federal Aviation Act of 1958 as amended by the Airline Deregulation Act of 1978) - "Small Community Air Service. Guaranteed Essential Air Service." Provides for the guarantee of a minimum level of air service to eligible communities. See EAS.

SEGMENTED CIRCLE - The segmented circle is a device used at uncontrolled airports to give pilots a visual indication of an airport's traffic pattern direction. It is normally located around the wind sock, wind tee, or tetrahedron, with L-shaped markers on the periphery of the circle used to indicate traffic pattern directions (left or right turns).

SEL - Sound Exposure Level.

SEPARATION MINIMA - The minimum longitudinal, lateral, or vertical distances by which aircraft are spaced through the application of air traffic control procedures.

SERVICE ROADS - Public or restricted roads within the airport boundary, primarily used for service purposes.

SHORT HAUL - Flights of less than 500 miles.

SLCIA - Salt Lake City International Airport.

SOCIOECONOMIC - Data pertaining to the population and economic characteristics of a region.

SPECIAL USE AIRSPACE - Airspace of defined dimensions, within which flight of aircraft, while not wholly prohibited, is subject to restrictions or hazards that may exist to non-participating aircraft.

SSD - Service Segment Data.

STOL - Short Take-off and Landing. A term applied to aircraft with specific performance capabilities. These include the ability to operate out of very short (often unprepared) airfields. STOL aircraft are useful in operations where terrain makes approach and departure paths difficult, or where steep approach and departure angles are desired to minimize noise effects.

STRAIGHT-IN APPROACH - A descent in an approved procedure in which the final approach course alignment and descent gradient permits authorization of straight-in landing minimums.

STUDENT ACTIVITY - Any aviation activity by student pilots.

T-HANGAR - A T-shaped aircraft storage building which provides economical shelter for a single aircraft.

TACAN - TACTical Air Navigation.

TAP - Terminal Area Plan.

TAXIWAY - A defined path over which aircraft can taxi from one airfield to another.

TAXIWAY SAFETY AREA - An area symmetrically located about the taxiway that performs the same function for airplanes on the taxiway as the runway safety area does for airplanes on the runway.

TERMINAL, CARGO - A building or facility located between landside loading/unloading docks and apron within which cargo processing takes place.

TERMINAL, PASSENGER - A building or facility located between curbside and apron within which passenger and baggage processing takes place.

TERMINAL AIRSPACE - The controlled airspace normally associated with aircraft departure and arrival patterns to/from airports within a terminal system and between adjacent terminal systems in which tower en route air traffic control service is provided.

TERMINAL CONTROL AREA (TCA) - The controlled airspace extending upward from the surface or higher to specified altitudes within which all aircraft are subject to positive air traffic control procedures.

TERMINATING FLIGHT - A flight, designated by a flight number, ending at the airport in question.

TERMINATING PASSENGER (Baggage, Cargo, Mail) - A passenger (baggage, cargo, mail) terminating transportation by air at the airport in question.

THRESHOLD - The physical end of runway pavement.

TIE-DOWNS - An area on an airport specifically designed for the outdoor storage of aircraft.

TOUCH-AND-GO - A touch-and-go operation is used for flight training or proficiency and is an operation in which the aircraft lands and begins take-off roll without stopping. It is counted as two operations.

TRA - TRA Airport Consulting.

TRAFFIC FORECAST - A forecast determining for certain future years the total traffic in passenger, cargo, mail, and aircraft movements.

TRAFFIC PATTERN - The traffic flow that is prescribed for aircraft landing at, taxiing on, and taking off from an airport. The usual components of a traffic pattern are upwind leg, crosswind leg, downwind leg, and final approach.

TRANSFER PASSENGER (Baggage, Cargo, Mail) - A passenger (baggage, cargo, mail) arriving by one flight and continuing the journey by another flight. (See also Interline Transfer, Intraline Transfer.)

TRANSIENT OPERATIONS - That portion of itinerant operations performed by aircraft other than those based at the airport in question.

TRANSITION AREA - Controlled airspace extending upward from 700 feet or more above the surface when designated in conjunction with an airport for which an approved instrument approach procedure has been prescribed; or from 1,200 feet or more above the surface of the earth when designated in conjunction with the airway route structure. Transition areas are designated to contain IFR operations in controlled airspace during portions of the terminal operation and while transitioning between the terminal and en route environment.

TRANSITIONAL SURFACE - An imaginary surface extending outward and upward at a right angle to the runway centerline plus the runway centerline extended at a slope of 7 to 1 from the sides of the primary surface and from the sides of the approach surfaces.

TURBOPROP - An aircraft that uses jet engine(s) to drive propeller(s).

TURNAROUND - A taxiway designed for turning around or holding aircraft at the end of a runway when a full parallel taxiway is not provided.

TVOR - Terminal VOR.

TW - Taxiway.

UHF - Ultra-High Frequency.

UNCONTROLLED AIRSPACE - That portion of the airspace that has not been designated as continental control area, control area, control zone, terminal control area, or transition area and within which ATC has neither the authority nor the responsibility for exercising control over air traffic.

UNICOM - Radio communications station which provides pilots with pertinent airport information (winds, weather, etc.) at specific airports.

USGS - United States Geological Survey.

VASI - Visual Approach Slope Indicator. A device that provides a visual glide path by requiring the pilot to line up a series of panels at each side of the runway.

VECTOR - A heading issued to an aircraft to provide navigational guidance by radar.

VFR - Visual Flight Rules that govern flight procedures in good weather, with conditions usually being at least a 1,000-foot ceiling and three miles visibility.

VHF - Very High Frequency.

VHF/DF - Very High Frequency - Direction Finder.

VICTOR AIRWAY - Designated air route between two points, using radials from appropriate VOR facilities and including the airspace within parallel lines four nautical miles each side of the runway centerline.

VISITOR - A non-passenger, non-employee using the terminal (e.g., a well-wisher accompanying a departing passenger, a greeter meeting an arriving passenger, or a sightseer).

VMC - Visual Meteorological Conditions.

VOR - Very High Frequency Omnidirectional Station; a ground-based radio (electronic) navigation aid transmitting radials in all directions in the VHF frequency spectrum; provides azimuth guidance to pilots by reception of electronic signals. VORs operate in the 108-117.85 MHz frequency band.

VORTAC - Co-located VOR and TACAN.

WEIGHT BEARING CAPACITY - An estimate of runway capability at an average level of activity. Many airport pavements are capable of supporting limited operations of 25 to 50 percent in excess of published figures.

WIDE-BODY AIRCRAFT - A term used for high-capacity aircraft such as the Boeing 747, Douglas DC-10, Lockheed 1011, Airbus A-300B, or similar (i.e., aircraft with double aisles in the passenger cabin and seating configurations exceeding six abreast), also colloquially known as "jumbo jets."

WIND CONE (SOCK) - Conical wind direction indicator.

WIND COVERAGE - Refers to orientation of runway in relationship to direction of prevailing wind (concerns usability of runway for takeoffs and landings).

WIND ROSE - A diagram indicating the prevalence of winds from various directions, at a specific place.

WIND TEE - A visual device used to advise pilots about wind direction.

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