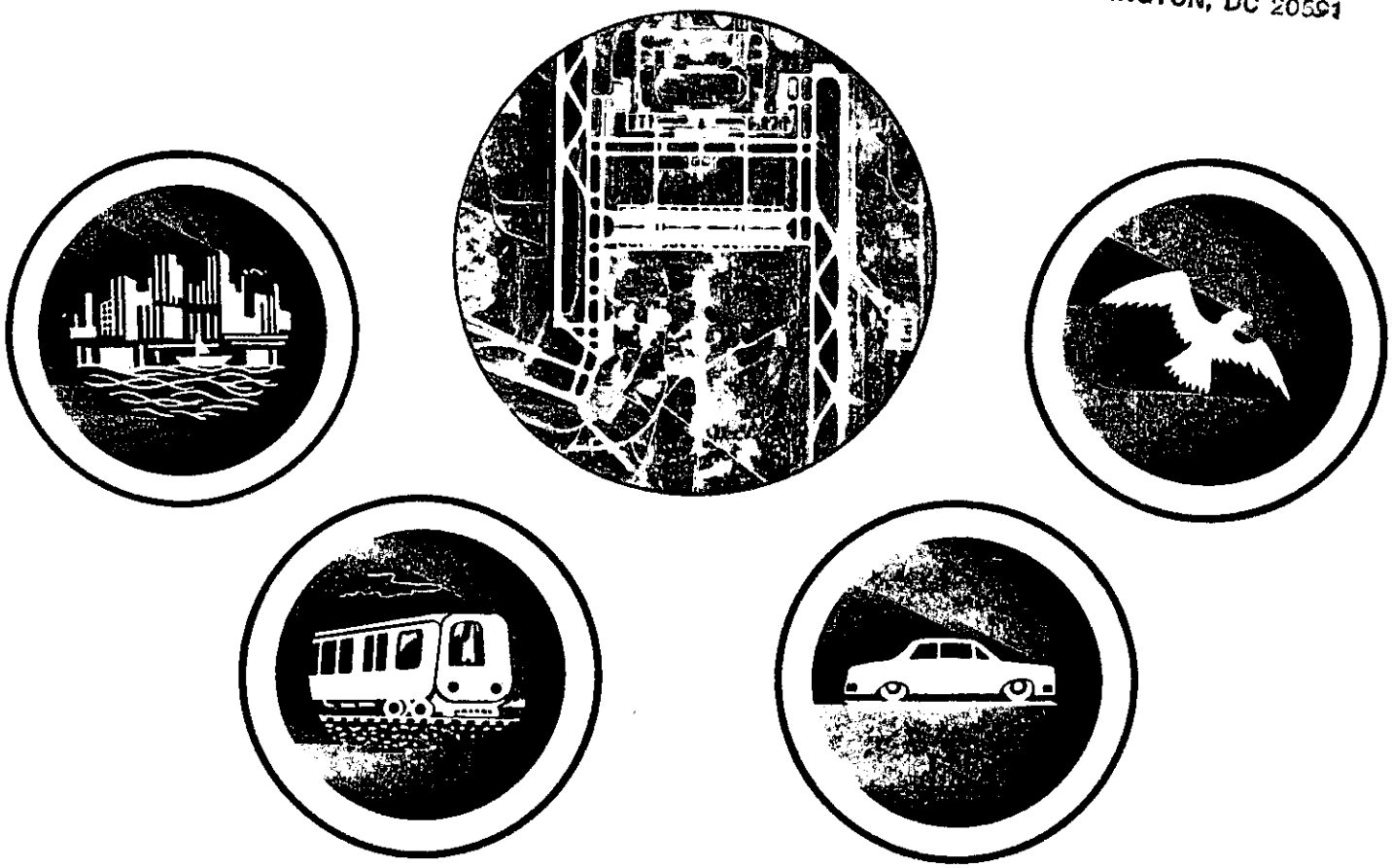
AC 150/5070-6

airport

MASTER PLANS



DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AC 150/5070-6

Airport Master Plans

February 1971

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

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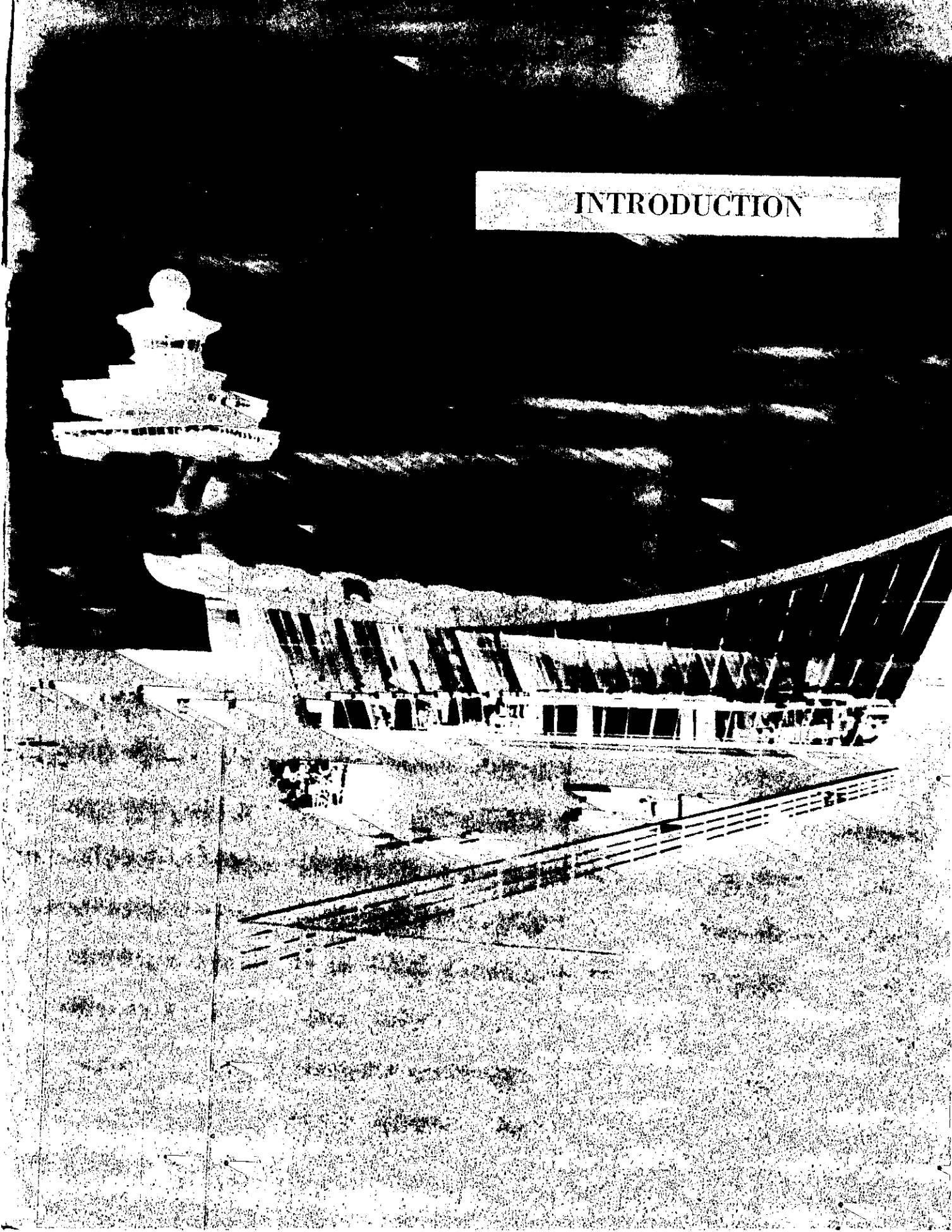
INTRODUCTION



INTRODUCTION

1. General. This advisory circular provides guidance for the preparation of individual airport master plans as provided for under the Airport and Airway Development Act of 1970. Planning efforts will vary with the size of the community the airport is to serve and with the complexities of the airport for which a master plan is to be established.

The problems of air transportation and the areas of consideration required for the proper development of airports have grown with the complexities of our society. Early master plans were developed on the basis of local aviation needs. More recent plans have accounted for the demands of the air transportation system, i.e., the needs of locally based aircraft, itinerant general aviation activity, and national and international air commerce. Today, the planner of individual airports must not only consider the requirements of all facets of aviation but must also weigh carefully the effects and relationships of aviation to environment, community development, and other modes of transportation.

If future airport developments are to be successful, they must be based on guidelines established as the result of comprehensive airport system plan studies and airport master plan studies. State, regional, and metropolitan area airport system plans, if available, will provide important backup for the development of airport master plans. If airport master plans are to be successful, they must present the results of master plan studies in a lucid package. Therefore, this advisory circular recommends procedures to be followed in making the master plan study of the individual airport and suggests methods of coordinating, organizing, and presenting the master plan document so that it will be a viable tool for the promotion of airport improvements proposed in the master plan.

This advisory circular cancels Advisory Circular 150/5310-2, "Airport Planning and Airport Layout Plans," dated September 19, 1968, and Advisory Circular 150/5060-2, "Airport Site Selection," dated July 19, 1967.

2. Master Plan Definition. An airport master plan presents the planner's conception of the ultimate development of a specific airport. It effectively presents the research and logic from which the plan was evolved and artfully displays the plan in a graphic and written report. Master plans are applied to the modernization and expansion of existing airports and to the construction of new airports, regardless of their size or functional role.

3. Objectives of the Master Plan. The overall objective of the airport master plan is to provide guidelines for future development which will satisfy aviation demand and be compatible with the environment, community development, other modes of transportation, and other airports. Specific objectives within this broad framework are as follows:

a. To provide an effective graphic presentation of the ultimate development of the airport and of anticipated land uses adjacent to the airport.

b. To establish a schedule of priorities and phasing for the various improvements proposed in the plan.

c. To present the pertinent backup information and data which were essential to the development of the master plan.

d. To describe the various concepts and alternatives which were considered in the establishment of the proposed plan.

e. To provide a concise and descriptive report so that the impact and logic of its recommendations can be clearly understood by the community the airport serves and by those authorities and public agencies which are charged with the approval, promotion, and funding of the improvements proposed in the airport master plan.

4. Coordination of the Master Plan Effort. Today's airport master plan draws widespread interest from the private citizen, community organizations, airport users, areawide planning agencies, conservation groups, ground transit officials, and aviation and airport concessionaire interests. If these groups are not consulted during the development of the plan, it will likely be unsuccessful when presented to the public. Therefore, it is essential that the master plan team coordinate their efforts with and seek the advice of these elements during the critical stages of the plan's development. This coordination will help pave

the way for acceptance and, more important, it will permit vital input from organized interests which will lead to the evolution of a well-integrated plan.

Effective coordination between members of the planning teams is also essential to the development of a successful master plan. A balanced effort is not easy to achieve because of the many disciplines involved in the plan's preparation. For large projects, input may be required from economists; financiers; scientists; architects; civil, mechanical, electrical, and traffic engineers; pilots; air traffic controllers; airline and concessionaire advisers; and airport managers. And to put the airport in its proper perspective, the roles of the environmentalist, ecologist, and urban planner must not be overlooked.

This is why the role of the coordinator of the master plan effort is so important. He must keep the enthusiasm of his advisers in check in order to balance the study efforts and costs of various master plan elements. If he is successful, he will develop a saleable master plan which will lead to the construction of a functional airport that blends pleasantly into the environment.

Coordination efforts required for development of the master plan will not be discussed in further detail in this introduction. Rather, they are elaborated on for each stage of development of the master plan in the chapters which follow.

5. Master Plan Phases and Elements. Planning efforts required for proper development of an airport vary with the size of the area or community which the airport is to serve and with the complexity of the airport for which a master plan is to be established. The phases and elements of study and development which may be included in the master plan effort, whether in toto or in part, are identified below. The extent of their inclusion depends on the size and status of the airport for which the master plan is to be prepared. The magnitude of development of the elements will depend on the size of the community the airport is to serve and on information which may be available from earlier planning efforts, such as State, regional, or metropolitan area airport system plans.

a. Phase I, Airport Requirements.

(1) *Inventory.* The initial step in the preparation of master plans is the collection of all types of data pertaining to the area which the airport is to serve. This includes inventory of existing airport facilities, area planning efforts which may affect the master plan, and historical information related to their development.

(2) *Forecasts of Aviation Demand.* This element of the master plan should provide short, intermediate, and long-range forecasts (approximately 5, 10, and 20 years) of air traffic including based aircraft, aircraft mix, aircraft operations, and enplaned passenger, air cargo, and airport access data. Aviation demand forecasts will be based on social, environmental, economic, and technical factors. It should be kept in mind that 20-year forecasts will be very approximate in nature.

(3) *Demand/Capacity Analysis.* Demand/ capacity analysis will provide a basis for determination of facility requirements and feasibility. It should include cost benefit analysis. Demand/capacity analysis should be applied to aircraft operations versus airfield improvements; to passenger enplanements versus terminal building improvements; to airport access traffic versus access roads and rapid transit facilities; and to other improvements as may be appropriate.

(4) *Facility Requirement Determination.* This element of the airport master plan provides for the establishment of a list of requirements for items such as the length, strength, and number of runways; number of gates; areas of aprons; square footage of terminal buildings and cargo buildings; number of public and employee parking spaces; types of airport access roads and rapid transit facilities; and the overall land area required for the airport. The list of facility requirements should not delve into matters of feasibility, site selection, or design concepts. The list will be used as a basis for making these studies.

(5) *Environmental Study.* Environmental factors should be carefully considered in the development of an airport master plan, both in the site selection process and in the design of the airport. Environmental studies should be made by qualified experts. The results of the studies should be incorporated into the development of the master plan to insure that the airport will be compatible with the environment.

b. Phase II, Site Selection. Site selection becomes an element of the master plan effort once the need for constructing a new airport has been established. The most important aspect of site selection is the proper evaluation of possible airport locations. In this evaluation the expansion of existing airport sites should also be considered. Evaluation of airport sites should include the study of airspace requirements, environmental factors, community growth, airport access, availability of utilities, land costs, site development costs, and political considerations.

c. Phase III, Airport Plans.

(1) *Airport Layout Plan.* After the airport site has been selected (new or existing) and facility requirements have been established, the master plan process moves on to the development of the airport layout plan. The development of the airport layout plan will establish the configuration of runways, taxiways, and aprons and will set aside areas for the establishment of terminal facilities. The location of air navigation facilities and runway approach zones are also incorporated in the airport layout plan. The airport layout plan provides for the positive dimensioning of airfield facilities.

(2) *Land Use Plan.* The configuration of airfield pavements and approach zones established in the airport layout plan provides the basis for the development of a land use plan for areas on and adjacent to the airport. The land use plan within the airport boundary should set aside areas for establishment of the terminal complex, maintenance facilities, commercial buildings, industrial sites, airport access, buffer zones, recreation sites, and other possible improvements as may be appropriate to the specific airport situation. The land use plan outside the airport boundary will include those areas affected by obstruction clearance criteria and noise exposure factors and should be limited to the suggestion of land uses in those areas. The location of navigation aids should also be shown and considered.

(3) *Terminal Area Plans.* The development of the terminal area plan and plans for components within the terminal area will evolve from the airfield configurations and land use criteria established in the airport layout and land use plans. The degree to which terminal area plans are developed should be limited to concept studies and conceptual drawings. Terminal area plans should provide an overall view of the terminal area and should then provide large scale drawings of important segments within the overall plan. Thus, large scale plans should be provided of terminal building areas, cargo building areas, hangar areas, airport motel sites, commercial and service areas, airport entrance and service roads, and other areas as may be appropriate to the particular airport development.

(4) *Airport Access Plans.* This element of the airport master plan should indicate proposed routings of airport access to central business districts or to points of connection with existing or planned arterial ground transportation systems. Various modes of surface transportation should be considered. The size of access facilities should be based on airport access traffic studies. Since access facilities beyond airport boundaries are normally outside the jurisdiction of airport sponsors, careful coordination will be required with other areawide planning bodies.

d. Phase IV, Financial Plan.

(1) *Schedules of Proposed Development.* Airport master plans are to be developed on the basis of short, intermediate, and long-range aeronautical demand (approximately 5, 10, and 20 years). Therefore, the master plan should indicate stage development of proposed facilities.

(2) *Estimates of Development Costs.* Construction cost estimates of the developments proposed in the airport master plan should be incorporated in the master plan report. These estimates should be related to the proposed schedule of development and should be based on forecast construction costs.

(3) *Economic Feasibility.* Although the primary objective of the airport master plan is to develop a design concept for the entire airport, it is essential to test the economic feasibility of the plan from the standpoints of airport operation and individual facilities and services. Economic

feasibility will depend on whether the capital investment required to implement the plan will be able to produce the revenue (which may be supplemented by local subsidies) required to cover annual costs attributable to capital investment plus the annual cost for administration, operation, and maintenance. The terms of economic feasibility should be based on short, intermediate, and long-range forecasts (approximately 5, 10, and 20 years).

(4) *Financing.* After the economic feasibility of the master plan has been established, financing must be obtained for capital improvements proposed in the plan. Financing may be raised from taxes, general obligation bonds, revenue bonds, government assistance, or a combination thereof. The establishment of financing is the final step in the master plan process. Thereafter, the final design and construction of improvements proposed in the plan can be implemented.

6. Feasibility of the Plan. The technical and economic feasibility of master plan considerations must be analyzed throughout the development of the plan. In the establishment of airport requirements, the planner must decide whether it is feasible to expand the existing airport or look for a new airport site. In the site selection process, the feasibility of constructing an airport at each possible location must be considered and, in some instances, it may be determined that the existing airport site should be expanded after all. After site selection, the feasibility of various airport concepts must be tested before the final airfield/terminal area/access plan is adopted. Finally, in the establishment of a financial plan for developments proposed in the master plan, a detailed economic feasibility study must be made of capital investment versus anticipated revenues. This study will provide the stimulus for establishment of required financing and the eventual implementation of the plan.

7. Public Hearings. The Airport and Airway Development Act of 1970 requires that airport sponsors must afford the opportunity for public hearings for projects involving the location of an airport, a new airport runway, or a runway extension.

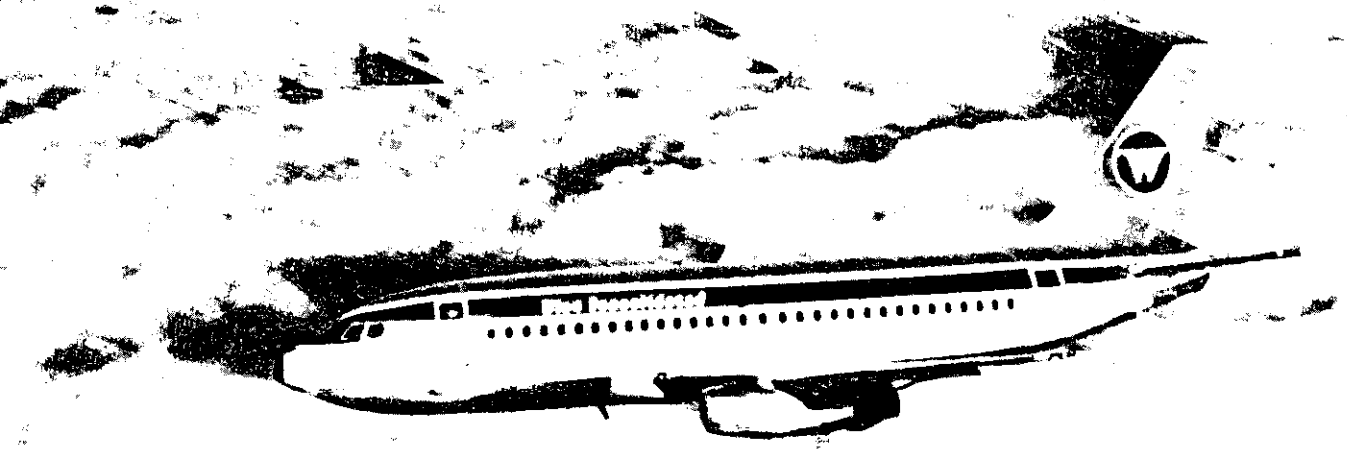
When master plans involve the selection of an airport site, sponsors are urged to afford the opportunity for public hearings as a part of the site selection process rather than wait until the time when an application is made for an ADAP grant for land acquisition. Under the FAA's Planning Grant Program, Federal funding of master plan elements beyond the site selection phase may be deferred pending the results of public hearings in order to assure that the site will not be rejected after all master planning steps are completed.

Likewise, if master plans propose new airport runways or runway extensions, sponsors are urged to afford the opportunity for public hearings at the time the master plan is presented to the public for approval rather than wait until the time when application is made for Federal development grants for particular segments of the runway improvements proposed in the master plan.

Public hearings held at the times of site selection and master plan approval will be earlier than those required for development projects by the Airport and Airway Development Act. However, if the public hearings are held at the times of site selection and master plan approval, the need for public hearings at the time of application for development projects may be forestalled by the earlier public acceptance.

Airport sponsors should refer to Advisory Circular 150/5100–7, "Requirement for Public Hearings in the Airport Development Aid Program," for guidance on meeting the latest statutory requirements for affording the opportunity for public hearings with respect to airport development projects.

AIRPORT REQUIREMENTS



Chapter 1. INVENTORY

8. General. The initial step in the preparation of a master plan for an individual airport is the collection of all types of data pertaining to the area which the airport is to serve. This includes inventory of existing airport facilities, area planning efforts which may affect the master plan, and historical information related to their development. This review will provide essential background information for the master plan report. It will also provide basic information for the development of forecasts and facility requirements.

9. Historical Review. This review should briefly trace the development of the community's airfield facilities and the air traffic which they have served. Information on the community's airports should include a description of each airport and the dates of their construction or major expansions. Airport ownership should also be mentioned. The decision to make a master plan study of a particular airport and the appropriation of funds for the study will probably have resulted from certain legislative actions and preliminary studies. These activities should also be cited in the historical review. The results of recommendations by steering committees and legislative study groups should be summarized. The dates and amounts of money included in enabling legislation by local and Federal authorities should be cited. Finally, the specific legislation for the particular airport master plan effort should be reported in detail.

10. Data Collection. The scope of the data collection should be limited to the area which the master plan airport will serve and to national trends which will affect that area. The planner should carefully research and study data which are available from current sources such as State, regional, and metropolitan airport system plans and other existing aeronautical studies.

Armed with the essential data the planner can then proceed to the next steps in the technical planning process, namely, the forecasting of aviation demand and the determination of facility requirements.

Existing airports and their configurations should be shown on a base map. Additional maps or overlays showing the airspace structure, the existing and planned ground transportation systems, and existing and projected land uses will also be useful.

11. Airports and Facilities. A key source document for airport information is the FAA Form 5010–1. This form provides essential landing area data. Appropriate aeronautical charts, the *Airman's Information Manual* (AIM), obstruction charts, and individual layout plans, if available, will also give pertinent information.

If a system plan for area airports has not been developed, visits to the individual airports should be made to obtain data not available from the above sources and to verify the accuracy and currency of information. From this information the planner will be able to determine the capacity of the existing system of airports.

12. Airspace Structure and Navaids. The planner should identify how the airspace is used in the vicinity of the master plan airport. Air navigation aids and aviation communication facilities which serve the area should also be identified as should proposed or existing man-made obstructions or structures and natural objects which affect the use of the airspace.

Airway and jet route structure should be ascertained because it will have a significant effect on the development of the master plan airport. The dimensions and configurations of the control zones and transition areas should be noted. These segments of controlled airspace are designed to accommodate only specific instrument flight rule (IFR) requirements such as instrument approach, departure, holding, and transition flight maneuvers. Thus, the inventory will show the current use of the area's IFR airspace and the balance of the airspace available for future use. Charts which are useful in identifying the airspace structure are the Federal and State aeronautical charts, instrument approach and departure charts, and Jeppeson Company and other recognized aeronautical publications.

13. Airport Related Land Use. An inventory of land uses in the vicinity of the master plan airport is necessary so that later in the planning process the feasibility of expansion or relocation can be determined. Current and planned land use should be displayed

graphically to assist in later steps in the development of the airport master plan. Existing estimates of the land values should also be collected.

Environmental data should be gathered. The results of existing aircraft noise exposure studies in the vicinity of the airport should be collected. A description should be provided for all recreation and conservation activities as they may relate to land uses which could be potentially incompatible with aeronautical activities. Thus, the location of current and planned public parks, recreation areas, wildlife/waterfowl refuges, and historical monuments should be noted and displayed on the area land use map. Data on the ecology of the area should also be obtained.

14. Existing Areawide Plans. Current plans which show existing and planned land uses, highways, utilities, schools, hospitals, etc., should be obtained from areawide agencies and transportation planning agencies which have jurisdiction over the area the master plan airport is to serve. This information will be used in later steps of the planning process as related to airport site selection, airport access, consideration of alternatives, and to planned community development and land use patterns.

15. Laws and Ordinances. Copies of zoning laws, building codes, and other regulations and ordinances which may be applicable to the development of an airport master plan should be obtained. Relevant State enabling statutes, laws pertaining to eminent domain, and interjurisdictional compacts should be researched.

16. Financial Resources. In addition to a history of the nature and extent of airport financing, the kinds of airport development financing available within the area to be served by the master plan airport should be noted. The information will be used in the preparation of the airport's financial plan, as described in Chapters 11 through 13.

17. Socio-Economic Factors. The collection of socio-economic data for the area to be served by the master plan airport is needed to answer basic questions regarding the type and volume of future airport and aviation activity.

Statistics and forecasts of population, economic activity, land uses, alternate means of transportation, etc., assist in determining the future market potential. Methods of developing aviation demand forecasts from socio-economic data are prescribed in Chapter 2 of this advisory circular.

Chapter 2. FORECASTS

18. General. Airport master plans must be developed on the basis of forecasts. From forecasts, the relationships between demand and the capacity of an airport's various facilities can be established and airport requirements can be determined. Since forecasts are to be short, intermediate, and long-range (approximately 5, 10, and 20 years), the planner may also establish a schedule of development for improvements proposed in the master plan. It should be recognized that 20-year forecasts are very approximate in nature.

Today's airport crisis can be attributed in part to the inadequacies of past forecasts. They have tended to underestimate aviation demand and to be narrow in scope. Of course, faulty planning can also hinder the proper development of an airport, even when reliable forecasts are available. And if the improvements proposed in a good airport master plan are not implemented, the congestion dilemma at high activity airports continues.

The inadequacies of past forecasts raise questions as to what the forecasts should encompass to provide proper guidance for the development of a master plan for the individual airport. Certainly the planner must go beyond the aviation demand forecast, and, in fact, must study carefully the impacts which social, environmental, economic, and technical forecasts will have on his airport. He must incorporate these influences in the development of aviation demand forecasts and in the logic of his planning.

But this necessity for broad scope analysis of forecasts does not give the planner license to develop a mass of far-ranging forecasts as a part of the master plan effort. The planner should first engage in a research of forecasts which exist for the area his airport is to serve, and then he should develop only those forecasts which are germane to the development of the master plan. The magnitude of development of forecasts will depend on the size of the community the airport is to serve and on information which may be available from earlier planning efforts such as State, regional, or metropolitan area airport system plans.

The paragraphs which follow provide guidance for the scope and design of the forecast study effort and for the preparation of forecasts for the individual airport master plan. It should be kept in mind throughout that forecast coverage should be complete but not superfluous.

19. Forecast Factors. The following factors should be considered in the development of forecasts for the individual airport master plan.

a. Demography. The size and structure of the area's population and its potential growth rate are basic factors in creating demand for air transportation services. The existing population along with its changing age and educational and occupational distributions can provide a primary index of the potential size of the aviation market and resultant airport employment over short, intermediate, and long-range forecast periods. Demographic factors influence the level of airport traffic and its growth, both in terms of incoming traffic from other states, regions, or cities, and traffic generated by the local or regional populations concerned.

b. Disposable Personal Income Per Capita. This is the purchasing power available to residents in any one period of time and, therefore, it is a good indicator of average living standards and financial ability to travel. High levels of average personal disposable income provide a strong basis for higher levels of consumer spending, particularly on air travel.

c. Economic Activity and Status of Industries. This refers to situations within the area the airport serves which generate activity in business aviation and air freight traffic. A community's population, size, and economic character affect its air traffic generating potential. Manufacturing and service industries tend to generate greater air transport activity than primary and resource industries, such as mining. Much will depend on established and potential patterns of internal and external trade. In addition, other aviation activities such as agricultural and instructional flying and aircraft sales are included in this factor.

d. Geographical Factors. The geographic distribution and distances between populations and commerce within the area which the airport serves have a direct bearing on the type of transportation services required. The physical characteristics of the land and

climatic differences are also important factors. In some cases, alternative modes of transportation may not be available or economically feasible. Moreover, physical and climatic attractions assist in determining focal points for holiday traffic and tourism and help in establishing the demand for air services which they generate.

e. Competitive Position. The demand for air service also depends on its present and future ability to compete with alternative modes of transportation. Also, technological advances in aircraft design and in other transportation modes, as well as industrial and marketing processes, can create transportation demands which have not previously existed.

f. Sociological Factors. The trend towards a more urbanized society, the increasing mobility of the population, rising educational levels, and a shorter work week with the resultant increase in leisure time are also major factors in determining demand for aviation services.

g. Political Factors. The granting of new traffic rights and routes for international air service will influence the volume of traffic at an airport. Demand for air transport also depends on government actions such as imposition of taxes, fees, and currency restrictions. In addition, government support of other modes of transportation may result in changes in demand for air transportation services.

h. Airport Traffic Data. Finally, in forecasting future airport traffic, historical airport traffic data should be considered. Data should include passenger and air cargo traffic and air carrier, general aviation, and military aircraft movements.

20. Research of Area Forecasts. To develop forecasts for all of the above factors would be a mammoth undertaking. Such extensive development of forecasts should not be necessary in the preparation of a master plan for an individual airport. Usually forecasts which cover these factors will have been developed as a part of other community planning efforts or from State, regional, or metropolitan area airport system plans.

Therefore, the airport master planner should conduct a research of forecasts which have been developed for the area and adapt and update them to the master plan effort. He should also discuss these forecasts with the planning agencies who were responsible for their development. Because of their experience in developing forecasts for the area to be served by the master plan airport, these forecasters may offer valuable assistance in the projection of travel demand.

State highway departments and urban transportation and metropolitan planning agencies usually have forecast information. State and regional planning offices may have developed forecasts of population, economic activity, and public facility needs. Area forecasts of aeronautical demand will likely have been developed by the Federal Aviation Administration, Air Transport Association, and aeronautically oriented consultants.

21. Forecasting. After the planner has chosen the most important forecast factors for the development of the master plan, he should research related forecast efforts to preclude duplication of effort.

Sound forecasting is basically a common-sense analysis of the important factors that account for air transportation demand. Good judgment which stems from a keen analytical ability and a stock of experience is essential in formulating predictions based on inadequate or inconclusive data. Forecasting, therefore, is not an exact science but the application of judgment which becomes more accurate through practice.

Various yardsticks are helpful in evaluating forecasts but they cannot provide exact measures of success. They include:

a. Consistency with past trends;

b. Comparison of directions of forecasted trends and realization;

c. Comparisons of rates of change;

d. Percentage deviations of forecasts from actual values; and

e. Comparisons of economic indicators.

22. Forecasting Methods. There are many ways in which to forecast future demands, and different forecasting methods are not necessarily competitive with one another. In some instances one method serves to supplement another. Some methods are applicable primarily to the very near future—a month, quarter, at most a year—while others are best suited for longer range forecasting. What is being forecasted also narrows the numbers of suitable methods. An appropriate forecasting method can best be selected when the various possible approaches are known, including the peculiarities of each. Brief descriptions of the principal forecasting methods are given below to assist the airport master planner in the development of aeronautical activity forecasts.

a. Mechanical Extrapolation. The rationale underlying the extrapolation procedure is that some past tendency or trend in the variable (activity or item) being forecasted reflects future trends. It may be

possible to quantify (to measure the quantity of) this tendency or trend and derive forecasts by extrapolating the relation into the future.

b. Surveys of Anticipations or Expectations. The survey approach is based on the premise that future trends are known to those people who will be primarily responsible in establishing those trends. Although an informative method, it is not nearly as simple and as rational as it sounds. Surveys are usually expensive; it is difficult to design meaningful questions and obtain reliable answers; and widely varying viewpoints cause additional uncertainty.

c. Analytical Forecasts. In this type of approach (which essentially combines diagnosis and prediction) explanations are sought of the factors influencing the variable to be forecast, and a mathematical relationship is developed between these factors and the given variable.

d. Judgment Forecasts. The judgment method is basically an estimate made by an individual who is closely acquainted with the factors related to the variable being forecast. These factors are weighed and evaluated according to the experience and intuition of the analyst. This method permits a broad range of information to be brought to bear on the forecast—national trends, sales reports, political situations, etc. It is especially advantageous when used in conjunction with any of the above methods, where there are a large number of variables for which relatively little data are available, or when intangible factors are expected to play a major role. The resultant forecasts from use of this method alone are the most difficult to defend under close scrutiny and may be subject to strong bias from the individual involved in the forecasting process.

e. Professional Services. The preparation of forecasts is a complex task and should be accomplished by experienced forecasters. This is especially true for airports serving large metropolitan areas.

23. Forecasts of Aviation Demand. Annual forecasts of airport traffic (for 5-, 10-, and 20-year periods) form the primary basis for determining the requirements for a master plan airport. It is essential to develop activity forecasts by the type of major user categories, i.e., air carrier, scheduled air taxi, general aviation, and military. In the development of the operational activity forecasts, an unconstrained approach is usually the best approach. Forecasts are sometimes expressed in terms of upper and lower limits of estimated aviation demand for given points in time. These upper and lower limits are then plotted against the forecast period so that planners can develop alternative scheduling of improvements proposed in the master plan.

The "unconstrained" forecast represents the potential aviation market in which all of the basic factors that tend to create aviation demand are used, without regard to any constraining circumstances (i.e., limited airport expansion capability, airspace, access, etc.) that could affect aviation growth at any specific airport or location. Using this approach, it is possible to determine the theoretical development needs in accordance with the total demand potential. For an airport serving an exceptionally high activity metropolitan area, however, potential constraints and alternative methods to reduce them should be considered.

There are five major types of operational activity forecasts considered necessary to determine airport requirements. They are listed and described below.

a. Enplaning Passengers. Total number of passengers departing on aircraft at an airport, including originations, stopovers, and transfer passengers. Where applicable, identify domestic and international passengers separately.

b. Enplaning Air Cargo. Total tonnage of priority, nonpriority, foreign mail, express, and freight (property other than baggage accompanying passengers) departing on aircraft at an airport, including originations, stopovers, and transfer cargo. Where applicable, identify domestic and international cargo separately.

c. Aircraft Operations (Movements). Total number of landings (arrivals) and takeoffs (departures) from an airport. There are two types of operations—local and itinerant—which should be identified separately.

(1) *Local Operations.* Aircraft which operate in the local traffic pattern or within sight of the tower and are known to be departing for or arriving from flights in local practice areas located within a 20-mile radius of the airport and/or control tower, and aircraft which execute simulated instrument approaches or low passes at the airport.

(2) *Itinerant Operations.* All aircraft arrivals and departures other than local operations described above. Where applicable, identify domestic and international itinerant operations separately.

d. Busy-Hour Operations. Total number of aircraft operations that are expected to occur at an

airport, averaged for two adjacent peak hours of a typical high activity day (use the 37th high activity day of the year). Identify busy-hour operations by each category of major user.

e. Based Aircraft. Total number of active general aviation and air carrier aircraft which use an airport as "home base" and have a current airworthiness certificate. Based aircraft should be categorized by gross weight, number and type of engines, and air carrier or general aviation use.

24. Aircraft Mix. In determining and planning for future airport facility requirements, it is necessary to forecast the types or categories of aircraft (aircraft mix) which are to be accommodated at the airport or location under consideration.

Therefore, it is essential to keep abreast of technological advances in aircraft design (such as the SST, large capacity subsonic transport aircraft, V/STOL, airbus aircraft, etc.) in order to insure the provision of adequate airfield and terminal design at the airport from which they are to operate. Generally, passenger and cargo volume forecasts will indicate the types of terminal facilities required, whereas, the number of aircraft operations by type will establish airfield configuration requirements.

25. Aviation Demand For Air Transportation Hubs. The FAA reports, "Aviation Demand and Airport Facility Requirement Forecasts for Large Air Transportation Hubs Through 1980," August 1967, and "Aviation Demand and Airport Facility Requirement Forecasts for Medium Air Transportation Hubs Through 1980," January 1969, are available as guides in the development of operational activity forecasts. Appendix 1 of the "Medium Hub" publication contains methodology developed by the FAA to obtain unconstrained aviation demand forecasts and illustrate how to apply various forecasting techniques. Also, the reference material and source documents used are listed with each method. These methods and techniques were developed primarily to obtain aggregate aeronautical activity forecasts for each large hub location. With some modification, they can be applied to almost any airport or location that requires aviation demand forecasts.

Chapter 3. DEMAND/CAPACITY ANALYSIS

26. General. Demand/capacity analysis is an essential step in the development of a master plan for the individual airport. It provides basic information for determination of facility requirements and economic feasibility. The study of the demand/capacity relationship will result in a requirement for the theoretical expansion of facilities and the cost of those improvements can then be related to revenues and to savings which will be realized by passengers, cargo handlers, and aircraft operators due to reductions in delay. This type of analysis should be applied to aircraft operations versus airfield improvements; to passenger enplanements versus terminal building improvements; to cargo tonnage versus cargo facility development; to airport access traffic versus access roads and rapid transit facilities; and to other improvements as may be appropriate. Airspace in the vicinity of the master plan airport should also be analyzed. Demand/capacity analysis should be applied to short, intermediate, and long-range developments (approximately 5, 10, and 20 years). In the case of large, complicated airports, it may be benecial to subject demand/capacity analysis to computer simulation.

Demand is based on forecasts developed in accordance with guidance set forth in Chapter 2. Capacity and the demand/capacity relationship should be established in accordance with the following guidance.

27. Limitations of Demand/Capacity Analysis. It should be kept in mind throughout the demand/capacity analysis that only approximations will be obtained for facility requirements, their costs, and savings which will result from reduced delays to airport users as well as anticipated revenues which may be obtained from proposed improvements. Thus demand/capacity analysis will yield preliminary estimates of number and configuration of runways, areas of apron, numbers of vehicle parking spaces, and capacities of airport access facilities. Preliminary estimates of economic feasibility may also be obtained. These approximations will provide a basis for developing the details of the airport master plan and for determining the feasibility of improvements considered therein. The development of these details will follow from demand/capacity analysis and should be performed in accordance with guidance offered in subsequent chapters and as dictated by the planner's imagination and understanding of airport design criteria. Demand/capacity study is an analytical tool and in no way should it be considered a substitute for creative design.

28. Aircraft Operational Requirements. The forecasts of aviation activity will indicate the kinds of aircraft which will use the master plan airport. The frequency of use, passenger/cargo load factors, and haul lengths will also be indicated. From this demand data, the planner can ascertain the required physical dimensions of the aircraft operational areas. While a capacity analysis provides requirements in terms of numbers of runways/taxiways, etc., the analysis of aircraft operational requirements allows for the determination of runway/taxiway/apron dimensions and lateral clearances between airport areas. Airport operational requirements will be determined in accordance with guidance listed in Chapter 4. Consultation with the airlines and the general aviation community is essential in verifying forecast equipment usage and in ascertaining user plans. Guidance on all facets of airport development related to aircraft operational requirements is contained in FAA advisory circulars (AC 150/5300 series). The National Airport System Plan will also prove helpful in ascertaining general development requirements.

29. Capacity Analysis. An analysis of the existing air traffic capacity of the area the master plan airport is to serve will help to determine how much additional capacity will be required at the master plan airport. Four distinct elements require investigation, namely: the airfield, the terminal area, the airspace, and surface access. The maximum capacity achievable will depend on the capacity limitations in any of these four elements.

After determining the airfield, terminal area, and airspace capacity, and those airports most likely to be retained in the system, the forecasted demand is imposed on the system, and the additional capacity required for the master plan airport is determined. The

master plan airport should be placed in an area predicated on maximum utilization consistent with the geographic distribution of air transportation users, the availability of adequate real estate, and minimum environmental problems. These factors are discussed in Chapter 6.

a. Airfield Capacity. Airfield capacity is the rate of aircraft movements on the runway/taxiway system which results in a given level of delay. Current methodology employed by the FAA considers that capacity is reached when delays to departures average four minutes during the two adjacent normal peak hours of the week for large transport type aircraft operations. For general aviation type operations with small aircraft, the average delay level is two minutes for the peak hour of the week.

The methods presented in Advisory Circular 150/5060-3A, "Airport Capacity Criteria Used in Long-Range Planning," should normally provide adequate approximate intermediate and long-range capacities for the development of an airport master plan. Advisory Circular 150/5060-1A, "Airport Capacity Criteria Used in Preparing the National Airport Plan," and the "Airport Capacity Handbook—Second Edition" provide more exacting methods for determining airfield capacities and their use will be necessary for short-range analysis (less than five years) and where highly complex analyses are required. For example, where a decision of whether to build a new airport or expand an existing one is not clear cut, the more precise methodology should be used.

b. Terminal Area Capacity. After preliminary calculations of the airfield capacity requirements have been made, it is necessary to determine the capacity requirements of the terminal area. Within the terminal area, individual elements should also be analyzed to keep the terminal area system in balance.

In comparing the terminal area capacity to the airfield capacity, it is necessary to use common demand terminology. Thus, the airfield capacity must be translated into numbers of passengers, tons of cargo, etc., in order to express the capacities in equivalent terms.

Terminal elements to be included in the analysis are:

(1) Airline gate positions.
(2) Airline apron areas.
(3) Cargo apron areas.
(4) General aviation apron areas.
(5) Airline passenger terminals.
(6) General aviation terminals.
(7) Cargo buildings.
(8) Auto parking.
(9) Aircraft maintenance facilities.

An example of determining the relationship of terminal area requirements to demand levels is contained in the FAA publication "Aviation Demand and Airport Facility Requirement Forecasts for Medium Air Transportation Hubs Through 1980." Additionally, the advice of industry organizations should be sought in determining acceptable current relationships between activity levels and terminal requirements.

It should be noted that requirements will also depend upon the terminal concept employed. For example, suburban or downtown passenger collection points will substantially lower the on-airport passenger terminal building requirements and convenient mass transit systems will alter auto parking needs. Consideration of the various terminal concepts and surface access systems should take place when developing and evaluating alternative terminal area concepts. See Chapters 9 and 10.

c. Airspace Capacity. The proximity of airports to one another, the relationship of runway alignments, and the nature of operations (IFR and VFR) are the principal interairport considerations which will affect the capacity of the master plan airport. For example, it is not uncommon in a large metropolitan area to have major or secondary airports spaced so closely that they share one discrete parcel of airspace. In such cases, there is a reduction in the IFR capacity for the airports involved due to the intermixing of traffic within the common parcel of airspace. When this occurs, aircraft, regardless of destination, must be sequenced with the proper separation standards, thus reducing the IFR capacity for a specific airport.

The FAA Order 7480.1, "Guidelines for Airport Spacing and Traffic Pattern Airspace Areas," gives the planner general guidance in determining areas of likely airspace interaction. Additional information on interairport relations for airspace capacity purposes may be obtained from the document "Capacity of Airport Systems in Metropolitan Areas—Methodology of Analysis"—FAA/BRD 403.

At this point, assistance should be asked of the FAA office having jurisdiction for FAA matters in the area to be served by the master plan airport. Responsibility for planning and design of the controlled airspace structure rests with the FAA which can give guidance on existing and available airspace capacity.

d. Airport Access Capacity. The establishment of capacity requirements for the master plan

airport will determine the capacity required for airport access. The airport capacity figures should be translated into numbers of movements by people and access vehicles. A preliminary examination of existing and planned highway and mass transit systems should allow a judgment as to the availability of surface access capacity.

In determining the volume of people, it is necessary to establish the percentage relationship between passengers, visitors, and airport employees. This can vary from one urban area to another and from one site to another. Information on the subject of airport access is contained in several publications, including those of the American Society of Civil Engineers and the Highway Research Board.

In attempting to ascertain such important data as the total number of people who can be expected to travel by private auto to and from the airport and the distribution of their travel routes throughout the area the master plan airport is to serve, the Regional Federal Highway Division Engineers Office as well as State and local highway offices should be consulted. The Urban Transportation Planning Program will be another valuable source of information. Metropolitan transit authorities should also be consulted to determine if mass transit service to the airport is feasible and to study the effects which mass transit facilities would have on surface access capacity. The potential of mass transit is a principal consideration in the analysis of airports serving scheduled air passengers. While surface access is not as critical an element for general aviation airports, it has a vital effect on airport utilization.

e. Air Traffic Control and Navaid Requirements. Demand/capacity analysis provides insight in terms of the type and timing of air traffic control facilities and air navigation aids that will be needed at the master plan airport. The extent of airspace available, the volume of traffic projected, and the nature of the operations (IFR and VFR) that could be expected are the determining factors.

In preparing a master plan for general aviation operations, every consideration should be given to having them capable of sustaining instrument operations. The demand forecasts will be used to determine this requirement and should indicate the operational reliability (approach minima) required. This, in turn, will dictate the kind of equipment (ILS, VOR, etc.) that should be planned for. The most sophisticated instrumentation available should be planned for airports served by certified air carriers.

Since the FAA can be expected to continue to be the supplier and operator of navaids and air traffic control facilities, current eligibility criteria for such installations should be obtained from that organization. Early consultation with the FAA is necessary at this point in order to ascertain what is being planned and what its views are on future instrumentation requirements and capabilities at the master plan airport. In addition, the FAA publication, "National Aviation System, Ten-year Plan," discusses eligibility and siting criteria for navaids.

30. Cost Benefit Analysis. When improvements proposed in an airport master plan will increase the capacity of an area to handle aircraft, then delays to aircraft operations in that area will be reduced. These reductions in delays will also reduce monetary losses to aircraft operators which have resulted from the delays. The money saved from the reduced delays can be compared with the costs of airfield improvements and cost benefit relationships can be established.

Advisory Circular 150/5060–1A provides the means of determining reductions in delays to aircraft which accompany increases in airfield capacity. From figure 17, page 36 of Appendix 2 of Advisory Circular 150/5060–1A, an increase in annual capacity (aircraft operations per year) will result in a reduction of annual delay (minutes per year). The cost per minute of delay can be established for aircraft using the airfield based on aircraft mix. Current estimates are $15 for class A aircraft, $8 for class B, $4 for class C, and $0.80 for classes D and E. These estimates should be updated to meet the time frame of the particular airport master plan.

The amount of annual savings to aircraft operators which will result from airfield improvements is obtained by multiplying the annual reduction in minutes of delay by the cost per minute of delay to aircraft.

Next, the cost of an improvement is estimated and spread over a period of amortization. The cost per year of the improvement is then compared with savings per year and a cost benefit ratio is obtained. Thus, if the annual cost of a runway improvement is one million dollars per year and the annual savings due to reduction in delays to aircraft is 2 million dollars, the cost benefit ratio is 1 to 2.

This same type of cost benefit analysis should be applied to the costs of terminal area facilities versus delay savings to passengers. Cargo facilities, automobile parking, and airport access should also be subjected to cost benefit study by the airport master planner as a part of demand/capacity analysis.

Whereas, the Federal Aviation Administration has developed criteria for comparing aircraft delays with airfield improvements, such criteria has not been established for other airfield facilities. This should be accomplished on the basis of conditions peculiar to the area which is to be served by the master plan airport. Cost benefit analysis, as described above, should be incorporated in the study of the economic feasibility of improvements proposed in the master plan as described in Chapter 12.

31. Computer Simulation. In the development of master plans for large complicated airports, it will often be beneficial to subject demand/capacity analysis to computer simulation of airfield and terminal area operations. There is a growing interest in this technique on the part of planners because it reduces greatly the time in which demand/capacity analysis can be accomplished and thus a number of alternative solutions to airport configuration and terminal area concept problems can be expeditiously studied. Past simulations have explored airfield configurations, taxiway complexes, terminal building flows, and, in some cases, simulations have encompassed airport movements from curb space to aircraft flight.

In deciding whether computer simulation should be applied to an airport master plan project, the planner should study the latest simulation projects to see if they are adaptable to his effort and should weigh carefully the cost of simulation with the overall estimated cost of the master plan effort. As stated previously in this chapter, demand/capacity studies are analytical in nature and provide a basis for the development of the master plan. Computer simulation will serve to expedite demand/capacity analysis but it is not a substitute for creative design.

Chapter 4. FACILITY REQUIREMENTS

32. General. Facility requirements are developed from information obtained in demand/capacity analysis and from FAA advisory circulars and regulations which provide criteria for design of airport components. Demand/capacity analysis yields approximation of number and configuration of runways, number of gates, square footage of terminal buildings and cargo facilities, and various types (mix) of aircraft which will use the master plan airport. From the mix of aircraft and number of aircraft operations, general requirements for lengths of runways, spacing of taxiways, layout and spacing of gates, and apron area requirements can be determined. This will enable the planner to estimate the overall size and shape of the new airport site or airport expansion which will be required. These approximations will be used as criteria for airport site selection and the development of the details of the airport layout plan. Information on terminal requirements from sources such as the Air Transport Association's Airport Affairs Technical Group should be explored and utilized.

33. Guidance in Developing Facility Requirements. The following table indicates the facilities for which size and spacing requirements should be developed. It also lists by reference the FAA guidance material which should be used in establishing the requirements. The references are fully described in the bibliography at the end of this advisory circular. They include criteria for developing facility requirements for airports serving certificated air carriers and airports primarily serving general aviation.

TABLE 1.—References for determination of facility requirements

Subject	Items	Reference [1]
Runway	Length	1q, 1l
	Width, clearances	1t, 1l
	Clear zones, approach slopes	1m, 1b
	Orientation, crosswind runway	1u, 1b
	Grades	1p
	Capacity, stage construction, delay and cost effectiveness	1b, 1c
Taxiways	Width, clearances	1t, 1l
	Exit design and location, grades	1v
	Effect on runway capacity, stage construction, cost effectiveness	1b, 1c
Terminal area	Clearances	1t, 1l
	Grades	1w
	Gate positions	3d
	Aircraft parking clearances	1w
	Space requirement in terminal and administration building for various activities	1gg
Service and hangar areas	Service equipment buildings	1ee
	Cargo facilities	1ff
	Fire and rescue equipment buildings	1j
Heliports	Planning and design	1hh
	Rooftop or elevated heliports	1hh
Obstructions	Standards of approach, horizontal, and other control surfaces	1l
	Clear zones	2a

[1] Reference numbers refer to the publications listed in the bibliography.

TABLE 1.—References for determination of facility requirements—Continued

Subject	Items	Reference [1]
Drainage	Structures, layout	1n
	Grades	1n
Paving	Fillets	1v
	Jet blast protection	1r
	Pavement types and details	1o
Lighting and marking	Approach lighting	1bb
	Runway lighting	1aa, 1dd
	Taxiway lighting	1y, 1cc
	Runway and taxiway marking	1x, 1z
	Helicopter landing area	1hh
	Obstructions	1jj
Wind data	Source of data	1u, 1b
Navaids	Location, grading requirements	1k
Airport types	Utility airports	1l
	General aviation airports	1l

Chapter 5. ENVIRONMENTAL STUDY

34. General. Environmental factors must be considered carefully in the development of the airport master plan, both in the site selection process and in the design of the airport. This is a requirement of the Airport and Airway Development Act of 1970. Studies of the impact of construction and operation of the airport or airport expansion upon accepted standards of air and water quality, ambient noise levels, ecological processes, and natural environmental values should be conducted to determine how the airport requirements can best be accomplished.

An airport is an obvious stimulus to society from the standpoints of economic growth and the services it offers to the public. However, this generation of productivity and employment may be negated by noise and air pollution and ecological compromises if compatibility between an airport and its environs is not achieved. Thus, the airport master plan must directly contend with those problems identified in the studies of environmental qualities so that the engineering of airport facilities will minimize or overcome those operations which contribute to environmental pollution.

35. Approach to Environmental Study. The accent on preservation of the environment has highlighted a dimension of the airport planner's job which has often been overlooked. This added environmental dimension should not be viewed as a handicap to technical progress, but rather as an opportunity to develop new and innovative ideas which will provide for economic growth in consonance with the preservation of natural and aesthetic land functions. Therefore, environmental studies for the airport master plan must be performed by specialists who are capable of analyzing environmental problems and developing sound solutions. To this end, the familiar airport master planning staff of architects, engineers, economists, and planners must be enlarged to include environmental specialists and ecologists. They should establish the environmental guidelines which will be incorporated, by practical means, into the airport master plan by the planners, architects, and engineers.

36. Aircraft Noise. Aircraft noise is probably the severest environmental problem to be overcome in the development of an airport. Where aircraft noise causes disturbance, it makes an airport unpopular no matter how well the airport serves its community. The resolution of the noise problem requires careful analysis, development of proper land use, and a coordinated approach on the part of the government, aircraft manufacturers, airport operators, and the community.

Improvements in design of engines may result in somewhat quieter aircraft in the future. Noise abatement procedures and special operational restrictions have resulted in substantial noise reduction from existing airports. Airport layouts which direct the noise away from built-up areas have also been a principal consideration in the development of new airport facilities.

One of the most effective means of reducing noise impact, however, is through the proper planning of land use for areas affected by airport noise. The difficulties which will be encountered in establishment of land use plans will depend on whether the environs are open or built up. The strategy employed in a given situation will depend on whether its application is preventative or remedial in nature. Methods of land use control include purchase for direct airport use; conversion to a use compatible with expected noise levels; acquisition of avigation easements; and the establishment of zoning and building codes.

The detailed criteria for the solution of airport noise problems are prescribed in Chapter 8, Land Use Plan. It is through the development of an effective land use plan that the airport becomes compatible with its human neighbors.

37. Air Pollution. While there is evidence that aircraft engine emission constitutes but one percent of the total air pollutants in a typical metropolitan area, this facet of the environmental impact of airport operations cannot be overlooked in the development of the airport master plan. It is rather evident to the observer on the ground that exhaust smoke does exist and that contaminants are emitted into the environment.

The Federal Government and industry are keenly aware of the public reaction to engine exhaust emis-

sions and are jointly working towards alleviating the problem. This is an easier problem to resolve from a technical and economic aspect than the noise alleviation problem, and it will probably be eliminated in the foreseeable future as a factor which the airport planner must deal with. However, the anticipated effects of air pollution and considerations given thereto should be reported in the airport master plan.

38. Natural Environmental Values. Public opposition to aircraft noise and the increasing requirements for land and airspace are causing new airports to be located away from built-up areas. But airport locations in the open countryside do not necessarily provide a solution to the problem of environment. Ecological problems must be carefully studied in the selection of an airport site.

Locations in or near national parks and wilderness areas or areas designated as wildlife and waterfowl refuges, public recreation areas, and historical monuments should not be considered for airport development unless there are no feasible alternatives. Also, expansion of existing airports into or adjacent to such areas should be avoided where possible.

39. Water Pollution. Although the means of controlling water pollution is probably the best understood aspect of the environmental problem, it should be studied carefully in the development of the airport master plan and means for overcoming water pollution problems should be incorporated in the plan. An airport can be a major contributor to water pollution if suitable treatment facilities for airport wastes are not provided. Sources of water pollution are:

a. Domestic Sewage from Airport Facilities. The need for sewage treatment plants or for construction of trunk sewers from the airport to existing community facilities should be analyzed. The need for keeping industrial wastes from hangar and fueling areas separate from domestic sewage is essential. When industrial wastes are introduced into sewage treatment plants, they will often prohibit the proper treatment of sewage. Regardless of how domestic sewage is treated, the process should be such that the effluent of sewage treatment plants will not pollute recipient water sources.

b. Industrial Wastes. Industrial wastes should be kept separate from domestic sewage and should be treated at the airport's industrial waste treatment plant. Oil wastes should be separated from other industrial wastes by the construction of special fuel (API) separators. Provisions should be made in storm drainage systems for containing apron fuel spills before they reach natural courses of water. Regardless of how industrial wastes are treated, the process should be such that effluents from industrial waste will not pollute recipient water sources.

c. High Temperature Water Degradation. It is conceivable that large regional airports will have independent sources of power supply or other industrial elements which will produce high temperature cooling water effluents. High temperature effluents pollute streams and cause ecological changes. Therefore, provisions must be made for cooling high temperature effluents before they are introduced into natural water courses.

40. Environmental Changes Caused By Airport Site Developments. The site developments proposed in airport master plans will often have important impacts on the natural environment. This is particularly true of developments proposed for very large airports where site work will cover thousands of acres. Flowing streams and major drainage courses may be changed, the habitats of wildlife may be disrupted, and natural areas including wilderness and seashores may be reshaped. Mines and quarries may be developed for the supply of airport construction materials.

The airport planner should take these factors into account in the development of the master plan. Otherwise, the construction program proposed for the master plan airport may not be realized. Factors to be considered in planning airport site developments should include:

a. Rehabilitation of quarry and mining areas which are developed for supply of airport construction materials.

b. Development of alternate areas and preserves for wildlife areas disrupted by airport site development.

c. The proper relocation of stream beds and preservation of drainage courses in the mass grading of airport areas.

d. The construction of flood control dams to accommodate increased water runoffs and silting caused by airfield paving and grading.

e. The preservation or relocation of natural areas disturbed by airport land acquisitions and site developments.

41. Federal Policy in Environmental Problems. Section 4(f) of the Department of Transportation Act requires responsible Federal action in

assuring the protection of natural environmental values through the following provision:

"It is hereby declared to be the national policy that special effort should be made to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges, and historic sites. The Secretary of Transportation shall cooperate and consult with the Secretaries of the Interior, Housing and Urban Development, and Agriculture, and with the States in developing transportation plans and programs that include measures to maintain or enhance the natural beauty of the lands traversed. After the effective date of the Federal-Aid Highway Act of 1968, the Secretary shall not approve any program or project which requires the use of any publicly owned land from a public park, recreation area, or wildlife and waterfowl refuge of national, State, or local significance as determined by the Federal, State, or local officials having jurisdiction thereof, or any land from an historic site of national, State, or local significance as so determined by such officials unless (1) there is no feasible and prudent alternative to the use of such land, and (2) such program includes all possible planning to minimize harm to such park, recreational area, wildlife and waterfowl refuge, or historic site resulting from such use."

Section 4(f) of the Department of Transportation Act represents an important step in an attempt to prevent further encroachment on environmental values. A new awareness has been created at all levels of government, and in the public in general, that our natural resources are being threatened and that this threat must be alleviated. A far reaching Federal law to protect and enhance the quality of the Nation's environment and natural resources was enacted on January 1, 1970. Public Law 91-190, the National Environmental Policy Act of 1969, declares a broad national environmental policy which calls on the Federal Government to exercise leadership in improving and coordinating Federal plans, functions, programs, and use of resources with the goals of preventing damage either to the environment or ecological systems and encouraging mutual productive harmony between man and his environment. The law also established, in the Executive Office of the President, a Council on Environmental Quality to develop guidelines for agencies affected by the law.

Insofar as airport development is concerned, any required Federal actions regarding proposals that significantly affect the quality of the environment must be accompanied by findings concerning:

a. The environmental impact of the proposed action.

b. Any adverse environmental effects which cannot be avoided should the proposal be implemented.

c. Alternatives to the proposed action.

d. The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity.

e. Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

42. Application of Environmental Criteria. In line with the above guidelines and policy, an airport master plan (including site selection) must be evaluated factually in terms of any proposed development which is likely to:

a. Noticeably affect the ambient noise level for a significant number of people.

b. Displace significant numbers of people.

c. Have a significant aesthetic or visual effect.

d. Divide or disrupt an established community or divide existing uses (e.g., cutting off residential areas from recreation or shopping areas).

e. Have any effect on areas of unique interest or scenic beauty.

f. Destroy or derogate from important recreational areas.

g. Substantially alter the pattern of behavior for a species.

h. Interfere with important wildlife breeding, nesting, or feeding grounds.

i. Significantly increase air or water pollution.

j. Adversely affect the water table of an area.


SITE SELECTION

Chapter 6. SITE SELECTION

43. General. The site selection process begins after a community has determined that it is feasible to plan for a new airport. This feasibility will have been established through the studies prescribed in Chapters 1 through 5 of this advisory circular, that is to say:

a. Inventory will have been taken of existing airport facilities serving the community.

b. Forecasts of aviation demand on the community will have been developed.

c. Demand/capacity analysis will have determined that existing facilities will not meet that demand or that it is not desirable or feasible to expand existing facilities to meet the demand.

d. General requirements for a new airport facility such as number and lengths of runways, number of gates, size of aprons, square footage of terminals, and overall land area will have been established by demand/capacity analysis.

e. Environmental considerations will have been studied.

f. Preliminary estimates of the economic feasibility of building a new airport will have been established.

Thus, the airport planner will have his mandate to study and recommend sites for the community's new airport. Site selection studies should evaluate airspace, environmental factors, community growth, airport access, availability of utilities, land costs, and site development costs and should recommend and give preferential ratings to possible sites.

The results of the site selection study should be presented in a positive and persuasive fashion since the actual selection will most likely be decided in the political arena. This is particularly true of airports which will serve large urban areas where the citizenry is very sensitive to environmental and socio-economic factors. The study should culminate in the recommendation of a specific site.

44. Study Goals and Purpose. The goal of the site selection effort should be the selection of a site of adequate size and suitable location to accommodate the residents and commerce of the area which will be served by the airport. The primary purpose of the study should be to evaluate the feasibility of possible locations through the forecast period from environmental, geographic, economic, and engineering standpoints.

45. Coordination. The site selection study should be thoroughly integrated with current local and regional comprehensive plans. During the course of study, close liaison should be maintained with Federal, State, regional, and metropolitan planning agencies having jurisdiction within the area to be served by the airport and with the airlines and other aviation interests operating in that area. The site selection team should take full advantage of data from recent studies which have been developed by these organizations. The contents of the site selection study should be treated confidentially throughout the study effort because of the impact of site considerations on land costs and community reaction. Public release of study information should not be made prematurely or without express permission of the sponsor.

46. Responsibility. The initial investigation of airport sites is the responsibility of the airport sponsor. Preliminary recommendations should be presented to the Federal Aviation Administration for review. After review, the FAA will confer with the sponsor regarding the preliminary recommendations and will assist the sponsor in evaluating the most desirable sites, if so requested. In some instances, this evaluation will result in a recommendation to the sponsor to study additional sites. When the sponsor has made a final recommendation, or recommendations, the FAA will state in writing its position on the proposed site selection. Grants for phases of an airport master plan which follow site selection will not be made until an airport site has been approved by the FAA.

a. Airspace Review. In its review of proposed airport sites, the FAA will evaluate them from an airspace standpoint. Federal Aviation Regulations Part 157, Notice of Construction, Alteration, Activation and Deactivation of Airports, amended June 27, 1970 requires proponents of civil or joint use (civil/

military) airport projects not involving Federal funds to notify the nearest FAA area or regional office before work on the project begins. During the course of a site selection study, the FAA will offer advice to sponsors regarding airspace for sites under consideration. A formal review of the effect of the site selected by the sponsor on navigable airspace will be conducted by the FAA, and the sponsor will be informed of the results of the aeronautical study. After receiving these results, the sponsor may determine that a more suitable site should be selected due to airspace problems. Additional information on this airspace review action may be obtained from Federal Aviation Regulation Part 157.

b. Airports to be Funded by Airport Development Aid Program (ADAP). If the sponsor intends to submit an application for an airport land acquisition or development grant under ADAP, endorsement of the proposed site should be obtained from FAA prior to application. FAA endorsement is a requirement before tentative allocation of ADAP funds can be made. The procedures to be followed in requesting ADAP assistance for land acquisition or airport development are specified in Federal Aviation Regulation Part 151.

c. Non-ADAP Public and Private Airports. Since these airports will not be funded under ADAP, endorsement of proposed sites by the FAA is not required. However, under the provisions of Federal Aviation Regulation Part 157, a proponent must give the FAA prior notice before an airport construction proposal is started in order that the FAA may advise him of the effects of the proposal on safe and efficient use of airspace. The proponent must also advise the FAA upon completion of the airport's construction. The FAA will assist sponsors in the investigation and location of sites if so requested. Sponsors should contact the nearest FAA area or regional office to obtain this assistance.

47. Determination of Facility Requirements. These requirements will have been established through the studies prescribed in Chapters 1 through 5 of this advisory circular. Before the site selection team begins its effort, it should have in hand a list of facility requirements which estimate the character of improvements and the size and type of airport which will be required. A suggested format for listing these requirements is shown in Chapter 4. The current National Airport System Plan (NASP) should also be checked for items of development and locations which are eligible for financial assistance under the ADAP. NASP may be a useful tool in determining basic airport needs. NASP is prepared by FAA on a continuous basis with publication anticipated every two years. For each community it lists airport development recommended for the national system of airports for the ensuing 10-year period. Sponsors should consult the FAA to obtain advice on specific airport recommendations contained in the NASP.

48. Preliminary Office Study of Possible Sites. The approximate size and type of airport for which a site is to be selected will have been established in the estimation of facility requirements. The next step in the site selection process is to review existing areawide plans and to plot possible airport sites on charts and maps which encompass the area the airport will serve. The preliminary office study should include:

a. Review of existing comprehensive land use plans and other community and areawide plans.

b. Analysis of available wind data to determine runway orientation and the need for crosswind runways.

c. Study of USC & GS quadrangle sheets and aeronautical charts and maps of ground transportation facilities and the plotting of possible airport sites thereon. The locations of existing and planned airports and ground transportation facilities should also be plotted. The possible airport sites will be investigated in more detail during subsequent field investigations.

d. Research of land costs and planned land uses in the areas of possible airport sites.

e. Study of obstructions, topographical features, recreational areas, and population distributions relative to possible airport sites.

f. Review of site development costs and problems such as availability of construction materials, soil conditions, and geological features in the vicinity of possible airport sites. Information may be available from the Bureau of Public Roads or the Soils Conservation Service of the Department of Agriculture.

g. Study of environmental and ecological factors at possible airport sites to determine the impact of noise on adjacent areas and the effect of site development on the ecology. The proximity of bird habitats such as lakes, rivers, ponds, and coastal areas should also be studied from the standpoint of the bird-strike hazard to aircraft.

h. Review of other factors such as possible snow glare, fog and smoke problems, status of zoning legis-

lations, and other items as may be appropriate to the particular sites under consideration.

i. Review and analysis of preliminary office studies should be performed by planning agencies and aviation interests having jurisdiction in such matters. This coordination effort should eliminate undesirable sites before costly field inspections of possible sites are undertaken. It will also bring responsible parties abreast of the site selection effort at an early stage of the developments. It may be beneficial to all parties concerned to establish a technical committee to consider site selection proposals at this stage of the study. An authorized technical committee should be made up of representatives of various interests and should often be able to make expeditious decisions on possible sites which warrant detailed field investigation studies. Such actions can improve the economy and efficiency of the overall site selection process.

49. Field Investigations of Airport Sites. After preliminary office studies of possible airport sites have been developed and the number of possible sites has been narrowed by the review and analysis of authorized agencies and aviation interests, the field investigation of the sites should begin. There will usually be preliminary and final field investigations. The same factors considered in office studies should be explored in the field investigations. The preliminary site investigation should be performed by the sponsor and his site selection consultant. Representatives from the FAA, other public agencies, and aviation interests should participate in final inspections of sites recommended as a result of the sponsor's preliminary field investigations.

a. Preliminary Field Investigations. These inspections should be made by the sponsor and his consultant. Physical inspection should be made of each site. Rough sketches showing the layout of the airport on each site should be prepared prior to inspection, and observations from the inspection should be noted thereon. Data pertinent to each airport site should be tabulated during the inspections. Soil borings should be taken. It is also recommended that ground level photographs be taken during the site inspections and that they be properly identified as to location on the particular airport site.

Aerial inspection of potential sites is desirable. If this is accomplished, the approaches to airport sites should be flown and photographed. In addition, overall site photographs will be helpful to site selection. In some instances, these photographs may be available from the Aerial Photograph Division, Agriculture Stabilization and Conservation Service, the Department of Agriculture, or from the Photogrammetry Division, Washington Science Center, National Oceanic and Atmospheric Administration. It may be beneficial to have photographs taken by companies which specialize in aerial photography. These photographs may be used in preparing airport layout sketches and in studying environmental factors, drainage patterns, road and obstruction locations, and in estimating costs of site development. From preliminary field investigations, the sponsor and his consultant should reduce the number of airport sites to the few most probable locations. Their findings from the preliminary field investigation should be presented to responsible agencies and aviation interests before a joint final investigation of the most desirable sites are undertaken.

b. Final Field Investigations. A final field investigation of the most desirable sites should be made after analysis of preliminary inspections. The final investigation should be a joint effort on the part of the sponsor, his consultant, and planning agencies and aeronautical interests having jurisdiction in such matters. FAA Airports representatives from regional or area offices should also participate. Before final investigations are made, information and data on preferred airport sites which have been developed from preliminary office studies and field investigations should be assembled and distributed to participants in the final investigation. The purpose of the final investigation will be to give participants a first hand view of the conditions at each site and thereby permit them to make knowledgeable judgments on the recommendations for site selection. The exercise of this knowledge will be vital to the selection of the most feasible airport site.

50. Final Evaluation and Selection. After office studies and field investigations have been completed, a detailed evaluation of the favorable airport sites should be made. This evaluation should rate these sites by preference and should state the reasons for the ratings in the final recommendation. Factors which require careful analysis in the final evaluation of sites should include:

a. Airspace analysis including proximity to other airports, existing and proposed air traffic control procedures, airways structure and capacity, and enroute and terminal area navaids at other airports and in the vicinity of the proposed airport sites.

b. Obstructions in the vicinity of the airport sites, whether they be natural, existing or proposed man-made structures. The criteria set forth in Fed-

eral Aviation Regulation Part 77, Objects Affecting Navigable Airspace, should be studied in the evaluation of alternate site locations.

c. Environmental factors in the vicinity of proposed sites, including existing and proposed land uses, population densities, zoning, and conservation and recreation developments.

d. Convenience of sites including study of passenger and employee Origination and Destination (O&D) surveys, computation of present and future average travel times and costs, and the effect population income groups will have on O&D surveys.

e. Ground access modes to proposed sites including existing and proposed highway and rapid transit systems to population centers and possible V/STOL links to nearby airports. Passenger and employee O&D surveys should provide a basis for analyzing access facilities.

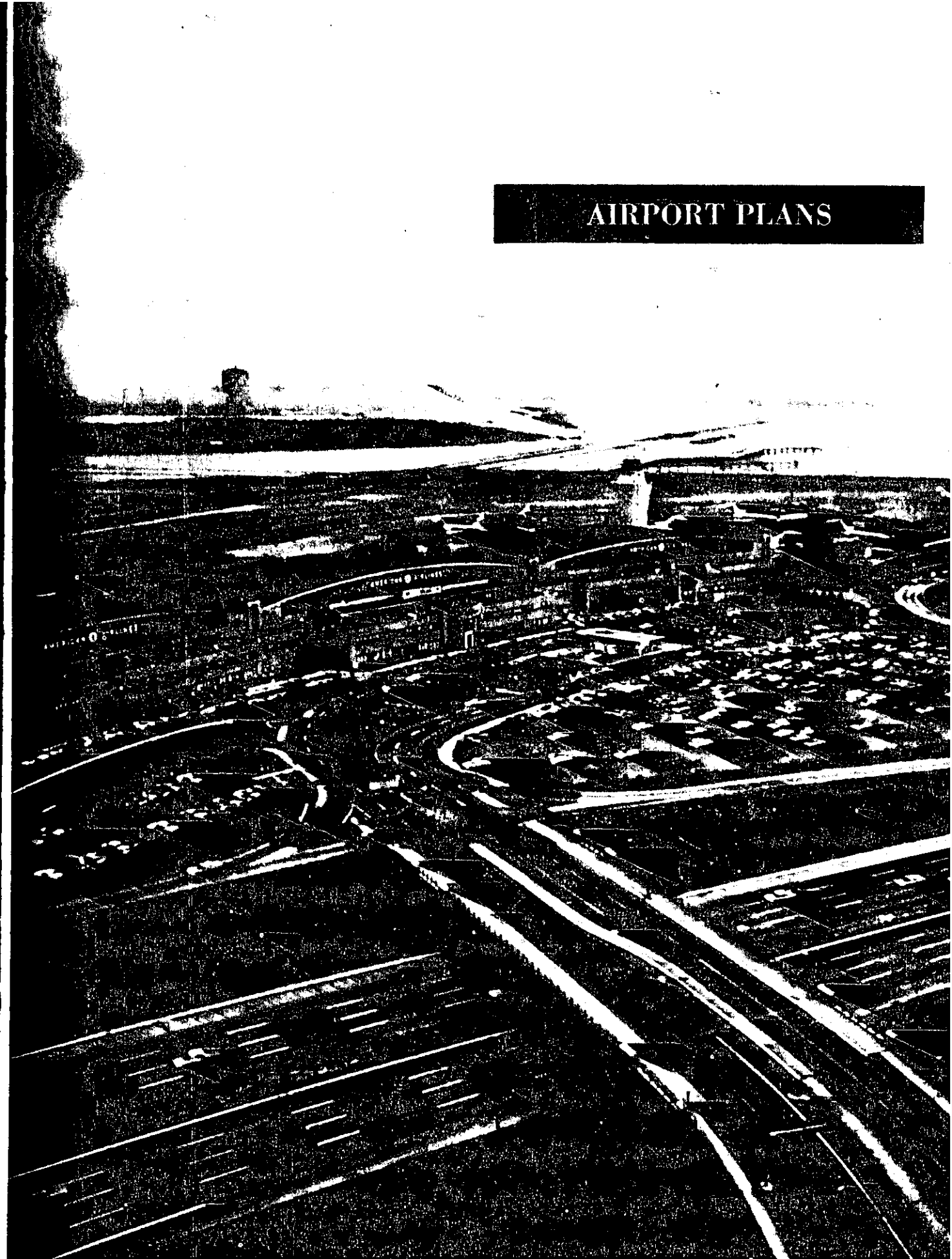
f. Physical characteristics of alternative sites. The effect on site development costs of topography, soil conditions, drainage, natural resources, and climatic conditions should be analyzed.

g. Utility services to alternative sites. The availability of major utilities such as electric, gas, water, and telephone should be compared as should the ability of each proposed site to accommodate utilities. The lead times required to extend utility plants in order to serve alternative sites should be considered.

h. Land costs of alternate sites. This study should include the history of land values at proposed locations, current and forecast land values, and the impacts on costs of zoning for improved and unimproved parcels.

i. Cost comparisons of alternate sites. A quantitative and qualitative comparison of the above factors should be made from the standpoint of cost. Quantitative analysis should evaluate the costs of land acquisition and easements, site developments, major utilities, foundations, access facilities, ground travel to users, and effects on surrounding areas such as noise, air and water pollution, and safety. Qualitative evaluation should consider accessibility to users, compatible land uses, expansion capabilities, and air traffic control compatibility.

AIRPORT PLANS



Chapter 7. AIRPORT LAYOUT PLAN

51. General. By definition, an airport layout plan is a graphic presentation to scale of existing and proposed airport facilities, their location on the airport, and the pertinent clearance and dimensional information required to show conformance with applicable standards. The preparation of the airport layout plan follows the establishment of facility requirements and the selection of a new or existing site for the master plan airport. The development of the airport layout plan should establish the configuration of runways, taxiways, and aprons and should set aside areas for the establishment of terminal facilities. Runway approach zones should be incorporated on the airport layout plan. Positive dimensioning of the locations of airfield facilities should be provided on the plan.

52. Approval of Airport Layout Plans.

a. All Airports. The layout plan is a graphic representation of the existing and foreseeable facilities which the owner deems are necessary for operation of the airport. An airport owner is encouraged to submit a tentative or preliminary plan to the Federal Aviation Administration for review and comment before developing a final airport layout plan. However, a detailed review by the FAA of the preliminary plan is not a commitment of final approval.

b. Airports Under the ADAP. A current airport layout plan approved by the FAA is a prerequisite to FAA approval of an ADAP development project. The maintenance of an up-to-date plan and conformity to the plan are obligations at a public airport on which Federal funds have been expended.

c. Non-ADAP Federally Developed Airports. Although a current airport layout plan at these airports is not mandatory, such a plan is desirable. Moreover, a current airport layout plan may be used as an exhibit to support a request to change an agreement with the United States involving compliance obligations at a public airport on which Federal funds have been expended.

d. Airports Not Subject to Federal Agreements. There is no requirement for airport layout plans at these airports. However, any airport will benefit from a carefully developed layout plan reflecting FAA standards and recommendations on airport design and planning. As part of its advisory services, the FAA will review and comment on any airport layout plan voluntarily submitted. The preparation of a layout plan is especially encouraged for airports in the NASP. Furthermore, when any airport proponent submits an FAA Form 4780–1, Notice of Landing Area Proposal, to the FAA for airspace analysis, the FAA recommends an airport layout plan be attached to the notice.

e. Filing of Construction Notices. The submission of airport layout plans in accordance with the provisions of this advisory circular does not relieve the airport owner from the responsibility of filing construction notices that are required under Part 77 and Part 157 of the Federal Aviation Regulations.

53. Airport Layout Plan Development.

a. Existing and Proposed Development, Environmental Features, and Land Uses. The layout plan depicts existing and proposed airport facilities and land uses, their locations, and the pertinent clearance and dimensional information required to show conformance with the applicable standards. It shows the airport location, clear zones, approach areas, and other environmental features that may influence airport usage and expansion capabilities. It is important to visualize and plan airport facilities in three dimensions, i.e., length, width, and height, particularly for airports which have growth potential and are to be developed in stages.

b. Facilities No Longer Needed. The airport layout plan identifies facilities which are no longer needed and describes the plan for their removal or phaseout. Some areas may be leased, sold, or otherwise used for commercial and industrial purposes; other areas, such as one or more taxiways or runways, are used so infrequently that the maintenance cost to keep them operational is difficult to justify. If the airport or any part of it was previously developed with Federal assistance (through either a transfer of surplus property or a Federal grant), its removal

or phaseout must be approved by the FAA by a procedure separate from the layout plan approval. Approval of an airport layout plan does not imply FAA approval for the actual removal or phaseout.

c. Airport Accessibility. When an airport layout plan is prepared as a separate entity from a master plan, consideration given to airport access should be prepared as described in Chapter 10, Airport Access Plans.

d. Balanced Capacities. An airport layout plan shall be based on balanced capacities determined in accordance with Chapter 3, Demand/Capacity Analysis.

e. Updating the Airport Layout Plan. The airport layout plan shall be updated with any changes in property lines; airfield configuration involving runways, taxiways, and aircraft parking apron size and location; buildings; auto parking; cargo areas; navigational aids; obstructions; and entrance roads. Airport layout plans should also be updated to show "as built" conditions when development proposed in the plan has been completed.

f. Designation of Instrument Landing System (ILS) Runway. The runway(s) designated for an ILS is selected by the FAA with the cooperation of the airport owner, airlines, and appropriate segments of the aviation industry. The airport layout plan should have noted thereon the designated ILS runway(s); and the related facilities which are required for precision approach operations such as the instrument clear zones, approach light system (ALS), and other navigational aids; a minimum runway size of 5000′ × 150′; high intensity runway lights; building restriction line; and other items consistent with current airport design standards.

54. Components of Airport Layout Plans. The airport layout plan consists of several components, depending on airport size and usage:

a. Airport Layout Plan Drawing.

(1) Airport layout.
(2) Location map.
(3) Vicinity map.
(4) Basic data table.
(5) Wind information.

b. Approach and Clear Zone Layout Drawing.

55. Airport Layout Plan Drawing. The airport layout plan, as a minimum, should have a drawing depicting the airport layout, a location map, a vicinity map, a basic data table, and wind information. These may be on one sheet if space permits.

a. Airport Layout. This is the main portion of the drawing. It should depict the existing and ultimate airport development and land uses drawn to scale and, where appropriate, should contain (but not be limited to) the following information:

(1) Prominent airport facilities such as runways, taxiways, aprons, blast pads, stabilized shoulders and extended runway safety areas, buildings, navaids, parking areas, roads, lighting, runway marking, pipelines, fences, major drainage facilities, segmented circle, wind indicators, and beacon.

(2) Prominent natural and man-made features such as trees, streams, ponds, rock outcrops, ditches, railroads, powerlines, and towers.

(3) Revenue - producing nonaviation - related property, surplus or otherwise, should be outlined with the current status and use specified. The details of this property may be shown on a separate drawing if these would clutter the airport layout plan. Show usable railroads, roads, etc.

(4) Areas reserved for existing and future aviation development and services such as for general aviation fixed base operations, heliports, cargo facilities, airport maintenance, or service areas, etc.

(5) Areas reserved for nonaviation development, such as industrial areas, motels, etc.

(6) Existing ground contours to an interval that does not clutter the drawing. Draw them very lightly, but legibly.

(7) Fueling facilities and tiedown areas.

(8) Facilities that are to be phased out.

(9) Airport boundaries and areas owned or controlled by the sponsor, including avigation easements; also give section and township corners, survey control points and bench marks, with adequate property ties.

(10) Approach and clear zone outlines. Indicate height and location of controlling objects, i.e., usually the tallest object within a confined area exceeding obstruction criteria if this information is

not given on other drawings. This can be done by a note if the objects are located outside the limits of the drawing.

(11) Airport reference point with latitude and longitude given based on U.S. Geological Survey grid system.

(12) Elevation of runway ends, high and low points, and runway intersections. For ILS runways, changes in elevation within 3,000 feet of the threshold.

(13) True azimuth of runways (measured from true north).

(14) North point—true and magnetic, with the magnetic declination.

(15) Pertinent dimensional data—runway and taxiway widths and runway lengths, taxiway-runway-apron clearances, apron dimensions, building clearance lines, clear zones, and parallel runway separation.

(16) Use a 24″ × 36″ layout sheet. If necessary, increase the sheet size but maintain the same 1:1½ ratio of sheet height to length. Include a map scale of approximately 200 to 600 feet to the inch depending on the size of the airport, and illustrate this scale on the layout in graphic form. Also include a legend in graphic and descriptive form with symbols that differentiate between existing, proposed, immediate, and proposed future development. Provide space for the title, revision, and necessary approvals. The use of photo mosaics is encouraged.

b. Location Map. This is a key map drawn to a scale sufficient to depict the airport, cities, railroads, major highways, and roads within 25 to 50 miles of the airport.

c. Vicinity Map. This is a key map showing the relationship of an airport to the city or cities, nearby airports, roads, railroads, and built-up areas. It should be drawn to a scale of 1:24,000 (U.S.G.S. 7½ minute quad sheets). A vicinity map may be omitted if sufficient area is shown on the Approach and Clear Zone Layout.

d. Basic Data Table. This table contains the following information on existing and ultimate conditions where applicable:

(1) Airport elevation (highest point of the landing areas).

(2) Runway identification such as 13/31 or 4/22.

(3) Percent effective runway gradient for each existing and proposed runway.

(4) Percent of wind coverage by principal runway, secondary runway, and combined coverage.

(5) Instrument Landing System (ILS) runway when designated, dominant runway otherwise, existing and proposed.

(6) Normal or mean maximum daily temperature of the hottest month.

(7) Pavement strength of each runway in gross weight and type of main gear (i.e., single, dual, and dual tandem, as appropriate).

(8) Plan for obstruction removal, relocation of facilities, etc.

e. Wind Information. A wind rose should be given with the runway orientation superimposed. Crosswind coverage and the source and period of data should also be given. This data may be on a separate sheet or sheets, especially if low visibility wind data are given. Wind information should be in terms of all-weather conditions, supplemented by IFR weather conditions where IFR operations are expected. Additional wind information and sources for airport wind data are given in Item 1u, Table 1. At locations where no satisfactory wind data exist, the basis for the wind analysis and runway alignment should be given in the airport layout plan report unless an appropriate note is included on the plan.

f. Detail Required. The foregoing requirements indicated that considerable detail should be included on the airport layout plan drawing.

However, not all items need to be drawn if a note can adequately cover the development or facility under consideration. For example, standard taxiway lighting, runway and taxiway marking, and the taxiway sign system can be covered by a note in the basic data table. Where detailed planning has not been performed for areas reserved for future aviation or nonaviation development, an outline of these areas is generally adequate.

56. Approach and Clear Zone Layout. This plan should depict the following information:

a. Areas under the imaginary surfaces as defined in FAR Part 77, Objects Affecting Navigable Airspace.

b. Existing and ultimate approach slopes and any height or slope protection established by local zoning ordinance.

c. A plan and profile of the clear zones and approach areas showing the controlling structures and trees therein (i.e., usually the tallest object within a cluster) and their elevations. Also roads, railroads, and polelines that cross clear zones and approach areas should be shown on the profile (highest elevation).

d. Location and elevation of obstructions exceeding criteria in FAR Part 77, (obstructions off the plan may be indicated by a note). If there is a cluster of tall objects within close proximity of each other, only the elevation of the tallest object need be shown. Any plans concerning the alteration or removal of obstructions should be noted.

e. For airports serving jet aircraft and within the boundaries defined by the imaginary surfaces given in FAR Part 77, an outline of all areas with present or potential concentrations of people should be shown on the drawing. Indicate the primary type of development in these areas such as industrial, residential, ballparks, schools, and hospitals. For other airports this information should be shown for the areas under the approach surfaces and at least 1,000 feet to either side of each runway or 500 feet from the nearest aircraft operational area. In densely populated areas, it is not necessary to pinpoint each hospital, school, etc., in close proximity to one another.

f. In the approach areas, tall smokestacks, television, and radio transmission towers, garbage dumps, or other areas attracting a large number of birds, and any other potential hazard to aircraft flight.

57. Airport Layout Plan Report. A current airport layout plan is a requirement of a project application for an Airport Development Aid Program (ADAP) grant and may be prepared for this purpose in lieu of a complete master plan. In this event, the airport layout plan should be accompanied by a written report which documents the following:

a. Reasoning behind design features such as demand/capacity analysis, etc.

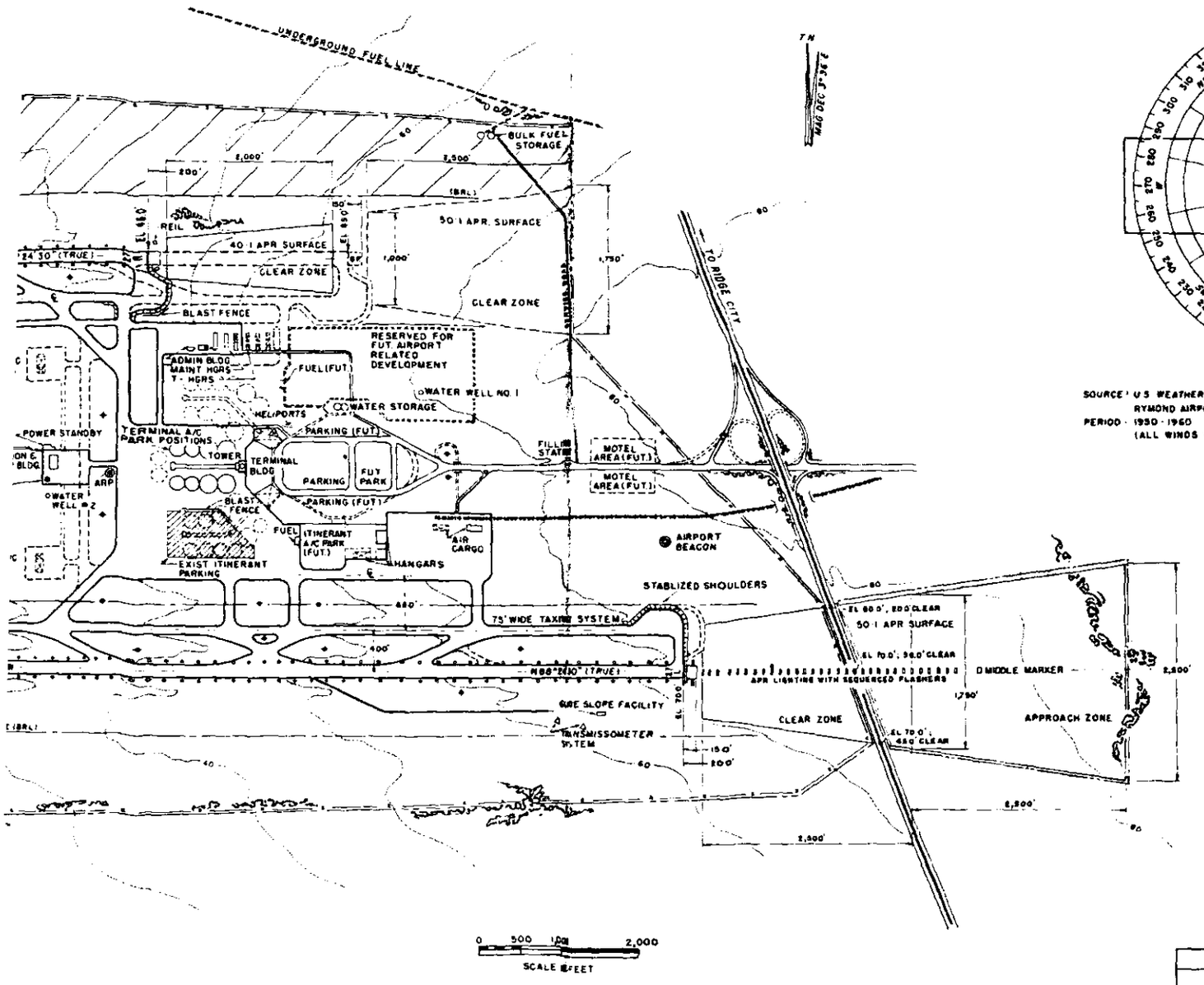
b. Basis and/or computation for the runway length design.

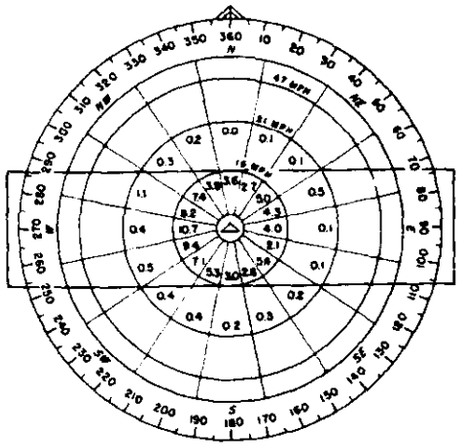
c. Basis for runway orientation if not aligned for maximum wind coverage.

d. Low visibility wind data where available. (Such data may be used for evaluating contemplated airport development.)

58. Typical Airport Layout Plans. Typical airport layout plans for a large, medium, and small airport are shown on the drawings, Figures 1 through 4. Guidance material which will be useful in the development of airport layout plans is listed in Chapter 4, Facility Requirements.

FIGURE 1





SOURCE: U.S. WEATHER BUREAU STATION, RYMOND AIRPORT.
PERIOD: 1950-1960
(ALL WINDS V.F.R. & I.F.R.)

15 M.P.H. CROSSWIND COVERAGE 98.2%
△ = 10.4 % CALMS; 0-3 M.P.H.
% OF V.F.R. WEATHER = 90.0
% OF I.F.R. WEATHER = 10.0

WIND ROSE

NOTES

1. THESE PLANS SHOULD NOT BE USED AS STANDARDS FOR PLANNING OR DESIGN.
2. NAVIGATIONAL AIDS ARE NOT TO SCALE.

NO.	REVISIONS	BY	APP	DATE

RIDGE CITY AIRPORT COMMISSION

SUBMITTED BY DATE 3-20-65
E. B. PETROLE INC.
CONSULTING ENGINEERS

APPROVAL BLOCK

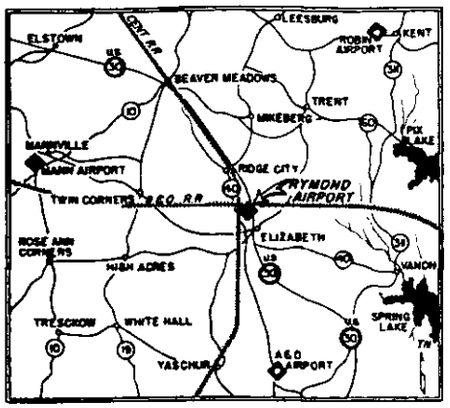
RYMOND AIRPORT
ANYWHERE, U.S.A.

AIRPORT LAYOUT PLAN

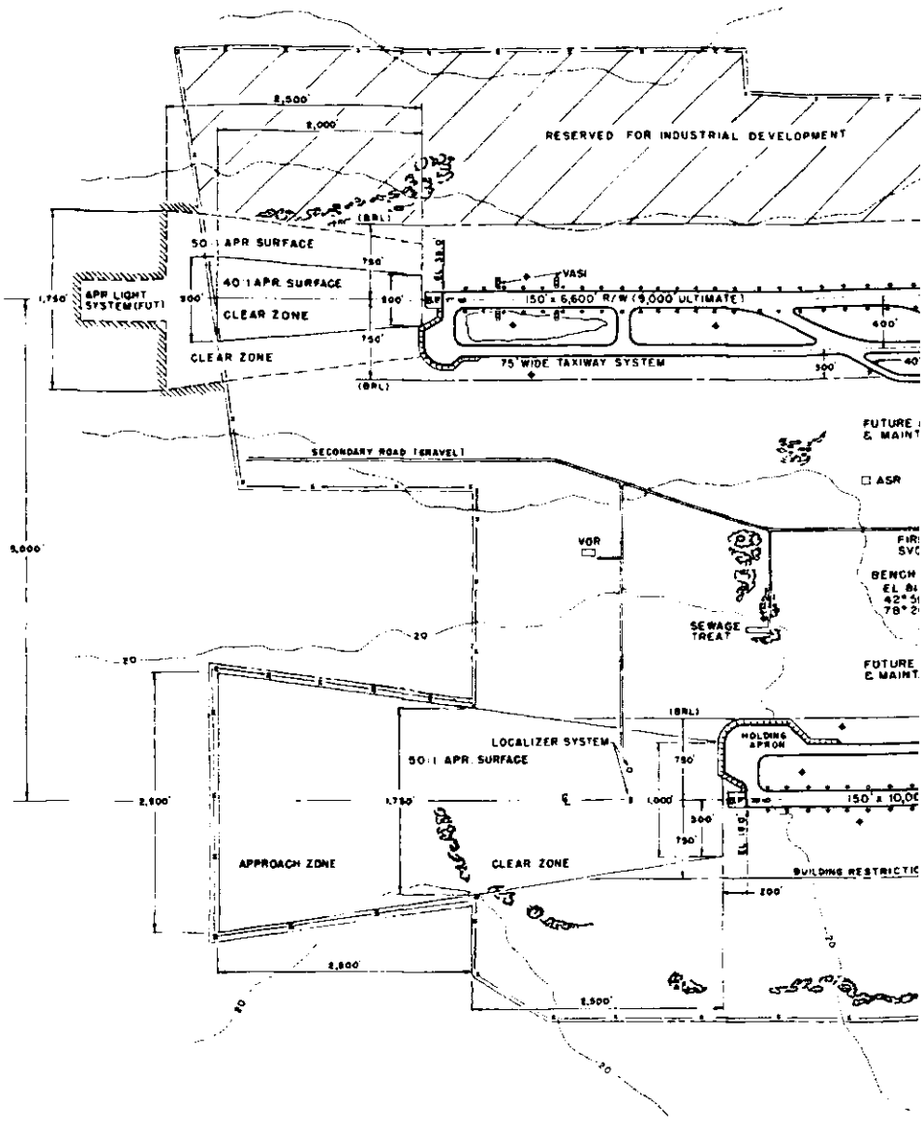
E. B. PETROLE INC.
CONSULTING ENGINEERS

DESIGNED BY _____ DATE: _____ TRACED BY: _____ DATE: _____
DRAWN BY: _____ DATE: _____ CHECKED BY: _____ DATE: _____

DRAWING NO. 4322 - A83
SCALE AS SHOWN
SHEET: 1 OF 2



LOCATION MAP



BASIC DATA TABLE

RUNWAY DATA

	RUNWAY 9R - 27L		RUNWAY 9L - 27R	
	EXISTING	ULTIMATE	EXISTING	ULTIMATE
EFFECTIVE GRADIENT (IN %)	0.52	SAME	0.12	0.29 ±
% WIND COVERAGE	98.2	SAME	96.2	SAME
INSTRUMENT RUNWAY	✓	✓		✓
PAVEMENT STRENGTH	170D, 300DT	SAME	60S, 80D, 450T ‡‡	170D, 300DT
APPROACH SURFACES	50:1	SAME	40:1	50:1
RUNWAY LIGHTING	HIRL	SAME	HIRL	SAME
RUNWAY MARKING	ALL WEATHER	SAME	INSTRUMENT	ALL WEATHER
NAVIGATIONAL AIDS	ALS, ILS	SAME	REIL, VASI ‡	ADD ILS, ALS

‡ RELOCATED FROM R/W 9L TO 9R WHEN ILS AND ALS IS ADDED TO R/W 9L.

‡‡ VALUES GIVEN ARE THE GROSS WEIGHT IN 1,000 LBS FOR SINGLE (S), DUAL (D), AND DUAL TANDEM (DT) GEAR AIRCRAFT.

BASIC DATA TABLE

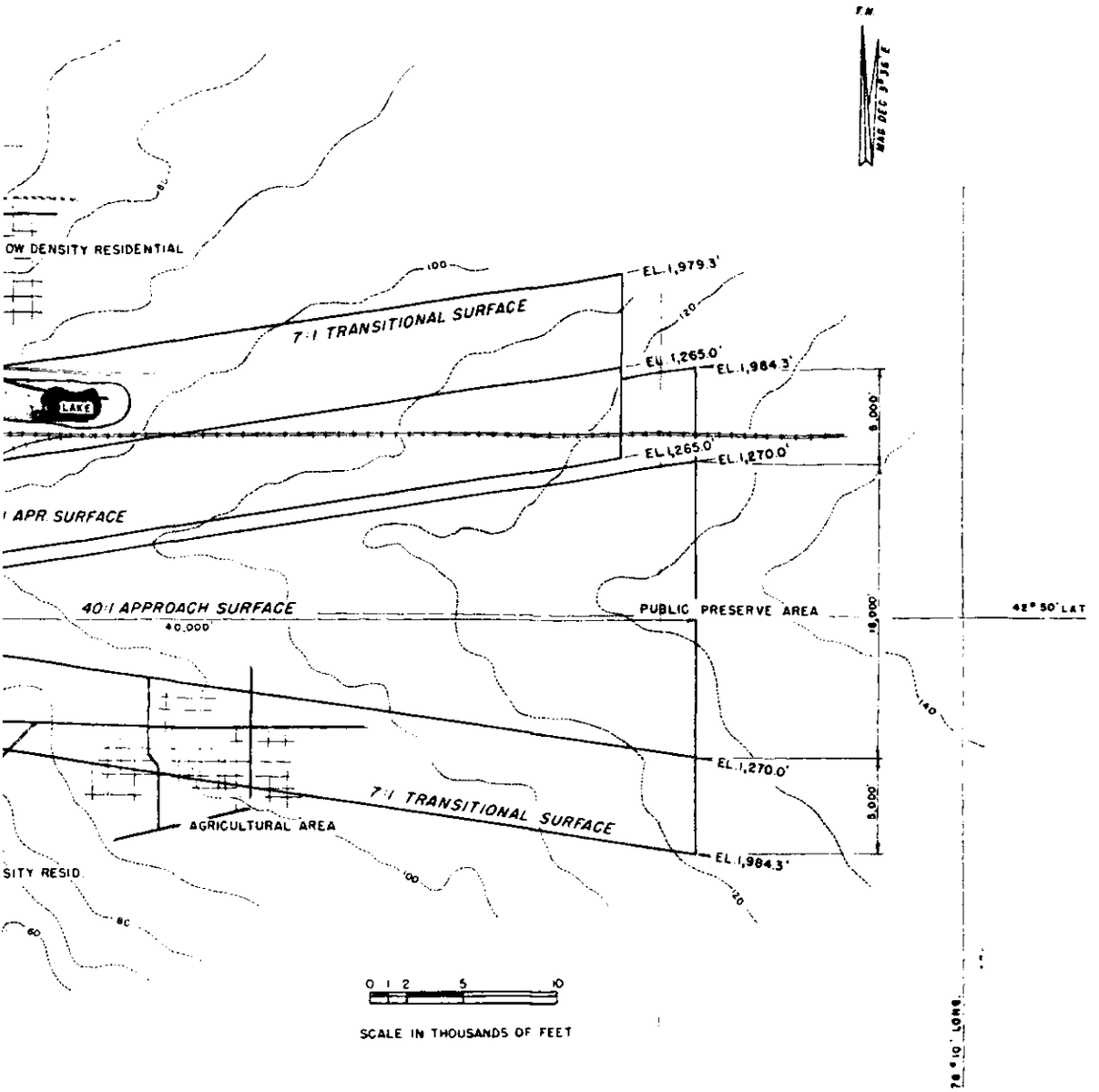
AIRPORT DATA

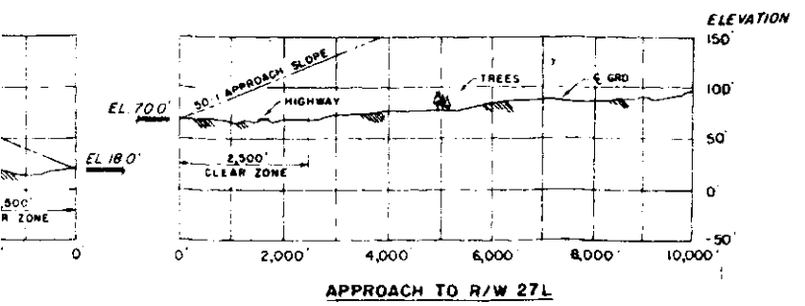
	EXISTING	ULTIMATE
AIRPORT ELEVATION	700'	SAME
AIRPORT REFERENCE POINT (ARP) COORDINATES	LAT 42°80'25" LONG 78°24'45"	SAME
MEAN MAX. TEMP. OF HOTTEST MONTH	80°F	SAME
AIRPORT AND TERMINAL NAV AIDS	VOR, ASR	SAME
MISCELLANEOUS FACILITIES		
TAXIWAY LIGHTING, CENTERLINE MARKING AND SIGN SYSTEM	✓	✓

LEGEND

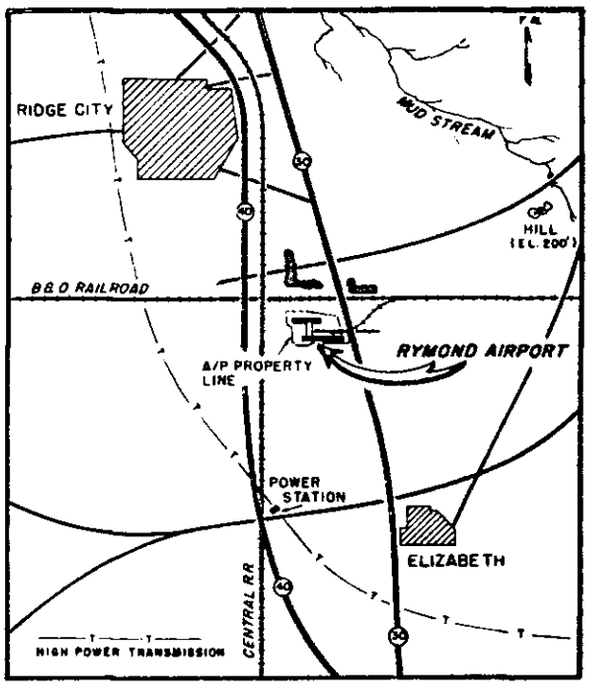
EXISTING	ULTIMATE	
		BOUNDARY FENCE
		RUNWAY LIGHTS
80		GROUND CONTOURS
		THRESHOLD BAR (ALS)
		FACILITIES
		SHOULDER STABLIZATION
		EASEMENT
		PROPERTY LINE
		BUILDING RESTRICTION LINE (BRL)
BP	(BP)	BLAST PAD
		STORM INLET
		RAILROAD TRACK

FIGURE 2





APPROACH TO R/W 27L



VICINITY MAP

ESTABLISHED AIRPORT ELEVATION : 70' 00"

AIRPORT REFERENCE POINT (ARP) COORDINATES : LAT 42° 50' 24"
LONG 78° 24' 45"

NOTE:
THESE PLANS SHOULD NOT BE USED AS STANDARDS FOR PLANNING OR DESIGN.

NO	REVISIONS	BY	APP	DATE

RIDGE CITY AIRPORT COMMISSION

SUBMITTED BY DATE
E. B. PETROLE INC.
CONSULTING ENGINEERS

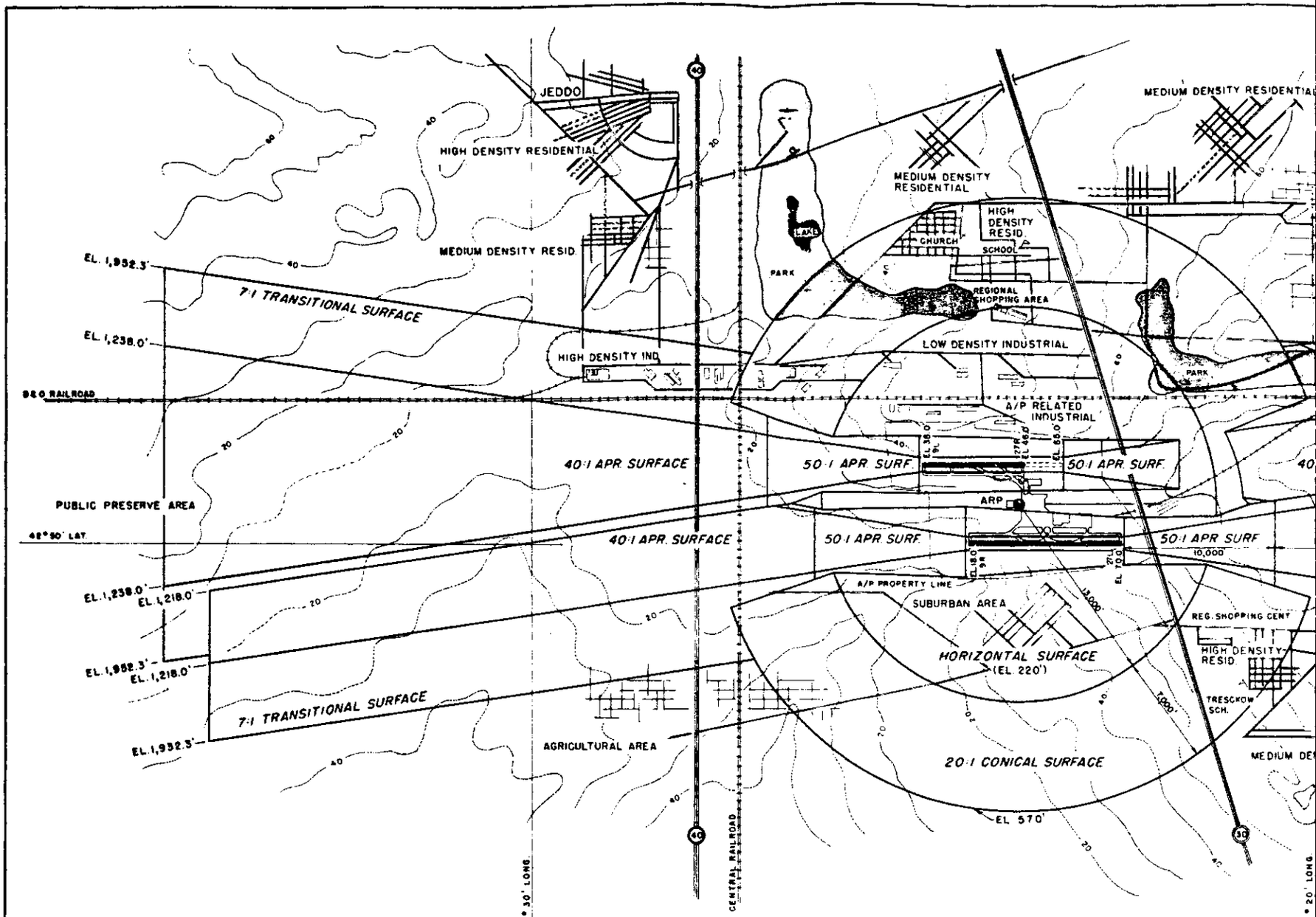
APPROVAL BLOCK

RYMOND AIRPORT
ANYWHERE USA

APPROACH & CLEAR ZONE PLAN

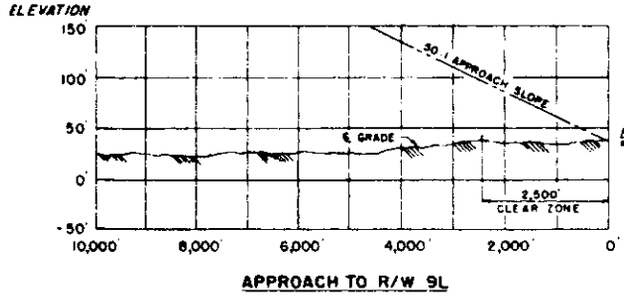
E.B. PETROLE INC.
CONSULTING ENGINEERS

DESIGNED BY	DATE	TRACED BY	DATE
DRAWN BY	DATE	CHECKED BY	DATE
DRAWING NO	4322 - AB 3	SCALE AS SHOWN	SHEET 2 OF 2

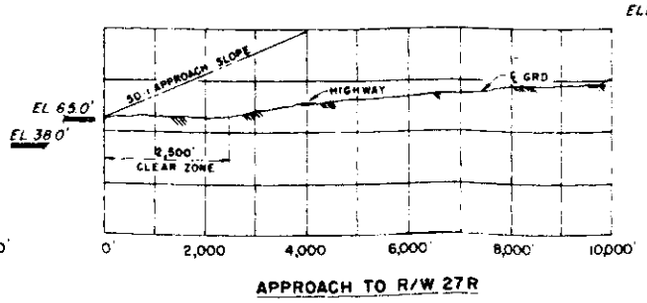


SCALES OF R/W PROFILES

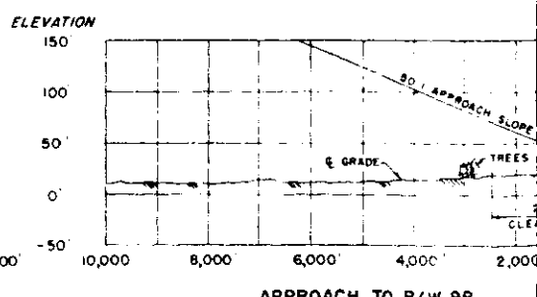
VERTICAL 1" = 100'
HORIZ. 1" = 2,000'



APPROACH TO R/W 9L

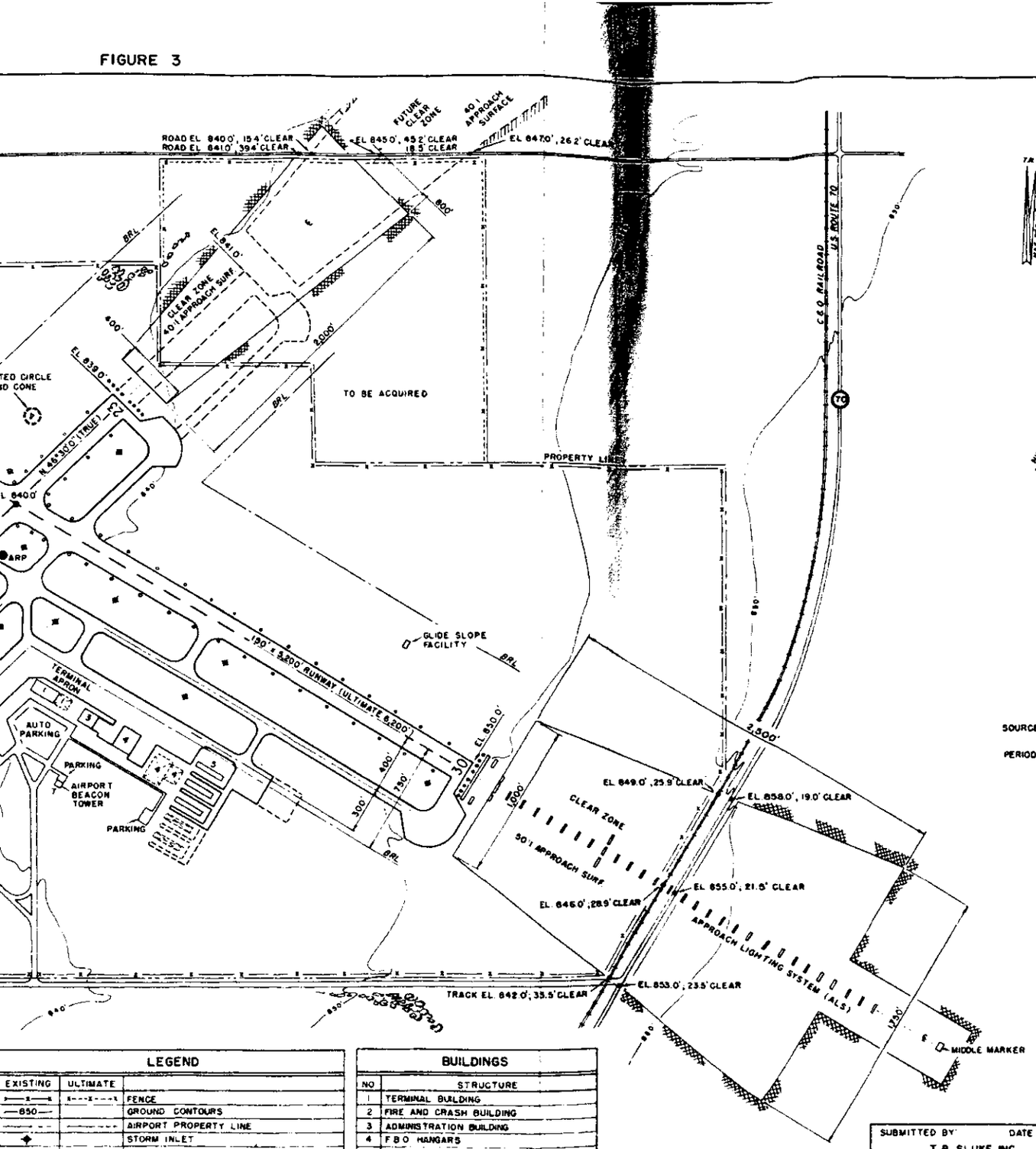


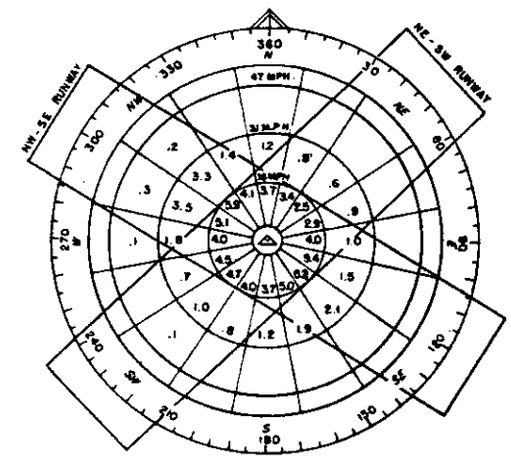
APPROACH TO R/W 27R



APPROACH TO R/W 9R

FIGURE 3





SOURCE: U.S. WEATHER BUREAU STATION — 15 M.P.H. CROSSWIND COVERAGE R/W 12/30 = 91.4 %
DEWALD AIRPORT — 15 M.P.H. CROSSWIND COVERAGE R/W 5/23 = 83.0 %
PERIOD: 1950-1960 — 15 M.P.H. CROSSWIND COVERAGE ALL RUNWAYS = 96.6 %
(ALL WINDS V.F.R. & I.F.R.)
△ = 6.3 % CALMS, 0-3 M.P.H.
% OF V.F.R. WEATHER = 90.0
% OF I.F.R. WEATHER = 10.0

WIND ROSE

NOTE
THESE PLANS SHOULD NOT BE USED AS STANDARDS FOR PLANNING OR DESIGN.

LEGEND		
EXISTING	ULTIMATE	
		FENCE
850		GROUND CONTOURS
		AIRPORT PROPERTY LINE
		STORM INLET
		RUNWAY THRESHOLD LIGHTS
		RUNWAY LIGHTS
		FACILITIES
		AIRPORT REFERENCE POINT
		EASEMENT
		BUILDING RESTRICTION LINE (BRL)
		RAILROAD
		BUILDING CONSTRUCTION

BUILDINGS	
NO	STRUCTURE
1	TERMINAL BUILDING
2	FIRE AND CRASH BUILDING
3	ADMINISTRATION BUILDING
4	F.B.O. HANGARS
5	T-HANGARS
6	ANG HANGARS
7	CONTROL TOWER
8	MAINTENANCE BUILDING
9	AIR FREIGHT

NO.	REVISIONS	BY	APP.	DATE

DEWALD CITY AIRPORT COMMISSION

SUBMITTED BY: DATE
T.B. SLUKE INC.
CONSULTING ENGINEERS

APPROVAL BLOCK

DEWALD AIRPORT
ANYWHERE, U.S.A.

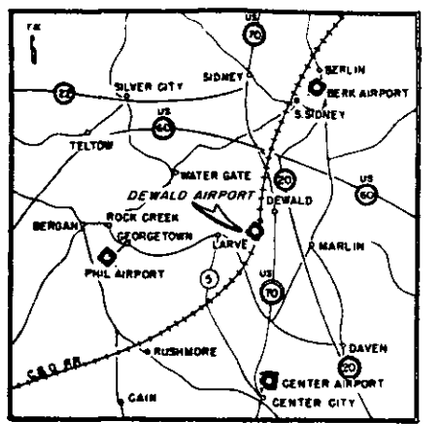
AIRPORT LAYOUT PLAN

T.B. SLUKE INC.
CONSULTING ENGINEERS

DESIGNED BY: _____ DATE: _____ TRACED BY: _____ DATE: _____
DRAWN BY: _____ DATE: _____ CHECKED BY: _____ DATE: _____

DRAWING NO: 23754-A

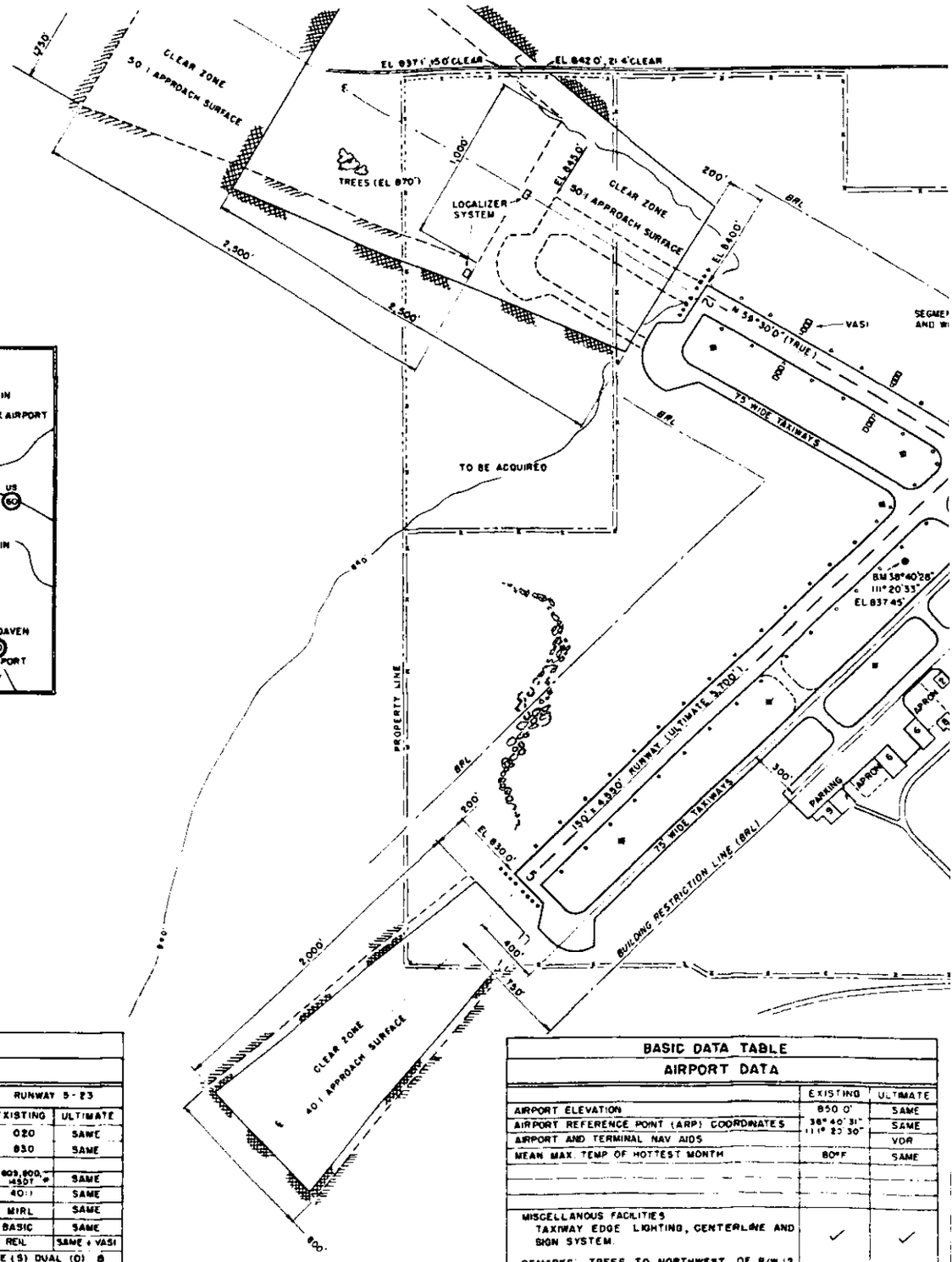
SCALE AS SHOWN
SHEET 1 OF 1



10 5 0 10 20

SCALE IN MILES

LOCATION MAP



BASIC DATA TABLE

RUNWAY DATA

	RUNWAY 12-30		RUNWAY 5-23	
	EXISTING	ULTIMATE	EXISTING	ULTIMATE
EFFECTIVE RUNWAY GRADIENT (IN %)	0.19	SAME	0.20	SAME
% WIND COVERAGE	91.4	SAME	85.0	SAME
INSTRUMENT RUNWAY	✓	✓		
PAVEMENT STRENGTH	60S,80D,-45DT *	SAME	60S,80D,-45DT *	SAME
APPROACH SLOPES & CLEAR ZONES	50:1	SAME	40:1	SAME
LIGHTING	MIRL	SAME	MIRL	SAME
MARKING	ALL WEATHER	SAME	BASIC	SAME
NAVIGATIONAL AIDS	ILS, ALS, VASI	SAME	REIL	SAME + VASI

* VALUES GIVEN ARE GROSS AIRCRAFT WEIGHT IN 1,000# FOR SINGLE (S) DUAL (D) & DUAL TANDEM (DT) GEAR AIRCRAFT

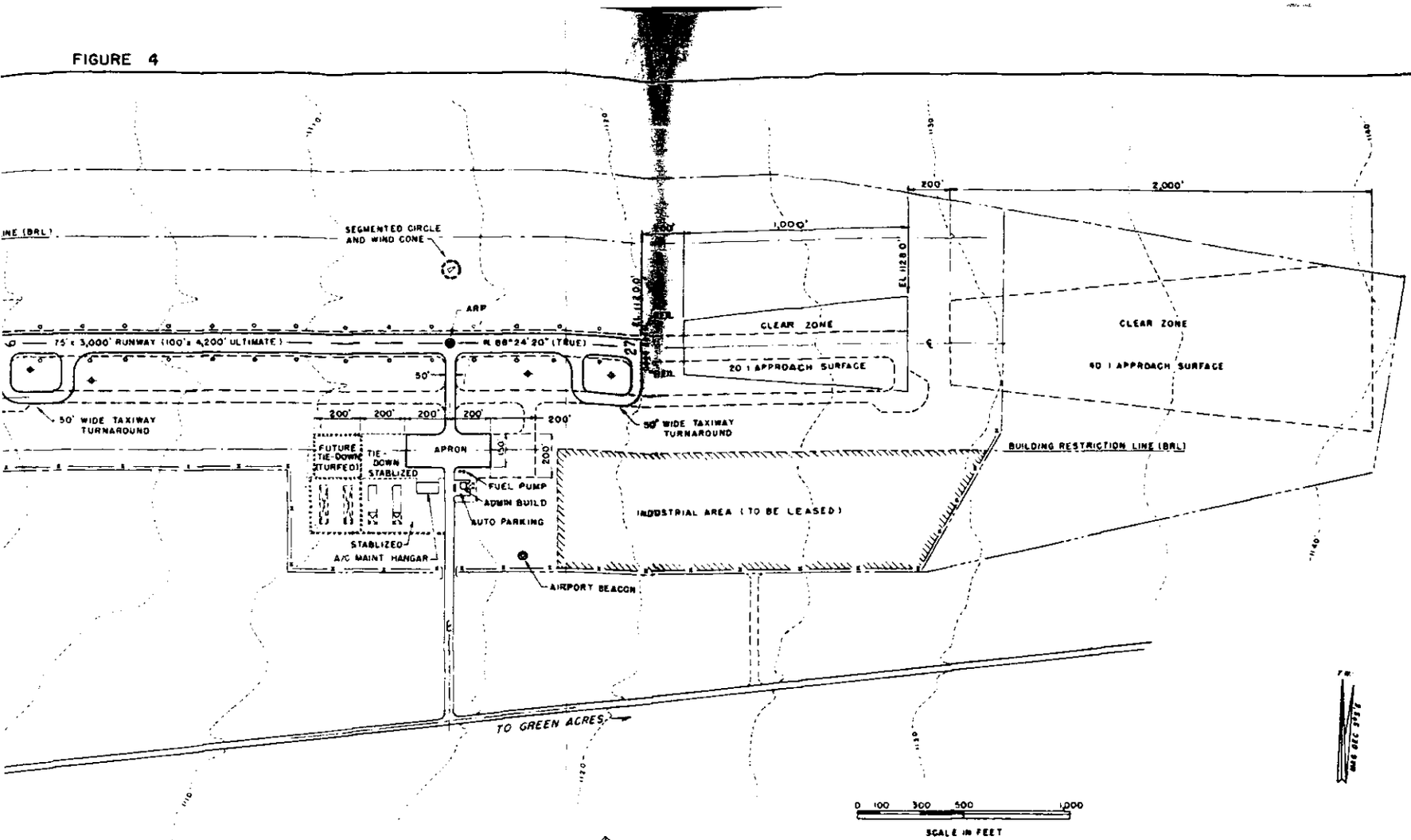
BASIC DATA TABLE

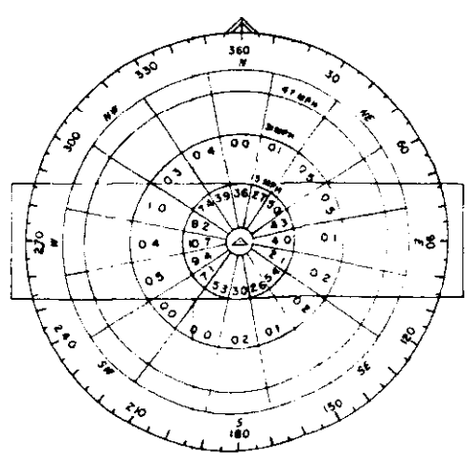
AIRPORT DATA

	EXISTING	ULTIMATE
AIRPORT ELEVATION	850.0'	SAME
AIRPORT REFERENCE POINT (ARP) COORDINATES	38° 40' 31" 111° 20' 30"	SAME
AIRPORT AND TERMINAL NAV AIDS		VOR
MEAN MAX. TEMP OF HOTTEST MONTH	80°F	SAME
MISCELLANOUS FACILITIES TAXIWAY EDGE LIGHTING, CENTERLINE AND SIGN SYSTEM.	✓	✓

REMARKS: TREES TO NORTHWEST OF R/W 12 TO BE REMOVED WHEN R/W 12 IS EXTENDED

FIGURE 4





SOURCE U.S WEATHER BUREAU STATION GREEN ACRES AIRPORT
PERIOD: 1950 - 1960 (ALL WEATHER WINDS)

15 MPH CROSS WIND COVERAGE 98.7%
△= 0.8% CALMS, 0-3 MPH

WIND ROSE

LEGEND

ULTIMATE	
	BUILDING RESTRICTION LINE (BRL)
	GROUND CONTOURS
	AIRPORT PROPERTY LINE
	THRESHOLD LIGHTS
	FACILITIES
	FENCE
	STORM INLET
	RUNWAY LIGHTS
	AREAS TO BE TREATED SHOWN

NOTE:
THESE PLANS SHOULD NOT BE USED AS STANDARDS FOR PLANNING OR DESIGN.

FOR UTILTY AIRPORT PLAN PREPARATION, SEE THE ADVISORY CIRCULAR *UTILITY AIRPORTS* INCLUDING THE *MODEL SET OF AIRPORT PLANS* FOR THE APPROPRIATE FACILITY DIMENSIONS AND CLEARANCES.

NO	REVISIONS	BY	APP	DATE

SUBMITTED BY DATE
W.G. TRESCKOW INC
CONSULTING ENGINEERS

APPROVAL BLOCK

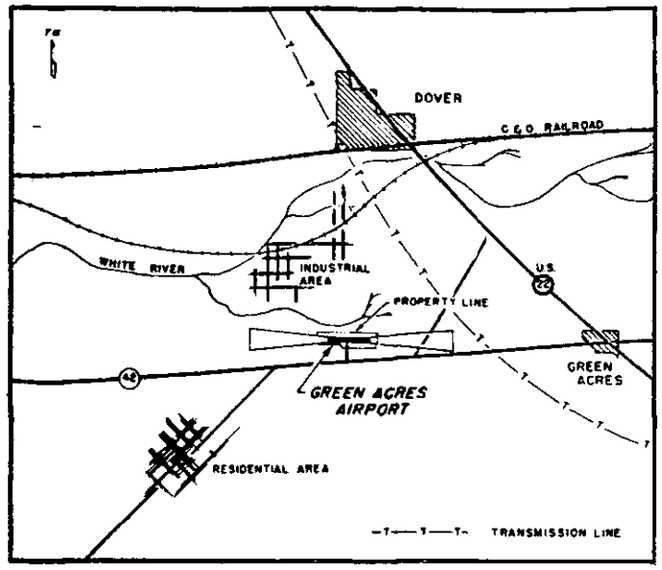
DOVER CITY AIRPORT COMMISSION

GREEN ACRES AIRPORT
ANYWHERE, U.S.A.

AIRPORT LAYOUT PLAN

W.G. TRESCKOW INC.
CONSULTING ENGINEERS

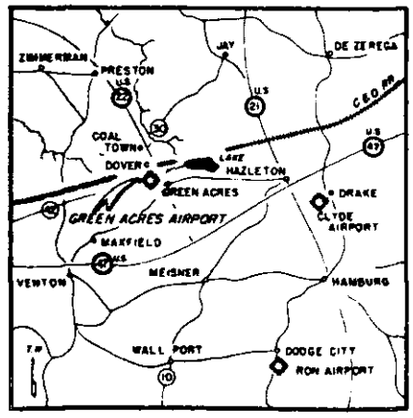
DESIGNED BY	DATE	TRACED BY	DATE
DRAWN BY	DATE	CHECKED BY	DATE
DRAWING NO. AB-639-C		SCALE AS SHOWN SHEET 1 OF 1	



0 1 2 4

SCALE IN MILES

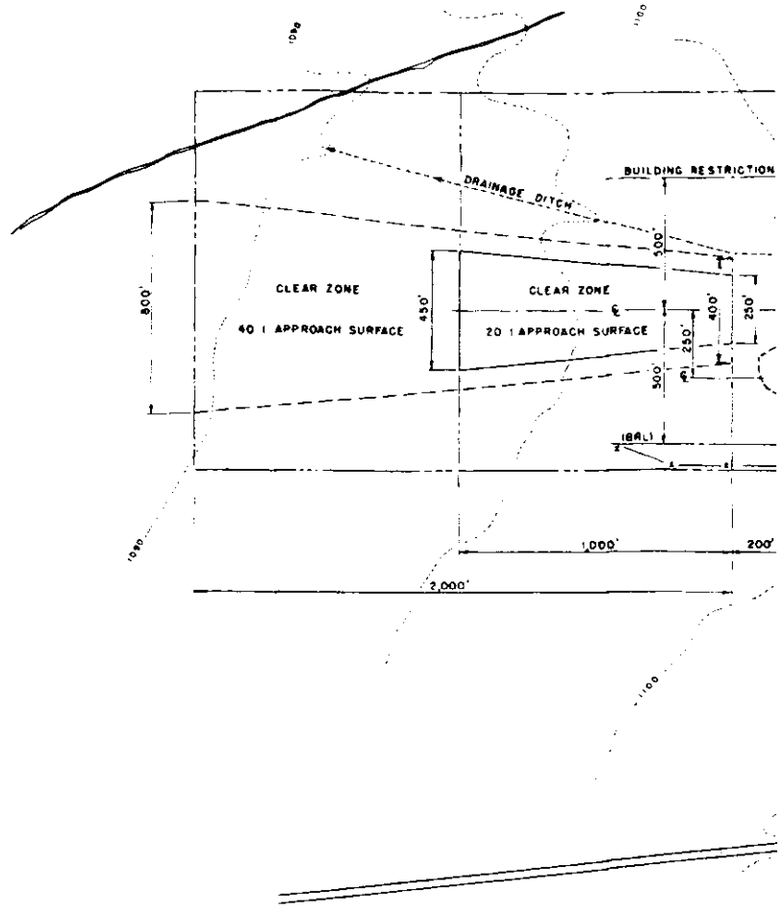
VICINITY MAP



0 5 15 30

SCALE IN MILES

LOCATION MAP



BASIC DATA TABLE

RUNWAY DATA

	RUNWAY 9-27	
	EXISTING	ULTIMATE
EFFECTIVE GRADIENT (IN %)	0.67	0.67
% WIND COVERAGE (15 MPH)	98.7	98.7
INSTRUMENT RUNWAY	NONE	NONE
PAVEMENT STRENGTH	20s*	20s*
APPROACH SLOPES AND CLEAR ZONES	20:1	40:1
LIGHTING	L-INTENSITY	SAME
MARKING	BASIC	SAME
NAVIGATIONAL AIDS	REIL	VASI & REIL

*VALUE GIVEN IS THE TOTAL AIRCRAFT WEIGHT IN 1000# FOR SINGLE (S), WHEEL GEAR AIRCRAFT

BASIC DATA TABLE

AIRPORT DATA

	EXISTING	ULTIMATE
AIRPORT ELEVATION	1120.0	SAME
AIRPORT REFERENCE POINT (ARP) COORD	LAT 39° 40' 30" LNG 70° 59' 31"	SAME
MEAN MAX TEMP HOTTEST MONTH	80°F	SAME
TAXIWAY MARKING	NONE	NONE
NAVIGATIONAL AIDS	NONE	NONE

EXISTING
1120...
●●● ●●●
◆
○ ○ ○ ○

Chapter 8. LAND USE PLAN

59. General. The airport land use plan will show on-airport land uses as developed by the airport sponsor under the master plan effort and off-airport land uses as developed by surrounding communities. The work of airport planners and community planners must be carefully coordinated. The configuration of airfield pavements and approach zones established in an airport layout plan provides the basis for development of the land use plan for areas on and adjacent to the airport. The land use plan for the airport and its environs in turn must be recognized as an integral part of an areawide comprehensive planning program. The location, size, and configuration of the airport needs to be coordinated with patterns of residential and other major land uses in the area as well as with other transportation facilities and public services. Within the comprehensive planning framework, airport planning, policies, and programs should be coordinated with the objectives, policies, and programs for the area which the master plan airport is to serve. To the extent there is a choice, decisions on runway alignment and airport expansion and volume and type of use are as essential to improving and preventing environmental conflicts as are the control and guidance of surrounding development to render it more compatible with the airport.

60. Noise. Incompatibility is the principal land use problem that airports and their neighboring communities share today. This problem is based primarily on the objection of people to aircraft noise that overspills the boundaries of airports and interferes with sleep, speech, teaching, recreation, and other activities. Thus, noise from operations at airports becomes a neighborhood nuisance; and as its effects begin to be felt, communities begin to protest.

A rational method for projecting the extent of aircraft noise has been available since 1962 when the concept of the CNR, or Composite Noise Rating, was adopted. Refinements to this approach have resulted from studies to develop the NEF, or Noise Exposure Forecast, concept. The basic difference between the two is that the NEF, in addition to utilizing all the data previously used in computing CNR's, also uses correction factors for discrete frequencies (tones) and noise duration. Although the CNR methodology has been widely used in the past, the FAA is transitioning to the use of the NEF and will produce all future noise contour maps utilizing this methodology. During this transition period it is expected that both CNR's and NEF's will be utilized outside the Federal Government; the latter, however, is preferable.

61. Land Uses on the Airport. The amount of acreage within the airport's boundaries will to some degree dictate the types of land uses to be found therein. For airports with limited acreage, most land uses will be aviation oriented. Large airports, however, may find that they have considerable acreage which is excess to actual aviation needs. Sound fiscal management demands that these excess lands be utilized to provide the greatest possible financial returns. In fact, in many instances these extra monies mean the difference between a profit and a loss for the airport's operation.

Considerable attention is being given these days to providing space on the airport for industrial users, especially those utilizing company aircraft or whose personnel travel extensively by air carrier or charter. Many times taxiway access is provided directly to the industry's door. In some instances, railroad tracks serving the industrial area, company parking lots, or low-level warehousing can be located directly under runway approaches (but free of clear zones). Care should be taken, however, to eliminate from consideration industries which might produce electronic disturbances which would interfere with aircraft navigational or communications equipment or cause visibility problems due to smoke. Some commercial activities are suitable for locating within the airport's boundaries. These should be evaluated on an individual basis. Recreational uses such as golf courses and picnicking areas are quite suitable for airport land uses and may in effect serve as good buffer areas. Certain agricultural uses are appropriate for airport lands but grain fields which attract birds should be avoided. Advisory Circular 150/5070-3, "Planning the Airport Industrial Park," offers guidance in de-

veloping airport land uses. Although lakes, reservoirs, rivers, and streams may be appropriate for inclusion within the airport's boundaries, especially from the standpoints of noise or flood control, care should be taken to avoid those water bodies which have in the past attracted large numbers of waterfowl. Dumps and landfills which may attract birds should also be avoided.

The following table is a partial listing of activities and facilities essential or desirable for airport operations. Also shown are those activities requiring direct access to the airport or to the landing area. Land uses in runway clear zones will be subject to the requirements of FAA Order 5335.2, "Airport Design Standards—Airports Served by Air Carrier—Extended Runway Safety Area."

TABLE 2.—Land uses that may be anticipated on an airport

Activity or facility	NEF value	Associated special facilities							
		Apron	Cargo term.	Hangar	High-way	Pass. term.	Rail siding	Acft. shops	Taxi-ways
Aircraft factories	40	AX			C		X		A
Aircraft sales	20–40	AX		X				X	A
Aircraft storage hangars	40	AX						X	A
Aircraft repair service	20–40	AX		X			X		A
Air freight forwarders	40	A	X		C	X	X		A
Air freight terminals (cargo)	40	AX			C		X		A
Air terminals—passenger	20–30	AX	X		CX				AX
Aviation oil & gas facilities	40	A		X	C	X	CX	X	A
Aviation-related Government Offices	20–30	A?		A?	C	X		A?	A?
Aviation schools	20–30	AX		A				A	X
Aviation services—Survey, Patrol, Photo., etc	20–30	A		A	C			A	A
Auto parking	40		(X)	(X)	X	(X)		(X)	
Electronic communications	40		(X)	(X)		(X)	(X)	(X)	
Distribution centers—supplied by air	20–40	A?	X		C	X	X		A?
Electric substations	40		(X)	(X)		(X)		(X)	
Factories—supplied by air	20–40	A?	X	A?	C	X	X	A?	A?
Fire & rescue station	20–30	C	C	C	C	C	C	C	C
Local access streets	40	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
Power transmission lines	40		(X)	(X)		(X)		(X)	
Utilities, Nonelectric	40	(X)	(X)	(X)		(X)		(X)	
Agriculture	> 40				(X)				

Associated special facilities code:
A —Aircraft access to associated special facility
C —Car/truck access to associated special facility
X —Located convenient to associated special facility
? —May have own aircraft
(X)—Usually essential to associated special facility

62. Land Uses Around the Airport. As mentioned earlier, the land use plan for environs surrounding the airport must be treated as part of the areawide comprehensive planning program. If the airport falls within political jurisdiction of the affected areas in question, compatible land use planning both on and off the airport is simplified. When the airport is operated by an entity other than the political subdivision in which it is located, or when jurisdiction of the airport environs is split between a city and a county, between two counties, or any other imaginative combination, extensive coordination is necessary. Naturally, the more political entities involved, the more complicated the coordination process becomes.

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Aircraft storage hangars	40	AX						X	A
Aircraft repair service	20–40	AX		X			X		A
Air freight forwarders	40	A	X		C	X	X		A
Air freight terminals (cargo)	40	AX			C		X		A
Air terminals—passenger	20–30	AX	X		CX				AX
Aviation oil & gas facilities	40	A		X	C	X	CX	X	A
Aviation-related Government Offices	20–30	A?		A?	C	X		A?	A?
Aviation schools	20–30	AX		A				A	X
Aviation services—Survey, Patrol, Photo., etc	20–30	A		A	C			A	A
Auto parking	40		(X)	(X)	X	(X)		(X)	
Electronic communications	40		(X)	(X)		(X)	(X)	(X)	
Distribution centers—supplied by air	20–40	A?	X		C	X	X		A?
Electric substations	40		(X)	(X)		(X)		(X)	
Factories—supplied by air	20–40	A?	X	A?	C	X	X	A?	A?
Fire & rescue station	20–30	C	C	C	C	C	C	C	C
Local access streets	40	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
Power transmission lines	40		(X)	(X)		(X)		(X)	
Utilities, Nonelectric	40	(X)	(X)	(X)		(X)		(X)	
Agriculture	> 40				(X)				

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This is when a Council of Governments or some similar organization crossing traditional political lines can perform a real service by lending a helping hand.

Numerous techniques have been devised for defining areas affected by an airport's operations. The one which is felt to offer the most promise, however, is the delineation of noise contours by either NEF or CNR methodologies, preferably the former. For planning purposes, contours should be developed for as far into the future as is possible. Arguments can be presented that long-range forecasts such as these are highly speculative and may later prove erroneous. Such arguments can be countered though by pointing out that these contours are only guidelines for planning purposes and that in later years, if circumstances change, the contours can be modified as necessary. This is in line with the concept that planning should be a continuous process. Once NEF (CNR) contours have been developed for the airport, all those land areas falling within NEF zones >20 should be planned for, with particular attention being given to those areas having NEF values >30.

After NEF (CNR) contours have been developed for areas in the vicinity of the airport, land uses can be planned based on the degree of adversity of noise effects. Special attention should be paid to noise contours close to the airport where they may take irregular shapes due to runway and traffic pattern configurations. Careful analysis may reveal pockets of less intensive noise adversity, where land is available for development of noise sensitive facilities. These will be choice locations because of their closeness to airport business activities.

The following table indicates appropriate land uses in the vicinity of an airport.

TABLE 3.—Land uses adjacent to airports (based on NEF or CNR noise contours)

NEF Values	CNR	CNR Zone	Remarks
20–30	90–100	1	Few activities will be affected by aircraft sounds, although building designs for especially sound sensitive activities such as auditoriums, churches, schools, hospitals, and theatres should consider sound control in areas closest to the airport. Detailed studies by qualified personnel are recommended for outdoor amphitheatres and like places of public assembly in the general vicinity of the airport.
30–40	100–115	2	Activities where uninterrupted communication is essential should consider sound exposure in design. Generally, residential development is not considered a suitable use although multi-family developments where sound control features have been incorporated in building design might be considered. Open-air activities and outdoor living will be affected by aircraft sound. The construction of auditoriums, schools, churches, hospitals, and theatres and like activities should be avoided within this zone where possible.
> 40	> 115	3	Land should be reserved for activities that can tolerate a high level of sound exposure such as some agricultural, industrial, and commercial uses. No residential developments of any type are recommended. Sound sensitive activities such as schools, offices, hospitals, churches, and like activities should not be constructed in this area unless no alternative location is possible. All regularly occupied structures should consider sound control in design.

63. A Land Use Planning Approach.

a. Concurrent with the delineation of the noise exposure areas, a survey of land use and related data is needed to provide the basis for an assessment of the noise impact and possible solutions. Things to be determined include:

(1) Number and kinds of properties, indicating the noise sensitivity of the respective land uses;

(2) Number and types of structures;

(3) Number and characteristics of people; and

(4) Value of residential and other noise sensitive properties. Special attention should be given to especially sensitive uses such as schools and hospitals.

b. Analyses should also consider the impact of reuse (renewal) of land in the affected environs, with specific respect to:

(1) Economic impact as it relates to employment patterns and tax base;

(2) Social impact, including relocation problems;
(3) Effects of land conversion on existing and proposed community land use and the provision of public facilities; and
(4) Relation to local planning proposals in these locations.

64. Land Use Strategies. In the past, the most common approach to controlling land uses has been zoning. Airports and their environs became involved in two types of zoning.

a. The first type of zoning is height and hazard zoning, which may protect the airport and its approaches from obstructions to aviation while restricting certain elements of community growth. FAR Part 77, Objects Affecting Navigable Airspace, is the basis for height and hazard zoning which is described in Advisory Circular 150/5190-3, "Model Airport Zoning Ordinance."

b. The second type of zoning, and the one which is most familiar to planners, is land use zoning. This type of zoning, however, has two major shortcomings. First, it is not retroactive and does not affect preexisting uses that will conflict with airport operations. Secondly, jurisdictions with zoning powers (usually cities and towns, or in some cases counties) may not take effective zoning action. This is partly because the airport may affect several jurisdictions and coordination of zoning is difficult. Or, the airport may be located in a rural area where the county lacks zoning powers and the sponsoring city may not be able to zone outside its political boundaries. Another problem is that the interest of the community is not always consistent with the needs and interests of the aviation industry. The locality wants more tax base, population growth, and rising land values, all of which are not often consistent with the need to preserve the airport environs for other than residential uses. There is also the problem in that zoning vacant land for compatible uses of an exclusive nature, such as commercial or industrial, may be considered a "taking" if there is no demand for such activity. A possible solution to overcoming the problem of multi-jurisdictional interest in the airport's environs would be to transfer zoning power to a regional authority, which could legitimately be given police powers. If zoning of airport environs is not feasible for legal or political reason, another approach needs to be tried. Some airport authorities have eminent domain powers, and the purchasing of easements may offer some solutions in this field. If airport authorities were given an adequate source of funds, they could use eminent domain power to acquire development rights over land within noise exposed areas around airports.

c. Subdivision regulations offer another method of land use control. Provisions can be written into the regulations prohibiting residential construction in intense noise exposure areas >115 CNR and >40 NEF—and requiring acoustical studies to be made for proposed residences within the 100–115 CNR/30–40 NEF contour. This in effect is not different from those ordinances prohibiting construction within flood plains.

d. A fourth alternative in controlling land use is relocation of residences or the use of urban renewal funds and the authority to eliminate existing incompatible uses. This technique raises many questions, but it may be worth exploring for severe noise exposure situations. Substantial additional funding would be required and problems of relocation of residences and neighborhood disruption would have to be handled in terms of benefits to the entire area.

65. Innovative Concepts for Compatible Land Use Development. The following development presents some examples of innovative concepts that could assist development of compatible land near airports. Other techniques will continue to be required until the problem is solved.

a. Joint Airport-Environs Development. A joint airport-environs development approach merits attention and evaluation to determine its applicability for developing the airport environs. The joint airport-environs development concept is based on the fact that separation between the noise generated components of an airport and adjacent land uses frequently requires enormous amounts of land which are difficult to keep in a state of nondevelopment often due to the economic growth pressures generated by the airport itself. It would, therefore, be desirable to commit the surrounding land to a more intensive form of development which is compatible with and could be developed jointly with the airport. This would then permit capitalizing on the growth generated by the airport and recovering, through increased land values and the development of income-producing properties, some of the cost of developing the airport proper. There is some precedent for this revolving fund provision and for the joint development concept in the United States which is presently being pursued in a somewhat different form for freeways and related development by both the Department of Housing and Urban Development and the Department of Transportation.

b. Noise Encroachment Zones. Since one of the major problems in controlling land uses around airports is the fragmentation of zoning powers among many individual municipalities, it would be desirable to develop an overriding mechanism, probably administered by the State government, which would be applied on top of or in addition to local zoning. A precedent for such action may be found in the flood encroachment zones which have been established by some States and which provide for the delineation of encroachment lines on either side of a stream bed. Within these lines, structures may be prohibited and other conditions attached for the use and development of the properties. Using this principle, it might be possible for States to delineate noise encroachment zones within which it would be similarly illegal to construct or develop incompatible uses. This might be restricted to only certain uses or might preclude any urbanization of the area.

c. Building Code Noise Attenuation Districts. Insulation requirements should be part of the local building codes, without which the building permits cannot be issued. This becomes an even more powerful tool when it is linked to an occupancy permit and an appropriate housing code. One of the problems with noise insulation requirements is that they are not appropriate or required in many portions of the city and would simply operate to inflate the cost of housing, which is already too high in many areas. However, it is equally obvious that homes and other noise sensitive uses will continue to be built in noise affected areas simply because of the demand for residential building sites in convenient locations. This being the case, it would be desirable to develop selective noise attenuation districts within which insulation would be required as a condition of issuing the building permit. The local municipality can delineate such districts around airports, railroad yards, expressways, and other such noise generators in a manner similar to the delineation of fire prevention districts, which is now practiced in most larger municipalities.

66. Summary. The responsibility for developing land uses within the boundaries of an airport lies with the airport owner. The responsibility for developing land uses adjacent to the airport boundaries lies with the governing bodies of adjacent communities. The land use plan developed under the master plan effort should show proposed on-airport land uses as developed by the airport owner and proposed off-airport land uses as developed by the surrounding communities.

If compatible land uses are to be developed, airport sponsors and the surrounding communities must work together if the proper resolution of noise and other environmental problems are to be resolved. Therefore, the management of land uses on and off the airport, especially in noise exposed areas, requires a comprehensive approach which involves planning, the political process, funding of programs, and the use of zoning processes, and acquisition and condemnation procedures.

Chapter 9. TERMINAL AREA PLANS

67. General. The development of the terminal area plan and plans for components within the terminal area will evolve from demand/capacity analysis and from the airfield configurations and land use criteria established in the airport layout and land use plans. This does not mean that the terminal area concept which is selected for a particular airport will not have a vital impact on the airport layout plan. In fact, the airfield configuration and the terminal area configuration must fit together and adjustments in both layouts must be made as the master plan evolves. Regardless of these necessary design adjustments, the details of the terminal area plan will follow the development of the airport layout plan.

The Airport and Airway Development Act of 1970 states that, "terminal area means that area used or intended to be used for such facilities as terminal and cargo buildings, gates, hangars, shops, and other service buildings; automobile parking, airport motels and restaurants, and garages and vehicle service-facilities used in connection with the airport; and entrance and service roads used by the public within the boundaries of the airport." This, of course, should be interpreted to include aircraft aprons and taxiways required for the maneuvering of aircraft and service equipment in the vicinity of terminal building gates and other facilities. In many instances, these facilities may be contiguous within one general location on the airport, and in other instances, particular segments of the terminal area such as hangar or cargo areas may be situated at locations remote from the main terminal complex. The general locations of these facilities will be indicated on the land use plan as described in Chapter 8. However, the details of the terminal area components should be developed and presented as prescribed in this chapter.

The degree to which terminal area plans are developed under master plan efforts should be limited to concept studies and conceptual drawings. This will include the dimensioning of overall areas on layout plans and development of schematic drawings adequate for delineating basic flows of passengers, baggage, cargo, and vehicles. This will include movement from car parking areas or curb space to aircraft and back again. The development of details which are required in construction drawings and specifications should not be included in the airport master plan. It should also be kept in mind that concept drawings should not be so definitive as to preclude important changes which will evolve with the development of detailed plans. Such changes are inevitable as an airport project moves through final design and construction.

Terminal area plans which are a part of the master plan should first provide an overall view of the terminal area (scale of $1''=500'$ to $1''=1000''$) and should then provide large scale drawings (scale of $1''=50'$ to $1''=100'$) of important segments within the overall plan. Thus, large scale views should be provided of terminal building areas, including aircraft parking and maneuvering areas, cargo building areas, hangar areas, airport motel sites, service facilities, and airport entrance and service roads, as appropriate to the particular airport development.

68. Objectives. The objective of the terminal area plan should be to achieve an acceptable balance between passenger convenience, operating efficiency, facility investment, and aesthetics. The physical and psychological comfort characteristics of the terminal area should afford the passenger orderly and convenient progress from his automobile or public transportation through the terminal to the aircraft and back again. One of the most important factors affecting the air traveler is walking distance. It begins when the passenger leaves his ground transportation vehicle and continues on to the ticket counter and to the point at which he boards the aircraft. Therefore, a prime objective in the development of a terminal area plan should be to minimize the walking distance by developing convenient auto parking facilities, convenient movement of passengers through the terminal complex, and conveyances which will permit fast and efficient handling of baggage. The planner should establish objectives for average walking distances from terminal points to parked aircraft. Conveyances for passengers such as moving walks and baggage handling systems should be considered. The functional arrangement of the terminal area complex with its aircraft

maneuvering areas should be flexible enough to meet the operating characteristics of the airline industry for handling passengers and for fast ground servicing of aircraft so that minimum gate occupancy time and maximum airline operating economy will be achieved. The final objective should be to develop a terminal area complex which provides all necessary services within an optimum expenditure of funds from the standpoints of capital investment and maintenance and operating costs. This should take into account flexibility and costs which will be required in future expansions of the terminal area.

69. Factors To Be Considered. A balanced flow should be established for the inbound and outbound movement of passengers and goods through airport terminal area facilities from curb, road, car parking, and public transportation stops to aircraft and in reverse order. Volumes of passengers and goods at typical peak hours and the resulting traffic by ground transportation vehicles must be established to determine the requirements for capacities of curbs, vehicular parking, and public ground transportation stations; terminal building areas including ticket lobbies, passenger holding areas, corridor widths, inbound and outbound baggage; and the number of aircraft gate positions and associated areas of aircraft aprons. These requirements are all closely related to passenger volumes, airline schedules, runway capacity, and number of operations by various types of aircraft. Only rough estimates of these space requirements should be developed for master plans since detailed analysis and dimensioning will follow in the final design stage. In the selection of a terminal area concept, the following factors should be carefully studied:

a. Passengers.

(1) Adequate terminal area curb space for private and public transportation.

(2) Minimum walking distance—Automobile parking to ticket counter.

(3) Minimum walking distance—Ticket counter to passenger holding area.

(4) Minimum walking distance—Passenger holding area to aircraft.

(5) Passenger transportation—Where long distances must be traversed.

(6) Pedestrian walkways to aircraft—As back-up to mechanical transportation systems for passengers.

(7) Efficiency of passenger interline connection.

(8) Baggage handling—Enplaning.

(9) Baggage handling—Deplaning.

(10) Convenient hotel-motel accommodations.

(11) Efficient handling of visitors and sightseers at the airport.

b. Passenger Vehicles.

(1) Public automobile flow separation from service and commercial traffic (a necessity at large airports).

(2) Public transportation to and from the airport.

(3) Public parking—long term (3 hours or more).

(4) Public parking—short term (less than 3 hours).

(5) Airport employee parking.

(6) Airline employee parking.

(7) Public auto service area.

(8) Rental car parking and service areas.

c. Airport Operations.

(1) Flexibility.

(2) Separation of apron vehicles from moving and parked aircraft.

(3) Passenger flow separation in the terminal building (departing and arriving).

(4) Passenger flow separation from apron activities.

(5) Concession availability and exposure to public.

(6) Airfield security and prevention of unauthorized access to apron and airfield.

(7) Air cargo and freight forwarder facilities.

(8) Airport maintenance shops and facilities.

(9) Airfield and apron drainage.

(10) Airfield and apron utility distribution.

(11) Utility plants, and heating, and air conditioning systems.

(12) Fire and rescue facilities and equipment.

d. Aircraft.

(1) Efficient aircraft flow on aprons and between terminal aprons and taxiways.

(2) Easy and efficient maneuvering of aircraft parking at gate positions.

(3) Aircraft fueling.

(4) Heliport areas.

(5) General aviation areas.

(6) Noise, fumes, and blast control.

(7) Apron space for staging and maneuvering of aircraft service equipment.

e. Safety (for the following functions and areas).

(1) Enplaning and deplaning at aircraft.

(2) Elevators, escalators, stairs and ramps as to location, speed, and methods of egress and ingress.

(3) People-mover systems as to location, speed, methods of egress and ingress.

(4) Road crossings as to protection of pedestrians.

(5) Provisions for disabled persons.

f. Expansion Capabilities to Accommodate.

(1) Increase of passenger volumes.

(2) Increase in number of aircraft positions.

(3) Increase in aircraft size.

g. Economics. To provide a proper balance between capital investment, aesthetics, operation and maintenance costs, and passengers and airport revenues.

70. Developing Criteria for the Terminal Area Plan. Specific planning criteria should be developed for the above factors and for major terminal area components. Information for terminal requirements should be obtained from the airlines, general aviation interests, concessionaires, airport management, and special technical committees. The criteria should be analyzed and agreed upon by all parties involved before it is incorporated in the master plan.

71. Selection of Terminal Area Concepts. During the course of development of plans for the terminal area the planner should give consideration to all terminal concepts which might be applicable to his particular airport situation. Through careful study and analysis, he should reduce these possibilities to those few concepts which will be most compatible with the planned airfield configuration. These most desirable concepts should then be presented to airport management, airline and general aviation interests, and airport concessionaires for their consideration and appraisal. It is essential that coordination with airport interests and users be effected before the final selection of a terminal area concept is made. If this is not done, the plan may well be rejected at the time of its official presentation. The following terminal area concepts should be considered in the development of the terminal area plan. Sketches of the concepts are shown in figure 5.

a. Simple Terminals. The simple terminal consists of a single common waiting and ticketing area with several exits onto a small aircraft parking apron. It is adaptable to airports with low airline activity and is also adaptable to general aviation operations whether it is located as a separate entity on a large airline-served airport or is the operational center for an airport used exclusively by general aviation. Where the simple terminal serves airline operations, it will usually have an apron which provides close-in parking for three to six commercial transport aircraft. Where the simple terminal serves general aviation only, it should be within convenient walking distance of aircraft parking areas and should be adjacent to an aircraft service apron. The simple terminal will normally consist of a single level structure where access to aircraft is afforded by a walk across the aircraft parking apron. The layout of the simple terminal should take into account the possibility of linear extension for terminal expansion.

b. Linear Terminals. The linear terminal concept is merely an extension of the simple terminal concept, that is, the simple terminal is repeated in a linear extension to provide additional apron frontage, more gates, and more room within the terminal for passenger processing. It is sometimes referred to as the gate arrival concept. The more sophisticated linear terminals often feature a two-level structure where enplaning passengers are processed direct from curb to aircraft on one level while the other level is used by deplaning passengers for baggage claim and access to ground transportation. Passenger walking distance from curb through terminal to aircraft is short, usually 75 to 100 feet. The linear configuration also lends itself to the development of adequate, close-in public parking. Ample curb frontage for loading and unloading ground transportation vehicles is provided with each extension of the linear terminal and there is a direct relationship of enplaning or deplaning curb frontage to departing or arriving aircraft. Linear terminals can be expanded with almost no interference to passenger processing or aircraft operations. Expansion may be accomplished by linear extension of existing structure or by developing two or more linear terminal units.

The loading of aircraft may be accomplished by nose-in/push-out operations or by loading bridges. Aircraft can maneuver on apron areas with unob-

structed flow if a maneuvering taxi lane and dual taxiway parallels are provided. The linear concept does not require long concourses, fingers, satellites, or service buildings, but it does not lend itself to common facilities such as waiting rooms, concessions, ticket counters, or hold rooms. These facilities are usually repeated with each linear extension. At large airports, the concept can also require an extensive system of directional signs since enplaning passengers must not only be directed to the correct airline area but also to the correct passenger processing module within that area. Another problem with the concept is that on a return flight to the airport, a passenger may find that his deplaning module is located a long distance from where he parked his car at his enplaning module. These factors must be taken into account in comparing the operating and construction costs of the linear terminal with other concepts. The configuration of the space occupied by the linear concept must also be compared with the space and configurations of other concepts in determining their compatibility with particular airport situations.

c. Finger Terminals. The finger or pier concept evolved in the 1950's when gate concourses were added to simple central terminal buildings. Since then, very sophisticated forms of the concept have been developed with the addition of hold rooms at gates, jetways and aircraft loading bridges, and vertical separation of the ticketing check-in function from the baggage claim function. However, the basic concept has not changed in that the main central terminal building is used to process passengers and baggage while the finger or pier provides a means of enclosed access from the central terminal to aircraft gate. Aircraft are parked at gates along the pier as opposed to the satellite concept where they are parked in a cluster at the end of a concourse.

Walking distances through finger terminals are long, averaging 400 feet or more. Curb space must be carefully planned since it depends on the length of the central terminal and is not related to the total number of gates afforded by fingers. This is particularly true of deplaning curbs near centralized baggage claim facilities.

Although the finger concept has afforded one of the most economical means of adding gate positions to existing terminals, its use for expansion should be limited. Existing fingers should not be extended at the expense of taxiway maneuverability nor should new fingers be added without providing adequate space for passenger processing in the main terminal. Most successful additions are effected by extending the main terminal and then increasing the number of fingers.

Adequate space must be provided between fingers for the maneuvering of aircraft. Dual taxi capability between fingers is desirable and aircraft growth should be taken into account in planning separation. Since most aircraft maneuvering takes place between piers, outside taxiways are free of push-out operations.

d. Satellite Terminals. The primary feature of the satellite concept is the provision of a single central terminal (with all ticketing, baggage handling, and ancillary services) which is connected by concourses to one or more satellite structures. It is sometimes called the rotunda concept. The features of the satellite concept are very similar to those of the finger concept except that aircraft gates are located at the end of a long concourse rather than being spaced at even intervals along the concourse. Satellite gates are usually served by a common hold room rather than individual hold rooms. Another feature is that the concourse can be located underground thereby providing space for aircraft taxi operations between the main terminal and the satellite.

The distance from the main terminal to a satellite is usually well above the average distance to gates found with the finger concept. Therefore, people-mover systems are being provided between terminal and satellite at many installations to reduce walking distances.

There is no direct relationship between the number of gates and curb space so that special care should be taken in planning enplaning and deplaning ramps for the central terminal to prevent curb overloads. One of the advantages of the satellite concept is that it lends itself to a compact central terminal with common areas for processing passengers. In some instances, where terminal area space is limited, structural parking is provided above the central terminal building.

Aircraft maneuvering areas are required around satellites so that push-out tug operations do not cause aircraft to block active taxiways. Wedge shaped aircraft parking positions around the satellite also tend to crowd the operation of aircraft servicing equipment.

Terminals developed under the satellite concept are difficult to expand without reducing ramp frontage or disrupting airport operations. Therefore, increases in terminal capacity are usually effected by the addition of terminal units rather than expansion of an existing unit.

e. Mobile Lounge Terminals. The mobile lounge or passenger transporter concept is in use at Dulles International Airport. It is sometimes called the remote aircraft parking concept. Aircaft parking aprons are remote from the terminal building. The mobile lounges transport passengers from the building to aircraft and can be used as hold rooms at terminal building gate positions. In this concept, the aircraft gate positions are placed in parallel rows at required spacings with mobile lounge and service vehicle roads running between the parallel rows of aircraft. Several sets of parallel aircraft parking rows can be provided for ultimate development of gate positions. Airline operations buildings must be provided adjacent to aircraft parking aprons.

With the mobile lounge concept, walking distances are held to a minimum since the compact terminal building contains common passenger processing facilities and curb frontage can be located directly across the terminal building from mobile lounge gates. Building and curb length, which is established in part by the number of mobile lounge gates, must be carefully planned to provide adequate frontage for enplaning and deplaning passengers.

The concept has good expansion capability in that capacity can be increased by the addition of mobile lounges and the main terminal and aprons can be expanded without the addition of extensive concourses, fingers, or satellites. With the mobile lounge concept, additions can be made with little impedance to airport operations and aircraft movements.

Aircraft maneuvering capability is excellent with this concept. Remote aircraft parking can reduce taxi time and distance to runways and avoid aircraft congestion next to terminal building facilities. This also removes the aircraft noise and jet blast problem from the building area. Mobile lounges must be capable of mating with various aircraft sill heights and terminal building floor heights.

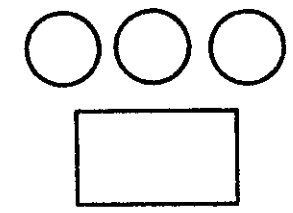
In comparing the mobile lounge concept with other concepts, the cost of independent terminal and service buildings and the purchase, operation, and maintenance of mobile lounges must be considered. The time required to move passengers between terminal and aircraft by mobile lounge should also be taken into account.

f. Unit Terminals. With the unit terminal concept described herein, the airlines build individual terminals around a system of interconnecting access and service roads. The terminals are spaced some distance apart and each terminal provides complete passenger processing and aircraft parking facilities. Airlines which provide limited service to an airport will sometimes combine their operations in a single unit terminal. The concept permits each airline to build a terminal to its own liking and provides for maximum airline identification. Kennedy International Airport is the best known example of the unit terminal concept.

Walking is held to comfortable distances since unit terminals are much smaller than large joint-use terminals. For this same reason, adequate curb frontage can be easily designed into the unit terminal.

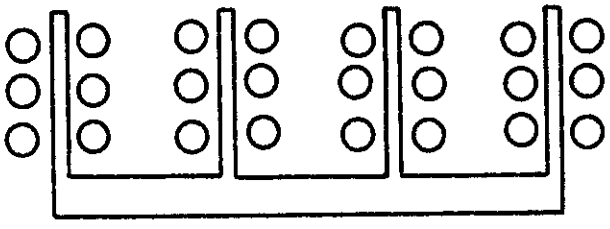
Expansion capability with the unit terminal concept can be difficult because of the gross area required for each individual terminal. Unit terminals probably require the greatest acreage for development and expansion of any of the terminal area concepts. Construction costs are high because passenger processing facilities, aircraft parking aprons, and public parking must be repeated with each unit terminal.

Aircraft maneuvering capability within the vicinity of unit terminals is usually good since the airlines have the opportunity to design aircraft aprons and passenger loading devices to suit their own operating requirements. However, the concept requires extensive taxiway systems which lead to complex taxi operations. With the unit terminal concept the relationship between adjacent terminals must be carefully planned if interference between aircraft flows is to be avoided and the capability of expanding individual terminals is to be preserved.

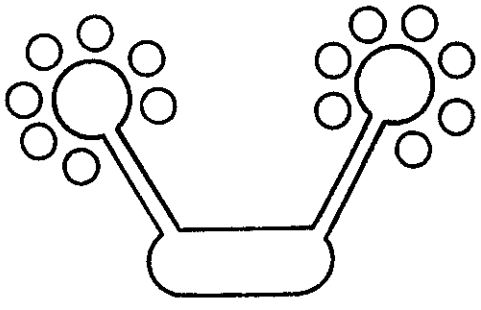


(A)
SIMPLE TERMINALS

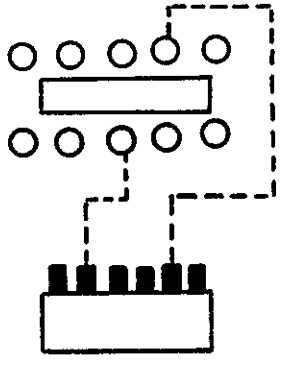
(B)
LINEAR TERMINALS



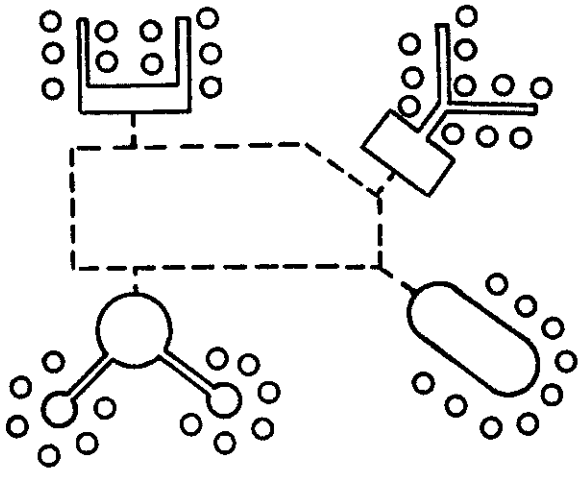
(C)
FINGER TERMINALS



(D)
SATELLITE TERMINALS



(E)
MOBILE LOUNGE TERMINALS



(F)
UNIT TERMINALS

FIGURE 5 TERMINAL AREA CONCEPTS

Chapter 10. AIRPORT ACCESS PLANS

72. General. This element of the airport master plan should indicate proposed routing of airport access to central business districts and to points of connection with existing or planned ground transportation arteries and beltways. All modes of access should be considered including highways, rapid transit, and access by vertical and short takeoff and landing (V/STOL) aircraft. The capacity requirement for the various modes considered should be determined from forecasts of passengers, cargo, and aircraft operations developed in Chapter 2. This information should be converted to trip data, by mode, to and from the airport. The need for in-town terminals should also be established. The airport access study should be of a general nature since detailed plans of access outside the boundaries of the airport will be developed by highway departments, transit authorities, and comprehensive planning bodies.

73. The Access Problem. In 1967–1968, the Bureau of Public Roads conducted an in-depth survey of highway access problems at all United States large and medium hub airports. They recommended that 30 minutes be considered as the maximum acceptable travel time from the central business district (CBD) to the airport. Tables 4 and 5 summarize the results of this survey. It will be noted that peak travel time at Chicago, Detroit, Los Angeles, New York, and Washington all exceed this BPR recommendation for travel from the CBD. Considering that these five cities account for 27 percent of all United States passenger movements, the airport access problem is obvious. With a forecasted tripling in demand by 1980, airport access will be critical and will involve many additional cities. The necessity to locate new jetports further from the CBD because of noise and limited availability of land will, in the future, impose even greater travel distances.

The decrease in flight time derived from jet service is helping the air traveler meet his time saving goal. However, surface access time constitutes an increasing proportion of portal-to-portal trip time as figures 6 and 7 graphically illustrate. The problem of airport ground access must also be considered in light of the overall urban transportation problem. To travel almost anywhere in today's urban environment requires increasing amounts of time. The daily commute to work, the weekend recreation jaunt, and even the neighborhood shopping trip is generating greater trip times. Thus, the inevitable question must be asked, "Why should an air traveler be able to get to the airport any faster than he can get to work, or shopping, or anyplace else in an urban area?" Although various trip purposes are difficult to evaluate, the failure of an air passenger to make his plane usually has more time-cost associated with it than does an occasional failure to make a shopping appointment or to arrive at work on time.

The nature and length of the air trips and the type of service which airports offer should also be considered in analyzing access problems. Medium length access times to small close-in airports which serve medium distance flights may be more critical than longer access times to large far out airports which serve long-haul flights. Therefore, the solution of each airport access problem must be judged on its own merits and it will often be more advantageous to establish an acceptable access time based upon total trip time and distance than to set an access trip time such as the 30-minute recommendation.

74. The Segments of Airport Access. Airport access is usually divided into three major segments or jurisdictions:

a. Access from the CBD and suburban areas via highway and rapid transit systems to the airport boundary;

b. Access from the airport boundary via airport roads and rapid transit to passenger unloading curbs at the terminal building; and

c. Access from terminal curbs through the terminal to aircraft.

The first segment is a part of the overall regional or urban transportation system and serves both general traffic and airport traffic. State and local highway departments and local transit authorities will bear the major responsibility for the administration, design, and construction of this first segment. Airport sponsors are responsible for developing the requirements

of airport traffic which must be served within the first segment. They are also responsible for promoting the development of facilities to serve that demand. Regional and local planning bodies are relied upon to bring together the general needs of urban transportation and the specialized needs of airports by the development of comprehensive transportation plans for metropolitan or regional areas as a whole. At the Federal level the Department of Transportation and the Department of Housing and Urban Development provide national inputs through programs such as the Federal Highway Grants-in-Aid Program, Urban Transportation Planning Funds, and High Speed Ground Demonstration Projects. Thus, with this diversification of responsibility, careful coordination is required if the first segment of airport access problem is to be effectively resolved.

The second segment of airport access, from the airport boundary to terminal building unloading curbs, is primarily the responsibility of airport management. They plan and construct the second segment of access, although they are often assisted by the airlines in this effort. Airport sponsors must take special care in planning on-airport access to insure that it is compatible with off-airport ground transportation plans and with ultimate terminal area development.

The third segment of airport access, from unloading curbs through terminals to aircraft, is a problem of terminal building design and is discussed in detail in Chapter 9. Segments 1 and 2 must be compatible with terminal building design and with the plans of airlines for the handling of passengers and baggage. Therefore, it is essential that the planning of all segments of airport access be coordinated with the major users of the airport.

75. The Peak Hour Problem. The airport access problem originates in part from the fact that airport travel tends to peak in the same morning and afternoon periods as does general urban and suburban travel. The first segment of access traffic is made up of general urban travelers, and airport passengers, visitors and employees. General urban travelers drop out after the first segment leaving only the airport traffic in the access system. Tables 6 and 7 indicate the relevant proportions of passengers, visitors, and employees found in the airport access system at selected cities. Because most visitors ride in the same vehicle with passengers during access, they do not add to the peaking problem except for congestion within the terminal building. Employees do, however, since they ride in separate vehicles. The peaking of passengers and employees usually has two pronounced humps. Airport access facilities are designed on the basis of typical peak hour traffic. At some of the busiest airports congestion rises in the morning, remains almost constant throughout the day, and does not taper off until mid-evening. This steady flow of traffic can be a help in promoting airport access facilities since a constant demand provides justification of improvements from a cost benefit standpoint.

76. Rapid Transit. Rapid transit has been proposed to relieve access problems to many of the most congested airports. A demonstration project for a tracked air cushion vehicle system to serve Los Angeles International Airport is planned through a grant by the Urban Mass Transportation Administration. A subway stop is being planned at Washington National Airport for Washington, D.C.'s new rapid transit system. Chicago and New York are studying rapid transit possibilities to their airports. The rapid transit concept is being incorporated in the design of many new airports which will be located long distances from city centers.

At the present time the rapid rail line from the city of Cleveland to Cleveland Hopkins International Airport is the only airport rapid transit system operating in the United States. It was constructed as an extension to Cleveland's existing subway system. In conjunction with the existing access highway system it is proving to be successful as a quick and practical airport access mode.

Cleveland's airport rapid transit should be studied, along with plans for new systems, in selecting access modes to airports. Means of improving baggage handling and reducing the numbers of enroute stops should be fully explored, and careful analysis should be made of the relationship between access highway and rapid transit demand to keep access modes in balance.

77. Priority of Airport Access in Metropolitan Transportation Planning. Although it plays an important role in air transportation, airport access is an integral part of the metropolitan area transportation network. Regional, metropolitan, and local transportation plans are deficient if they do not include linkage to the airport. The priority of completing segments of the metropolitan system linking the airport should recognize the airport's (and its environs) economic value to the community. In this way, the airport is treated as one of many major traffic generators in a metropolitan area and can be compared on an equal basis with other large activity centers.

TABLE 4.—Connections between CBD's of 21 cities and their primary major hub service

City	Airport	1960 Population (1000's)	District (miles)	Travel time peak	Travel time off-peak	Speed peak (m.p.h.)	Speed off-peak (m.p.h.)	Percent freeway
Atlanta		768.1	8.9	24.5	12.7	21.8	42.0	93.3
Boston	Logan	2,413.2	4.0	25.0	16.0	9.0	15.0	12.5
Chicago	O'Hare	5,959.2	17.5	45.0	27.0	23.4	39.0	85.7
Cincinnati		993.6	13.0	22.8	16.8	33.2	46.5	69.2
Cleveland		1,784.9	14.0	25.0	20.0	33.6	42.0	67.9
Dallas	Love	932.3	7.5	16.5	14.0	27.3	32.2	58.6
Denver	Stapleton	803.6	6.1	17.2	15.5	21.3	23.6	0.0
Detroit	Metropolitan	3,537.7	18.3	47.0	32.0	23.5	34.5	73.8
Kansas City	International	921.1	19.2	25.0	25.0	46.0	46.0	88.5
Los Angeles		6,488.8	15.0	40.0	—c	22.5	—c	36.7
Miami		852.7	7.4	24.0	21.0	18.5	21.1	0.0
Minneapolis-		1,377.1	12.3	21.0	18.0	35.2	41.0	47.1
St. Paul			8.3	17.0	16.0	29.3	31.2	42.1
New Orleans		845.2	14.4	30.0	23.0	28.6	37.4	65.2
New York	Kennedy	14,114.9	14.3	50.0	30.1	17.2	28.5	49.0
New York	LaGuardia	14,114.9	7.8	31.5	19.1	14.9	24.4	87.1
New York	Newark	14,114.9	11.0	23.7	15.9	27.8	41.5	94.5
Philadelphia		3,635.2	8.9	24.0	20.0	22.0	27.7	46.1
Pittsburgh		1,804.4	17.0	—c	—c	—c	—c	——
San Francisco		2,430.6	14.5	35.0	23.0	25.0	38.0	89.6
Seattle	Seatac	864.1	14.0	22.0	20.0	38.0	42.0	92.5
St. Louis		1,667.7	14.8	25.5	21.0	35.0	42.2	92.5
Washington	National	1,808.4	4.0	17.0	13.0	14.0	18.5	12.5
Washington	Dulles	1,808.4	24.8	52.0	39.0	28.6	38.2	56.0

c = Not reported

TABLE 5.—Connections between CBD's of 31 cities and their primary medium hub service

City	Airport	1960 Population (1000's)	District (miles)	Travel time peak	Travel time off-peak	Speed peak (m.p.h.)	Speed off-peak (m.p.h.)	Percent freeway
Albany	Albany County	455	8.4	24.8	19.3	20.3	26.1	0
Albuquerque	Sunport	241	4.3	8.6	8.6	30.0	30.0	32
Baltimore	Friendship	1,419	10.5	17.0	16.1	37.0	39.1	0
Birmingham		521	5.1	14.0	12.0	21.8	25.4	0
Buffalo	International	1,054	9.8	22.8	18.0	25.8	32.7	0
Charlotte	Douglas	209	7.2	21.8	19.2	19.8	22.5	0
Columbus	Port Columbus	617	8.2	22.0	17.1	22.4	28.8	17
Dayton	Cox	512	13.3	23.5	18.0	34.0	44.4	74
Des Moines		241	5.2	14.0	12.4	22.2	25.1	0
El Paso		277	8.3	14.0	12.0	35.6	41.5	78
Hartford	Bradley	362	16.0	30.0	20.0	32.0	48.0	74
Indianapolis		639	7.9	24.6	20.4	19.3	23.2	18
Knoxville	McGhee-Tyson	173	14.2	18.7	17.2	49.6	40.5	6
Louisville	Standiford	607	6.0	15.0	11.0	24.0	32.8	100
Memphis		545	12.3	20.5	13.0	36.0	41.0	68
Milwaukee	Mitchell	1,150	7.5	20.7	17.0	21.8	28.5	43
Nashville	Berry	347	6.9	12.2	10.0	34.0	41.4	72
Norfolk		508	11.0	17.2	16.3	38.4	40.5	68
Oklahoma City	Will Rogers	429	10.6	18.8	16.3	38.8	39.0	47
Omaha	Eppley	390	4.5	11.0	11.0	25.0	25.0	73
Phoenix	Sky Harbor	552	7.4	17.8	15.4	25.0	28.8	0
Portland, Ore.		652	10.5	24.1	16.9	29.4	37.3	51
Providence	Green	660	10.0	15.0	15.0	40.0	40.0	78
Raleigh		94	14.5	30.1	23.3	29.0	37.3	0
Rochester	Monroe County	403	4.2	19.5	15.0	13.0	16.8	0
Sacramento	Sacramento Co.	452	12.8	21.0	20.0	36.5	38.5	23
Salt Lake City		349	8.6	22.0	23.0	36.3	36.3	27
San Antonio		642	8.5	15.0	13.0	34.0	39.3	15
San Diego		830	3.1	9.5	9.3	20.0	22.0	0
Syracuse		333	8.1	16.7	17.7	29.0	27.5	68
Tulsa		299	8.5	26.2	20.6	19.5	24.8	0

TABLE 6.—Estimated total airport populations average day (1966–67)

Airports (1)	Passengers [1] (2)	Employees [2] (3)	Visitors (4)	Total [4] (5)
Atlanta	29,600	12,000	36,700	78,300
Chicago-O'Hare	50,000	16,000	25,000	91,000
Denver-Stapleton	5,500	5,500	8,500	19,500
Kansas City Municipal	6,700	1,100	1,500	10,300
Los Angeles	42,000	33,000	43,700	118,700
Miami	22,000	5,000	3,000 [3]	30,000
New York-Kennedy	46,800	23,000	22,800	92,600
New York-LaGuardia	17,200	3,300	4,000	24,500
New York-Newark	14,000	3,300	4,200	21,500
Phoenix-Sky Harbor	6,000	300	8,400	14,700
San Diego	3,000	1,600	3,200	7,800
Seattle-Tacoma	10,000	4,000	4,700	18,700
Washington, D.C.—National	26,000	13,100	26,000	65,100

[1] Total arrivals, departures, and intra-airport transfers.

[2] Data indicate employee counts on typical day. Total airport employee population may be considerably higher due to flight crew rotations, shifts, etc.

[3] Visitor traffic at Miami estimated to be low because of tourist-trade nature of the airplane passenger traffic.

[4] Data indicate total number of people at airports on typical day. Total number of airport access trips are different however: each passenger, with the exception of intra-airport transfers, accounts for one single direction airport access trip per day. Each employee and visitor accounts for two single direction airport access trips per day.

TABLE 7.—Estimated total airport populations peak day (1966–67)

Airports (1)	Passengers [1] (2)	Employees [2] (3)	Visitors (4)	Total [4] (5)
Atlanta	59,200	14,400	91,500	165,100
Chicago-O'Hare	60,000	16,500	50,000	126,500
Denver-Stapleton	6,900	5,500	10,700	23,100
Kansas City Municipal	9,000	1,200	2,000	12,200
Los Angeles	52,500	33,000	54,300	139,800
Miami	31,900	5,500	4,000 [3]	41,400
New York-Kennedy	58,500	23,000	30,800	112,300
New York-LaGuardia	18,400	3,300	4,300	26,000
New York-Newark	15,500	3,300	4,700	23,500
Phoenix-Sky Harbor	6,500	3,700	4,800	15,000
San Diego	3,900	1,000	3,300	8,800
Seattle-Tacoma	12,000	4,000	5,600	21,600
Washington, D.C.—National	33,090	13,100	33,000	79,100

[1] [2] [3] [4]. See notes on Table 6

TRAVEL TIME CHANGES

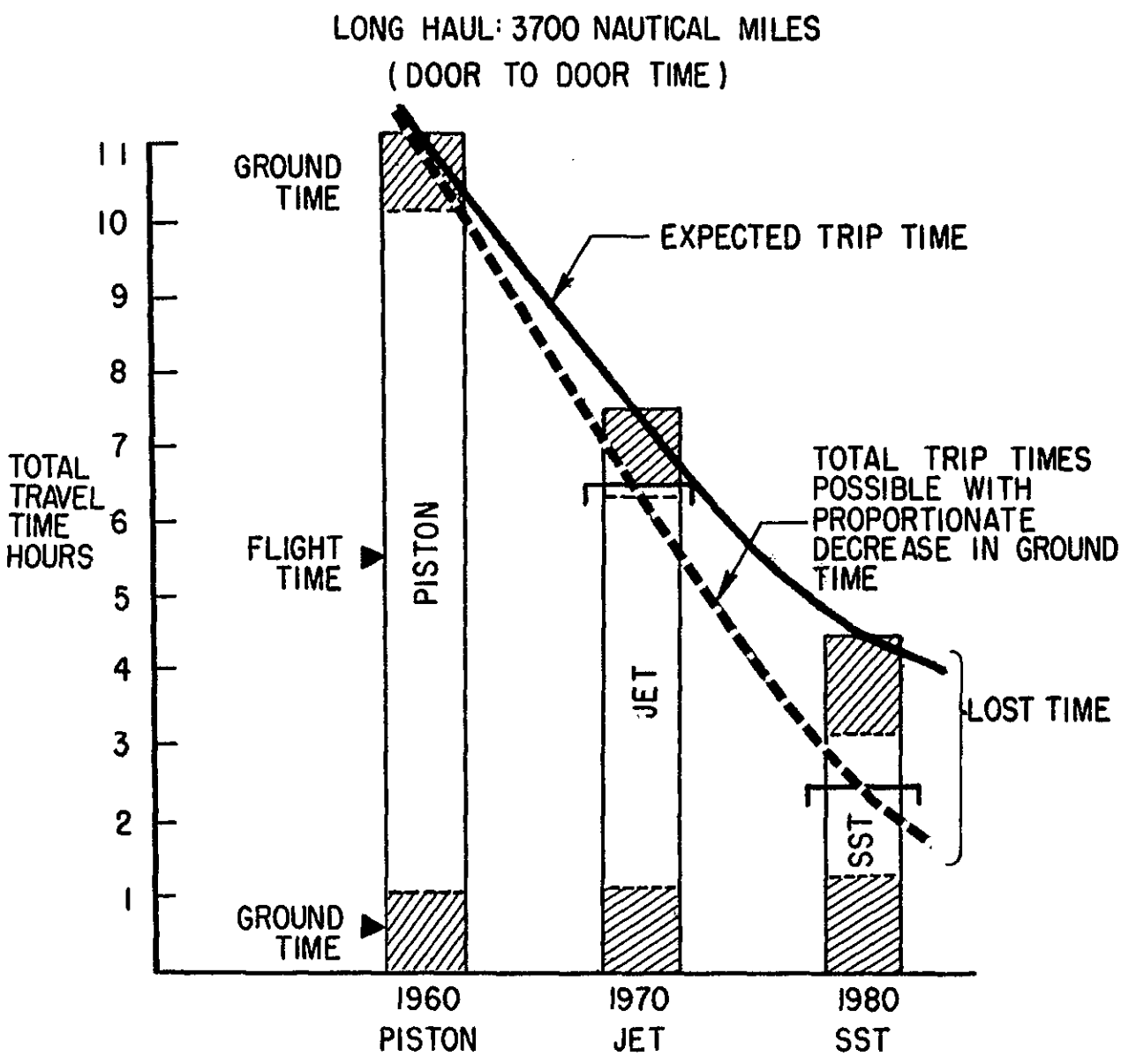


FIGURE 6

TRAVEL TIME CHANGES

MEDIUM HAUL: 600-1,000 NAUTICAL MILES

(DOOR TO DOOR TIME)

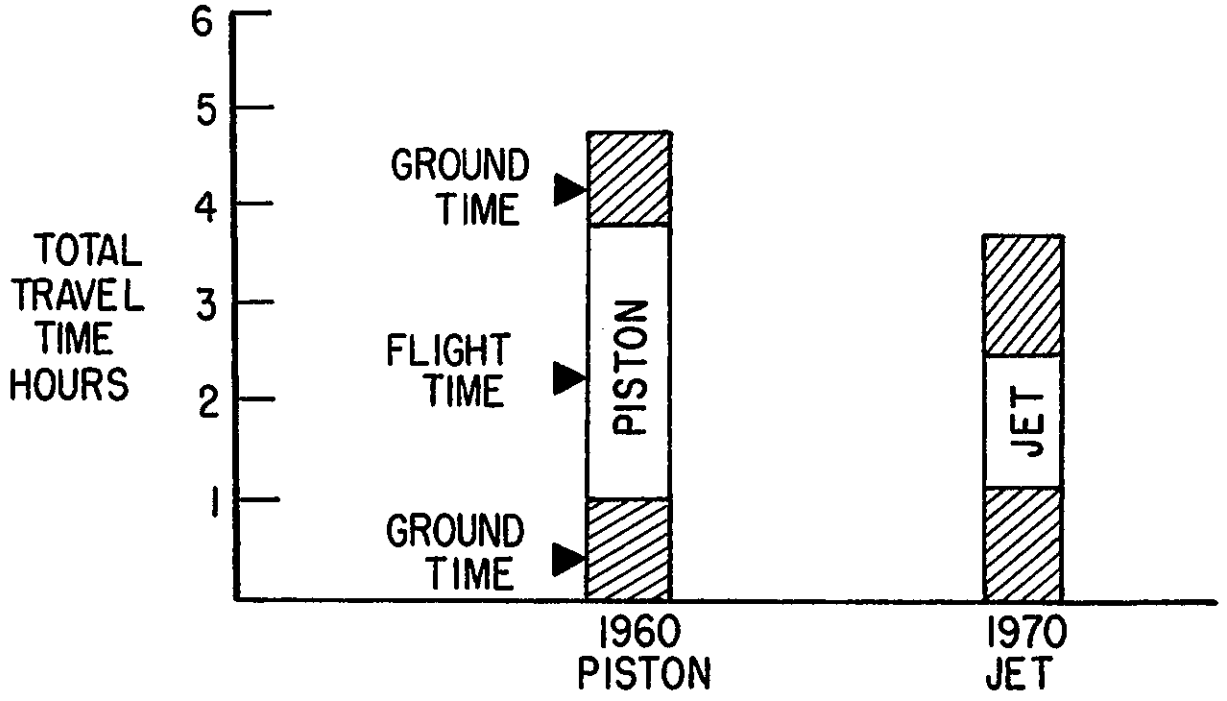


FIGURE 7

FINANCIAL PLAN

Chapter 11. SCHEDULES AND COST ESTIMATES OF PROPOSED DEVELOPMENTS

78. General. Schedules and cost estimates of improvements proposed in the master plan should be developed on the basis of short, intermediate, and long-range forecasts of aeronautical demand (approximately 5, 10, and 20 years). They establish the basis for the study of economic feasibility described in Chapter 12.

79. Schedules. The master plan or layout plan should indicate stage development of proposed facilities. The drawings should be legended to indicate staging shown on the plan, either on single or separate sheets (see figures 8 through 10). Charts which show the schedule of development for various items of the master plan should be developed for incorporation in the master plan report. The schedule should be accompanied by appropriate descriptive narrative.

80. Cost Estimates. Construction cost estimates of developments proposed in the airport master plan should be incorporated in the master plan report. These estimates should be related to the proposed schedule of development (see tables 8 through 10). Estimates should be based on forecast construction costs. It should be kept in mind, throughout the design of the master plan, that the costs of developments it proposes will be vital to its adoption.

TABLE 8.—First stage preliminary project cost estimate

Paving		
Airfield: (includes lights)		
Runway	$ 388,500	
Taxiways	697,640	
Aprons	169,410	
Roads:		
Terminal and service	164,000	
Parking lot	45,000	
Buildings		
Expansion of existing terminal	1,120,000	
Relocation		
Fixed base operator	200,000	
National Guard	40,000	
Airport maintenance	35,000	
Miscellaneous		
Electrical	135,000	
Utilities	45,000	
Drainage	30,000	
Fencing	10,000	
Site preparation	226,000	
Total estimated construction		$3,305,550
Legal, administrative, engineering		708,459
Total project		$4,014,009
Land acquisition		1,612,500
Total estimated cost		$5,626,509

TABLE 9.—Second stage preliminary project cost estimate

Paving		
Airfield: (includes lights)		
Runways	$ 88,967	
Taxiways	389,942	
Aprons	152,270	
Roads:		
Terminal and service	150,000	
Buildings		
Expansion of existing terminal	380,000	
Relocation		
National Guard	100,000	
Miscellaneous		
Electrical	22,000	
Drainage	15,000	
Site preparation	134,000	
Total estimated construction		$1,432,179
Legal, administrative, engineering		314,639
Total project cost		$1,746,818

TABLE 10.—Third stage preliminary project cost estimate

Paving		
Airfield: (Includes lights)		
Runways	$1,053,100	
Taxiways	994,130	
Aprons	855,000	
Roads:		
Terminal and service	696,000	
Parking lot	145,000	
Buildings		
New terminal	6,300,000	
Fire/crash	100,000	
Airport maintenance	165,000	
Miscellaneous		
Electrical	84,000	
Utilities	200,000	
Drainage	175,000	
Landscaping	150,000	
Fencing	40,000	
Site preparation	590,000	
Total estimated construction		$11,547,230
Legal, administrative, engineering		2,540,391
Total project cost		$14,087,621

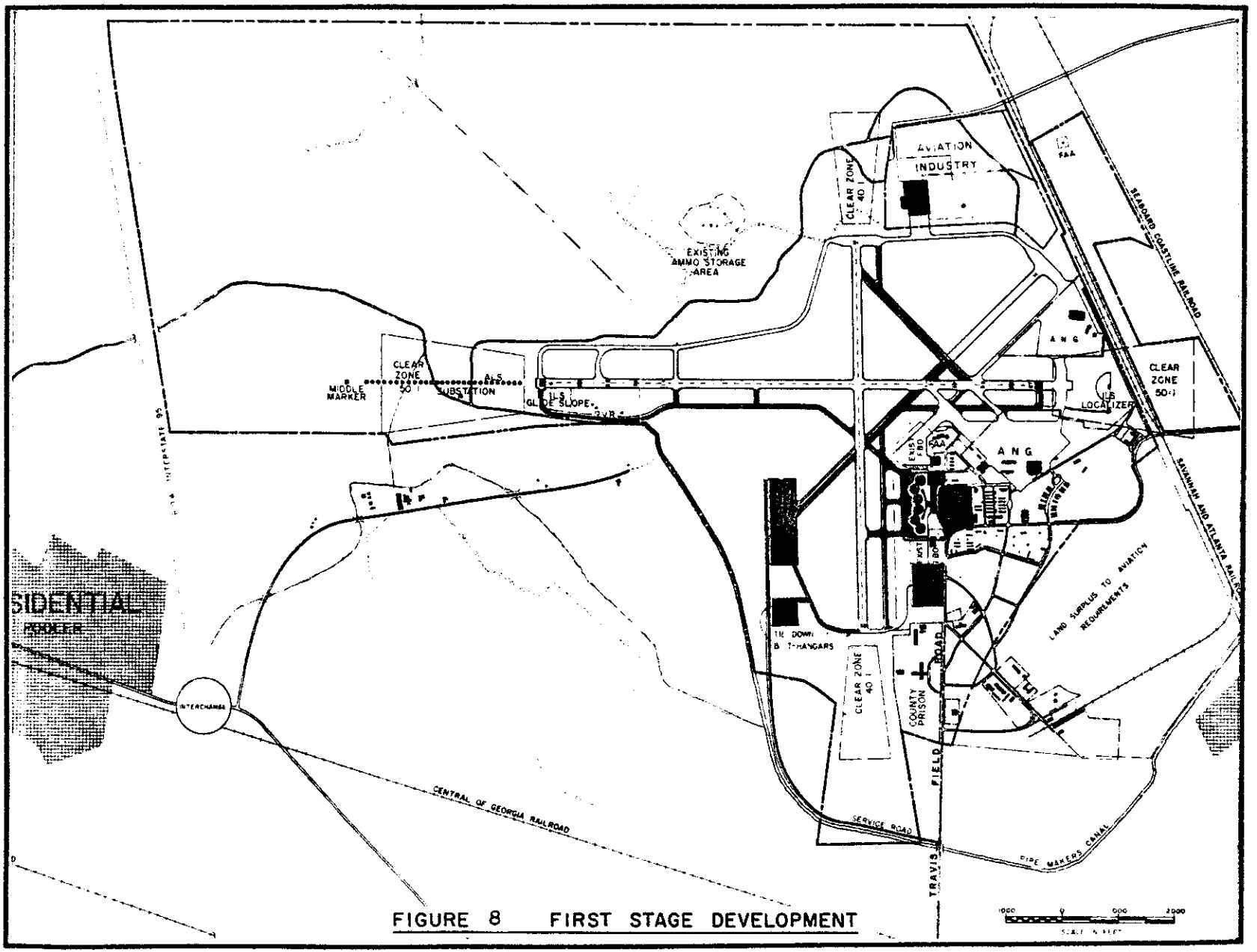


FIGURE 8 FIRST STAGE DEVELOPMENT

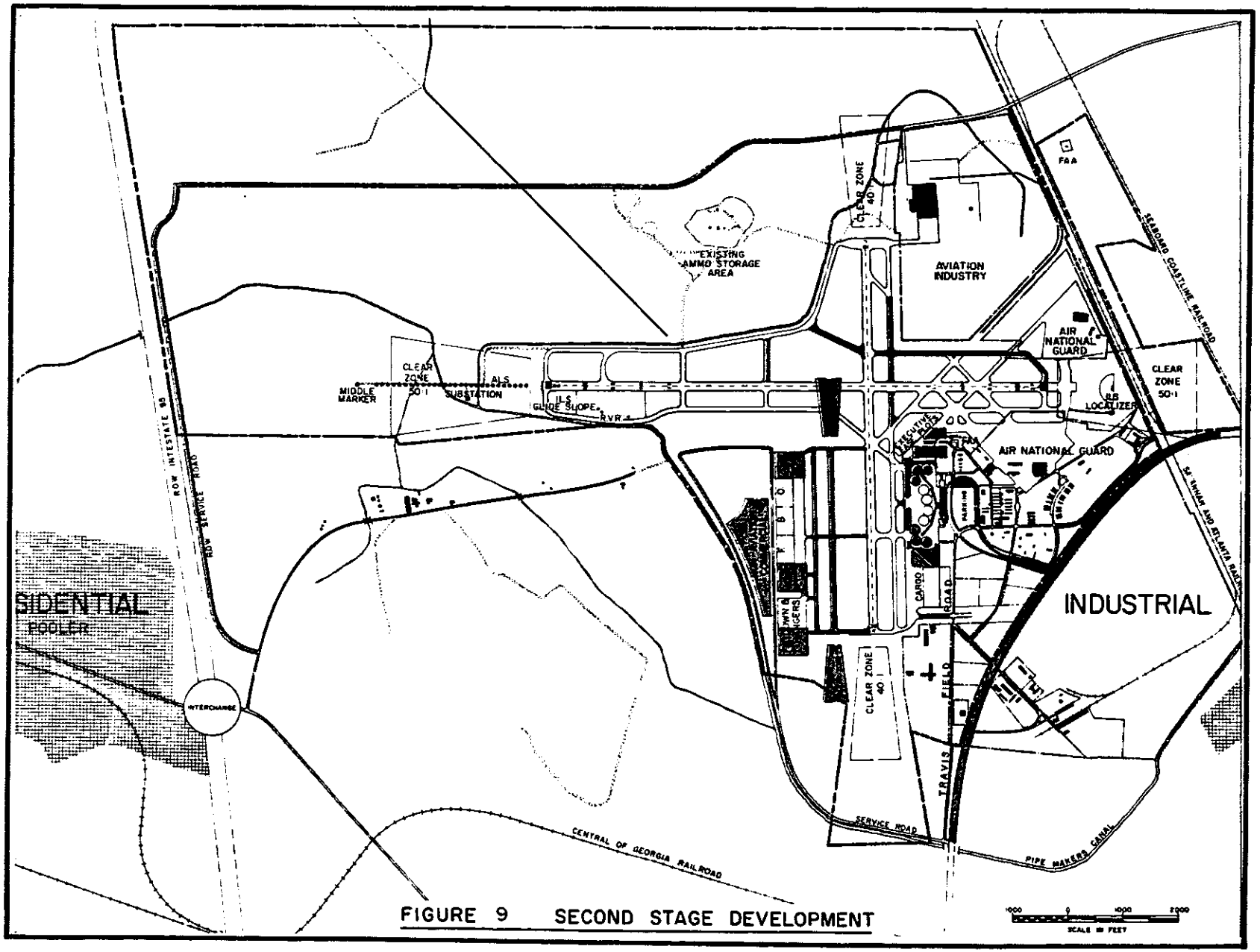


FIGURE 9 SECOND STAGE DEVELOPMENT

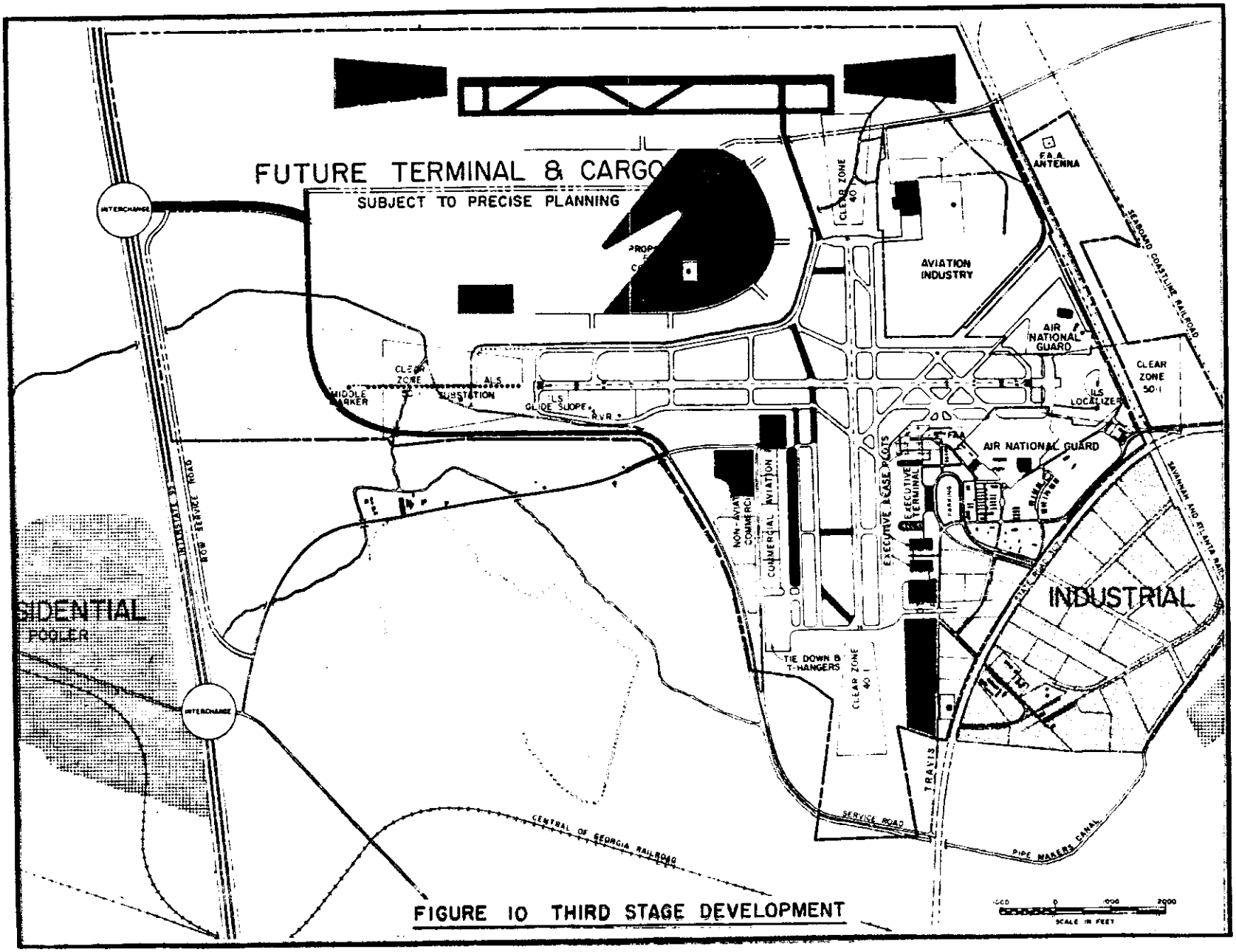


FIGURE 10 THIRD STAGE DEVELOPMENT

Chapter 12. ECONOMIC FEASIBILITY

81. General. As stated in the introduction to this advisory circular, the technical and economic feasibility of master plan considerations must be analyzed throughout the development of the plan. In the establishment of airport requirements, the planner must decide whether it is feasible to expand the existing airport or look for a new airpoort site. In the site selection process, the feasibility of constructing an airport at each possible location must be considered. After site selection, the feasibility of various airport concepts must be tested before the final airfield/terminal area/access plan is adopted. In each case, preliminary estimates must be made of capital investment, anticipated revenues, and the ability of users to pay costs attributable to proposed improvements. Methods such as determination of facility cost per enplaned passenger, as is used by some airlines, may be helpful in establishing feasibility during the various stages of the plan's development.

After these steps have been taken during the development of the plan, a final evaluation of economic feasibility should be made to establish what the financial prospectus of the airport will be when the plan is implemented and to establish a financial plan for the implementation of the proposed improvements. The terms of economic feasibility should be based on short, intermediate, and long-range forecasts (approximately 5, 10, and 20 years).

In simple terms the practicality of the master plan will depend on whether the users of the airport improvements programmed under the plan can produce the revenues (as may be supplemented by Federal, State, or local subsidies) required to cover annual costs attributable to capital investment plus the annual cost for administration, operation, and maintenance. This must be determined for each stage of development scheduled in the master plan. This consideration should include the cost of capital to be employed in the improvement, the annual costs of facilities, and prospective annual revenues.

82. Capital Investment. The schedule of improvements proposed in the master plan, as well as the cost estimates of those improvements, should be developed as prescribed in Chapter 11. They should schedule construction by phases and break down the costs of proposed improvements by elements such as the passenger terminal area, cargo area, landing area, airport administration, and operations and maintenance areas. This will provide the basic capital investment information needed for evaluating the feasibility of individual facilities. Estimated construction costs should be adjusted to include allowance for architect and engineer fees for preparation of detailed plans and specifications, overhead for construction administration, allowance for contingencies, and allowance for interest during construction. Estimated costs of land acquisition, as well as the costs of easements required to protect approach and departure areas, should be included. If the master plan provides for the expansion of an existing airport, the cost of the existing capital investment may be required to be added to the new capital costs.

83. Break-Even Need. The annual amount which is required to cover cost of capital investment and costs of administration, operation, and maintenance can be called the break-even need. The revenues required to produce the break-even need are derived from user charges, lease rentals, and concession revenues produced by the airport as a whole. To be assured, however, that individual components of the airport are generating a proper share of the required annual revenues, the airport can be divided into cost areas to allow allocation of costs to such areas following generally accepted cost accounting principles. Carrying charges on invested capital will include depreciable and nondepreciable items.

84. Nondepreciable Investment. Nondepreciable items are those which will have a permanent value even if the airport site is converted to other uses. Nondepreciable items include the cost of land acquisiton, excavation and fill operations, and road relocations which enhance the value of the airport site. The annual cost of capital invested in nondepreciable assets depends in the first instance on the source of the capital used. If revenue or general obligation bonds have been issued to acquire the asset,

the total of the principal and interest payments and required reserves or coverage payments called for by the bonds is used. Assets acquired with airport operating surpluses of prior years, general tax revenues, or gifts do not ordinarily impose a cash operating requirement and the treatment of these investments will require a decision by the operator based upon legal considerations and financial operating objectives of the airport. Interest or depreciation charges are not required to be recovered on amounts secured by the airport under the Federal Aviation Act of 1958 as grants-in-aid or under the Airport and Airway Development Act of 1970. Treatment of funds acquired under State grants-in-aid programs should be governed by the terms of the act involved.

85. Depreciable Investment. The annual cost of capital invested in plant and equipment (as distinguished from land) can be regarded as depreciation. The annual charge for depreciation depends on the useful life of the asset and the source of capital used in acquiring the asset. If payments of principal and interest on bonds issued to pay for the asset are required over a shorter period than the useful life of the asset, this schedule would govern and form the basis for depreciation charges unless other revenues are available to service the debt. Depreciation charges for capital assets acquired with operating surpluses of prior years, general tax revenues, or gifts do not ordinarily impose a cash operating requirement on the operator and the treatment of this investment will require a policy decision by the operator. Interest or depreciation charges are not required to be recovered on amounts secured under the Federal Aviation Act of 1958 or the Airport and Airway Development Act of 1970. Funds secured under State grants-in-aid will be governed by the terms of the act involved.

86. Expenses for Administration, Operation, and Maintenance. Prospective expenses for administration, operation, and maintenance should be developed for each airport cost area based on unit costs for direct expenses. For nonrevenue areas, these expenses should be forecasted separately and distributed to various airport operations. For utility expenses, the net amount expected to be owed from utility purchase, after sale of utility services, should be forecast.

87. Potential Airport Revenue. From the above, the sum of the prospective annual carrying charges on invested capital and the prospective average annual expenses of administration, operation, and maintenance should establish the break-even need for each revenue-producing facility and for the airport as a whole. The next step in establishing economic feasibility is to determine if sufficient revenues (which may be supplemented by Federal, State, and local subsidies) can be expected at the airport to cover the break-even needs. Therefore, forecasts should be prepared for revenue-producing areas. These areas will include:

a. Landing Area. This area should include runways and related taxiways and circulation taxiways. Flight fee revenue determination should be distributed between scheduled airlines, other air carrier users, and general aviation. Flight fee amounts should provide sufficient revenues to cover the landing area break-even need.

b. Aircraft Aprons and Parking Areas. Revenues to obtain the break-even need for airline terminal aprons and cargo aprons should be assigned to the scheduled airlines. Those for general aviation ramps should be assigned to private aircraft. Apron and parking area fees should provide sufficient revenues to cover the break-even needs for specific aircraft aprons and parking areas.

c. Airline Terminal Buildings. Revenues for concessionaires and ground transportation services are usually based on a percentage of gross income with a fixed rate minimum for each type of service. Space for scheduled airlines and other users is payed for on a fixed rental. In order to establish rental rates, forecasts of potential revenue from concessions and ground transportation must be established. Rental rates should be based on the break-even need of the terminal building after giving credit for forecasted revenues from concessions and ground transportation.

d. Public Parking Areas. Public parking is usually operated on a concessionaire basis with revenues obtained from rentals based on a percentage of gross income with a fixed-rate minimum. The revenue amount required to meet break-even needs will depend on whether parking facilities are constructed by the airport owner or under provisions of the concessionaire contract. These revenues apply to public parking for both airline and general aviation terminals. Revenues in excess of the break-even need for public parking should be allocated to the break-even need for the airport as a whole.

e. Cargo Buildings. Rentals are usually charged on a rate per square foot and should cover investments in employee parking, truck unloading

docks, as well as building space. Rates are established to meet break-even needs.

f. Aviation Fuel. Fees charged to aviation fuel handling concessionaires should be established to cover the costs of fuel storage areas and associated pumping, piping, and hydrant systems.

g. Hangars. Rentals are usually based on a rate per square foot and should cover investments in associated aircraft apron space and hangar related employee parking. Hangar office space should be charged on a similar basis and should cover office related employee parking.

h. Commercial Facilities. Airport office buildings, industrial facilities, and hotels are usually operated on a lessee-management basis with revenues obtained from rentals on a square foot basis. The facilities are often financed by private capital. Revenues in excess of the break-even need should be allocated to the break-even need of the airport as a whole.

i. Other Usable Areas. Various uses of ground space for activities such as gasoline stations, service facilities for rental car operators, and bus and limousine operators usually obtain revenues on a flat rate basis. Those facilities are often financed by private capital. Revenues in excess of the break-even need should be allocated to the break-even need of the airport as a whole.

88. Final Analysis of Economic Feasibility. After analysis of the break-even needs for individual components of the master plan has been made, economic feasibility should be analyzed on an overall basis. The goal of overall analysis is to determine if revenues will equal or exceed the break-even need. This determination requires an evaluation of the scope and phasing of the plan itself in terms of the users requirements and their ability to make the financial commitment necessary to support the costs of the program. If this review indicates that revenues will be insufficient, revisions in the scheduling or scope of proposed master plan developments may have to be made, or recovery revenues rates for airport cost areas may require adjustment. These factors should be adjusted until the feasibility of the master plan is established, that is to say, airport revenues, as may be supplemented by Federal, State, or local subsidies, will match capital investment throughout the master plan forecast period. When the economic feasibility of improvements proposed in the master plan has been established, capital budget and a program for financing those improvements should be developed as prescribed in Chapter 13.

Chapter 13. FINANCING

89. General. The establishment of the airport master plan's economic feasibility, i.e., the balance between annual cost of capital investment and airport revenues, is vital to the promotion of financing for the improvements proposed in the plan. The implementation of the airport master plan will depend largely on the proper financing of those capital improvements. The primary responsibility for financing the development plans rests with local operating agencies or authorities. There are many ways in which public financing of airport development can be accomplished. Financing may be raised from taxes, general obligation bonds, revenue bonds, private financing, government assistance, or a combination thereof.

90. General Obligation Bonds. General obligation bond financing for airport improvements backed by taxing powers has been used for financing. However, fiscal pressures on local governments for all manners of activities have been especially great in recent years. The need for school construction and other essential public works has required a considerable volume of general obligation bond financing. In numerous cases, local governments have reached statutory bond limits or desire to reserve whatever margin is left for more general functions of government. It is becoming increasingly difficult to obtain taxpayer approval for general obligation bond issues for airports.

91. Revenue Bonds. Revenue bond financing for airport improvements has become the most common financing method. Financing with revenue bonds presents an opportunity to provide those improvements without direct burden to the taxpayer.

92. Private Financing. Private financing of specific facilities such as hangars, fuel distribution systems, even hotels and the like, may be practical. Such facilities can be constructed with private capital on land leased from the airport. The obvious advantage of such an arrangement is that it relieves the community of all responsibility for raising the capital funds for the particular improvements involved.

93. Financing by Nonprofit Corporations. Another method of obtaining capital for the construction of airport improvements is through the nonprofit corporation approach. In some jurisdictions, the law provides for the formation of a nonprofit corporation to be used for financing of improvement for the benefit of a local governmental agency. The principal requirement is that the improvements constructed will revert to an airport authority after the bonds issued for the construction of the facilities have been retired. This method of financing can be used for the construction of facilities such as airline maintenance hangars and air cargo terminals.

94. Federal Grants for Airport Construction. Government assistance for development projects recommended in airport master plans is provided for by grants-in-aid covered by the Airport and Airway Development Act of 1970.

95. Master Plan Implementation. The development of a financial plan is the final step in the airport master plan process. Thereafter, the overall master plan must be accepted by authorities having jurisdiction over such matters and by the public. Once the plan has been adopted and the financing has been obtained, the final design and construction of improvements proposed in the master plan can be implemented.

96. Capital Budget. With a determination of the projects to be constructed and their timing, a capital budget should be prepared to show on an annual basis the requirement for capital funds and the source of funds. This analysis will also permit accurate estimation by the operator of the amount of interest to be earned on capital funds held from the sale of bonds prior to the need to commit such funds for construction purposes.

APPENDIX

Bibliography

1. Advisory Circulars. These publications may be obtained free of charge, unless otherwise indicated, from the Department of Transportation, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

a. "Planning the State Airport System" may be obtained from the Department of Transportation, Federal Aviation Administration, Environmental Planning Branch, AS-440, 800 Independence Ave., S.W., Washington, D.C. 20591.

b. "Airport Capacity Criteria Used in Preparing the National Airport Plan."

c. AC 150/5060-3A, "Airport Capacity Criteria Used in Long-Range Planning."

d. AC 150/5070-3, "Planning the Airport Industrial Park."

e. AC 150/5070-5, "Planning the Metropolitan Airport System," may be obtained from the Superintendent of Documents,* U.S. Government Printing Office, Washington, D.C. 20402. Price $1.25—Catalog No. TD 4.108:M 56/2.

f. AC 150/5090-1, "Regional Air Carrier Airport Planning."

g. AC 150/5100-3A, "Federal-aid Airport Program—Procedures Guide for Sponsors."

h. AC 150/5100-4, "Airport Advance Planning and Engineering."

i. AC 150/5190-3, "Model Airport Zoning Ordinance."

j. AC 150/5210-10, "Airport Fire and Rescue Equipment Building Guide."

k. AC 150/5300-2A, "Airport Design Standards—Site Requirements for Terminal Navigational Aids."

l. AC 150/5300-4A, "Utility Airports," may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price $1.75—Catalog No. TD 4.8:Ai 7/968.

m. AC 150/5300-6, "Airport Design Standards—General Aviation Airports—Basic and General Transport."

n. AC 150/5320-5B, "Airport Drainage," may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price $1.00—Catalog No. TD 4.8:D 78/970.

o. AC 150/5320-6A, "Airport Paving."

p. AC 150/5325-2B, "Airport Design Standards—Air Carrier Airports—Surface Gradient and Line of Sight."

q. AC 150/5325-4, "Runway Length Requirements for Airport Design."

r. AC 150/5325-6, "Effects of Jet Blast."

s. AC 150/5325-7, "Is Your Airport Ready for the Boeing 747?"

t. AC 150/5330-2A, "Runway/Taxiway Widths and Clearances for Airline Airports."

u. AC 150/5330-3, "Wind Effect on Runway Orientation."

v. AC 150/5335-1A, "Airport Design Standards—Airports Served by Air Carriers—Taxiways."

w. AC 150/5335-2, "Airport Aprons."

x. AC 150/5340-1C, "Marking of Paved Areas on Airports."

y. AC 150/5340-4B, "Installation Details for Runway Centerline and Touchdown Zone Lighting Systems."

z. AC 150/5340-5, "Segmented Circle Airport Marker System."

aa. AC 150/5340-13A, "High Intensity Runway Lighting System."

* Include in orders to the Superintendent of Documents the complete publication title and its GPO Catalog Number. (Subscription publications do not require a catalog number.) Order subscription service publications separately from single-sale publications.

bb. AC 150/5340-14B, "Economy Approach Lighting Aids."

cc. AC 150/5340-15A, "Taxiway Edge Lighting System."

dd. AC 150/5340-16B, "Medium Intensity Runway Lighting System and Visual Approach Slope Indicators for Utility Airports."

ee. AC 150/5360-1, "Airport Service Equipment Building."

ff. AC 150/5360-2, "Airport Cargo Facilities."

gg. AC 150/5360-3, "Federal Inspection Service Facilities at International Airports."

hh. AC 150/5390-1A, "Heliport Design Guide," may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 75 cents—Catalog No. TD 4.108:H36.

ii. AC 70/7460-1, "Obstruction Marking and Lighting," may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price 60 cents—Catalog No. TD 4.8:06 7/968.

2. Federal Aviation Regulations. These publications may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price as indicated. Send check or money order made payable to the Superintendent of Documents.

a. *Volume X*—Federal Aviation Regulations. Contains "Part 151, Federal Aid to Airports." Subscription Price $4.50.

b. *Volume XI*—Federal Aviation Regulations. Contains "Part 77, Objects Affecting Navigable Airspace." Subscription Price $2.75.

3. Other Publications. These publications may be obtained as indicated:

a. "The Airport—Its Influence on the Community Economy," may be obtained from the Department of Transportation, Distribution Unit TAD-484.3, Washington, D.C. 20590. No charge.

b. "Land Use Planning Relating to Aircraft Noise." Also "Appendix A." Both may be obtained from the National Technical Information Service, Springfield, Va. 22151. Price $3.00 each. Order No. AD 615 015. Appendix A Order No. AD 617 954.

c. "Alternative Approaches for Reducing Delays in Terminal Areas," may be obtained from the National Technical Information Service, Springfield, Va. 22151. Price $3.00. Order No. AD 663 089.

d. "Aviation Demand and Airport Facility Requirements Forecasts for Medium Air Transportation Hubs Through 1980," may be obtained from the National Technical Information Service, Springfield, Va. 22151. Price $3.00. Order No. AD 688 826.

e. "Aviation Demand and Airport Facility Requirement Forecast for Large Air Transportation Hubs Through 1980," may be obtained from the National Technical Information Service, Springfield, Va. 22151. Price $6.00. Order No. AD 684 811.

f. "Noise Exposure Forecasts, Contours for 1967, 1970, 1975, Operations at Selected Airports, 1970," may be obtained from the National Technical Information Service, Springfield, Va. 22151. Price $3.00. Order No. AD 712 646.

g. "Airport Environs: Land Use Controls," may be obtained from the Department of Housing and Urban Development. No charge.