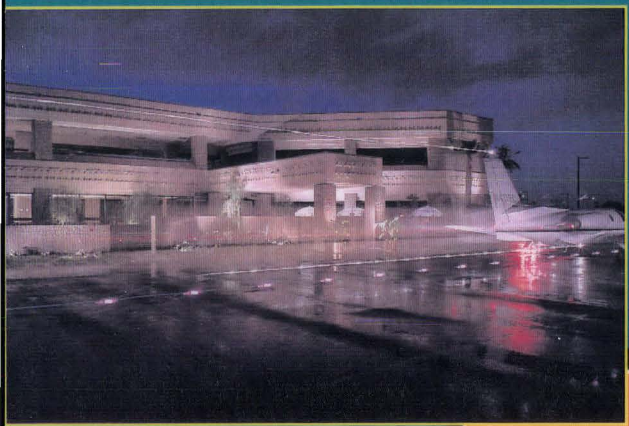
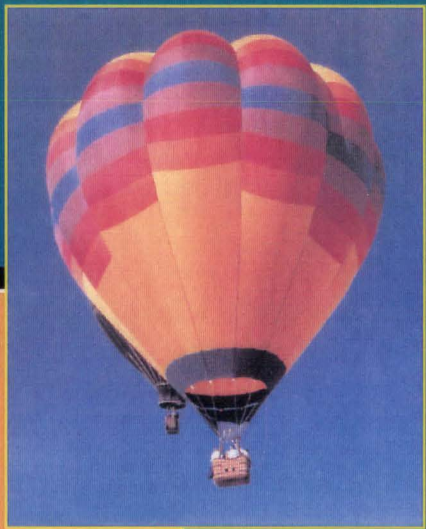
GLENDALE

MUNICIPAL AIRPORT





F.A.R. PART 150 NOISE COMPATIBILITY STUDY

NOISE EXPOSURE MAPS

GLENDALE MUNICIPAL AIRPORT

F.A.R. Part 150
Noise Compatibility Study

NOISE EXPOSURE MAPS

Prepared For

The City of Glendale, Arizona

By

Coffman Associates

April, 1994

TABLE OF CONTENTS

GLENDALE

MUNICIPAL AIRPORT

CONTENTS

GLENDALE MUNICIPAL AIRPORT
Glendale, Arizona

F.A.R. PART 150 NOISE COMPATIBILITY STUDY

NOISE EXPOSURE MAPS

Chapter One
INVENTORY

Chapter One (Continued)

Chapter Two
AVIATION NOISE

Chapter Two (Continued)

Chapter Three
COMMUNITY NOISE

Chapter Four
NOISE IMPACTS

Chapter Four (Continued)

APPENDICES

EXHIBITS

EXHIBITS (Continued)

NOISE EXPOSURE MAPS

GLENDALE

MUNICIPAL AIRPORT

INTRODUCTION

The Noise Exposure Maps documentation for Glendale Municipal Airport presents current aircraft noise impacts and anticipated impacts in five years. The documentation contains sufficient information so that reviewers unfamiliar with local conditions and the local public unfamiliar with the technical aspects of aircraft noise can understand the findings.

The Noise Exposure Maps document includes the first four chapters of the complete F.A.R. Part 150 Noise Compatibility Study. Chapter One, Inventory, presents an overview of the airport, airspace, aviation facilities, existing land use, and local land use policies and regulations.

Chapter Two, Aviation Noise, presents existing and forecast aircraft noise exposure based on the assumption of no additional noise abatement efforts. This provides baseline data for evaluating potential noise abatement strategies in the second part of the study.

Chapter Three, Community Noise, involves an analysis of existing background noise in the study area. This is related to existing aircraft noise to define the total noise exposure in the study area, thus revealing where aircraft noise may be partially masked or particularly loud relative to background levels. This information can be useful in the analysis of potential noise abatement strategies.

Chapter Four, Noise Impacts, analyzes the impact of the baseline aircraft noise defined in Chapter Two on noise-sensitive land uses and the resident population. It also includes an analysis of potential residential development trends in the study area.

The official Noise Exposure Maps are presented in this section following page vi. For the convenience of FAA reviewers, FAA's official Noise Exposure Map checklist is presented on pages ii through v.

F.A.R. PART 150
NOISE EXPOSURE MAP CHECKLIST

AIRPORT NAME: Glendale Municipal Airport
Glendale, Arizona

REVIEWER: ____________________

	Yes/No/NA	Page No./ Other Reference
I. IDENTIFICATION AND SUBMISSION OF MAP DOCUMENT:		
A. Is this submittal appropriately identified as one of the following, submitted under F.A.R. Part 150:		
1. a NEM only?	Yes	Title Page, p. i
2. a NEM and NCP?	No	
3. a revision to NEMs which have previously been determined by FAA to be in compliance with Part 150?	No	
B. Is the airport name and the qualified airport operator identified?	Yes	Title Page, p. i
C. Is there a dated cover letter from the airport operator which indicates the documents are submitted under Part 150 for appropriate FAA determinations?	Yes	
II. CONSULTATION: [150.21(b), A150.105(a)]		
A. Is there a narrative description of the consultation accomplished, including opportunities for public review and comment during map development?	Yes	Appendix E, and supplemental volume, Supporting Information on Project Coordination and Local Consultation
B. Identification:		
1. Are the consulted parties identified?	Yes	Appendix E, and supplemental volume, Supporting Information on Project Coordination and Local Consultation
2. Do they include all those required by 150.21(b) and A150.105(a)?	Yes	Appendix E, and supplemental volume, Supporting Information on Project Coordination and Local Consultation
C. Does the documentation include the airport operator's certification, and evidence to support it, that interested persons have been afforded adequate opportunity to submit their views, data, and comments during map development and in accordance with 150.21(b)?	Yes	p. vi; Appendix E, and supplemental volume, Supporting Information on Project Coordination and Local Consultation
D. Does the document indicate whether written comments were received during consultation and, if there were comments, that they are on file with the FAA region?	Yes	Appendix E, and supplemental volume, Supporting Information on Project Coordination and Local Consultation
III. GENERAL REQUIREMENTS: [150.21]		
A. Are there two maps, each clearly labeled on the face with year (existing condition year and 5-year)?	Yes	See NEM Maps, Exhibits 1 & 2 after p. vi
B. Map currency:		
1. Does the existing condition map year match the year on the airport operator's submittal letter?	Yes	Current year labeled 1994. Based on 1993 operations
2. Is the 5-year map based on reasonable forecasts and other planning assumptions and is it for the fifth calendar year after the year of submission?	Yes	See 1999 NEM after p. vi; Appendix C; Chapter Two pp. 2-11 - 2-13
3. If the answer to 1 & 2 above is no, has the airport operator verified in writing that data in the documentation are representative of existing condition and 5-year forecast conditions as of the date of submission?	N/A	
C. If the NEM and NCP are submitted together:		
1. Has the airport operator indicated whether the 5-year map is based on 5-year contours without the program vs. contours if the program is implemented?	N/A	

F.A.R. PART 150
NOISE EXPOSURE MAP CHECKLIST

AIRPORT NAME: Glendale Municipal Airport
Glendale, Arizona

REVIEWER: ____________________

	Yes/No/NA	Page No./ Other Reference
2. If the 5-year map is based on program implementation:		
a. are the specific program measures which are reflected on the map identified?	N/A	
b. does the documentation specifically describe how these measures affect land use compatibilities depicted on the map?	N/A	
3. If the 5-year NEM does not incorporate program implementation, has the airport operator included an additional NEM for FAA determination after the program is approved which shows program implementation conditions and which is intended to replace the 5-year NEM as the new official 5-year map?	No	
IV. **MAP SCALE, GRAPHICS, AND DATA REQUIREMENTS: [A150.101, A150.103, A150.105, 150.21(a)]**		
A. Are the maps sufficient scale to be clear and readable (they must not be less than 1" to 8,000'), and is the scale indicated on the maps?	Yes	See NEM Maps after p.vi
B. Is the quality of the graphics such that required information is clear and readable?	Yes	
C. Depiction of the airport and its environs.		
1. Is the following graphically depicted to scale on both the existing conditions and 5-year maps:		
a. airport boundaries?	Yes	
b. runway configurations with runway end numbers?	Yes	
2. Does the depiction of the off-airport data include:		
a. a land use base map depicting streets and other identifiable geographic features?	Yes	
b. the area within the 65 Ldn (or beyond, at local discretion)?	Yes	
c. clear delineation of geographic boundaries and the names of all jurisdictions with planning and land use control authority within the 65 Ldn (or beyond, at local discretion)?	Yes	
D. 1. Continuous contours for at least the 65, 70, and 75 Ldn?	Yes	
2. Based on current airport and operational data for the existing condition year NEM, and forecast data for the 5-year NEM?	Yes	Chapter Two, pp. 2-11 - 2-16
E. Flight tracks for the existing condition and 5-year forecast timeframes (these may be on supplemental graphics which must use the same land use base map as the existing condition and 5-year NEM), which are numbered to correspond to accompanying narrative?	Yes	Chapter Two, Exhibits 2F and 2G after p. 2-16
F. Locations of any noise monitoring sites (these may be on supplemental graphics which must use the same land use base map as the official NEMs)	Yes	Chapter Two, Exhibit 2A after p. 2-4
G. Noncompatible land use identification:		
1. Are noncompatible land uses within at least the 65 Ldn depicted on the maps?	Yes	See NEM Maps after p. vi
2. Are noise sensitive public buildings identified?	Yes	
3. Are the noncompatible uses and noise sensitive public buildings readily identifiable and explained on the map legend?	Yes	

F.A.R. PART 150
NOISE EXPOSURE MAP CHECKLIST

AIRPORT NAME: Glendale Municipal Airport
Glendale, Arizona

REVIEWER: ______________________

	Yes/No/NA	Page No./ Other Reference
4. Are compatible land uses, which would normally be considered noncompatible, explained in the accompanying narrative?	N/A	
V. NARRATIVE SUPPORT OF MAP DATA: [150.21(a), A150.1, A150.101, A150.103]		
A. 1. Are the technical data, including data sources, on which the NEMs are based adequately described in the narrative?	Yes	Chapter Two, pp. 2-11 - 2-16; Appendix C
2. Are the underlying technical data and planning assumptions reasonable?	Yes	Chapter Two, pp. 2-11 - 2-16; Appendix C
B. Calculation of Noise Contours:		
1. Is the methodology indicated?	Yes	Chapter Two, p. 2-10
a. is it FAA approved?	Yes	Chapter Two, p. 2-10
b. was the same model used for both maps?	Yes	Chapter Two, p. 2-10
c. has AEE approval been obtained for use of a model other than those which have previous blanket FAA approval?	N/A	
2. Correct use of noise models:		
a. does the documentation indicate the airport operator has adjusted or calibrated FAA-approved noise models or substituted one aircraft type for another?	No	Chapter Two, pp. 2-11 - 2-13. No calibrations done. Some composite aircraft descriptors used.
b. if so, does this have written approval from AEE?	N/A	All aircraft INM designators used are on AEE's pre-approved list of substitutions.
3. If noise monitoring was used, does the narrative indicate that Part 150 guidelines were followed?	Yes	Chapter Two, pp. 2-1 - 2-9, 2-16
4. For noise contours below 65 Ldn, does the supporting documentation include explanation of local reasons? (Narrative explanation is highly desirable but not required by the Rule.)	Yes	Chapter Four, p. 4-9
C. Noncompatible Land Use Information:		
1. Does the narrative give estimates of the number of people residing in each of the contours (Ldn 65, 70, and 75, at a minimum) for both the existing condition and 5-year maps?	Yes	Chapter Four, pp. 4-11, 4-18
2. Does the documentation indicate whether Table 1 of Part 150 was used by the airport operator?	Yes	Chapter Four, p. 4-9, Exhibit 4B
a. If a local variation to Table 1 was used:		
(1) does the narrative clearly indicate which adjustments were made and the local reasons for doing so?	N/A	
(2) does the narrative include the airport operators complete substitution for Table 1?	N/A	

F.A.R. PART 150
NOISE EXPOSURE MAP CHECKLIST

AIRPORT NAME: Glendale Municipal Airport
Glendale, Arizona

REVIEWER: ____________________

	Yes/No/NA	Page No./ Other Reference
3. Does the narrative include information on self generated or ambient noise where compatible/noncompatible land use identification consider non-airport/aircraft sources?	Yes	Chapter Three
4. Where normally noncompatible land uses are not depicted as such on the NEMs, does the narrative satisfactorily explain why, with reference to the specific geographic areas?	N/A	
5. Does the narrative describe how forecasts will affect land use compatibility?	Yes	Chapter Four, pp. 4-16 - 4-19
VI. **MAP CERTIFICATIONS: [150.21(b), 150.21(e)]**		
A. Has the operator certified in writing that interested persons have been afforded adequate opportunity to submit views, data, and comments concerning the correctness and adequacy of the draft maps and forecasts?	Yes	Certification statements on NEM Maps and p. vi
B. Has the operator certified in writing that each map and description of consultation and opportunity for public comment are true and complete?	Yes	Certification statements on NEM Maps and p. vi

SPONSOR'S CERTIFICATION

The Noise Exposure Maps and accompanying documentation for Glendale Municipal Airport, including the description of consultation and opportunity for public involvement, are hereby certified as true and complete to the best of my knowledge and belief. It is hereby certified that adequate opportunity has been afforded interested persons to submit views, data, and comments on the Noise Exposure Maps and forecasts.

____

Date of Signature

____

Timothy F. Ernster
Deputy City Manager
City of Glendale, Arizona

92SP16-94NEM-4/20/94-R1

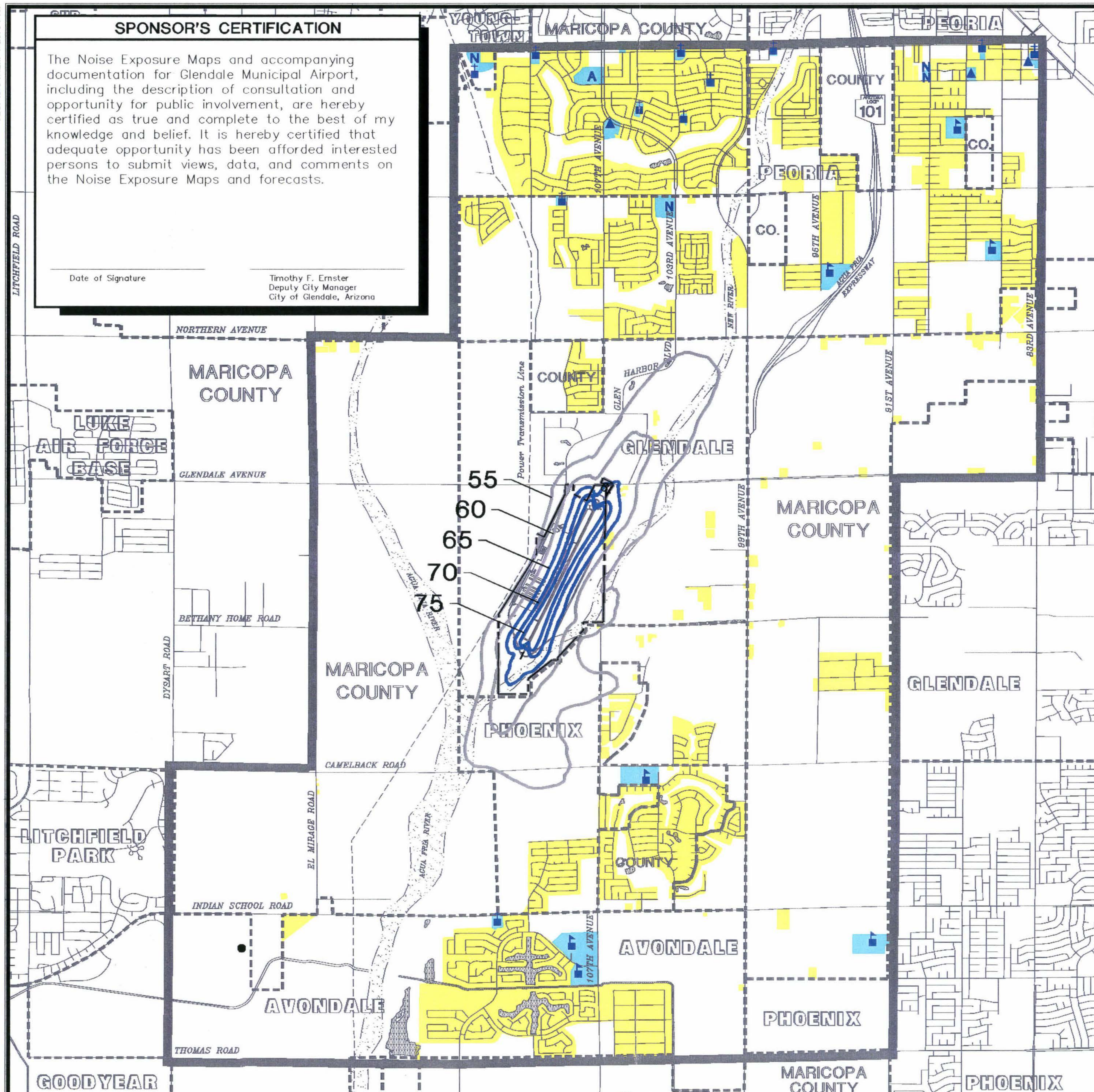
Exhibit 1
1994 NOISE EXPOSURE MAP

SPONSOR'S CERTIFICATION

The Noise Exposure Maps and accompanying documentation for Glendale Municipal Airport, including the description of consultation and opportunity for public involvement, are hereby certified as true and complete to the best of my knowledge and belief. It is hereby certified that adequate opportunity has been afforded interested persons to submit views, data, and comments on the Noise Exposure Maps and forecasts.

Date of Signature

Timothy F. Ernster
Deputy City Manager
City of Glendale, Arizona



LEGEND

- Study Area Boundary
- Jurisdiction Boundary
- Airport Boundary
- DNL Contour-Marginal Impact
- DNL Contour-Significant Impact
- Existing Residential
- Undeveloped
- Existing Public and Institutional
- School
- Church
- Community Center
- N Nursing/Rest Home
- A Amphitheater
- Site on National Register of Historic Places

Projected Aircraft Operations 1994	
GENERAL AVIATION	
Itinerant	36,868
Local	77,021
Total	113,889

NORTH

0 4000 8000
SCALE IN FEET

GLENDALE MUNICIPAL AIRPORT

92SP16-99NEM-4/20/94-R1

SPONSOR'S CERTIFICATION

The Noise Exposure Maps and accompanying documentation for Glendale Municipal Airport, including the description of consultation and opportunity for public involvement, are hereby certified as true and complete to the best of my knowledge and belief. It is hereby certified that adequate opportunity has been afforded interested persons to submit views, data, and comments on the Noise Exposure Maps and forecasts.

Date of Signature

Timothy F. Ernster
Deputy City Manager
City of Glendale, Arizona

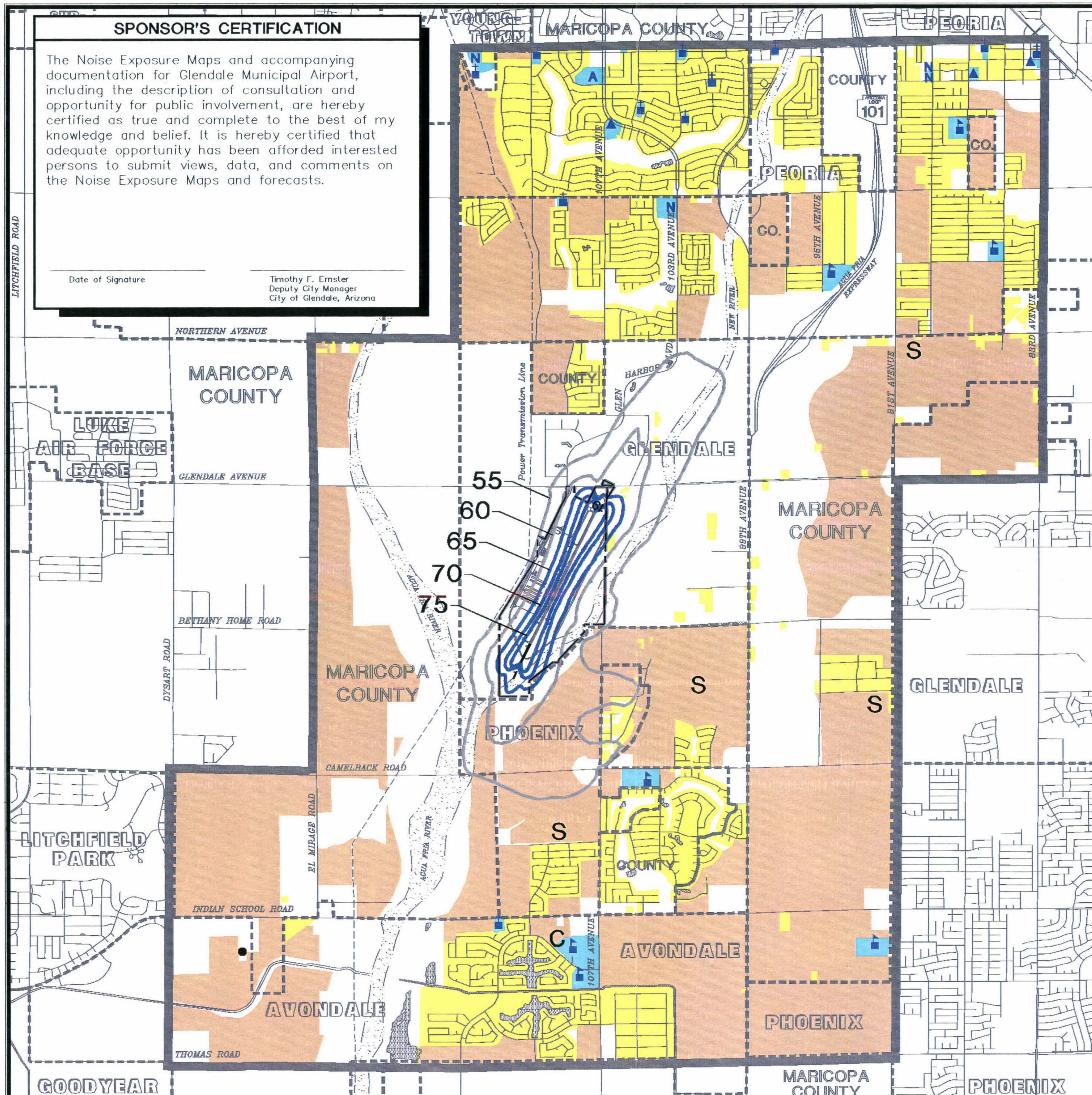


Exhibit 2
1999 NOISE EXPOSURE MAP

LEGEND

- Study Area Boundary
- Jurisdiction Boundary
- Airport Boundary
- Runway Extension
- DNL Contour-Marginal Impact
- DNL Contour-Significant Impact
- Existing Residential
- Undeveloped
- Existing Public and Institutional
- School
- Church
- Community Center
- N Nursing/Rest Home
- A Amphitheater
- Site on National Register of Historic Places
- Potentially Available for Residential Development
- C Future Church Site
- S Future School Site

Forecast Aircraft Operations 1999	
GENERAL AVIATION	
Itinerant	48,800
Local	90,500
Total	139,300

NORTH

0 4000 8000
SCALE IN FEET

GLENDALE MUNICIPAL AIRPORT

CHAPTER ONE
INVENTORY

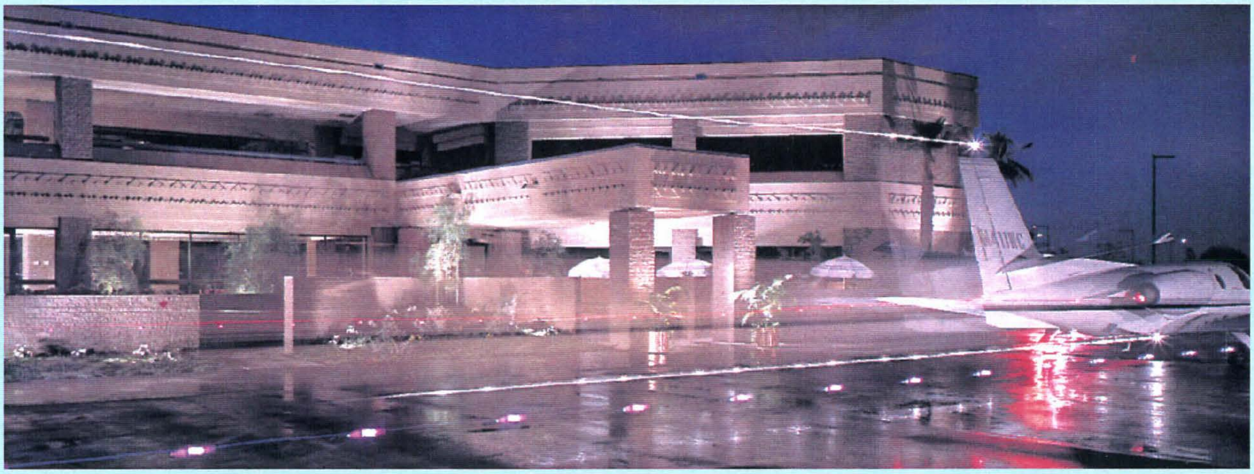
GLENDALE

MUNICIPAL AIRPORT

CHAPTER 1

INVENTORY

GLENDALE MUNICIPAL AIRPORT
F.A.R. Part 150 Noise Compatibility Study



This chapter presents an overview of Glendale Municipal Airport and its relationship to the surrounding communities. The background information in this chapter, which will be used in later stages of the noise compatibility planning process, is as follows:

- The goals and objectives of the study.
- A description of the setting, local climate, and historical perspective of the airport.
- A summary of existing air traffic activity and air service.
- A description of key airport facilities and navigational aids.
- A socioeconomic profile of the study area, including general information on population and economic activities.
- A description of existing land uses in the study area.
- A discussion of the local land use planning and regulatory framework within the study area.

The Federal Aviation Regulation (F.A.R.) Part 150 Noise Compatibility Study for Glendale Municipal Airport involves the preparation of two official documents: the Noise Exposure Maps (NEM) and the Noise Compatibility Program (NCP). The NEM document is a baseline analysis showing existing and potential future noise conditions at the airport. The NCP document presents plans for effectively dealing with adverse noise impacts based on a two-part perspective. First, the NCP addresses steps to reduce or shift the noise by changing air traffic control or aircraft operating procedures. Second, it addresses special noise mitigation techniques or changes in land use planning to reduce the impact of noise on sensitive land uses in the area.

GOALS AND OBJECTIVES

Goals and objectives have been developed to guide the study. The goals describe the study's basic purposes, and the objectives provide guidelines and criteria for determining how well the goals are being met. The goals and objectives for this study are as follows:

GOAL NO. 1

Reduce, to the extent feasible, the impact of aircraft noise on neighboring residents and noise-sensitive land uses through noise abatement and noise mitigation.

Objectives

1.1 Reduce the number of people exposed to noise.

1.2 Ensure that no residential uses are impacted by aircraft noise above 75 DNL.

1.3 In selecting noise abatement actions, avoid those that would adversely affect airport capacity or result in significant delays.

1.4 In selecting noise abatement actions, avoid imposing restrictions on airport use that would be discriminatory or interfere with interstate commerce.

1.5 In selecting noise abatement actions, avoid those which could erode prudent margins of safety.

1.6 Prepare mitigation measures for noise-sensitive land uses expected to be impacted by significant aircraft noise levels (above 65 DNL) for the next five years.

1.7 Ensure that mitigation projects are capable of being fully funded and implemented. Ensure that mitigation projects are eligible for FAA funding assistance through the noise set-aside of the Airport Improvement Program.

GOAL NO. 2

Promote the development of compatible land uses in undeveloped areas expected to remain impacted by high noise levels.

Objectives

2.1 Promote the land use planning and development objectives of local governments in the airport area to the extent those are compatible with aircraft noise levels.

2.2 Promote long-term economic development in the airport area consistent with the land use planning and development objectives of local governments.

2.3 Develop realistic plans for future land use, recognizing the carrying capacity of the land and economic feasibility.

2.4 Balance the need for compatible land use in the airport area with the rights of affected landowners and residents.

GOAL NO. 3

Provide for an open public forum in developing a Noise Compatibility Program.

Objectives

3.1 Establish and maintain effective working relationships between the project team, cities of Glendale, Phoenix, Peoria, and Avondale, Maricopa County, the Maricopa Association of Governments, the State of Arizona, the FAA, homeowners, and the private sector.

3.2 Coordinate with the Glendale Aviation Advisory Commission to ensure local issues are addressed in a timely and effective manner.

3.3 Encourage and utilize comments from all sectors of the aviation community, local governments and the general public in developing this study.

3.4 Identify the implementation mechanisms for the plan and determine implementation responsibilities for both the public and private sectors.

JURISDICTIONS AND RESPONSIBILITIES

Reduction of aircraft noise impacts is a complex issue, with several parties sharing in the responsibility: the federal government, state and local governments and planning agencies, the airport proprietor, military and civilian airport users, and local residents. All interests must be considered in the development of an airport noise compatibility plan. It is also important for each of the parties to understand their scope of authority in dealing with aircraft noise.

FEDERAL

Aviation plays a vital role in interstate commerce. Recognizing this, the federal government has assumed the role of coordinator and regulator of the nation's aviation system. Congress has assigned administrative authority to the Federal Aviation Administration (FAA). Specific responsibilities of the FAA include:

(1) The regulation of air commerce in order to promote its development, safety, and fulfill the requirements of national defense.

(2) The promotion, encouragement and development of civil aeronautics.

(3) The control of the use of navigable airspace and the regulation of both civil and military aircraft operations to promote the safety and efficiency of both.

(4) The development and operation of a common system of air traffic control and navigation for both military and civil aircraft.

The FAA also administers a program of federal grants-in-aid for the development of airport master plans, the acquisition of land, and for the planning, design and construction of eligible airport improvements. In addition, Congress has passed legislation and the FAA has established regulations governing the preparation of noise compatibility programs. They have also created laws and regulations requiring the conversion of the civilian aircraft fleet to quieter aircraft.

F.A.R. Part 150

The Aviation Safety and Noise Abatement Act of 1979 (ASNA, P.L. 96-193), signed into law on February 18, 1980, was enacted, ". . . to provide and carry out noise compatibility programs, to provide assistance to assure continued safety in aviation, and for other purposes." The FAA was vested with the authority to implement and administer the Act.

Federal Aviation Regulation (F.A.R.) Part 150, the administrative rule promulgated to implement the Act, sets requirements for airport operators who choose to undertake an airport noise compatibility study with federal funding assistance. Part 150 provides for the development of two final documents: noise exposure maps and a noise compatibility program.

- NOISE EXPOSURE MAPS

The noise exposure maps document shows existing and future noise conditions at the airport. It can be thought of as a baseline analysis defining the scope of the noise situation at the airport. It includes maps of noise exposure for the current year and a five-year forecast. The noise contours are shown on a land use map to reveal areas of non-compatible land use. The document includes detailed supporting information explaining the methods used to develop the maps.

Part 150 requires the use of standard methodologies and metrics for analyzing and describing noise. It also establishes guidelines for the identification of land uses which are incompatible with noise of different levels. Airport proprietors are required to update noise exposure maps when changes in the operation of the airport would create any new, substantial non-compatible use. This is considered to be an increase in noise levels of 1.5 DNL over non-compatible land uses.

A limited degree of legal protection can be afforded to the airport proprietor through preparation and submission of noise exposure maps. The ASNA Act provides, in Section 107(a), that:

> No person who acquires property or an interest therein . . . in an area surrounding an airport with respect to which a noise exposure map has been submitted . . . shall be entitled to recover damages with respect to the noise attributable to such airport if such person had actual or constructive knowledge of the existence of such noise exposure map unless . . . such person can show --
>
> (i) A significant change in the type or frequency of aircraft operations at the airport;
>
> (ii) A significant change in the airport layout;
>
> (iii) A significant change in the flight patterns; or
>
> (iv) A significant increase in night-time operations occurred after the date of acquisition of such property . . .

The ASNA Act provides that "constructive knowledge" shall be imputed to any person if a copy of the noise exposure map was provided to him at the time of property acquisition, or if notice of the existence of the noise exposure map was published three times in a newspaper of general circulation in the area. In addition, Part 150 defines "significant increase" as an increase of 1.5 DNL. For purposes of this provision, FAA officials consider the term "area surrounding an airport" to mean an area within the 65 DNL contour. (See F.A.R. Part 150, Section 150.21 (d), (f) and (g)).

Acceptance of the noise exposure maps by FAA is required before it will approve a noise compatibility program for the airport.

- NOISE COMPATIBILITY PROGRAM

A noise compatibility program includes provisions for the abatement of aircraft noise through aircraft operating procedures, air traffic control procedures, airport regulations, or airport facility modifications. It also includes provisions for land use compatibility planning and may include actions to mitigate the impact of noise on non-compatible land uses. The program must contain provisions for updating and periodic revision.

F.A.R Part 150 establishes procedures and criteria for FAA evaluation of noise compatibility programs. Among these, two criteria are of particular importance: the airport proprietor may take no action that imposes an undue burden on interstate or foreign commerce, nor may the proprietor unjustly discriminate between different categories of airport users.

With an approved noise compatibility program, an airport proprietor becomes eligible for federal funding to implement the eligible items of the program. Twelve and one-half percent of the total appropriations to the Federal Airport Improvement Program have been set aside exclusively for noise abatement and noise mitigation projects.

Federal Aircraft Noise Regulations

The FAA has required reduction of aircraft noise at the source through certification, modification of engines, or replacement of aircraft. F.A.R. Part 36 prohibits the further escalation of noise levels of subsonic civil turbojet and transport category aircraft. It also requires new airplane types to be markedly quieter than earlier models. Subsequent amendments have extended the noise standards to include small, propeller-driven airplanes and supersonic transport aircraft.

F.A.R. Part 36 has three stages of certification. Stage 3 is the most rigorous and applies to aircraft certificated since November 5, 1975. Stage 2 applies to aircraft certificated between December 1, 1969 and November 5, 1975. Stage 1 includes all previously certificated aircraft.

F.A.R. Part 91, Subpart I, known as the "Fleet Noise Rule," mandated a compliance schedule under which Stage 1 aircraft were to be retired or refitted with hush kits or quieter engines by January 1, 1988. A very limited number of exemptions have been granted by D.O.T. for foreign aircraft operating into specified international airports.

Pursuant to the Congressional mandate in the Airport Noise and Capacity Act of 1990, FAA has established amendments to F.A.R. Part 91 by setting a schedule for the phase-out of all Stage 2 aircraft exceeding 75,000 pounds from the fleets of all commercial airlines. The regulation requires airlines to phase-out Stage 2 aircraft by December 31, 1999. FAA may grant an airline an extension of the deadline to December 31, 2003 if, by July 1, 1999, their fleets include no more than 15 percent Stage 2 aircraft. The Part 91 amendments also provide for two alternative phase-out schedules through the 1990s. The first is described in terms of the phase-out of Stage 2 aircraft; the second in terms of the phase-in of Stage 3 aircraft.

Under the first alternative, an airline must have eliminated or retro-fitted 25 percent of its Stage 2 fleet by the end of 1994, 50 percent by the end of 1996, and 75 percent by the end of 1998. Under the second alternative, an airline must have a fleet of no less than 55 percent Stage 3 aircraft by the end of 1994, 65 percent by the end of 1996, and 75 percent by the end of 1998.

No Federal requirements yet exist for the phase-out of Stage 2 jet aircraft under 75,000 pounds. This size category includes most business jet aircraft.

Neither F.A.R. Part 36 or 91 apply to military aircraft. Nevertheless, many of the advances in quiet engine technology are being used by the military as they upgrade aircraft to improve performance and fuel efficiency.

Regulation of Airport Noise and Access Restrictions

F.A.R. Part 161 sets forth requirements for notice and approval of local restrictions on aircraft noise levels and airport access. Part 161 was developed in response to the Airport Noise and Capacity Act of 1990. It applies to local airport restrictions that would have the effect of limiting operations by Stage 2 or 3 aircraft. These include direct limits on maximum noise levels, nighttime curfews, and special fees intended to encourage changes in airport operations to lessen noise.

In order to implement noise or access restrictions on Stage 2 aircraft, the airport operator must provide public notice of the proposal and provide at least a 45-day comment period. This includes notification of FAA and publication of the proposed restriction in the Federal Register. An analysis must be prepared describing the proposal, alternatives to the proposal, and the costs and benefits of each.

Noise or access restrictions on Stage 3 aircraft can be implemented only after receiving FAA approval. Before granting approval, FAA must find that six conditions specified in the statute are met:

(1) the restriction is reasonable, non-arbitrary and nondiscriminatory;

(2) the restriction does not create an undue burden on interstate or foreign commerce;

(3) the proposed restriction maintains safe and efficient use of the navigable airspace;

(4) the proposed restriction does not conflict with any existing federal statute or regulation;

(5) the applicant has provided adequate opportunity for public comment on the proposed restriction; and

(6) the proposed restriction does not create an undue burden on the national aviation system.

In its application for FAA review and approval of the restriction, the airport operator must include an environmental assessment of the proposal and a complete analysis addressing the six conditions. Within 30 days of the receipt of the application, FAA must determine whether the application is complete. After a complete application has been filed, the FAA publishes a notice of the proposal in the Federal Register. It must approve or disapprove the restriction within 180 days of receipt of the completed application.

Airport operators that implement noise and access restrictions in violation of F.A.R. Part 161 are subject to termination of eligibility for airport grant funds and authority to impose and collect passenger facility charges.

Air Traffic Control

The FAA is responsible for the control of navigable airspace and the operation of air traffic control systems at the nation's airports. Airport proprietors have no direct control over airspace management and air traffic control, although they can propose changes in procedures.

The FAA reviews any proposed changes in flight procedures, such as flight tracks or runway use programs, proposed for noise abatement on the basis of safety of flight operations, safe and efficient use of the navigable airspace, management and control of the national airspace and traffic control systems, effect on security and national defense, and compliance with applicable laws and regulations. Typically, FAA implements and regulates flight procedures pertaining to noise abatement through the local air traffic control manager.

STATE AND LOCAL

Control of land use in noise-impacted areas around airports is a key tool in limiting the number of citizens exposed to noise. The FAA encourages land use compatibility in the vicinity of airports, and F.A.R. Part 150 has guidelines relating to land use compatibility based on varying levels of noise exposure. Nevertheless, the federal government has no legal authority directly to regulate land use. That responsibility rests exclusively with state and local governments.

State

Although the State of Arizona does not directly implement and administer general purpose land use regulations, it has vested cities, towns, and counties with that power through enabling legislation. Arizona Revised Statutes do not mandate the establishment of planning commissions, agencies or department in municipalities; however, where such appointments are made, the municipality is required to prepare and adopt a long-range general plan, and may regulate zoning, subdivision and land development, consistent with the plan.

The State does mandate that counties prepare and adopt comprehensive plans, subdivision regulations, zoning ordinances, and zoning maps. Counties with zoning may also adopt a building code and other related codes. Arizona Revised Statutes provide for the commissions, boards of adjustment, and building code advisory boards.

City and County

In the Glendale Municipal Airport Study Area, Maricopa County, the cities of Glendale, Phoenix, Avondale, and Peoria, and the Town of Youngtown share responsibilities for land use regulation.

Maricopa County is administered by a County Board of Supervisors, made up of representatives of the five voting districts. The City of Glendale operates under the council/manager form of government. The Glendale City Council is composed of six members plus the mayor who is elected directly by the voters. The City of Phoenix also has the council/manager form of government with a directly elected mayor. The Phoenix City Council is comprised of eight council members. Both the cities of Avondale and Peoria offer council/manager forms of government and are comprised of seven-member councils, including the mayor who is again directly elected by the voters. The Mayor of the Town of Youngtown is selected from among the elected council members; Youngtown does not operate under a council/manager form of government.

In addition to regulating land use, local governments may acquire property to mitigate or prevent airport noise impacts or may sponsor soundproofing programs for this purpose. They are also eligible to apply for FAA grants under Part 150 if they are designated as a sponsor of a project in an approved noise compatibility program.

Maricopa Association of Governments

The Maricopa Association of Governments (MAG) serves as the designated Metropolitan Planning Organization (MPO) for all jurisdictions within Maricopa County, Arizona, including the Phoenix Urbanized area. MAG is a regional planning agency, consisting of 24 cities and towns, Maricopa County, the Gila River Indian Community and ADOT for transportation-related issues.

As the MPO, MAG is responsible for conducting regional transportation planning and preparing air and water quality plans. It is also responsible, in accordance with FAA Order 5100.38, for sponsoring regional aviation system planning studies. MAG adopted its first Regional Aviation System Plan (RASP) in 1979 and updates in 1986 and 1993. The RASP serves as a guide for meeting the future air transportation needs of the region.

School Districts

Three school districts are located within the Glendale Municipal Airport Study Area. Pendergast Elementary District operates three elementary schools within the study area: Villa de Paz, Pendergast and Garden Lakes. Approximate enrollment totals 825 for Villa de Paz, 735 for Pendergast and 1,077 for Garden Lakes.

Peoria Unified School District also operates three elementary schools within the study area: Alta Loma, Sun Valley and Cotton Boll. Approximate enrollment totals 1,039 students for Alta Loma, 911 for Sun Valley and 925 for Cotton Boll.

The Tolleson Union High School District operates one school within the study area, Westview High School, which supports approximately 1,547 students.

While none of these districts have a land use regulatory function, they are important in the noise compatibility planning process because of their responsibilities for locating and operating highly noise-sensitive public institutions.

AIRPORT PROPRIETOR

Glendale Municipal Airport is owned and operated by the City of Glendale. The eight airport commissioners are appointed by the City Council. The City, as airport proprietor, has limited power to control what types of civil aircraft use its airport and to impose curfews or other use restrictions. The City may propose limits on runway use or flight paths, but these can be implemented only with the explicit approval of the FAA.

Airport proprietors may take steps to control on-airport noise by installing sound barriers and acoustical shielding and by controlling the times when engine maintenance run-ups may take place. Within the limits of the law and financial feasibility, airport proprietors may acquire land or partial interests in land, such as air rights, easements, and development rights, so as to assure the use of property for purposes which are compatible with airport operations.

Airport proprietors are prohibited from taking actions which would impose undue burdens on interstate or foreign commerce, unjustly discriminate between different categories of airport users, or constitute unilateral action in matters preempted by the federal government.

AIRPORT SETTING

Glendale Municipal Airport is attended daily throughout the year by a professional aviation department. It is classified in the *National Plan of Integrated Airport Systems (NPIAS)* as a Reliever Airport for Phoenix-Sky Harbor International Airport. Reliever airports provide an alternative landing site for general aviation pilots, reducing congestion at metropolitan commercial service airports.

LOCALE

Glendale Municipal Airport is located on approximately 427 acres of land on the western edge of the City of Glendale, in Maricopa County. It is approximately six miles west of downtown Glendale, Arizona, five miles east of Luke Air Force Base, three miles southwest of downtown Peoria, four miles northeast of Litchfield Park, and is immediately north of the western reaches of the Maryvale Village Planning Area in the City of Phoenix. Phoenix-Sky Harbor International Airport is located approximately 18 miles east-southeast of the airport. Also located nearby are the communities of Sun City, Avondale, Tolleson, Goodyear, Youngtown, and El Mirage.

The airport is bordered on the north by Glendale Avenue, the south and east by New River, and on the west by above ground, extra high voltage electric power lines and the Agua Fria River. The Glen Harbor Industrial Park is located immediately north of the airport. Residential development is located north, south and east of Glendale Municipal Airport, interspersed with agricultural land.

Exhibit 1A depicts the location of the airport in its regional setting. The primary access to Glendale Municipal Airport is from Glen Harbor Boulevard, off of Glendale Avenue. The airport is accessible from I-10 to the south, by following 99th Avenue five miles north to Glendale Avenue. This north-south arterial also serves as the alignment for the future "Outer Loop" highway which will connect I-10, west of downtown Phoenix, to I-17, north of Phoenix.

CLIMATE

Weather plays an important role in the operational capabilities and capital development of an airport. Temperature is an important factor in determining runway length required for aircraft operations. The percent of time visibility is impaired due to cloud coverage is a major factor in determining the use of instrument approach aids. Wind speed and direction determine runway selection and operational flow.

Precipitation at Glendale Municipal Airport averages approximately seven inches annually, with most of this falling during the winter months, January through April, and the remainder during the thunderstorm season in July and August. There are occasional periods of blowing dust and high winds during thunderstorm passage when visibilities are temporarily reduced to less than one mile. Normally July is the hottest month with a mean maximum temperature of 103.7 degrees Fahrenheit. The average relative humidity is 40 percent with the driest month in June (20.1 percent relative humidity) and the wettest month in January (58.4 percent).

Ceiling and visibilities at the airport are generally excellent year-round. Visual flight rule conditions, with ceilings equal to or greater than 1500 feet and visibilities equal to or greater than three miles, exist 99.5 percent of the year. Clear and scattered cloud conditions (0-30 percent cloud cover) are present 70 percent of the year while overcast (100 percent cloud cover) conditions are encountered only 11 percent of the year.

Winds are normally light at the airport where approximately 52 percent of the winds register below 3 miles per hour, although gusts have been recorded as high as 50 miles per hour during thunderstorms. Runway 01-19 provides 99.2 percent coverage of winds equal to or below 12 miles per hour (mph), and 99.8 percent coverage of winds equal to or below 15 mph.

AIRPORT HISTORY

In 1971, through a bankruptcy sale, the City of Glendale purchased a small, 27 acre parcel of land, within what was then the Town of Peoria, on which to locate its first municipal airport. Upon acquisition of the property by the City, the airport was included in the nation's *National Airport Systems Plan* (now referred to as the *National Plan of Integrated Airport Systems*). The City immediately began upgrading the airport, paving a 2300 x 75 foot north/south runway, a full parallel taxiway and aircraft parking apron. In 1972, the City purchased a 13 acre parcel of land adjoining the new airport, increasing the size of the airport to 40 acres.

The airport grew rapidly, spurred by the expanding population growth in the metropolitan area. It was recognized early that the physical size of the airport limited expansion possibilities and the

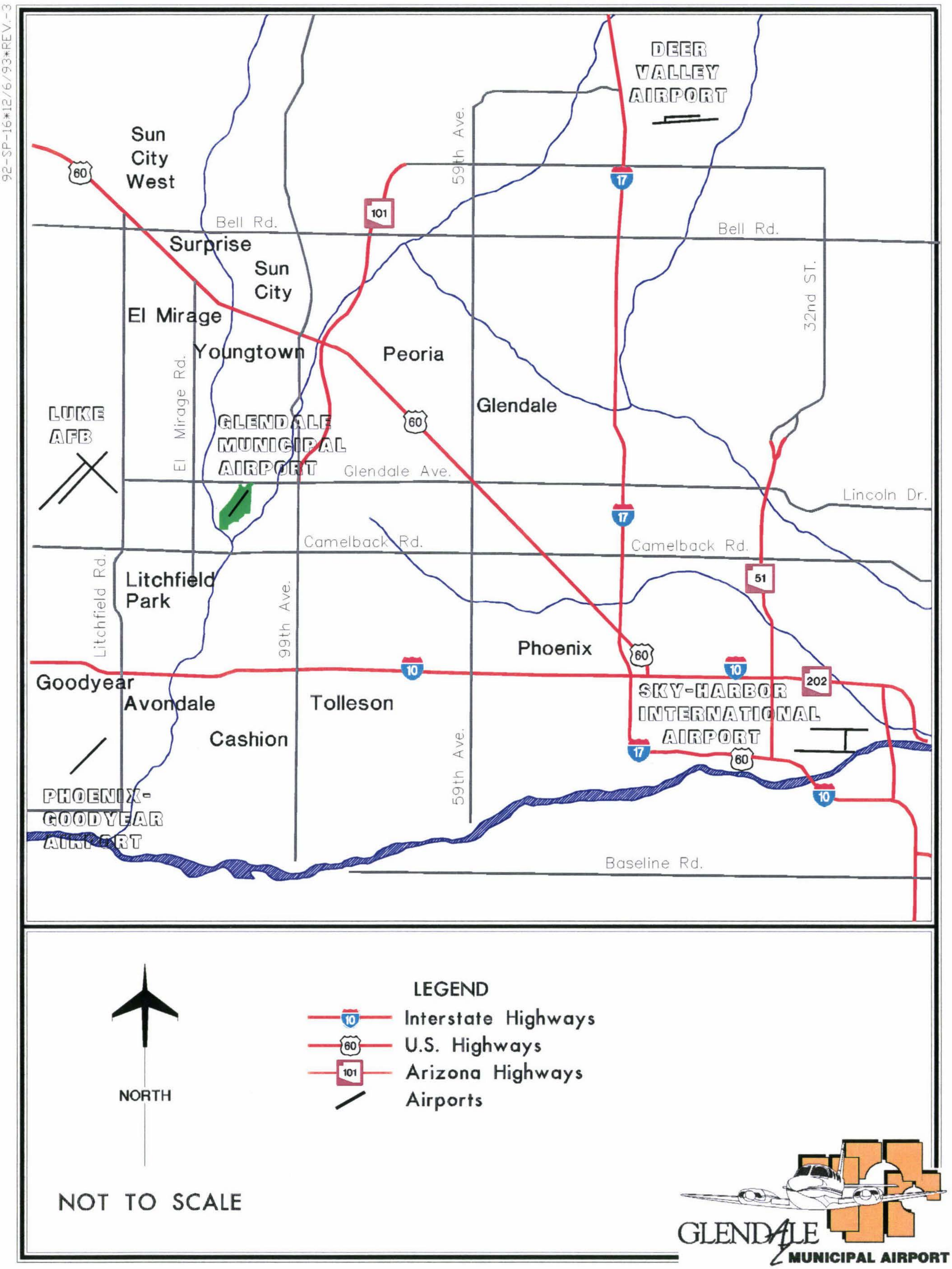


Exhibit 1A
LOCATION MAP

City began addressing possible methods of increasing the airport's capacity. Expansion of the existing airport site was constrained by the jurisdictional boundaries of the Town of Peoria, which was not interested in releasing additional land to the City of Glendale. The City began to search for an alternative airport site. During the 1976-1978 period, a site analysis study concluded that the rapidly expanding community precluded locating any airport near the City center and recommended a site west of the City.

In 1980, a federal/state grant was provided to conduct a site selection and master plan for a new Glendale airport. Eight potential airport sites were evaluated, including the present site, located approximately five miles east of Luke Air Force Base. Potential airspace conflicts were evaluated by the FAA and were considered to be resolved by operating the new airport under Visual Flight Rule (VFR) conditions and having a control tower operating whenever the military base was conducting local operations. The Maricopa Association of Governments (MAG) supported the selection of the new airport site during the final selection process.

In 1983, construction began on the 427 acre, $10.3 million dollar airport, and the new facility was opened for operations on June 30, 1986. Construction of the new general aviation terminal was also completed in 1986. The large, Fixed Base Operator hangar was initiated in 1986 and completed in 1987.

In the early 1990's, Glendale Municipal Airport installed a roof for the wash rack/maintenance bay facility, located near the air traffic control tower and aircraft hangar area. In 1991, the old air traffic control tower was removed and a replacement tower relocated from Scottsdale Airport. Finally, in 1993, a nondirectional radio beacon (NDB) was installed at Glendale Municipal Airport to provide an airport navigation aid for pilots.

AIR TRAFFIC ACTIVITY

Air traffic activities are recorded by the airport management and by the FAA. Operations data at Glendale Municipal Airport is summarized in **Table 1A.** Operations (takeoffs and landings) are classified as itinerant or local. Itinerant operations are those from or to other airports which either originate or terminate at Glendale. Local operations are those which originate or terminate at Glendale and which do not leave the local area. All touch-and-go operations are classified as local.

The total number of operations at the airport has fluctuated from an initial low of 32,201 (reflecting the latter half of 1986) to the estimated current level of 104,799. Operations peaked in 1990 with a total of 151,662.

AIRSPACE AND AIR TRAFFIC CONTROL

The Federal Aviation Administration (FAA) Act of 1958 established the FAA as the responsible agency for the control and use of navigable airspace within the United States. The FAA Western-Pacific Region with offices in Los Angeles, California has administrative control of air traffic in Arizona. The FAA has established the National Airspace System (NAS) to protect persons and property on the ground and to establish a safe and efficient airspace environment for civil, commercial, and military aviation. The NAS covers the common network of U.S. airspace, including air navigation facilities; airports and landing areas; aeronautical charts; associated rules, regulations, and procedures; technical information; personnel and material. The system also includes components shared jointly with the military.

TABLE 1A
Total Aircraft Operations (1986-1993)
Glendale Municipal Airport

	Itinerant		Local		
Year	General Aviation	Military	General Aviation	Military	Total
1986[1]	12,477	170	19,402	182	32,201
1987	26,167	325	46,112	368	72,972
1988	33,652	60	59,207	44	92,963
1989	40,688	267	104,235	90	145,280
1990	42,567	60	108,933	102	151,662
1991	40,713	23	95,928	8	136,672
1992	36,614	26	76,193	4	112,837
1993[2]	33,508	47	71,166	78	104,799

SOURCE: "A/C Operations Report;" Glendale Municipal Airport; December 1993.

NOTE: [1] Partial Year (July 1 through December 31).
[2] Estimate based on December 1, 1992 through November 30, 1993.

AIRSPACE STRUCTURE

Airspace structure currently falls into two primary categories: controlled and uncontrolled. Ground to air communications, navigation aids and air traffic services govern controlled airspace. FAA completed a major airspace reclassification on September 16, 1993. The FAA began the program as part of an effort to establish an international standard for airspace. The FAA has taken a lead role in international efforts to attain consistency in airspace nomenclature and requirements. Ultimately, the program will enable pilots to fly in any country without having to master a whole new airspace system. **Exhibit 1B** shows the new classifications and terminology and their relationship to the old system.

Several types of controlled airspace exist in the Glendale area:

- Class A airspace, formerly known as the Positive Control Area.
- The Phoenix Sky Harbor International Airport Class B airspace, formerly known as the Terminal Control Area (TCA).
- Class D airspace, formerly known as control zones and airport traffic areas for airports with air traffic control towers.

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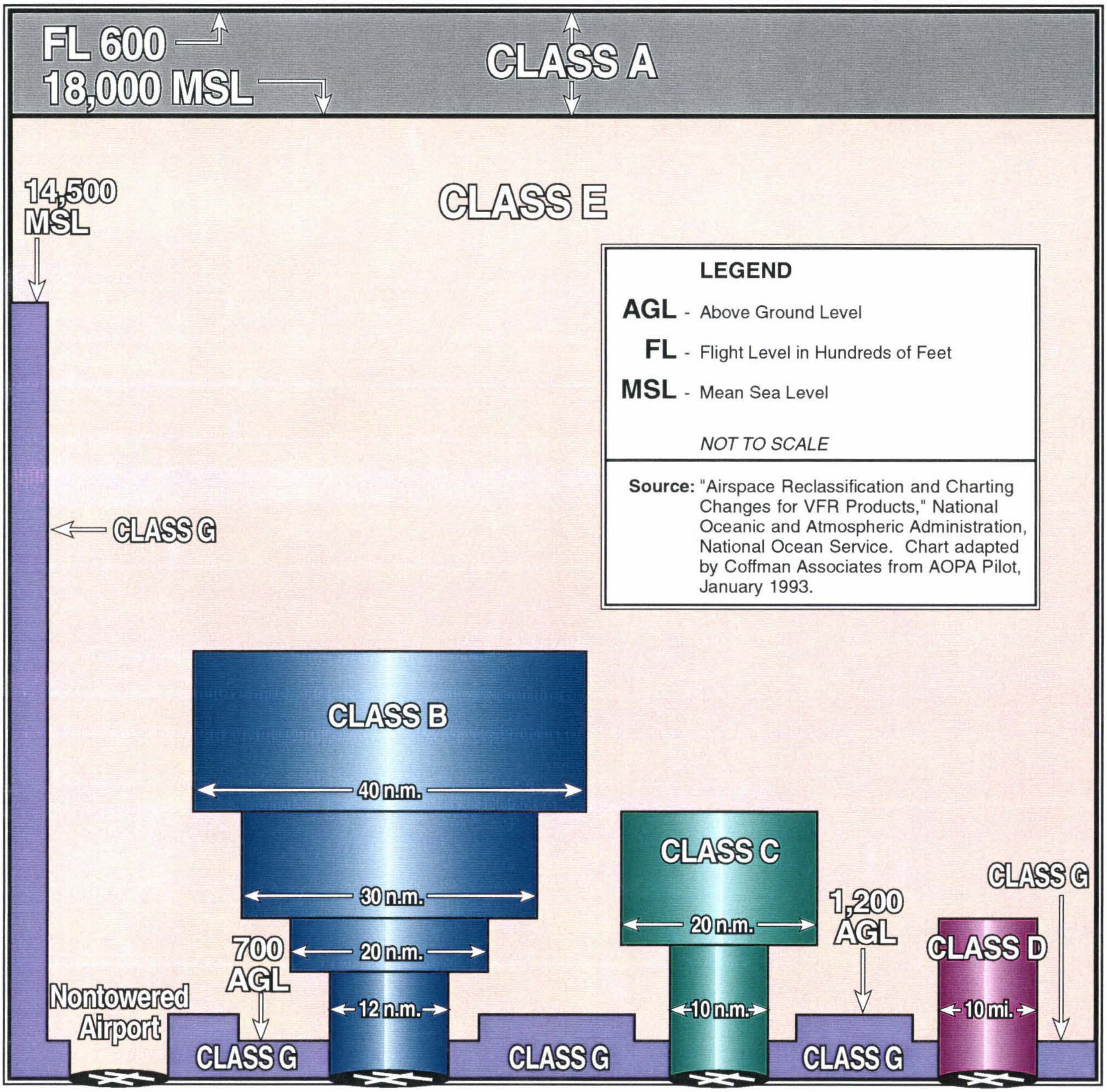

NEW CLASSIFICATION	OLD CLASSIFICATION
CLASS A	Positive Control Area, Continental Control Area (part)
CLASS B	Terminal Control Area (TCA)
CLASS C	Airport Radar Service Area (ARSA)
CLASS D	Control Zone with Tower, Airport Traffic Area
CLASS E	Continental Control Area (part), Transition Areas, Control Zones without Tower
CLASS G	Uncontrolled Airspace

GLENDALE MUNICIPAL AIRPORT

Exhibit 1B
AIRSPACE CLASSIFICATION

- Class E airspace, formerly known as transition areas and control zones for airports without air traffic control towers.

- Class G airspace under the new system covers uncontrolled airspace.

Class A Airspace

Class A airspace is designated in F.A.R. Part 71.193 for positive control of aircraft. The area includes specified airspace within the coterminous United States from 18,000 feet above mean sea level (MSL) to and including Flight Level 600 (60,000 feet MSL). The Positive Control Area allows only Instrument Flight Rules (IFR) operations. The aircraft must have special radio and navigation equipment and the pilot must obtain an Air Traffic Control (ATC) clearance to enter Class A airspace. The pilot must have at least an instrument rating.

Class B Airspace

Class B airspace has been established at 29 high density airports in the United States as a means of regulating air traffic activity in these areas. They are established on the basis of a combination of enplaned passengers and volume of operations.

Class B airspace is designed to regulate the flow of uncontrolled traffic above, around and below the arrival and departure airspace required for high performance, passenger-carrying aircraft at major airports. Class B airspace is the most restrictive controlled airspace routinely encountered by pilots operating under visual flight rules (VFR) in an uncontrolled environment.

In order to fly through Class B airspace, the aircraft must have special radio and navigation equipment and must obtain an air traffic control (ATC) clearance. In order to operate within the Phoenix Class B Airspace, a pilot must have at least a private pilot's certificate or be a student pilot who has met the requirements of F.A.R. 61.95, requiring special ground and flight training for the Class B airspace. Helicopters do not need special navigation equipment or a transponder if they operate at or below 1,000 feet and have made prior arrangements in the form of a Letter of Agreement with the FAA controlling agency. Aircraft are also required to have and utilize a Mode C transponder within a 30 nautical mile range of the center of the Class B airspace.

Exhibit 1C shows the Phoenix Class B Airspace extending a radius of some 20 to 25 nautical miles from the Phoenix VORTAC facility located at Sky Harbor International Airport. Phoenix has the only Class B airspace in the State of Arizona.

The Phoenix Class B Airspace consists of concentric rings at specific distances from the Phoenix VORTAC facility. Each of these rings contains airspace sectors defined by the upper and lower bounds of the Class B Airspace in that section. The upper boundaries are generally at 10,000 feet MSL with the lower varying from the surface around Sky Harbor International Airport to 8,000 feet MSL in the outer areas of the Class B airspace.

The Phoenix Terminal Radar Approach Control Facility (TRACON) controls all aircraft operating within the controlled airspace of the Class B Airspace. The TRACON operates continuously.

The Glendale Municipal Airport is located just inside the northwestern boundary of the Phoenix Class B Airspace. This area is adjacent to the Luke Air Force Base Radar Approach Control airspace west of Glendale.

Class D Airspace

The Class D airspace includes that airspace within a horizontal radius of 5 statute miles of the airport, extending from the surface up to a designated vertical limit, typically set at approximately 2,500 feet above the airport elevation. If an airport has an instrument approach or departure, the Class D airspace has an extension along the approach or departure path. The Class D airspace around Luke Air Force Base has an upper limit of 3,600 feet MSL.

At Glendale Municipal Airport the Class D airspace has an upper limit of 3,100 feet. The field elevation at Glendale is 1,066 feet MSL. The Class D airspace lateral boundary to the west is overlapped by the Luke Air Force Base Class D Airspace. In this area the Luke Class D Airspace takes precedence over the Glendale Class D Airspace.

Class E Airspace

The Class E Airspace consists of controlled airspace designed to contain IFR operations during portions of the terminal operation and while transitioning between the terminal and enroute environments. The airspace extends upward from 700 feet above the surface when established in conjunction with an airport which has an instrument approach procedure, or from 1,200 feet above the surface when established in conjunction with airway route structures or segments. Unless otherwise specified, Class E Airspace terminates at the base of the overlying airspace.

Class G Airspace

Class G airspace consists of airspace not designated as any of the previously mentioned airspace classifications. Air traffic control (ATC) does not have the authority or responsibility to exercise control over aircraft within this airspace.

Special Use Airspace

Special Use Airspace is defined as airspace where activities must be confined because of their nature or where limitations are imposed on aircraft not taking part in those activities. While there are a number of Military Operations Areas (MOAs) in the Phoenix area, these are relatively distant from the Glendale Municipal Airport and have little or no affect on traffic in the Glendale area. However, immediately west and northwest of Glendale Municipal Airport there is an Alert Area which affects the Glendale traffic.

The Alert Area A-231 abuts the Phoenix Class B Airspace just west of Glendale Municipal Airport and extends approximately 23 nautical miles west and 10 to 25 nautical miles north of the airport. The area extends from 500 feet above ground level (AGL) to a ceiling of 6,500 feet MSL. This area is advisory in nature and indicates an area of concentrated student jet transition training at Luke AFB.

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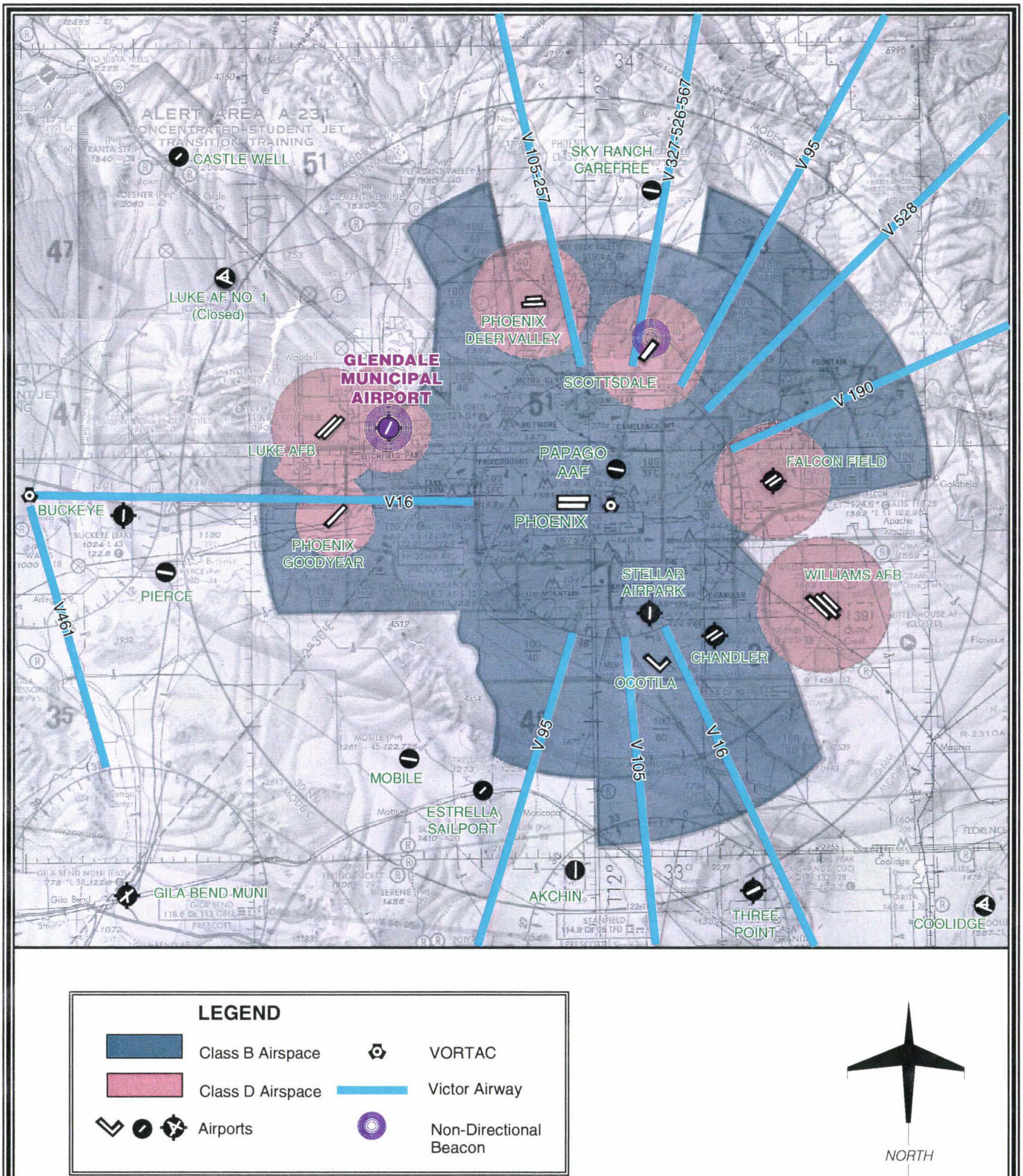

Not To Scale

GLENDALE MUNICIPAL AIRPORT

Exhibit 1C
AIRSPACE

AIR TRAFFIC CONTROL

Air Route Traffic Control Center (ARTCC)

The FAA has established 21 Air Route Traffic Control Centers (ARTCC) in the continental United States to control aircraft operating under instrument flight rules (IFR) within controlled airspace and while in the enroute phase of flight. An ARTCC assigns specific routes and altitudes along federal airways to maintain separation and orderly air traffic flow. ARTCCs use radio communication and long range radar with automatic tracking capability to provide enroute air traffic services. Typically, the ARTCC splits its airspace into sectors and assigns a controller or team of controllers to each sector. As an aircraft travels through the ARTCC, one sector hands off control to another. Each sector guides the aircraft using discrete radio frequencies.

The Albuquerque ARTCC located in Albuquerque, New Mexico, controls IFR aircraft entering and leaving the Phoenix area. The area of jurisdiction for the Albuquerque center includes most of the States of New Mexico and Arizona, and portions of the States of Texas, Colorado, and Oklahoma.

Terminal Radar Approach Control (TRACON)

The ARTCC delegates certain airspace to local terminal facilities which are responsible for the orderly flow of air traffic arriving and departing the major terminals. The Albuquerque ARTCC has delegated airspace to the Phoenix Terminal Radar Approach Control (TRACON) facility. The TRACON uses direct radio communications and the latest Automated Radar Terminal tracking system (ARTS IIIA) to control air traffic within its jurisdiction. Air traffic control services provided by the Phoenix Approach Control facility include radar vectoring, sequencing and separation of IFR aircraft, and traffic advisories for all aircraft.

Luke Air Force Base Radar Approach Control (RAPCON)

A Radar Approach Control (RAPCON) is located at Luke Air Force Base to provide services similar to the Phoenix TRACON for military aircraft operating at the base. Through a Letter of Agreement with the Phoenix TRACON, the Luke RAPCON handles the IFR traffic at Glendale Municipal Airport. The Luke RAPCON Airspace is generally west of Glendale Municipal Airport. Some areas of the RAPCON airspace to the south of Luke overlap with the Phoenix Class B Airspace. In these areas the TRACON Airspace and the RAPCON airspace are segregated vertically with a 1,000-foot buffer zone. The Luke RAPCON operates from 6:00 a.m. to 10:00 p.m. local time seven days per week.

Glendale Control Tower

The Glendale Municipal Airport control tower provides visual separation of air traffic in the Glendale vicinity and coordinates IFR traffic with the Luke RAPCON. The tower also provides coordination for ground traffic and VFR departure clearance. The tower is open from 6:00 a.m. to 8:30 p.m. on Monday through Friday and from 7:00 a.m. to 7:00 p.m. on Saturdays and Sundays. ATC personnel are supplied by a private firm via a contract with the city.

Customary ATC and Flight Procedures

Flights to and from Glendale Municipal Airport are conducted using both Instrument Flight Rules (IFR) and Visual Flight Rules (VFR). Instrument Flight Rules are those that govern the procedures for conducting instrument flight under all weather conditions. Visual Flight Rules govern the procedures for conducting flight under visual conditions (good weather). Most air carrier, military, and general aviation turbojet operations are conducted under IFR regardless of the weather conditions. At Glendale, the vast majority of the flight operations are conducted under VFR during good and fair weather conditions. Since the airport currently has no published approaches, operations during IFR weather conditions are minimal.

- VISUAL FLIGHT RULE PROCEDURES

VFR operations represent the majority of the air traffic operations at Glendale Municipal Airport. Under these conditions, the pilot is responsible for her own collision avoidance and will typically contact the tower when approximately 20 miles from the airport for sequencing into the traffic pattern. While VFR arrival and departure traffic at Glendale are not required to contact the Phoenix TRACON or the Luke RAPCON, they may do so to expedite their progress through the area.

Aircraft entering the Phoenix Class B Airspace east of Glendale must contact the Phoenix TRACON. Generally, VFR general aviation traffic stays clear of these more congested areas and follows the recommended VFR flyways in the area. **Exhibit 1D** illustrates a focused view of the Glendale vicinity airspace with the recommended VFR flyways. The exhibit also illustrates the transitions from the flyways to and from the Glendale Municipal Airport that were observed during radar flight tracking. A typical traffic pattern at Glendale is also shown.

Generally, traffic arriving from or departing to the north use the Salt River Project Power Plant and the Metro Center Mall as visual references to access the VFR flyways. This route allows VFR traffic to avoid the Phoenix Class B Airspace and the Luke Class D Airspace. It also helps reduce the traffic over Sun City and other residential areas north of Glendale Municipal Airport.

VFR traffic south of Glendale typically use the Tank Farm at I-10 and 51st Avenue and the Phoenix International Raceway as references for transition to the flyway routes. This routing keeps traffic east of the Phoenix-Goodyear Class D Airspace and is roughly parallel to the Sierra Estrella Mountains.

Pattern traffic at Glendale is generally routed to the east of the airport to avoid conflicts with the high tension lines just west of the airport and the Luke Class D Airspace. The published pattern altitudes are 2,600 feet MSL for turbine aircraft, 2,000 feet MSL for propeller aircraft, and 1,700 feet MSL for rotorcraft.

- INSTRUMENT FLIGHT RULE PROCEDURES

The Luke RAPCON handles all IFR traffic to and from Glendale Municipal Airport. IFR arrival traffic is either transferred to Luke RAPCON by the ARTCC or the Phoenix TRACON

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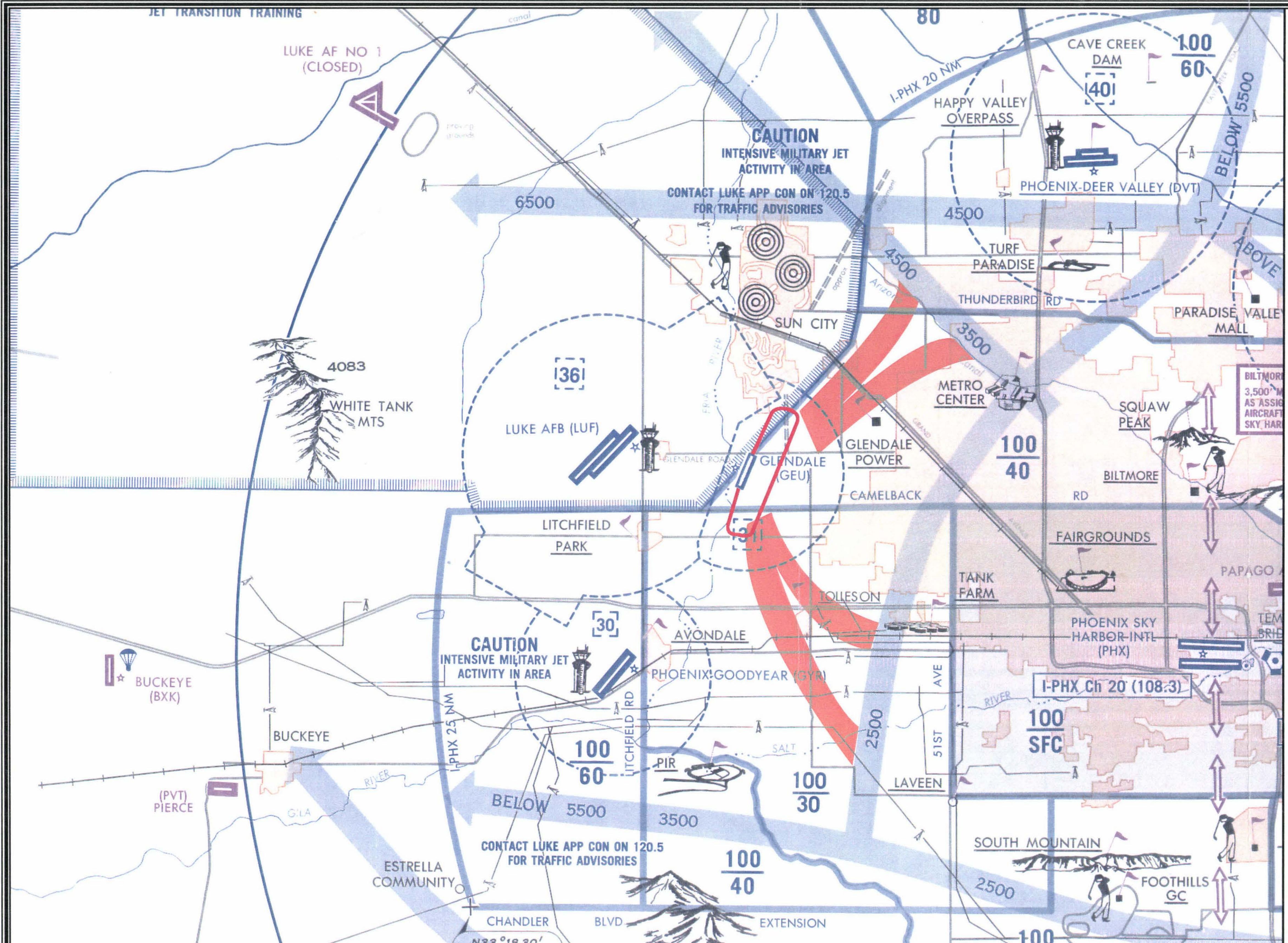

Exhibit 1D
VFR FLIGHT ROUTES

LEGEND

- Suggested VFR Flyway and Altitude
- Typical VFR Flight Routes to and From GEU
- Typical VFR Traffic Pattern at Glendale
- Alert, Prohibited, Restricted and Warning Areas
- Class B Airspace
- Class D Airspace

NORTH

NOT TO SCALE

GLENDALE MUNICIPAL AIRPORT

depending on the direction of flight. The traffic is then vectored to Glendale for a final approach.

IFR departures from Glendale require clearance from the Luke RAPCON. Because of the proximity to Luke AFB, an IFR departure from Glendale essentially requires a brief shut-down of Luke traffic. The departures are assigned a left turn to a 340 degree heading and an altitude of 3,000 feet MSL. Aircraft departing on Runway 19 are advised to remain within 2 nautical miles of Glendale to remain in the Glendale Class D Airspace. The departure is then assigned one of several preferential departure routes (PDRs) out of the area.

Airspace Conflicts

There are no direct airspace conflicts in the Glendale area. However, there are a number of airspace constraints in the area that limit the general traffic patterns around Glendale Municipal Airport.

The proximity of Glendale Municipal Airport to the Phoenix Class B Airspace and the Luke Class D Airspace tends to limit the available area near the airport for unrestricted VFR flying. Additionally, the high tension power lines located one-quarter of a mile west of the runway limit the access to the airspace west of the airport.

Noise Abatement Procedures

The City of Glendale has published a pilot guide describing preferred flight corridors and turns to promote noise abatement. Pilots are encouraged to avoid overflights of nearby residential areas whenever possible. Pattern traffic on Runway 19 is encouraged to keep the base leg of the pattern south of Northern Avenue when possible. Similarly, traffic in the Runway 1 pattern is asked to keep the base leg north of Indian School Road when ever possible.

Departure traffic to the north is encouraged to turn right at the end of the runway to utilize the New River corridor. Departures to the south are asked to use a straight out route over the Agua Fria River bottom.

ENROUTE NAVIGATIONAL AIDS

Enroute Navigational Aids (NAVAIDs) help to promote accurate enroute air navigation. Various devices use ground-based transmission facilities and on-board receiving instruments. Enroute navaids often serve navigation to more than one area airport as well as to aircraft simply traversing the area. Several enroute NAVAIDS operate in the Phoenix-Glendale area.

The non-directional beacon (NDB) transmits non-directional signals whereby the pilot of an aircraft equipped with direction-finding instruments can determine a bearing to or from the radio beacon. The Glendale NDB, located at Glendale Municipal Airport provides a beacon for aircraft entering and exiting the Glendale vicinity. This beacon transmits a continuous three-letter identifier code, "GEU", in international morse code on a frequency of 215 KHz. Other NDBs in the area are located at Scottsdale Airport and further east at Falcon Field.

A VORTAC (Very High Frequency Omni-directional Range Station) incorporates a navigation course guidance signal (VOR) and a distance measuring function into a single channelized VHF/UHF system. The distance measuring equipment (DME) or tactical air navigation equipment (TACAN) emit signals enabling pilots to determine their line-of-sight distance from the facility. The TACAN also provides azimuth information for military aircraft. Operating in conjunction with the ground station, the pilot of a properly equipped aircraft can translate the VORTAC signals into a visual display of both azimuth and distance.

The Phoenix VORTAC (PXI), located approximately 2 nautical miles east of Sky Harbor International Airport, provides primary navigation information for approaches into Sky Harbor Airport as well as the Phoenix vicinity. The VOR operates on a frequency of 115.6 MHz and the TACAN on Channel 103. The beacon transmits a continuous three-letter identifier code, "PXI", using International Morse Code. The Buckeye VORTAC (BXK)to the west and the Gila Bend VORTAC (GBN) to the southwest also provide guidance information to pilots in the Phoenix and Glendale areas.

VORs define low-altitude (Victor) and high-altitude airways (jet routes) through the area. Most aircraft enter the Phoenix area via one of these numerous federal airways. Aircraft assigned to altitudes above 18,000 feet MSL use the Jet Route system. Other aircraft use Low Altitude Airways, also known as Victor Airways. Radials off VORs define the centerlines of these flight corridors. The Phoenix VORTAC defines portions of eight Victor Airways: V16, V105-527, V327-562-567, V95, V528, V190, V105, and V95. **Exhibit 1C** shows these airways and the enroute navigational aids previously discussed.

AVIATION FACILITIES

Aviation facilities influencing the use of airspace and the use of the airfield are important in the noise compatibility planning process. These include the runways, the taxiway system, and terminal and aircraft activity areas.

RUNWAYS

Glendale Municipal Airport, at an elevation of 1,066 feet above mean sea level, currently operates one runway oriented predominantly north-south. Runway 01-19, depicted on **Exhibit 1E**, is constructed of asphaltic concrete and is 5,350 feet in length and 75 feet in width; it has a pavement strength of 30,000 pounds single wheel loading (SWL) and 37,500 pounds dual wheel loading (DWL). The runway is marked for visual operations and has a rising gradient of 0.52 percent from south to north. The runway is equipped with Medium Intensity Runway Lights (MIRLs), Runway End Identifier Lights (REILs) and Precision Approach Path Indicator Lights (PAPIs).

The current airport layout plan for Glendale Municipal Airport shows a planned extension and widening of Runway 1-19 to 6,100 feet by 100 feet. A new parallel runway, 4,000 feet long, is also planned.

TAXIWAYS

Taxiways are provided to facilitate aircraft movement between the runway and terminal areas. There are eight taxiways existing at Glendale Municipal

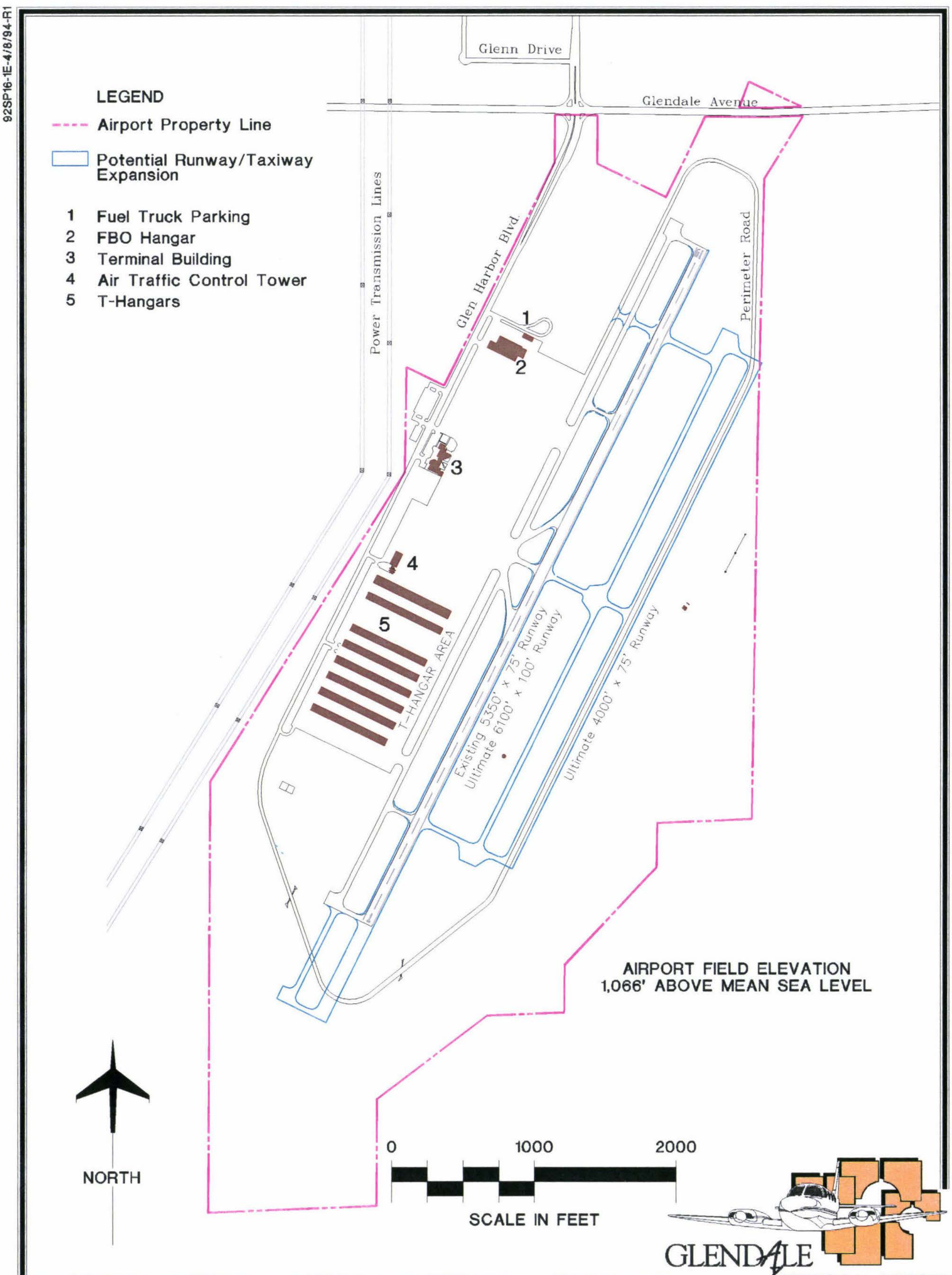

Exhibit 1E
AIRPORT FACILITIES

Airport. The full length, parallel taxiway, designated Taxiway A, has a width of 35 feet and is located along the west side of Runway 01-19. The runway and parallel taxiway are connected by seven taxiways: two end taxiways and a middle taxiway (35 feet in width), two intermediate taxiways (25 feet in width) and two high-speed exit taxiways (40 feet in width).

TERMINAL AREAS

Aircraft activity on the ground is concentrated around various terminal areas. The location of these areas can be an important influence on runway selection. The key terminal areas include the terminal building, Fixed Base Operator (FBO) and aircraft hangar/parking areas. **Exhibit 1E** illustrates the location of these areas at Glendale Municipal Airport.

The terminal building and tiedown areas are located near midfield, a location conducive for both midfield exits for landing from either runway end and short taxiways to both runway ends. The two-story terminal building offers a restaurant, pilot/gift shop, flight planning area, airport administration offices, and leased office space for aviation related businesses (a flight school and an aircraft broker). The tiedowns are located on three apron areas east of the terminal building; the north apron area is leased to the FBO, the south apron area is reserved for future aircraft hangars and shades.

The FBO building is located north of the terminal building, closer to the arrival end of Runway 19. FBO is the designation given to a business providing a required minimum level of aviation services under a lease agreement with the airport. The Glendale Municipal Airport FBO, Aces Aviation, provides aircraft maintenance and fueling services, manages tiedowns for transient aircraft, and serves as a flight school. The aircraft hangar area is located south of the terminal building, closer to the arrival end of Runway 01. Also in this area are the aircraft washrack/maintenance bay and the air traffic control tower (ATCT) facilities.

STUDY AREA

A study area boundary has been delineated to establish a consistent basis for reporting background information. The study area boundaries are intended to contain the areas impacted by present and future aircraft noise. In addition, it includes areas which could conceivably be affected by high single event noise levels or by potential future airport development or potential rerouting of aircraft flight tracks.

The selected study area, shown in **Exhibit 1F**, covers approximately 31 square miles and is located in the northwest portion of the Phoenix metropolitan area. The area includes portions of the cities of Glendale, Phoenix, Avondale, and Peoria, a small portion of the Town of Youngtown (Baptist Village South), and portions of unincorporated Maricopa County. The study area is bounded by Peoria Avenue on the north, 115th Avenue, El Mirage and Dysart Roads on the west, Thomas Road on the south, and 83rd and 91st Avenues on the east.

The study area boundary is used primarily for statistical convenience. It can be modified later in the study, if necessary. The study area boundary depicts an area where detailed background data is available and is not intended to define the noise impact area. Areas adversely affected by aircraft noise will be defined in later analyses.

SOCIOECONOMIC PROFILE

The socioeconomic characteristics of the study area provide information which is useful in the analysis of current and potential aircraft noise impacts. Population data helps to reveal settlement patterns and growth trends. Employment, housing and development trends data helps describe growth trends while shedding light on opportunities for non-residential land development, the least noise-sensitive urban use.

POPULATION

The study area incorporates a small portion of Maricopa County, historically the most populated county in the State of Arizona, accounting for from 50 to 58 percent of the total population. **Table 1B** illustrates the historical population data available for the study area, Maricopa County and the State of Arizona. Information on the study area was collected using Traffic Analysis Zone (TAZ) data, as compiled by the Maricopa Association of Governments. With the exception of a small portion of Youngtown, containing the southern portion of Baptist Village, and the northwest corner of the intersection of Camelback Road and El Mirage, TAZ boundaries closely follow those of the study area. The population of "Baptist Village South" was assumed to be 224, based on information received from the facility regarding the number of beds and rooms. In 1990, the population of the study area accounted for approximately 1.26 percent of the entire population of the County.

TABLE 1B
Historical Population Data

Year	Study Area*	Maricopa County	State of Arizona
1960	N/A	663,510	1,302,161
1970	N/A	971,228	1,775,399
1980	N/A	1,509,175	2,716,546
1990	26,648*	2,122,101	3,665,228
1992	N/A	2,291,200	3,957,960

SOURCES: Arizona Department of Employment Security, Population Statistics Unit; 1993. 1960-1990 data are for April 1; 1993 data are for July 1.

* Estimate by Coffman Associates. Developed from Traffic Analysis Zone data published in "Update of the Population and Socioeconomic Database for Maricopa County, Arizona;" Maricopa Association of Governments; March 1993.

Table 1C depicts the projected population growth for the study area, County and State, from 1995 through 2020. In general, Maricopa County and

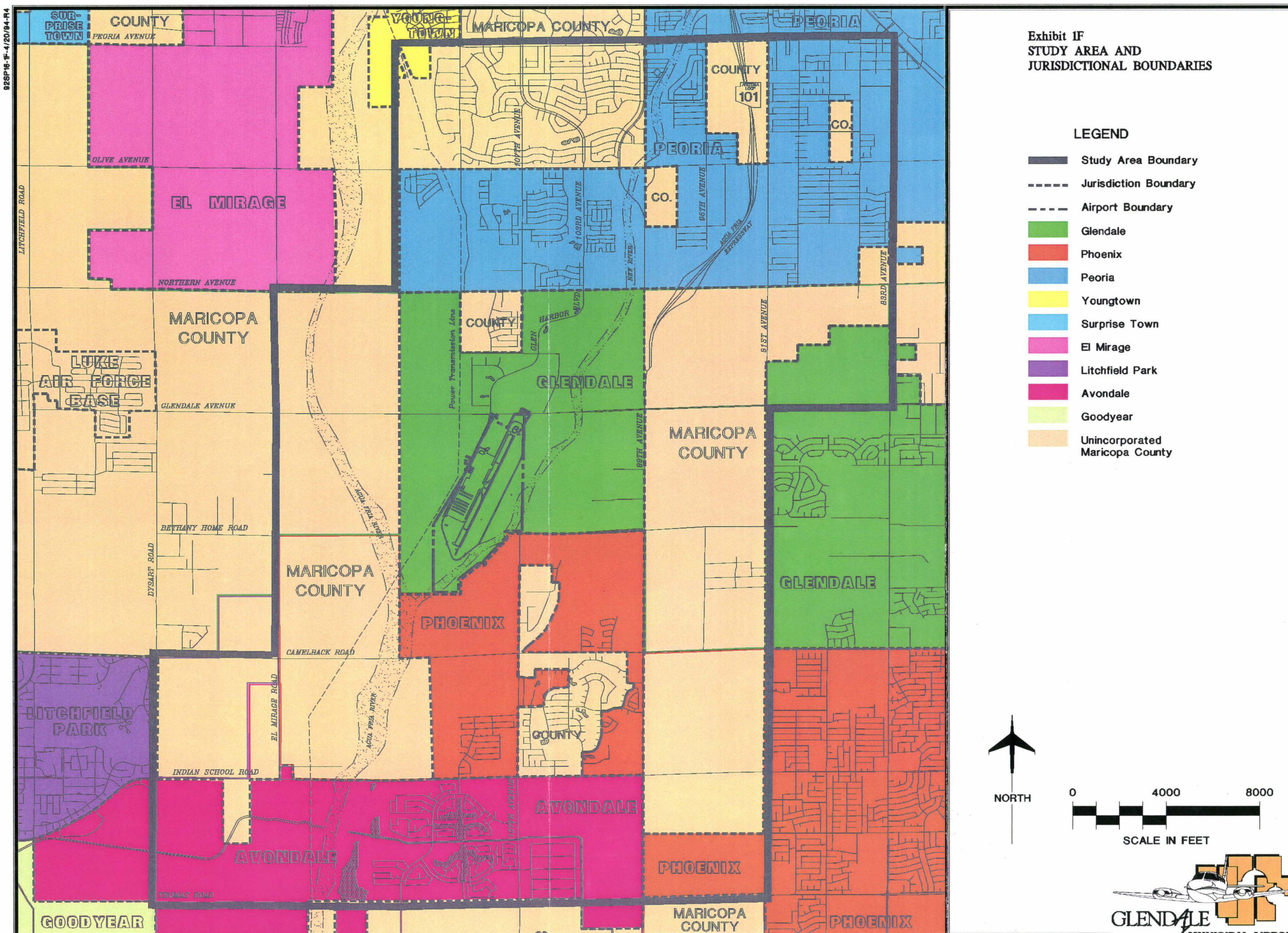

Exhibit 1F
STUDY AREA AND
JURISDICTIONAL BOUNDARIES

the State of Arizona are continuing to attract new residents, a trend that is expected to continue. The population share of the study area is anticipated to increase to approximately 2.2 percent of Maricopa County's population. The County is expected to account for over 60 percent of the State's population by the year 2020. For the purposes of this study, the resident population of Baptist Village South was assumed to remain 224 throughout the study period.

TABLE 1C
Projected Population Data

Year	Study Area*	Maricopa County	State of Arizona
1995	35,954	2,399,600	4,134,925
2000	51,255	2,715,100	4,632,875
2005	62,947	3,031,350	5,132,725
2010	75,726	3,362,675	5,652,525
2015	82,424	3,724,100	6,212,000
2020	92,932	4,116,600	6,811,900

SOURCES: Arizona Department of Employment Security, Population Statistics Unit; 1993.

* Estimates by Coffman Associates. Developed from Traffic Analysis Zone projections published in "Update of the Population and Socioeconomic Database for Maricopa County, Arizona;" Maricopa Association of Governments; March 1993.

Demographic Characteristics

Demographic data, based on 1990 Census information, indicates that Maricopa County population as a whole is predominantly adult, between 25 and 44 years old. This represents a population made up primarily of "babyboomers," those born between 1945 and 1961. Less than 12.5 percent of the County population is comprised of individuals of retirement age (65 and over). Those under 19, considered to be school age, comprise almost 30 percent of the total population. The "working age" population, between the ages of 25 and 64, constitutes slightly over 50 percent of the total population of Maricopa County.

EMPLOYMENT

Table 1D provides a breakdown of the employment sources in both the study area and Maricopa County. The employment categories are consistent with those used by the Maricopa Association of Governments in their database; they are based on adopted land use plans. Information on the study area was compiled using Traffic Analysis Zone (TAZ) data, as provided by MAG. The table illustrates that both the County and the study area are expected to experience significant employment growth between 1990 and 2020, the County by 85 percent and the study area by over 500 percent (a total increase of almost 13,000 jobs). The table also indicates that the study area, located on the western edge of the existing urban area, is expected to provide a greater share of employment in the County in 2020, as compared with 1990 (0.85 percent versus 0.26 percent, respectively).

TABLE 1D
Projected Employment Change (1990-2020)

	Study Area			Maricopa County		
Employment Type	1990	2020	Percent Change	1990	2020	Percent Change
Retail	776	6,202	699%	234,168	447,280	91%
Office	55	1,327	141%	238,284	468,045	96%
Industrial	289	1,519	426%	254,420	392,553	54%
Government	820	4,144	404%	130,194	276,671	113%
Other	584	2,159	270%	117,971	222,233	88%
Total	2,524	15,351	508%	975,037	1,806,578	85%

SOURCE: "Update of the Population and Socioeconomic Database for Maricopa County, Arizona;" Maricopa Association of Governments; March 1993.

By far, the majority of employment in the study area is expected to be associated with the retail sector, accounting for around 40 percent of total employment by the year 2020, compared to roughly 25 percent for the County. Government employment is also expected to be more significant within the study area than within the County as a whole, providing almost 27 percent of the regions jobs, compared with 15 percent for the County. Office and industrial employment are expected to be more significant within the County economy than within the study area. Industry is expected to account for nearly 22 percent of County jobs in 2020, compared with less than 10 percent of jobs within the study area. The office employment sector is expected to account for nearly 26 percent of County jobs in 2020, compared with 8.6 percent in the study area.

HOUSING CHARACTERISTICS

Table 1E, compares the number of housing units, vacancy rates and household income in the study area, Maricopa County and the State of Arizona. Occupancy of housing within the study area appears comparable to that of the County and State, accounting for slightly less than 86 percent of the total.

TABLE 1E
1990 Housing Characteristics

	Housing Units				Household Income	
Place	Total	Vacant	Occupied	Vacancy Rate	Median	Average
State of Arizona[1]	1,659,430	290,587	1,368,843	17.51%	$27,540	N/A
Maricopa County[1]	952,041	144,481	807,560	15.18%	$30,797	$39,061[2]
Study Area[2]	12,358	1,782	10,576	14.42%	N/A	$36,118

SOURCES: [1]1990 Census.
[2] Developed from Traffic Analysis Zone data published in "Update of the Population and Socioeconomic Database for Maricopa County, Arizona;" Maricopa Association of Governments; March 1993.

DEVELOPMENT TRENDS

Given the study area's location within the western region of the growing metropolitan area, it is reasonably expected to continue to experience tremendous growth pressures over the next decade. The western reaches of the Valley are prime for development due to geographical constraints to the north, south and east, relatively inexpensive land costs, and its vicinity to the local and interstate highway system. A section of the region's proposed "Outer Loop" Freeway (101 Loop) will run through the eastern portion of the study area, connecting I-10 to I-17. Until then, the southern reaches of the study area are just a little more than a mile from I-10, providing direct access to the urban core.

All of the planners interviewed for the project felt that completion of the Outer Loop Freeway would result in even greater development pressures on the study area, both for commercial and residential land uses. According to the Maricopa Association of Governments *Long Range Transportation Plan Summary and 1993 Update*, the completion of this portion of the Outer Loop Freeway is a 2005 priority. It is not scheduled in the current five-year plan, but should be programmed soon afterward.

The lack of the Outer Loop Freeway has not suppressed development within the area. Garden Lakes, in Avondale, is a new residential development, begun in the early 1990's. Country Meadows, in Peoria, is a phased residential development with some sections being approved as recently as 1993. There are also proposed residential developments both in and immediately adjacent the study area in both Avondale and Phoenix, including Camelback Ranch, located immediately south of Glendale Municipal Airport, and D-C Ranch. Glen Harbor Industrial Park has also experienced recent development activity with the approval of Kay Bee Toys and the Sun City Animal Rescue Facility; Anthony Manufacturing and Conair are two additional manufacturing developments proposed for the area.

Development is constrained primarily by the availability of sewer and water. Most cities require development within their jurisdiction to connect to municipal facilities. Some cities require that proposed developments not already within their jurisdictional boundaries, but within their planning area, be annexed prior to connection and development. The County does approve some developments with package treatment plants; however, they prefer connection to a city system. (Package plants are small sewage treatment plants intended to serve a very limited area.) The County also enforces a state requirement for a 100-year certificate for water availability.

EXISTING LAND USE

Exhibit 1G shows existing land use in the Glendale Municipal Airport Study Area. The map was based on a 1990 existing land use map for the area compiled by the Maricopa Association of Governments, aerial photographs taken in July 1993 and a consultant field survey conducted in November 1993. The land use categories shown on the map were selected to conveniently fit noise and land use compatibility planning requirements. **Table 1F** lists the land use categories shown on the existing land use map.

TABLE 1F
Existing Land Use Categories Shown on Existing Land Use Map

Category	Generalized Land Uses
Single-family Residential	Single-family homes.
Multi-family Residential	Duplexes, townhouses, apartments, and condominium buildings.
Mobile Homes	Manufactured and mobile homes.
Recreational Vehicle Park	Areas designed for short-term or long-term parking of recreational vehicles.
Commercial,Industrial, Transportation, Utilities	Businesses, offices, industrial uses, mines, rock quarries, government buildings, quasi-public institutional, and utilities not classified as noise-sensitive. Examples include city halls, fire stations, fraternal lodges, power substations, and the airport property.
Noise-sensitive Institutional	Schools, libraries, churches, hospitals, ambulatory care centers, group quarters.
Parks and Open Space	Parks, golf courses, cemeteries, ponds, and nature preserves.
Agriculture	Land actively in cultivation.
Undeveloped	Vacant lots, undeveloped desert.

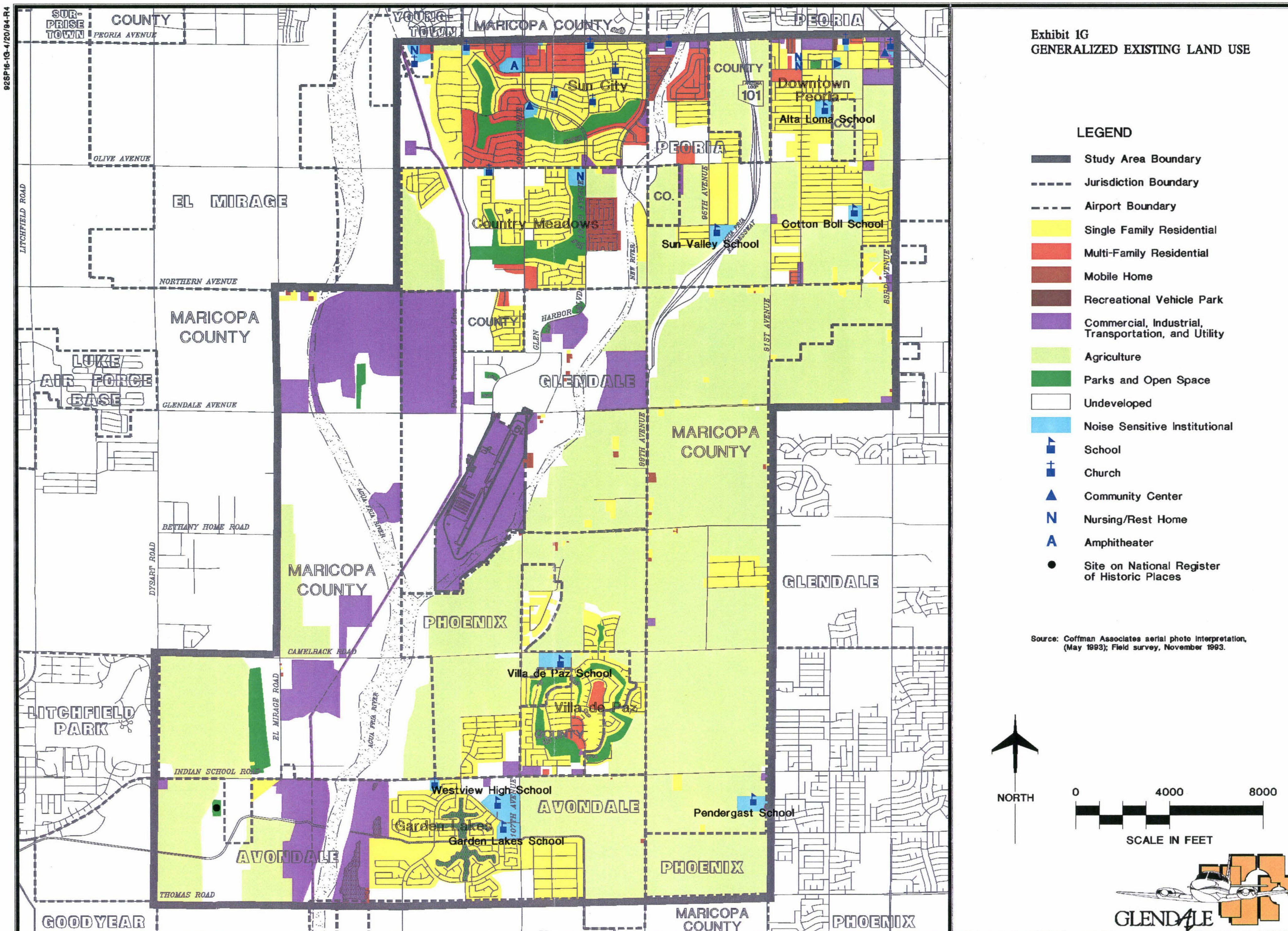

Exhibit 1G
GENERALIZED EXISTING LAND USE

Most of the land in the study area is currently in agricultural production. Agriculture in the area is a mixture of crops and dairy farms, concentrated in the southern and eastern sections of the study area.

Developed land in the study area is predominantly residential grouped into five primary areas and developments: Sun City (Maricopa County), downtown Peoria, Country Meadows (Peoria), Villa de Paz (Maricopa County and Phoenix), and Garden Lakes (Avondale). Industrial land uses are concentrated in the vicinity of Glendale Municipal Airport, including the Glen Harbor Industrial Park, and along the dry river beds where a number of sand and gravel extraction operations are found. Commercial land uses are concentrated along the section lines, particularly Indian School Road between 115th Avenue and 99th Avenue; Olive Avenue and Peoria Avenue.

The Sun City area, on the northern boundary of the study area, is comprised predominantly of single-family and two-family residences. Interspersed are churches and community centers. Sun City residents are predominantly of retirement age. Immediately west of Sun City, along 111th Avenue, is a single-family development of large, "horse-lots." Also in this area is Baptist Village South containing a 128 bed nursing home, 32 room extended care facility and 64 apartments. (Baptist Village North is outside of the study area.)

East of Sun City and west of the Outer Loop Freeway is a combination of residential land use categories, including apartment complexes, a mobile home park, single-family and two-family developments. East of the freeway to 83rd Avenue is the City of Peoria downtown area, including City Hall, library, police and fire stations, the Alta Loma Elementary School, and commercial retail and office establishments. Also included in this area are single-family residential developments, two-family developments, condominiums, retirement homes, apartment complexes, and a mobile home park.

South of Sun City, within the City of Peoria, are the developments of Country Meadows and Barclays Suncliff Estates. these are predominantly single-family developments, with some condominiums and multi-family sections near Northern Avenue. This area also includes the Country Meadows Country Club, a mobile home park, a nursing home and extended care facility, churches and commercial retail developments.

Continuing east, between 99th Avenue and 83rd Avenues, are predominantly single-family residential developments, including some with large horse-lots. Agricultural fields and two elementary schools, Sun Valley and Cotton Boll, are also in this area.

Land use between Northern and Glendale Avenues is primarily agriculture, including a dairy farm and a nursery operation. Immediately north of the airport is the Glen Harbor Industrial Park. North of the industrial park is a section of Country Meadows, comprised of single-family and multi-family developments. Northwest of Glendale Municipal Airport is the City of Glendale landfill, a commercial recreational development (go-cart racing) and a sand and gravel excavation operation.

Directly east of the airport is agricultural land with scattered, residences, comprised of both single-family and individual mobile homes. Land west of the airport, adjacent the Agua Fria River, remains undeveloped.

Southwest of the airport, west of the Agua Fria River are predominantly agricultural and sand and gravel excavation operations. There are some residences and commercial businesses at the intersection of Indian School Road and El Mirage Road. Also in this area is the Phoenix Trap and Skeet Club, shown on the map as "parks and open space."

East of the Agua Fria is a combination of agricultural and residential land uses. Immediately south of the airport is agricultural land, slightly to the east is the Thoroughbred Farms single-family, horse-lot subdivision and Camelback Greens, a single-family residential development. Villa de Paz, a development located partially in the City of Phoenix and partially in unincorporated Maricopa County, and Villa de Paz Elementary School are located south of Camelback Greens, between Camelback and Indian School Roads; Garden Lakes is located south and west of Villa de Paz. Villa de Paz is predominantly single-family residences with some apartments and condominiums. Garden Lakes, in the City of Avondale, is a single-family planned development still under construction. It includes both the Garden Lakes Elementary School and the Westview High School. East of these areas the land remains in agricultural use, with the exception of the Pendergast Elementary School and some scattered residences.

ELECTRIC TRANSMISSION CORRIDOR

An extra high voltage electric power corridor is located directly west of the airport. From east to west, the corridor is comprised of a double circuit 230 kilovolt (kV) transmission line on lattice steel towers owned by The Salt River Project (SRP). These towers support two 230 kV circuits, one owned by SRP and the second owned by the U.S. Department of Energy, Western Area Power Administration.

The second transmission line within the corridor is an Arizona Public Service single pole structure, currently supporting one 230 kV circuit. The line has been designed to support a second 230 kV circuit at a future date.

The third existing transmission line is owned by Tucson Electric Power (TEP). On lattice steel towers, this powerline currently supports one 345 kV circuit, and is designed to support a second 345 kV circuit. In addition, there is adequate space within the TEP right-of-way to construct a second powerline, which is permitted for a 500 kV line. The typical overall width of the powerline corridor is roughly 460 feet.

HISTORIC PLACES

The study area contains one site which is included within the National Register of Historic Places: Pioneer Cemetery, located east of Dysart Road and south of Indian School Road, in unincorporated Maricopa County. Some of the farm homes, sites of agricultural worker camps and irrigation facilities may be eligible for listing, but have not been pursued.

LAND USE PLANNING POLICIES AND REGULATIONS

In most cities and counties, the chief land use regulatory document is the zoning ordinance which regulates the types of uses, building height, bulk, and density permitted in various locations. Subdivision regulations are another important land use tool, regulating the platting of land. Local communities also regulate development through building codes. Non-regulatory policy documents which influence development include the general plan and the local capital improvements program. The general plan provides the basis for the zoning ordinance and sets forth guidelines for future development. The capital improvements program is typically a short-term schedule for constructing and improving public facilities, such as streets, sewers and water lines.

The following paragraphs describe each of the above areas as a means towards understanding the land use planning policies and regulations impacting the study area.

REGULATORY FRAMEWORK

In the Glendale Municipal Airport Study Area, Maricopa County, the cities of Glendale, Peoria, Phoenix, and Avondale, and the Town of Youngtown share the responsibility for land use regulation. Collectively, the six jurisdictions administer zoning ordinances, subdivision regulations, and building codes.

Arizona state law requires counties to prepare a comprehensive, generalized land use plan for development of the area of jurisdiction. The county plan shall also provide for zoning and the delineation of zoning districts. The county is also responsible for regulating the subdivision of all lands within its corporate limits, except subdivisions which are regulated by municipalities. Adoption of building codes are optional to those counties which have adopted zoning.

Arizona state law permits cities and towns to prepare, adopt and implement comprehensive, long-range, generalized land use plans for land both under their current jurisdiction and for unincorporated sections of the county which are likely to be annexed by the city/town. Local governments shall regulate the subdivision of all lands within its corporate limits and may also prepare and adopt zoning ordinances and building codes. Zoning must be consistent with the General Plan, where one has been prepared. General land use plans include plans and policies explaining the community's goals, objectives, principles, and standards for overall growth and development.

Within the Glendale Municipal Airport Study Area, the County and each of the four cities have prepared and adopted general plans, zoning ordinances, subdivision regulations and building codes; some of the jurisdictions have also prepared Capital Improvement Programs. These planning and development tools are described below.

GENERAL PLANS

Comprehensive, long-range plans serve as a guide to individual communities and jurisdictions to provide quality growth and development. The plans represent a generalized guideline, as opposed to a precise blueprint, for locating future development. The plan generally consists of elements which examine existing land uses and designate proposed future land uses and facilities. By illustrating preferred land use patterns, including extraterritorial areas, a general plan can be used by community staff, developers, investors, and citizens to assist them in evaluating future development opportunities.

Exhibit 1H depicts the proposed future land uses for the study area, as contemplated by the individual jurisdictions. Residential land uses are classified in three categories: rural, low density, and medium-high density. While all of the various general plans classify future residential development in terms of development density, the classifications used by each city are not identical. For purposes of **Exhibit 1H**, "rural residential" is generally considered to be a density of less than 2 units per acre. "Low Density" is between 2 and 6 units per acre. "Medium-high density" is greater than 6 units per acre.

Glendale General Plan: Development Guide

The Glendale City Council adopted their general plan on January 24, 1989. The plan provides for 19 land use categories, including: residential, retail, office, industry, public facility, park and open space. The majority of land in the immediate vicinity of the Glendale Municipal Airport property is planned for business park, light industry, general commercial, and open space (along the New River floodplain). East of the proposed Outer Loop Freeway, the *General Plan* calls for low-density residential land uses and the associated schools, neighborhood parks, and small office and retail developments.

In the Public Facilities and Services Element, adopted in June 1993, the City notes its intentions to locate additional public services in the study area. These services include police and fire stations, a park-and-ride lot, a water reclamation facility, public parks, and public golf courses. The City also proposes developing a multiple-use trail along New River with connection to a similar trail along the Grand Canal.

Peoria Comprehensive Master Plan

The City of Peoria originally adopted their *Comprehensive Master Plan* in May 1987; they have since adopted amendments to the plan in 1990 and 1992. The Plan calls for seven generalized land uses including: low and high density residential, resorts, community commercial, business park/ industrial, and park/open space. Within the study area the primary recommended land uses are low density residential, park/open space (along the New River floodplain), and business park/industrial (along the Agua Fria Freeway). The downtown area, located in the northeast corner of the study area, is proposed for community commercial land uses.

To service the study area, the Peoria general plan calls for the development of neighborhood parks, public schools and a fire substation. The City also proposes to develop a linear park corridor along the New River. The area is already served by the City's new municipal complex.

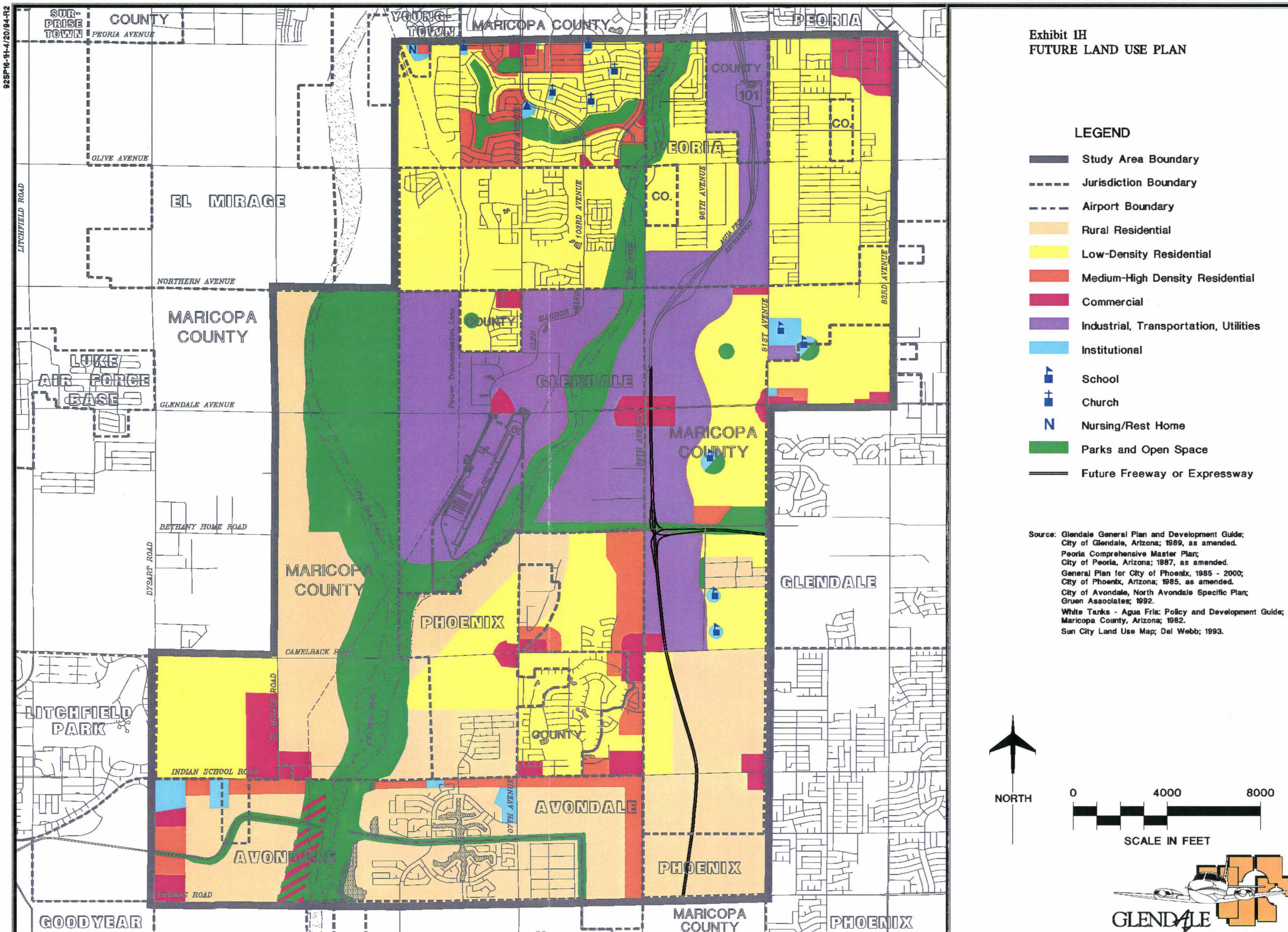

Exhibit 1H
FUTURE LAND USE PLAN

General Plan for Phoenix (1985-2000)

The City of Phoenix adopted their *General Plan* in October 1985. It has been amended several times since then, most recently in July 1992; amendments are typically made by the City on an annual basis. The plan calls for fifteen land uses, including: residential, mixed use, commercial, industrial, public, parks/open space, and development constrained (hillside and floodplain). Within the study area, the City of Phoenix proposes primarily residential land uses, from very low (0-2 dwelling units per acre) to high density (15+ du/a); commercial; and parks/open space (along the Agua Fria River).

According to the *General Plan,* the City does not currently anticipate locating libraries or other public facilities within the Glendale Municipal Airport Study Area.

City of Avondale:
North Avondale Specific Plan

The City of Avondale prepared and adopted a specific plan for the North Avondale area to provide greater detail for development guidance than is otherwise available in their General Plan. The *North Avondale Specific Plan* includes the Avondale portion of the Glendale Municipal Airport Study Area. The Plan calls for seven generalized land uses including: Residential (Rural-Low); Residential (Medium); Transition (Commercial/Multi-Family); Commercial/Employment; Public/ Quasi-Public; Open Space/Recreation; and Drainage/Open Space. Within the study area, the plan calls for primarily residential and commercial land uses. Also discussed is a trail along the Roosevelt Irrigation Canal and the Agua Fria River.

According to the *City of Avondale: Freeway Corridor Specific Plan,* the new downtown would be located just outside of the study area. Land uses in this area include commercial, office, public, and moderate to high density residential.

Maricopa County

Maricopa County has two plans related to land use and development within the study area; these are the *White Tanks -- Agua Fria: Policy and Development Guide* and the *County-wide Comprehensive Plan Goals, Policies and Standards.*

The *White Tanks -- Agua Fria: Policy and Development Guide* was adopted by the Maricopa County Board of Supervisors in November 1982. It contains a statement of goals, objectives and policies that affect the western portion of the Glendale Municipal Airport Study Area, west of the Agua Fria River. According to the Generalized Future Land Use exhibit found within the document, future land uses west of the Agua Fria and within the study area (the area between Camelback, Thomas, El Mirage and Dysart Roads) are expected to be urban residential and floodplain. Urban residential describes those areas which are considered appropriate for future urban development; gross residential densities will be greater than one house per acre.

The *County-wide Comprehensive Plan Goals, Policies and Standards* document is intended to provide a basis for public and private actions to guide orderly and planned growth within the County, promote high quality development, and improve and expand transportation and public facilities for the County.

ZONING

Zoning ordinances are important in noise compatibility planning because they control the type and intensity of land uses in the area. Zoning also can be used in certain circumstances to attach special conditions to the use of land which may in some way serve to protect the public's general health and welfare. The purpose of this analysis is to indicate which zoning districts around the airport provide a compatible land use buffer for the airport and which ones may potentially allow encroachment by noise-sensitive land uses. The analysis can also reveal whether some districts where noise-sensitive uses are allowed may be easily adapted to promote noise compatible development. For example, a noise-sensitive land use which is permitted only as a conditional use in a particular district could potentially be prohibited from noise-impacted areas if sufficient guidelines were provided in the zoning ordinance. Alternatively, it may be decided later in this study, on the basis of further analysis, that such land uses should be entirely prohibited in noise-impacted areas.

The zoning ordinances of Maricopa County and the Cities of Glendale, Peoria, Phoenix, and Avondale are briefly discussed in the following sections. **Appendix B** provides a more detailed review of the various zoning districts and their potential for noise-sensitive land uses. A generalized zoning map for the area is shown in **Exhibit 1J**.

City of Glendale

The most recent edition of Glendale's *Zoning Ordinance* became effective in July 1993. The ordinance provides for 30 zoning districts categorized under nine groups: Agricultural, Suburban Residential, Urban Residential, Multiple Residence, Office, Downtown, Commercial, Industrial, and Planned Area Development. There are also five overlay districts: Airport Impact Overlay, Planned Residential Development, Mobile Home, Historic Preservation, and Special Use District. The key provisions of each fixed district are reviewed in **Appendix B, Table B1.** Uses allowed in the various districts include "permitted" uses, which require design review and approval by administrative officials, and "conditional" uses, which require review and approval by the Planning Commission.

City of Peoria

The Peoria *Zoning Ordinance* provides for 27 zoning districts, including six Special District, nine Residential Districts and 12 Non-Residential Districts. The key provisions of the ordinance relating to noise compatibility planning are summarized in **Appendix B, Table B2.**

City of Phoenix

The Phoenix *Zoning Ordinance* provides for 37 fixed zoning districts, including 16 residential use districts and 21 non-residential use districts. A number of the commercial use zones do not set specific minimum lot size requirements; these are determined based on proposed uses and required setbacks, parking,

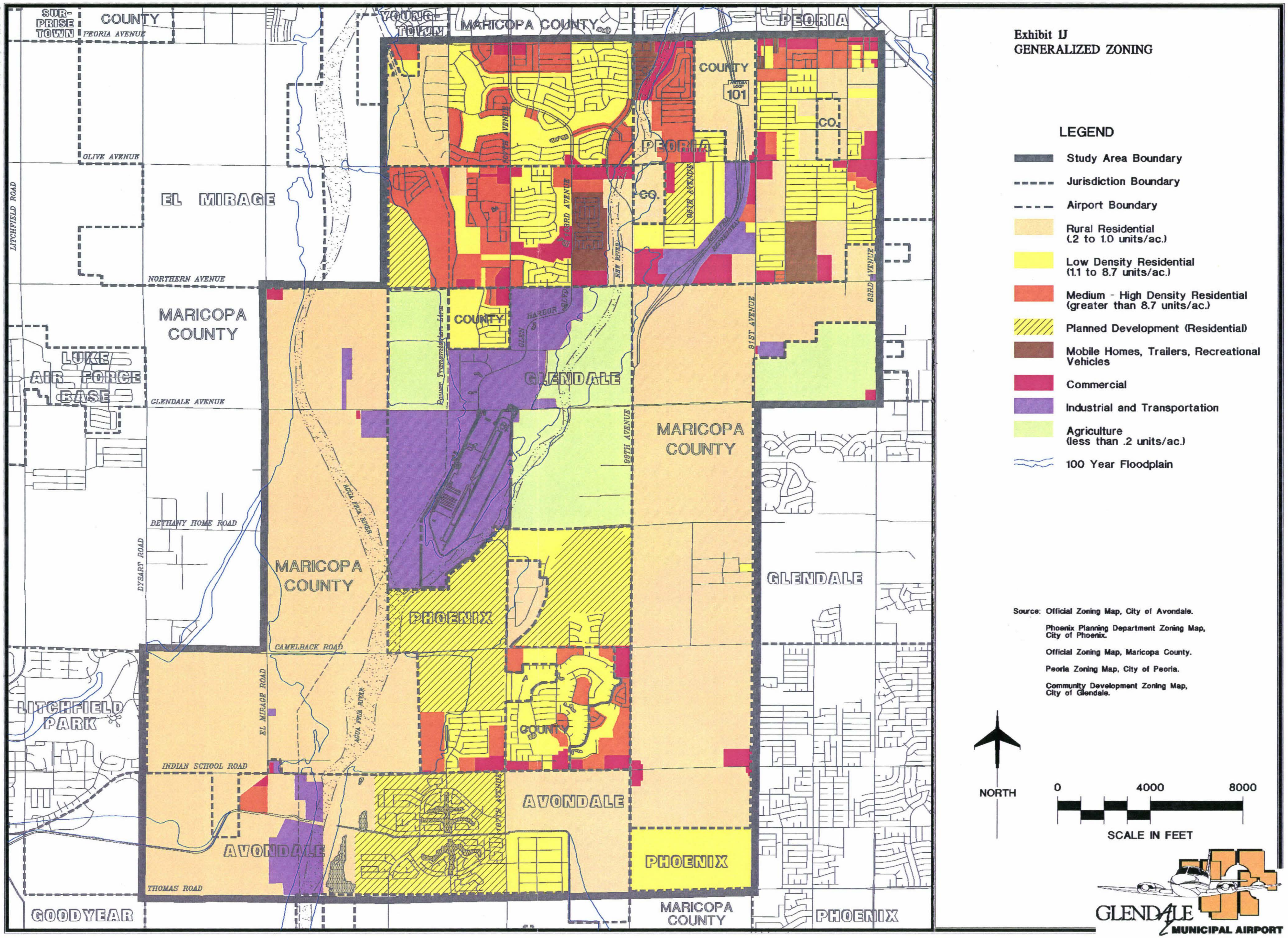
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Exhibit 1J
GENERALIZED ZONING
LEGEND
Study Area Boundary
Jurisdiction Boundary
Airport Boundary
Rural Residential (.2 to 1.0 units/ac.)
Low Density Residential (1.1 to 8.7 units/ac.)
Medium - High Density Residential (greater than 8.7 units/ac.)
Planned Development (Residential)
Mobile Homes, Trailers, Recreational Vehicles
Commercial
Industrial and Transportation
Agriculture (less than .2 units/ac.)
100 Year Floodplain
Source: Official Zoning Map, City of Avondale.
Phoenix Planning Department Zoning Map, City of Phoenix.
Official Zoning Map, Maricopa County.
Peoria Zoning Map, City of Peoria.
Community Development Zoning Map, City of Glendale.
NORTH
0
4000
8000
SCALE IN FEET
GLENDALE MUNICIPAL AIRPORT
SURPRISE TOWN
COUNTY
PEORIA AVENUE
YOUNGTOWN
MARICOPA COUNTY
PEORIA
OLIVE AVENUE
EL MIRAGE
LITCHFIELD ROAD
NORTHERN AVENUE
MARICOPA COUNTY
LUKE AIR FORCE BASE
GLENDALE AVENUE
BETHANY HOME ROAD
DYSART ROAD
CAMELBACK ROAD
LITCHFIELD PARK
INDIAN SCHOOL ROAD
EL MIRAGE ROAD
AVONDALE
THOMAS ROAD
GOODYEAR
AGUA FRIA RIVER
PHOENIX
GLENDALE
Power Transmission Line
COUNTY
CO.
101
99TH AVENUE
91ST AVENUE
83RD AVENUE
107TH AVENUE
MARICOPA COUNTY
GLENDALE
AVONDALE
PHOENIX
MARICOPA COUNTY
PHOENIX

landscaping, etc. The City has set forth detailed Development Review Procedures regarding their review of zoning and development plans. The key provisions of the ordinance relating to noise compatibility planning are summarized in **Appendix B, Table B3.**

City of Avondale

The City of Avondale *Zoning Ordinance* provides for 16 zoning districts, in 4 general categories: residential, commercial, industrial, and planned development. In some districts, the minimum lot size is not predetermined, instead, it is based on design standards. The key provisions of the ordinance relating to noise compatibility planning are summarized in **Appendix B, Table B4.**

Maricopa County

The Maricopa County *Zoning Ordinance* provides for 23 zoning districts, including rural, residential, commercial and industrial. The key provisions of the ordinance relating to noise compatibility planning are summarized in **Appendix B, Table B5.**

Summary Of Zoning Classifications

Table 1G summarizes the classification of zoning districts shown in **Exhibit 1J.** There are eight generalized zoning districts which correspond to the various zoning designations of the cities and county. The "Agriculture," "Mobile-Homes," "Commercial," and "Industrial" categories include permitted uses relevant to these districts where applicable. The "Low-Density" category applies to single-and two-family districts, with the "Medium-Density" category applying to districts permitting such development as multi-family dwellings, apartments, and high-rises. The "Planned Development" category primarily encompasses mixed use development in designated areas suitable for such development. The "Floodplain" category applies to areas subject to inundation by flood waters.

FLOODPLAIN MANAGEMENT

The Flood Control District of Maricopa County, as a district of County government, provides flood and stormwater management services for Maricopa County. In this capacity, their services include regulatory activities, master planning, technical assistance, and structural flood control projects such as dams, channels, and stormdrains. The District does not have the authority to prohibit construction within the floodplain. While municipalities do have the authority to implement floodplain regulations, of those municipalities located within the study area, the City of Peoria is the only jurisdiction that has incorporated a floodplain district into its zoning ordinance. The intent of their district is to ". . . establish such regulations as are necessary to protect private and public property from the hazards of flood water and to protect the public from the hazards and costs which may be incurred when unsuitable development occurs in such areas."

As designated on the Federal Emergency Management Agency Flood Insurance Rate Maps, the 100-year floodplain within the study area is primarily associated with the Agua Fria River, located to the west of the airport, and its tributary, New River, located to the east of the airport. New River flows into the

Agua Fria just south of the airport's southern boundary (**Exhibit 1J**). The Flood Control District of Maricopa County is currently completing flood control improvements for New River, between Olive Avenue and Bethany Home Road. At this time, no flood control improvements are currently planned for that portion of the Agua Fria River within the study area.

TABLE 1G
Generalized Zoning Districts

District	City of Glendale	City of Phoenix	City of Peoria	City of Avondale	Maricopa County
Agriculture (less than .2 units/acre)	A-1	--	--	--	--
Rural Residential (.2 to 1.0 units/acre)	--	S-1, S-2, RE-43	SR-43, AG	AG	Rural-190, Rural-70, Rural-43
Low Density Residential (1.1 to 8.7 units/acre)	SR-30, SR-17, SR-1, R1-10, R1-8, R1-7, R1-6, R1-4	RE-24, R1-14, RE-35, R1-18, R1-10, R1-8, R1-6	R1-35, R1-18, R1-12, R1-10, R1-8, R1-6	R1-35, R1-15, R1-8, R1-6, R1-5	R1-35, R1-18, R1-10, R1-8, R1-7, R1-6
Medium-High Density Residential (greater than 8.7 units/acre)	R-2, R-3, R-4, R-5, R-O	R-2, R-3, R-3A, R-4, R-4A, R-5, H-R, H-R1	RM-1	R-2, R-3, R-4	R-2, R-3, R-4, R-5, SC
Mobile Homes	--	--	RMH-1, RMH-2	R-5	MHR
Planned Development	PAD, PRD	PAD, PC	PUD, PAD	PAD	PD
Commercial	C-O, G-O, PR, SC, C-1, C-2, C-3	R-O, C-O, C-1, C-2, C-3, B-3, R-H, PSC, RSC	O-1, C-1, PC-1, PC-2, C-2, C-3, C-4, C-5	C-O, C-1, C-2	C-S, C-O, C-1, C-2, C-3
Industrial and Transportation	B-P, M-1, M-2, M-P	A-1, A-2	PI-1, I-1, I-2, BPI	CP, A-1	IND-1, IND-2, IND-3
Floodplain	--	--	FP	--	--

SUBDIVISION REGULATIONS

Subdivision regulations apply in cases where a parcel of land is proposed to be divided into lots or tracts. They are established to ensure the proper arrangement of streets, adequate and convenient open space, efficient movement of traffic, adequate and properly-located utilities, access for fire-fighting apparatus, avoidance of congestion, and the orderly and efficient layout and use of land.

Subdivision regulations can be used to enhance noise-compatible land development by requiring developers to plat and develop land so as to minimize noise impacts or reduce the noise sensitivity of new development. The regulations can also be used to protect the airport proprietor from litigation for noise impacts at a later date. The most common requirement is the dedication of a noise or avigation easement to the local government by the land subdivider as a condition of development approval. The easement authorizes overflights of the property, with the noise levels attendant to such operations. It also requires the developer to provide noise insulation in the construction of the buildings.

While each of the jurisdictions regulates the subdivision of land, none of them require special development considerations in the vicinity of the Glendale Municipal Airport.

BUILDING CODES

Building codes regulate the construction of buildings, ensuring that they are built to safe standards. Building codes may be used to require sound insulation in new residential, office, and institutional buildings when warranted by existing or potential high aircraft noise levels. Each of the jurisdictions involved in the study area have adopted versions of the Unified Building Code (UBC). None of the jurisdictions have additional regulations related to noise in the vicinity of Glendale Municipal Airport.

CAPITAL IMPROVEMENT PROGRAMS

Capital improvements programs (CIP) are multi-year plans, typically covering five or six years, which list major capital improvements planned to be undertaken by a particular jurisdiction during each year. The CIP does not include facility improvements that are proposed to be funded entirely by developers.

Most capital improvements have no direct bearing on noise compatibility; few municipal capital improvements are noise-sensitive. The obvious exceptions to this are schools and, in certain circumstances, libraries, medical facilities and cultural/recreational facilities. The noise compatibility planning process includes a review of planned facilities of these types as a matter of course.

Some capital improvements, however, may have an indirect, but more profound, relationship to noise compatibility. For instance, sewer and water facilities may open up large vacant areas for private development of noise-sensitive residential uses. In contrast, the same types of facilities, sized for industrial users, could permit industrial development in the same noise-impacted area that might otherwise be attractive for residential development on septic tanks.

All of the jurisdictions in the study area prepare capital improvement programs. Currently, there are no projects listed which would impact on this study. The City of Avondale proposes some street repaving and replacement of existing water lines.

MAG Transportation Improvement Program

The Maricopa Association of Governments has prepared a five-year Transportation Improvement Program (TIP) for the Phoenix Metropolitan Statistical Area (MSA), including the study area. The TIP review process is initiated by MAG, as the Metropolitan Planning Organization (MPO), each year with participating agencies and jurisdictions, and culminates in the adoption of the TIP document describing planned transportation improvements. This document, which currently covers the 1994-1998 period, is intended to serve as a five-year regional guide for the preservation, management and expansion of public transportation services including surface roads, transit, demand management and alternative mode improvements. Major TIP projects within the study area are described in **Table 1H** and depicted on **Exhibit 1K.** Of the nine projects proposed for the study area, five are roadway widenings to accommodate higher levels of traffic.

TABLE 1H
Transportation Improvement Program
Projects in Study Area

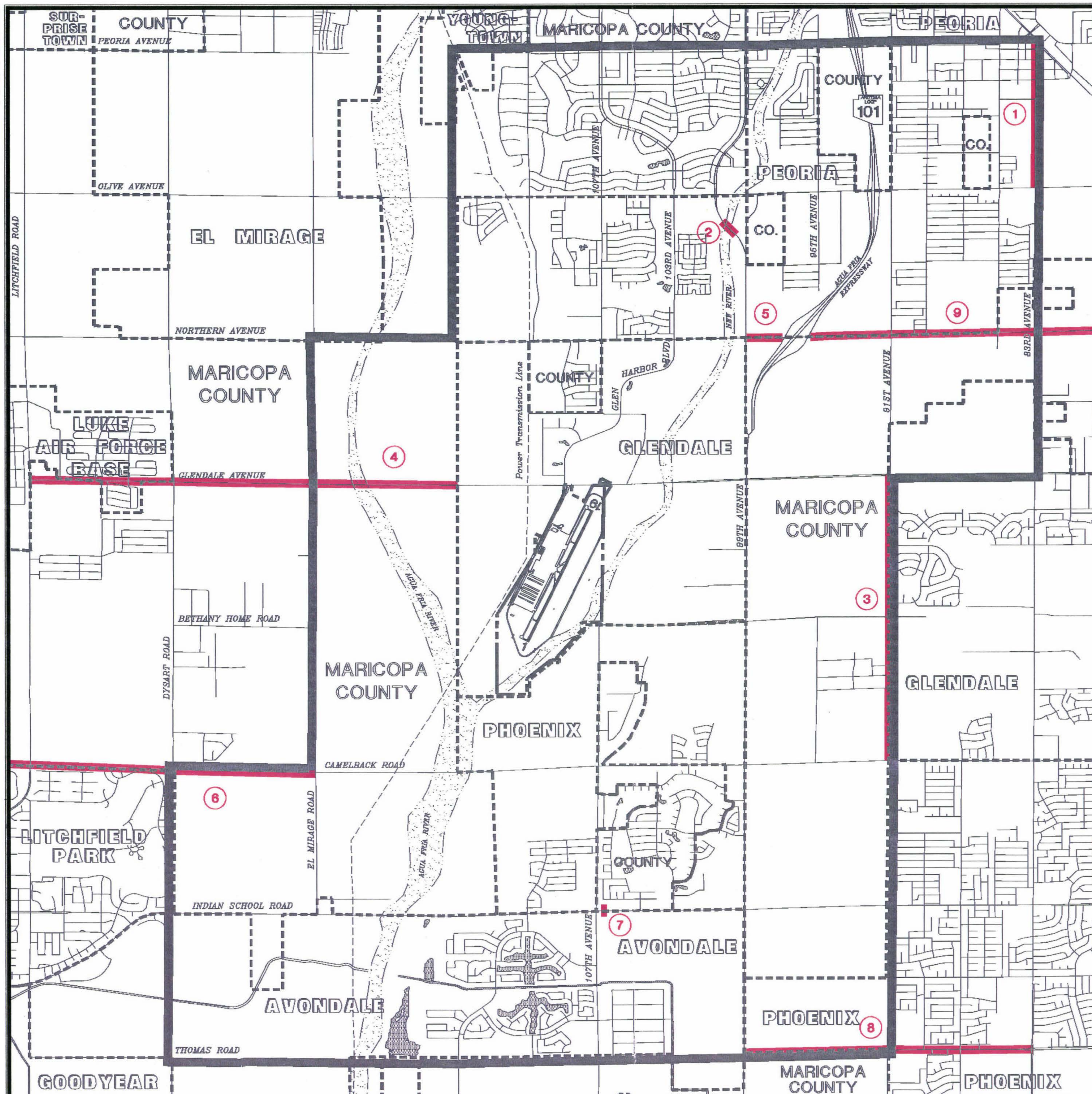
Year	Location	Project
1994	83rd Avenue Olive to Washington Street	Widening, paving, curb, and gutter
1994	99th Avenue	Bridge across New River
1995	91st Avenue Camelback Rd to Glendale Ave	Reconstruct 2 to 4 lanes
1995	Glendale Avenue Litchfield Rd to 115th Ave	Overlay 4 lanes
1995	Northern Avenue 99th Ave to Loop 101	Reconstruct 2 to 4 lanes
1996	Camelback Road Litchfield Rd to El Mirage Rd	Reconstruct 2 to 4 lanes
1996	Indian School Road 100 ft east of 107th Ave	Box or pipe culvert
1997	Thomas Road 99th Ave to 83rd Ave	Reconstruct to 84 ft cross section, adding 3 new lanes
1998	Northern Avenue Loop 101 to 71st Ave	Reconstruct 2 to 4 lanes

SOURCE: MAG 1994-1998 Transportation Improvement Program; Maricopa Association of Governments; September 1993.

SUMMARY

The information discussed in this chapter provides a foundation upon which the remaining elements of the planning process will be constructed. Information on current airport facilities and utilization serve as a basis for the development of forecasts of aviation activity, demand/capacity analyses and existing aircraft noise determinations during the next phase of the study. This

Exhibit 1K
TRANSPORTATION IMPROVEMENT PROGRAM PROJECTS



LEGEND

- Study Area Boundary
- Jurisdiction Boundary
- Airport Boundary
- T.I.P. Project

1. 83rd Avenue - Widening, paving
2. 99th Avenue - Bridge replacement
3. 91st Avenue - Reconstruction
4. Glendale Avenue - Overlay
5. Northern Avenue - Reconstruction
6. Camelback Road - Reconstruction
7. Indian School Road - Culvert
8. Thomas Road - Widening
9. Northern Avenue - Reconstruction

Source: "MAG 1994 - 1998 Transportation Improvement Program" (T.I.P.), Maricopa Association of Governments, September 1993

GLENDALE MUNICIPAL AIRPORT

92SP16-1K-4/20/94-R3

information will, in turn, provide guidance to the assessment of potential changes to aviation facilities or procedures necessary to meet the goals of the planning process.

The inventory of airport facilities will allow the determination of the needs presented by airport users in both the short and long terms and the preparation of plans to meet those needs. The inventory of the airport environs will allow the assessment of the impacts associated with noise levels generated by airport users.

In the Glendale Municipal Airport Study Area, five jurisdictions share primary responsibilities for land use regulation and development: the cities of Glendale, Peoria, Phoenix, and Avondale, and Maricopa County. The Town of Youngtown has the responsibility for a small portion of the study area in the northwest corner. The study area is located in a rapidly growing section of the metropolitan urban area, as evidenced by the newly constructed and proposed residential developments to the south and the growing industrial park north of the airport. Growth in this area is expected to increase with the completion of the Outer Loop Freeway (Route 101). The existing agricultural, industrial and open space land uses in the immediate vicinity are generally compatible with the airport. Existing residential areas are located further north and south of the airport. Additional residential development is proposed closer to the airport itself.

In essence, this inventory represents the first step in the complex process of determining those factors which will help reduce aircraft noise and its impacts.

CHAPTER TWO
AVIATION NOISE

GLENDALE
MUNICIPAL AIRPORT

CHAPTER 2

AVIATION NOISE

This chapter describes the noise exposure maps for Glendale Municipal Airport. Noise contour maps are presented for three study years: 1994, 1999, and 2015. The 1994 noise contour map shows the current noise levels based on actual operations for the calendar year 1993. The 1999 and 2015 maps are based on operations levels as projected in Appendix C of this document. The 1994 and 1999 maps are the basis for the official "Noise Exposure Maps" required under F.A.R. Part 150.

These noise contour maps are considered as baseline analyses. They assume operations based on the existing procedures at Glendale. No additional noise abatement procedures have been assumed in these analyses. These noise contour maps will serve as baselines against which potential noise abatement procedures will be compared at a later point in the study.

The noise analysis presented in this chapter relies on complex analytical methods and uses numerous technical terms. Appendix D presents helpful background information on noise measurement and analysis.

AIRCRAFT NOISE MEASUREMENT PROGRAM

A noise measurement program was conducted over a six day period from December 3, 1993 through December 8, 1993. The field measurement program was designed and undertaken to provide real data for comparisons with the computer predicted values. These comparisons provide insights into the actual noise conditions around the airport and can serve as a guide for evaluating the assumptions developed for the computer modeling. The measurement program was designed to obtain aircraft noise measurements throughout the area of anticipated impact. This information includes the acoustical output, as measured at known locations, and the flight trajectory (ground track and altitude profile).

It must be recognized that field measurements made over a 24-hour period are applicable only to that period of time and may not -- in fact in many cases, do not -- reflect the average conditions present at the site over a much longer period of time. The relationship between field measurements and computer generated noise exposure forecasts is analogous to the relationship between weather and climate. While an area may be characterized as having a cool climate, many individual days of high temperatures may occur. In other words, the modeling process derives overall average annual conditions (climate), while field measurements reflect daily fluctuations (weather).

Information collected during the noise monitoring program included 24-hour measurements for comparison with computer-generated DNL values. DNL -- day-night sound level -- is a measure of cumulative sound energy during a 24-hour period. In addition, all noise occurring from 10:00 p.m. to 7:00 a.m. is assigned a 10 dB penalty because of the greater annoyance typically caused by nighttime noise. Use of the DNL noise metric in airport noise compatibility studies is required by F.A.R. Part 150. Additional information included single event measurements to indicate typical dBA and Sound Exposure Levels (SEL) within the study area and comparative ambient noise measurements in areas affected by aircraft noise. In addition to aircraft noise measurements, one-hour sample measurements of other transportation and ambient noise sources were also collected. These background measurements are detailed later in this chapter.

ACOUSTICAL MEASUREMENTS

This section provides a technical description of the acoustical measurements which were performed for the Glendale Municipal Airport F.A.R. Part 150 Noise Compatibility Study. Described here are the instrumentation, calibration procedures, general measurement procedures, and related data collection items and procedures.

Instrumentation

Three sets of acoustical instrumentation and analysis equipment were employed in order to obtain acoustical data to compare with standard and predicted data associated with aircraft noise. The major instrumentation which was utilized for these purposes is given in **Table 2A**.

The field measurement instrumentation consisted of a high quality microphone connected to a 24-hour environmental noise monitor unit. Each unit was periodically calibrated to assure consistency between measurements at different locations. A GenRad Minical Calibrator, with an accuracy of 0.5 decibels, was used for all measurements. At the completion of each field measurement, the calibration was rechecked, the accumulated output data was downloaded to a portable computer and the data memories were cleared before placement at a new site.

The equipment indicated in the table was supplemented by accessory cabling, windscreens, tripods, security devices, etc., as appropriate to each measurement site.

TABLE 2A Acoustical Measurement Instrumentation	
3	Metrosonics dB-604 Portable Noise Monitors
3	Gen Rad Model 1962-9600 1/2" Electret-Condenser Microphone
3	Gen Rad Model 1972-9600 Pre-amplifier/Adaptor
1	Gen Rad Model 1987 Minical Sound-Level Calibrator
1	AMS '486 Portable Computer

Measurement Procedures

Noise resulting from all noise sources was recorded at each of the noise measurement sites. This information, when correlated with flight track information, is used to estimate aircraft single event levels for comparison with predicted single event levels from the Integrated Noise Model.

Two methods were used to attempt to minimize the potential for non-aircraft noise sources to unduly influence the results of the measurements. First, for single-event analysis, minimum noise thresholds of five to ten decibels (dB) greater than ambient levels were programmed. This procedure resulted in the requirement that a single noise event exceed thresholds ranging from 63 to 65 dB depending on the measurement site. Second, a minimum event duration longer than the time associated with ambient single events above the threshold (for example, road traffic) was set (generally at five seconds). The combination of these two factors limited the single events analyzed in detail to those which exceeded the preset threshold for longer than the preset duration. In spite of these efforts, contamination of the single event data is always possible. In fact, because of the nature of the aircraft events at the measurement sites around Glendale Municipal Airport, the thresholds of 60 to 65 dB are relatively low and some ambient noise events can surpass these levels. This is particularly true during moderate weather conditions when the outdoor ambient noise levels in residential areas tend to be somewhat higher than during other seasons.

Although only selected single events were specially retained and analyzed, the monitors do, however, cumulatively consider all noise present at the site, regardless of its level, and provide hourly summations of Equivalent Noise Levels (Leq). Additionally, the equipment optionally provides information on the hourly maximum decibel level, SEL values for each event which exceeds the preset threshold and duration, and distributions of decibel levels throughout the measurement period.

Weather Information

The noise measurements taken during this study were obtained during a period of seasonably normal winter weather for Glendale. Conditions were generally clear throughout the program. Winds were generally calm with occasional light gusts from various directions. Temperatures were seasonable and generally colder than the average annual temperatures for the area. Daily high temperatures ranged from the low to the mid-70s.

Aircraft Noise Measurement Sites

Sites used to obtain aircraft noise data are shown on **Exhibit 2A**. Specific sites were selected on the basis of background information, local observation during the field effort, and suggestions from the Airport Management. Specific selection criteria include the following:

- Emphasis on areas of marginal or greater than marginal aircraft noise impact according to earlier evaluations; less emphasis on areas closer to the airport since these have less variation in aircraft operation and exposure.

- Representative sampling of all major types of operations and aircraft using the airport.

- Screening of each site for local noise sources or unusual terrain characteristics which could affect measurements.

- Location in or near areas from which a substantial number of complaints about aircraft noise were received, or where there are concentrations of people exposed to significant aircraft overflights.

While there is no end to the number of locations available for monitoring, the selected sites, as individually discussed in the following paragraphs and shown on the map, fulfill the above criteria and provide a representative sampling of the varying noise conditions in the airport vicinity. A total of twelve sites were measured for a 24-hour period with one-hour measurements at an additional six locations.

- 24-HOUR MEASUREMENT SITES

Site #1 was located at 10317 West Loma Lane. This is a home on the southeast side of the Country Meadows subdivision north of Northern Avenue. The equipment was set up at the rear of the house. The area is a single family residential area of contemporary homes on medium lots. The back yard at the site was enclosed by a wall and is adjacent to the Northern Avenue right of way. The site is located about one and a quarter miles north of the airport and approximately 1,000 feet west of the Runway 1-19 centerline.

A total of 65 single events were recorded above the preset thresholds. Of these, eight were observed during flight tracking as aircraft overflights near enough to the site to correlate with the measurements. These overflight events ranged from 71.9 to 86.7 dB. The average DNL for sound levels above the threshold was 48.2 dB.

Site #2 was in the Villa de Paz subdivision at 10344 West Hazelwood. This is an area of single family homes on medium sized lots. The equipment was placed at the rear of the house in the back yard. The site is located about one and one half miles southeast of the airport.

The measurements at this site identified 47 single events above the threshold during the 24 hours of measurements. Two of these events were correlated with aircraft flight track data. The levels generated by these overflights were 77.6 and 78.0 dB. The duration of the events was nine seconds and ten seconds, respectively. The average DNL above the threshold at the site was 44.4 DNL.

Site #3 was located at 4314 North 111th Drive. This is a single family home in a subdivision located just west of the Villa de Paz subdivision. The measurement equipment was set up in the back yard which is adjacent to a large open field affording a direct line-of-site view of the airport. There was occasional barking

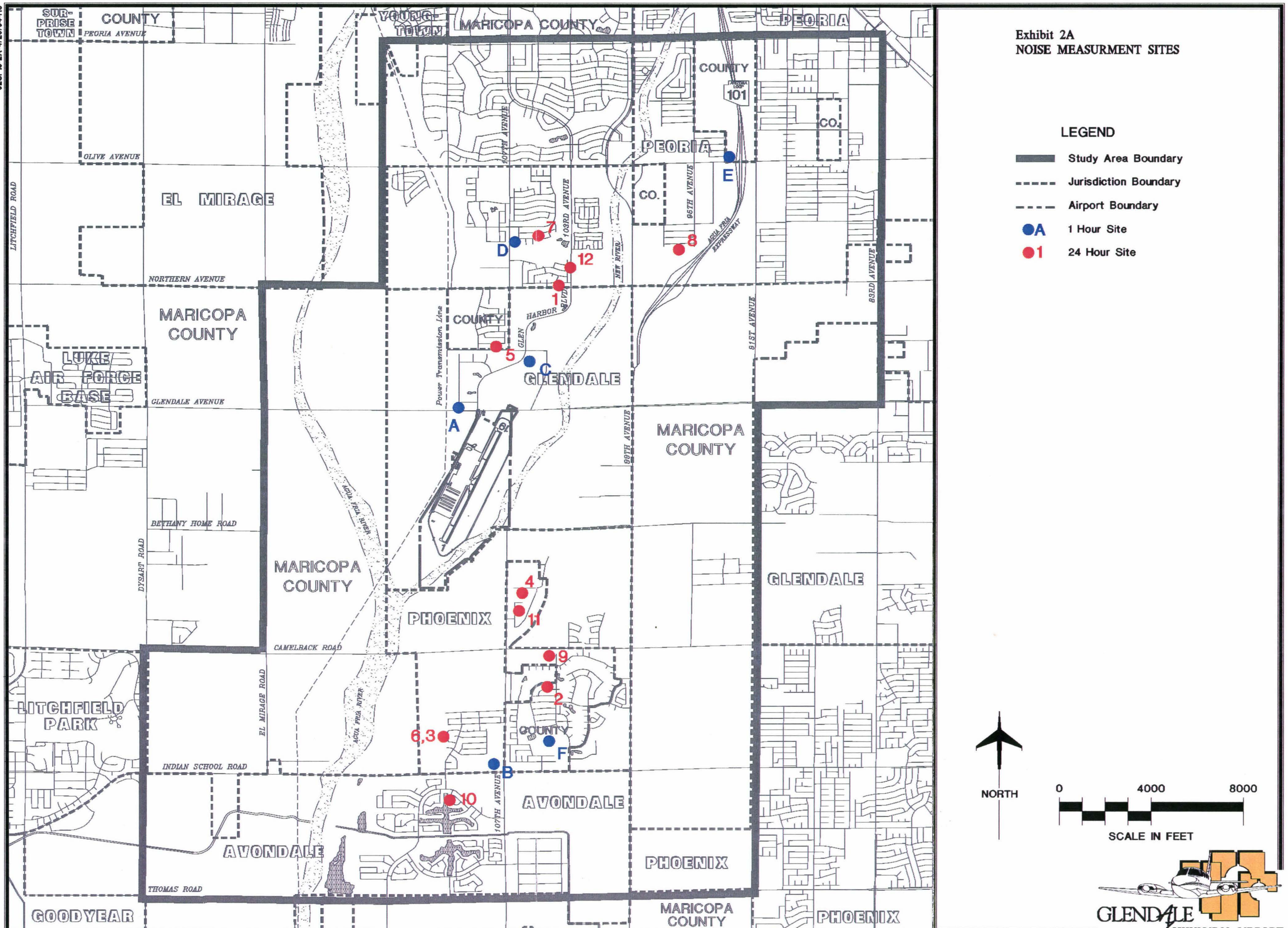


Exhibit 2A
NOISE MEASURMENT SITES
LEGEND
Study Area Boundary
Jurisdiction Boundary
Airport Boundary
A 1 Hour Site
1 24 Hour Site
NORTH
0 4000 8000
SCALE IN FEET
GLENDALE MUNICIPAL AIRPORT
92SP16-2A-4/20/94-R3
SUR-PRISE TOWN
COUNTY
PEORIA AVENUE
YOUNG-TOWN
MARICOPA COUNTY
PEORIA
COUNTY
CO.
101
OLIVE AVENUE
EL MIRAGE
NORTHERN AVENUE
MARICOPA COUNTY
LUKE AIR FORCE BASE
GLENDALE AVENUE
GLENDALE
LITCHFIELD ROAD
DYSART ROAD
BETHANY HOME ROAD
CAMELBACK ROAD
INDIAN SCHOOL ROAD
THOMAS ROAD
EL MIRAGE ROAD
AGUA FRIA RIVER
NEW RIVER
AGUA FRIA EXPRESSWAY
103RD AVENUE
107TH AVENUE
99TH AVENUE
96TH AVENUE
91ST AVENUE
83RD AVENUE
GLEN HARBOR BLVD
Power Transmission Line
PHOENIX
LITCHFIELD PARK
AVONDALE
GOODYEAR

from nearby dogs during setup. The site is located approximately one and one half miles south of the airport and about 3,000 feet east of the Runway 1-19 extended centerline.

Some 27 single events were recorded at the site, three of which were observed during the flight tracking. The observed events ranged from 75.9 to 82.5 dB. The average DNL above the threshold was 46.6.

Site #4 was located just east of the Airport in the Camelback Farms subdivision. The equipment was placed at 10637 West Missouri just east of 107th Avenue. This is a small subdivision of contemporary homes on large, "horse" lots. The microphone was placed in the back yard to avoid exposure to road noise. The site is located about three-quarters of a mile east of the Airport and abeam the Runway 1 threshold.

This site should receive both arrival and departure overflights from pattern activity at Glendale Municipal regardless of the traffic flow direction. The 24-hour measurement identified 34 single events above the preset thresholds. Twelve of these events were observed at this site during the radar tracking programs. These observations correlated to events that ranged from 71.2 to 82.0 dB. The average DNL above the threshold for the site was 45.6 DNL.

Site #5 was located north of the airport in the southern portion of the Country Meadows subdivision. This site is about 3,000 feet directly north of the airport and just west of the Runway 1-19 extended centerline. This is an area of newer single family homes on medium sized lots. The equipment was placed at the side of the home to avoid pets and children playing.

The measurements at this site indicated that 25 single events were recorded. Three of these were able to be correlated with the tracking data. The single events due to the aircraft operations ranged from 72.8 to 74.9 dB. The average DNL sound level above the threshold was 47.7 DNL.

Site #6 was located at the same site as Site #3, providing an additional 24 hours of measurements at this location. See the description for Site #3.

Site #7 was again located north of the airport in the Country Meadows subdivision. The equipment was placed at 10449 Echo Lane on the southern edge of the golf course. The microphone was placed in the back yard to avoid exposure to road noise. This site is located about two miles north of the airport and approximately 4,000 feet west of the Runway 1-19 centerline.

Eleven single events were recorded during the measurement period. However, none of these were observed during flight tracking and identified as aircraft overflights. The average DNL above the threshold for the measurement period was 42.9 DNL.

Site #8 was located in a residential area north of the airport near the Agua Fria Expressway in Peoria. The equipment was located at 9615 West Las Palmaritas Drive. This is a small pocket subdivision located in a generally rural area. The homes are contemporary on medium sized lots. The site is about two miles northeast of the airport and about 3,000 feet east of the Runway 1-19 centerline.

During the 24-hour measurement period there were 69 single events recorded. No observed flight tracks were able to be correlated with any of the registered single events. The average DNL above the threshold for the site was 47.1 DNL.

Site #9 was located at the Villa de Paz Elementary School located just south of Camelback Road in the northern portion of the Villa de Paz subdivision. The equipment was placed on the roof of the school to avoid exposure to playground activities. The site is located in the same general area as Site #2 and is about a mile east of the airport.

During the measurement period there were 123 single events recorded by the equipment. Only two of these events were able to be correlated with radar tracking observations. Both were overflights from pattern training activity. The events measured 71.0 and 76.3 dB, while the loudest single event recorded was 84.8 dB. A considerable amount of the noise recorded was due to children playing and moving through the outside corridors of the school. The average DNL above the threshold was 48.8.

Site #10 was located south of the airport in the Garden Lakes Subdivision at 3828 North Carnation Lane. This is an exclusive area of contemporary homes of medium to large size. The site is located approximately two miles south of the airport and is about a mile east of the centerline for Runway 1-19.

The measurements at this site recorded 22 single events during the 24-hour period. There were no radar tracking observations which were able to be correlated with single events at the site. There were a number of unusually loud events recorded at the site with long durations upwards of one to three minutes. The loudest event recorded was 115.1 dB. These events were associated with yard and landscaping work using power equipment that was done during the measurement period. These events were removed from the calculations to reveal an average DNL above the threshold at the site of 44.0 DNL.

Site #11 was located just east of the airport in the Camelback Farms subdivision. The measurements were taken at 5315 North 106th Drive. The area is similar to that described for Site #4 and is located just under a mile east of the airport.

Measurements at this site recorded 37 single events. Five of these events were correlated with aircraft flight tracking data. The overflight events ranged from 71.4 to 89.1 dB, the latter being the loudest event recorded at the site. The average DNL above the threshold was 46.4.

Site #12 was located north of the airport in the Country Meadows subdivision. A home at 8201 North 103rd Drive was chosen for this site. The location is very similar to Site #1 and provides additional data for the north side of the airport.

Some 18 single events were recorded at the site ranging from the low 70s to 86.7 dB. Only one of the events was correlated with any of the observed flight tracking data. This event was a departure from the airport and measured 76.5 dB. The average DNL above the threshold for the measurement period was 46.5 DNL.

- ONE-HOUR MEASUREMENT SITES

Site A was located in the Glenn-Harbor Industrial Park just north of the airport. This is a newly developed commercial/

industrial area just north of Glendale Avenue. The site is located at the end of an "L" intersection with an open field to the south.

Traffic accessing a nearby emissions check facility and other businesses generated the majority of the background noise. The traffic generated some 57 single events during the one-hour period. A direct overflight from a helicopter was observed and generated a single event of 87.8 dB. Traffic event sound levels ranged from the mid-70s to the mid-80s. The average sound level during the hour was 62.4 dB with the average above the threshold being 59.2 dB.

Site B was located in the retail shopping area at the northwest corner of 107th Avenue and Indian School Road south of the airport. This is a corner retail area of a number of strip shops and restaurants. The site is located about two miles south of the airport and just over a mile east of the Runway 1-19 extended centerline. The equipment was set up in the parking lot to record the sound levels typical to a retail land use.

Traffic accessing the parking lot generated the majority of the background noise. There were five single events recorded during the one-hour period. The single event levels ranged from the mid to high 70s at the site. The average sound level during the hour was 56.2 dB with the average above the threshold being 45.4 dB.

Site C was also located in the Glenn-Harbor Industrial Park just north of the airport. The site was located along Glenn Harbor Boulevard nearly on the Runway 1-19 extended centerline.

A number of jet aircraft sounds from Luke AFB were observed during the hour. There were four single events recorded during the one-hour period. The single event levels ranged from the low to mid-70s at the site. Jets from Luke were identified with single event levels of 74.6 and 74.9 dB. The average sound level during the hour was 54.4 dB with the average above the threshold being 44.0 dB.

Site D was located in the parking lot of the Country Meadows golf course club house. This is located in the center of the Country Meadows subdivision north of the airport.

The site was relatively quiet with few noticeable traffic events. Distant military jet activity was heard from Luke AFB. These events accounted for five of the 13 recorded single events. The military jet activity generated single event noise levels from 73.8 to 78.1 dB. A single-engine prop aircraft was observed turning onto a final approach to Glendale during the measurement hour. The noise from this overflight was not sufficient to exceed the single event measurement thresholds. The average sound level during the hour was 56.7 dB with the average above the threshold being 52.0 dB.

Site E was located north of the airport and adjacent to the Agua Fria Expressway at Olive Avenue. This is on the eastern edge of a small residential area near the highway. The site is about three miles north of the airport and slightly east of the extended runway centerline.

Traffic on the Agua Fria Expressway generated the majority of the background noise. There were 58 single events recorded during the one-hour period. The single event levels ranged from the low 70s to the low 80s at the site. The only noise events observed during the hour were from truck and car traffic on the highway. The average sound level during the hour was 61.7 dB with the average above the threshold being 57.0 dB.

Site F was at a small neighborhood park in the center of the Villa de Paz subdivision. The site is about two miles southeast of the airport and about a mile and a half east of the extended runway centerline.

The noise at this site was due to a combination of local traffic, school busses, and aircraft overflights. There were eight single events recorded during the one-hour period. The single event levels ranged from the low 70s to the mid-80s at the site. The two aircraft overflight events that were observed during the hour generated single event levels from 76 to 85 dB. The average sound level during the hour was 58.1 dB with the average above the threshold being 54.1 dB.

Measurement Results Summary

The noise data collected during the measurement period are presented in **Tables 2B** and **2C**. The information includes average 24-hour Equivalent Noise Levels (Leq) for each site. The Leq metric is derived by accumulating all noise during a given period and logarithmically averaging it. It is similar to the DNL metric except that no penalty is attached to nighttime noise.

Two DNL values are presented for each site. DNL(24) represents the DNL from all noise sources. DNL(t) is developed only from noise exceeding the loudness and duration thresholds defined at each measurement site. The DNL(t) is a reasonable approximation of the DNL attributable to aircraft noise alone. Aircraft noise events are usually the only ones exceeding these thresholds if the site and the thresholds are carefully selected. It is this DNL(t) value against which modeled noise may be compared to assess the adequacy of the computer predictive model in describing actual conditions.

In addition, the L(90) and L(50) values for each site are presented. These values represent the sound levels above which 90 percent and 50 percent of the samples were recorded. The L(90) value is generally recognized as the background noise level at the site. All of the cumulative data presented represents the average values for the duration of the measurements at each site.

The table also provides data on other measures of noise impact which may be used to validate the models used for noise contour generation and to assess various noise abatement alternatives. These include:

- Maximum recorded noise level in dBA (Lmax);
- Maximum recorded sound exposure level (SELmax);
- Longest single-event duration in seconds (Dur max);
- Most frequently recorded decibel level (Mode dB);

For comparative purposes, normal conversation is generally at a sound level of 60 decibels while a busy street is approximately 70 decibels along the adjacent sidewalk.

TABLE 2B
Glendale Municipal Airport
24-Hour Measurement Results Summary

	MEASUREMENT SITES											
	1	2	3	4	5	6	7	8	9	10	11	12
Cumulative Data												
Average Leq	55.4	54.3	53.9	49.5	54.1	53.3	48.3	54.7	56.2	69.8	52.1	52.1
Average DNL	59.3	61.2	59.9	52.9	55.7	59	53.6	61.2	61.9	70.1	55.6	56.6
Average DNL(t)	48.2	44.4	46.6	45.6	47.7	47.1	42.9	47.1	48.8	44.0	46.4	46.5
Mode dB	51	54	50	46	40	49	41	51	52	56.0	45.0	48.0
L(90)	42	39	42	37	38	42	38	43	48	46	42	41
L(50)	51	49	48	44	42	48	44	50	53	54	47	47
Single Event Data												
L(max)	81.1	83.8	80	76.6	93.2	80	70.6	77.3	78.7	106.9	80.9	78.2
SEL(max)	86.7	93	83.9	84.6	97.4	83.9	79.3	85.1	84.8	115.1	89.1	86.7
Duration(max) min:sec	0:19	0:48	0:21	0:28	0:26	0:21	0:12	1:19	0:31	4:21	0:28	0:30
# of SEL's	65	47	27	34	25	29	11	69	123	22	37	18
Number of Single Events Above												
70	65	47	27	34	25	29	11	69	123	22	37	18
80	5	24	11	11	13	10	0	13	10	13	8	4
90	0	1	0	0	6	0	0	0	0	8	0	0
100	0	0	0	0	0	0	0	0	0	7	0	0

TABLE 2C
Glendale Municipal Airport
One-Hour Measurement Results Summary

	Site A	Site B	Site C	Site D	Site E	Site F
Cumulative Data						
Average Leq	62.4	56.2	54.4	56.7	61.7	58.1
Average Leq(t)	59.2	45.4	44	52	57	54.1
Mode dB	58	52	50	54	59	54
L(90)	55	49	50	43	54	48
L(50)	50	53	51	51	59	54
Single Event Data						
L(max)	77.9	70.2	71	73.8	77.3	78.6
SEL(max)	87.8	79.4	74.9	80.6	81.6	85.2
Duration(max) min:sec	0:57	0:17	0:09	0:15	0:25	0:33
# of SEL's	57	5	4	13	58	8

The program resulted in a total of 12 measured 24-hour periods from 12 sites around the airport. A total of 507 single events were recorded during the program and 288 average hourly sound levels were calculated and recorded.

AIRCRAFT NOISE ANALYSIS METHODOLOGY

The standard methodology for analyzing the prevailing noise conditions at airports involves the use of a computer simulation model. The Federal Aviation Administration (FAA) has approved two models for use in F.A.R. Part 150 Noise Compatibility Studies -- NOISEMAP and the Integrated Noise Model (INM). NOISEMAP is used most often at military airports, while the INM is most commonly used at civilian airports.

The Integrated Noise Model (INM) was developed by the Transportation Systems Center of the U.S. Department of Transportation at Cambridge, Massachusetts. It is undergoing continuous refinement. The model is designed as a conservative planning tool, tending to slightly overstate noise. The model and its database are periodically updated based on the philosophy that each version should err on the side of overprediction while each subsequent update moves slightly closer to reality.

Version 4.11 is the most current version of the model at this time. It is the version used for the noise analysis described in this chapter.

The INM works by defining a network of grid points at ground level around the airport. It then selects the shortest distance from each grid point to each flight track and computes the noise exposure for each aircraft operation, by aircraft type and engine thrust level, along each flight track. Corrections are applied for air-to-ground acoustical attenuation, acoustical shielding of the aircraft engines by the aircraft itself, and aircraft speed variations. The noise exposure levels for each aircraft are then summed at each grid location. The cumulative noise exposure levels at all grid points are then used to develop noise exposure contours for selected values (e.g. 65, 70, and 75 DNL). Noise contours can be plotted using the Leq or DNL metrics. **Exhibit 2B** graphically shows this calculation process.

In addition to the mathematical procedures defined in the model, the INM has another very important element. This is a data base containing tables correlating noise, thrust settings, and flight profiles for most of the civilian aircraft, and many common military aircraft, operating in the United States. This data base, often referred to as the noise curve data, has been developed under FAA guidance based on rigorous noise monitoring in controlled settings. In fact, the INM database was developed through more than a decade of research including extensive field measurements of over 10,000 aircraft operations.

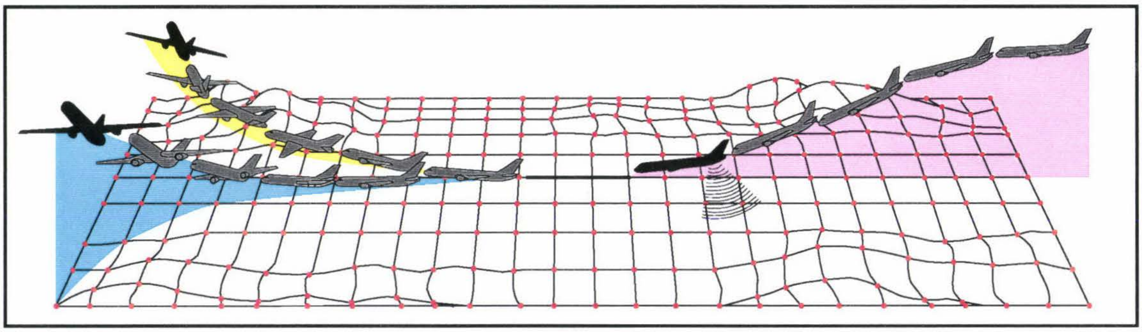
The database also includes performance data for each aircraft to allow for the computation of airport-specific flight profiles (rates of climb and descent).

A variety of user-supplied input data is required to use the Integrated Noise Model. This includes the airport elevation, a mathematical definition of the airport runways, the mathematical description of ground tracks above which aircraft fly, and the assignment of specific aircraft with specific engine types at specific takeoff weights to individual flight tracks. This is

INPUT

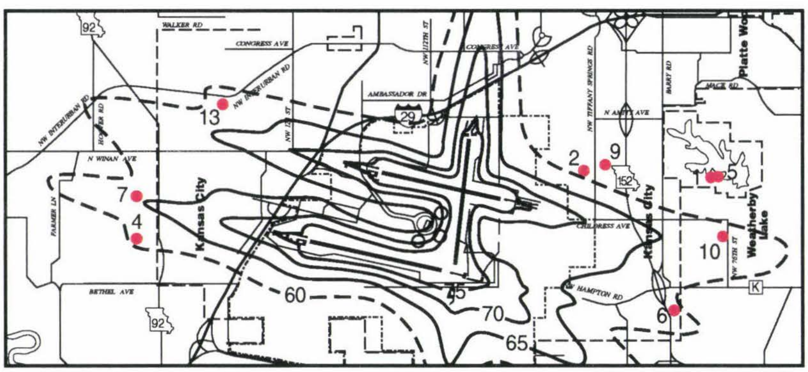
- Airport Description
- Operations
- Fleet Mix
- Time of Day
- Runway Use
- Flight Tracks
- Approach Profiles
- Departure Profiles

CALCULATION PROCESS



- Computer accesses stored noise curve data for aircraft types specified in input.
- Model determines noise contribution at nodes from each aircraft operation along each flight track.
- Model sums all contributions at node.

OUTPUT



Contours and Plots

Simple and Detailed Grid Analysis

GLENDALE MUNICIPAL AIRPORT

Exhibit 2B
INM PROCESS

summarized in **Exhibit 2B**. In addition, aircraft not included in the model's data base may be defined for modeling, subject to FAA approval.

ACTIVITY DATA

For this analysis, aircraft operations data were derived from current (1993) and forecasts of future (1999 and 2015) activity prepared for this study and presented in Appendix C of this document. To define the level of operations (take-offs and landings) for this analysis, all aircraft were assigned in accordance with recorded or forecast levels. These are briefly summarized in **Table 2D**.

Average daily aircraft operations were calculated by dividing total annual operations by 365 days. The distribution of these operations among various categories, users, and types of aircraft is critical to the development of the input model data.

TABLE 2D
Actual And Forecast Operations
Glendale Municipal Airport

	ACTUAL	FORECASTS	
Operations	1993	1999	2015
General Aviation			
Itinerant	36,868	48,800	101,320
Local	77,021	90,500	151,980
Total	**113,889**	**139,300**	**253,300**

Source: Appendix C, Forecasts, Table C5, p. C-8.

FLEET MIX

The selection of individual aircraft types is important to the modeling process because different aircraft types generate different noise levels. The noise footprints presented in **Exhibit 2C** illustrate this concept graphically. The footprints represent the noise pattern generated by one departure and one arrival of the given aircraft type. The propeller aircraft illustrated are some of those commonly found at Glendale. The two jets, the Lear 35 and the G-IIB, have used the airport on occasion.

While specific data regarding the aircraft type for each flight operation is not routinely kept at Glendale, discussions with air traffic control personnel and airport management provided insights into the general fleet mix estimations. This information was coupled with the direction indicated in the forecast review and the based aircraft trends among the users of Glendale Municipal Airport to develop fleet mix projections for the airport. **Table 2E** summarizes the fleet mix data input into the noise analysis by annual aircraft operations.

DATABASE SELECTION

The FAA has published a Pre-Approved List of Aircraft Substitutions. The list indicates that the general aviation single engine variable pitch propeller model, the GASEPV, represents a number of single engine general aviation aircraft. Among others these include the Beech Bonanza, Cessna 177 and 180, Piper Cherokee Arrow, Piper PA-32, and the Mooney. The general aviation single engine fixed pitch propeller model, the GASEPF, also represents several single engine general aviation aircraft. These include the Cessna 150 and 172, Piper Archer, Piper PA-28-140 and 180, and the Piper Tomahawk. The model also provides a composite single engine propeller aircraft, COMSEP, to cover the remaining range of general aviation single engine aircraft. For comparison purposes, the COMSEP generates a noise footprint slightly larger than that shown for the Cessna 170, but smaller than the footprint for the Beech Bonanza.

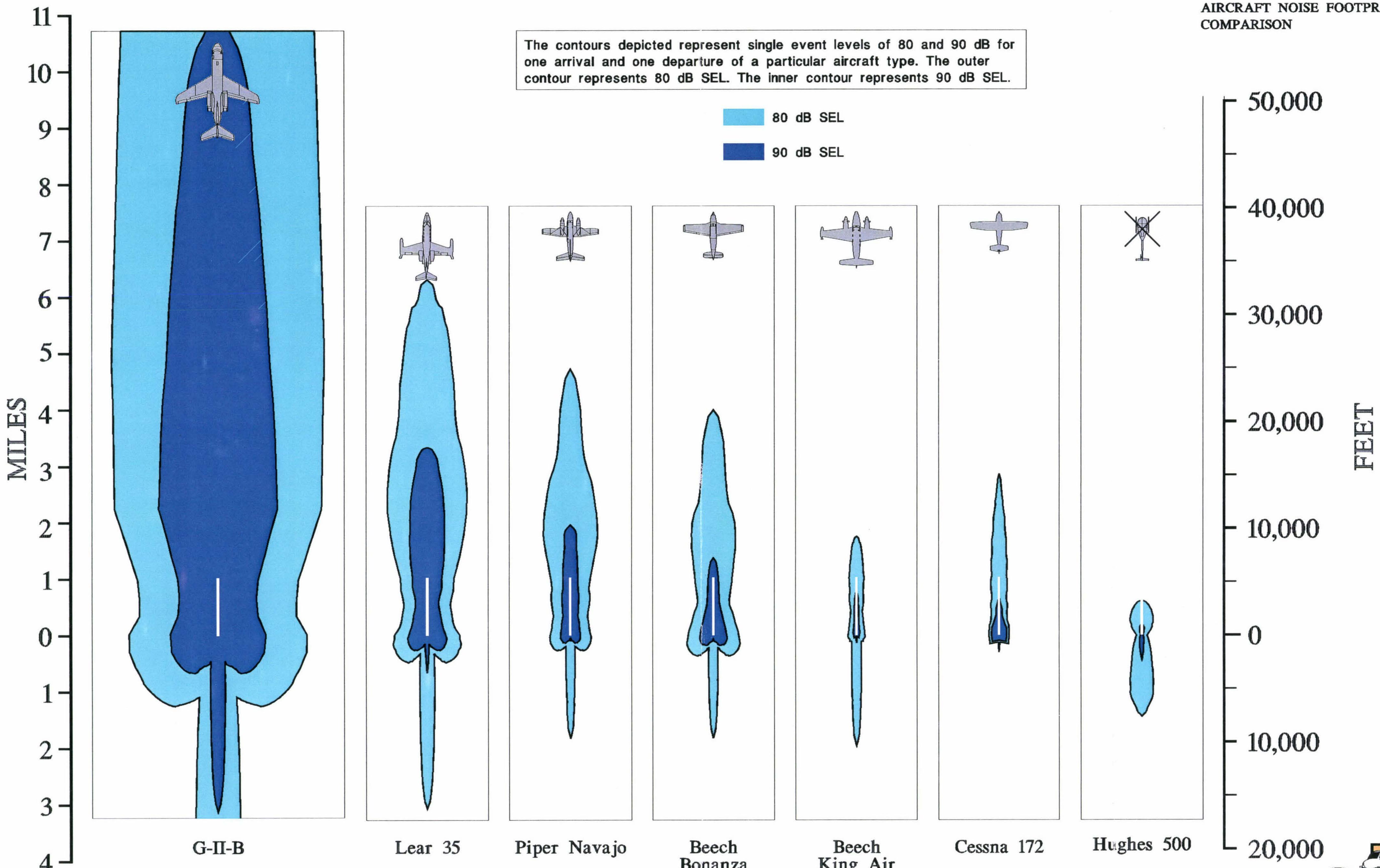
TABLE 2E
Fleet Mix And Operational Data

	1994		1999		2015	
	Number	Percent	Number	Percent	Number	Percent
ITINERANT OPERATIONS						
Beech Bonanza, etc.	11,060	9.7%	17,080	12.3%	35,462	14.0%
Cessna 172, etc.	14,747	12.9%	17,080	12.3%	30,396	12.0%
Other Single Engine	7,374	6.5%	7,271	5.2%	12,158	4.8%
Light Twins	1,843	1.6%	3,416	2.5%	10,132	4.0%
Twin Turboprops	737	0.6%	1,464	1.1%	5,066	2.0%
Lear Jets, etc.	184	0.2%	342	0.2%	2,634	1.0%
G-II, etc.	184	0.2%	195	0.1%	405	0.2%
Helicopters	737	0.6%	1,952	1.4%	5,066	2.0%
Subtotal	36,868	32.4%	48,800	35.0%	101,320	40.0%
LOCAL OPERATIONS						
Beech Bonanza, etc.	23,106	20.3%	27,150	19.5%	54,713	21.6%
Cessna 172, etc.	30,808	27.1%	32,580	23.4%	37,995	15.0%
Other Single Engine	15,404	13.5%	18,100	13.0%	30,396	12.0%
Light Twins	6,162	5.4%	9,050	6.5%	19,757	7.8%
Helicopters	1,540	1.4%	3,620	2.6%	9,119	3.6%
Subtotal	77,021	67.6%	90,500	65.0%	151,980	60.0%
TOTAL	113,889	100%	139,300	100%	253,300	100%

Note: Percentages have been rounded.

The FAA's substitution list recommends the BEC58P, the Beech Baron, to represent the light twin-engined aircraft such as the Piper Navajo, Beech Duke,

Exhibit 2C
AIRCRAFT NOISE FOOTPRINT COMPARISON



GLENDALE MUNICIPAL AIRPORT

Cessna 31, and others. The CNA441 effectively represents the light turboprop and twin-engine piston aircraft such as the King Air, Cessna 402, Gulfstream Commander, and others.

While there are no jet aircraft currently based at Glendale, there are occasional itinerant jet aircraft operations at the airport. The discussions with the air traffic control personnel and airport staff indicated that a variety of jet aircraft occasionally stop at Glendale. These ranged from Lear 35s and 55s to G-IIs and G-IVs. These aircraft generally break down into two groups. The louder jet aircraft like the G-IIs were represented with the G-IIB from the INM database. The quieter jets like the Lear 35s and 55s and G-IVs were represented with the LEAR35 from the model.

Helicopter operations are not a major portion of the traffic at Glendale but several operations were noted during the noise measurements. These were conducted by light Hughes 500 class helicopters. The H500 data was extracted from the FAA's Helicopter Noise Model (HNM) to simulate the helicopter activity at Glendale.

All substitutions are commensurate with published FAA guidelines.

TIME-OF-DAY

The time-of-day at which operations occur is important as input to the INM due to the penalty weighting of nighttime (10:00 p.m. to 7:00 a.m.) flights. In calculating airport noise exposure, one operation at night has the same noise emission value as 10 operations during the day by the same aircraft. The Air Traffic Control Tower at Glendale operates from 6:00a.m. to 8:30p.m. Monday through Friday and 7:00a.m. to 7:00p.m. on weekends. Consequently, specific counts for nighttime operations are not available. However, discussions with airport staff and experience at similar airports around the country provides a basis for some reasonable assumptions about the nighttime activity at the airport. It was assumed that three percent of the single engine propeller activity would occur during the nighttime hours (10 p.m. to 7 a.m.). One to two percent of the twin engined aircraft activity might occur at night while no more than one percent of the jet and helicopter activity is likely to occur during the nighttime hours. These estimates are intended to identify average annual trends.

RUNWAY USE

Runway usage data is another essential input to the INM. For modeling purposes, wind data analysis usually determines runway use percentages. However, wind analysis provides only the directional availability of a runway and does not consider pilot selection, primary runway operations, or local operating conventions. At Glendale, the single runway configuration offers only two directions of choice. The airport management at Glendale has designated Runway 19 as the "calm wind runway". Consequently, this is the direction of choice in most conditions where winds allow a south flow. The analysis of wind data from Luke AFB indicates that a Runway 19 operation can be accommodated at Glendale about 60 percent of the time. The remaining 40 percent of the time the wind conditions are such that a north flow on Runway 1 is preferable for most aircraft operating at the airport. These percentages reflect average annual conditions and were incorporated into the INM analysis.

FLIGHT TRACKS

Flight track data was collected from on-site observations conducted during the noise measurement program as well as from discussions with air traffic controllers.

The radar flight tracking program was conducted during the noise measurement program, over a six-day period from December 3, 1993 through December 8, 1993. A technician was stationed at a radar scope in the Radar Approach Control (RAPCON) at Luke AFB. Clear acetate overlays were placed on the radar screen and aircraft movements were traced as they occurred. Information regarding aircraft position and altitude was recorded periodically as each aircraft operation was traced. Operational logs were kept to identify operation type, time, and track number. Aircraft type information was not available from the system for VFR operations which constitute the majority of the operations at Glendale. This effort resulted in some 105 individual flight tracks recorded along with 30 other aircraft movements observed and logged.

It is important to understand that while the radar tracings are a reasonably accurate and efficient method of collecting flight track data, the opportunity for parallax errors ranging from 500 to 1,500 feet exists. The radar system itself has limitations. For example, the system records aircraft locations as points at each sweep of the radar antenna; it does not record continuous tracks. Thus raw flight track data is actually a series of points. When these points are connected, they often appear as jagged lines.

Exhibit 2D presents the raw flight track data for the Runway 01 operations that were observed at the radar scope. The tracks are color coded by operational type. Blue tracks are arrivals to Runway 01 while red depicts the departures from Runway 01. The green tracks represent the training or touch-and-go operations. The touch-and-go activity along with arrivals from the north generally flew a downwind path east of, and parallel to the airport. This corridor ranges from about a half mile to one and one half miles east of the airport. Arrival traffic from the south and southeast tended to enter the area south of the airport on a heading that is generally perpendicular to the runway. Most flew over the Villa de Paz area and turned to a final approach about a half mile to three-quarters of a mile south of the runway. The departure traffic generally followed a relatively straight-out pattern with a slight early right turn to avoid Country Meadows. A few early left and right turns were also recorded.

The raw flight track data for the Runway 19 operations are illustrated in **Exhibit 2E**. The same color code is used to identify each operational type. The touch-and-go activity along with arrivals from the south tend to fly a downwind path similar to that observed for the Runway 01 operations. The corridor is slightly wider and ranges from less than a half mile to about one and one-half miles east of the airport. Arrival traffic from the north and northeast generally enters the area north of the airport on a heading along Northern Avenue. Most overflew the open areas south of Northern Avenue while a few were over the residential areas near the Agua Fria Expressway north of Northern Avenue. The departure traffic generally turned left early and entered the downwind corridor for destinations north and east of Glendale. A few left turns to the east and southeast were also recorded.

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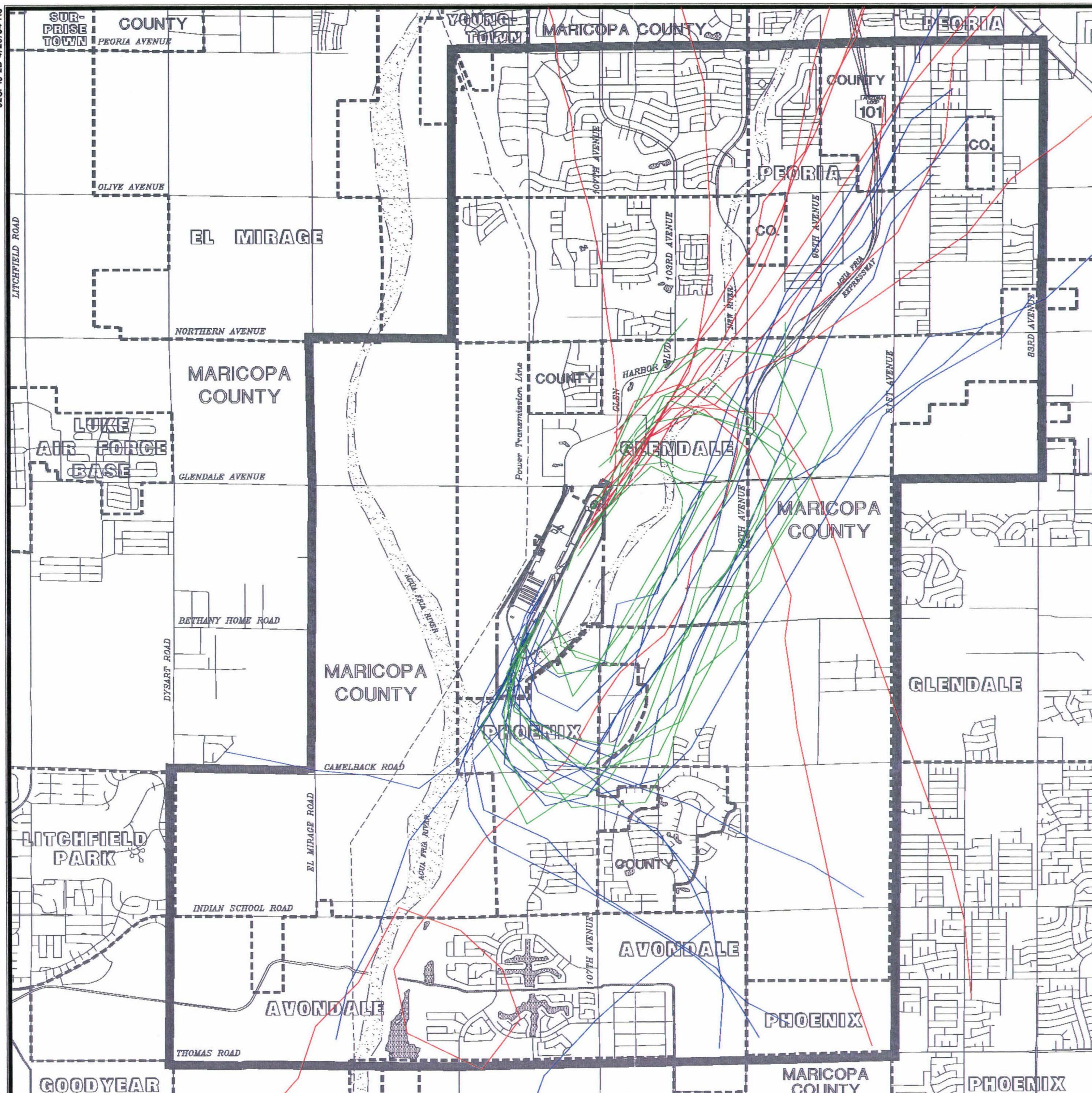


Exhibit 2D
OBSERVED FLIGHT TRACKS:
RUNWAY 01

LEGEND

- Study Area Boundary
- Jurisdiction Boundary
- Airport Boundary
- Arrival Flight Tracks
- Departure Flight Tracks
- Touch and Go Tracks

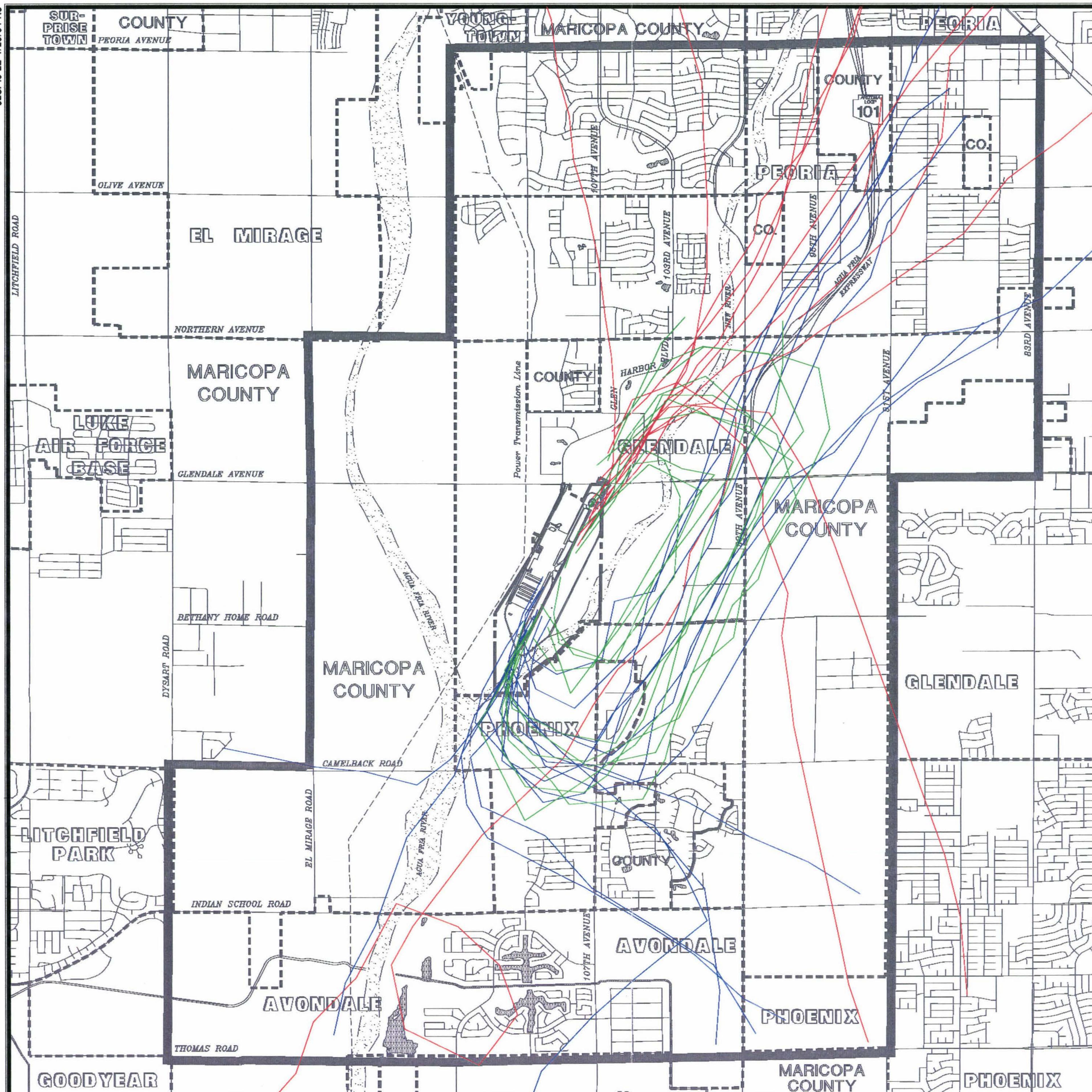
Period of observation: December 3-8, 1993

NORTH

0 4000 8000

SCALE IN FEET

GLENDALE MUNICIPAL AIRPORT



92SP16-2E-4/20/94-R3

Exhibit 2E
OBSERVED FLIGHT TRACKS:
RUNWAY 19

LEGEND

- Study Area Boundary
- Jurisdiction Boundary
- Airport Boundary
- Arrival Flight Tracks
- Departure Flight Tracks
- Touch and Go Tracks

Period of observation: December 3-8, 1993

NORTH

0 4000 8000

SCALE IN FEET

GLENDALE MUNICIPAL AIRPORT

Straight out and right turn departures were rare.

In conjunction with an analysis of local and regional air traffic control procedures, the collected flight tracks were analyzed to develop consolidated flight tracks. This analysis required the reduction of data to individual tracks used by aircraft accessing the Glendale facility. The resultant groupings of individual tracks were then further reduced to form consolidated flight tracks describing the average corridors which lead to and from the various flight routes to and from Glendale Municipal Airport.

Although the consolidated flight tracks appear as distinct paths, they actually represent averages of the observed tracks and are reflected that way on the exhibits. They illustrate the areas of the community where aircraft operations most often can be expected. At a general aviation airport such as Glendale, aircraft traffic is expected over most areas around the airport. The density of the air traffic generally increases closer to the airport. The flight tracking data presented in the previous paragraphs indicates that aircraft overflights do occur over most of the areas around Glendale Municipal Airport. While the observed tracks indicate variances from track to track there are readily discernable areas of common overflights. The consolidated tracks were developed to reflect these common patterns and to account for the inevitable flight track dispersions around the airport.

Exhibit 2F illustrates the consolidated flight tracks used for the modeling of operations on Runway 01. As with the previous exhibits, the flight tracks are color coded by operational type. A number of arrival and departure tracks have been identified based on the radar observations. The touch-and-go pattern flight tracks are identified as a number of oval shaped patterns to the east of the airport. The progressively larger patterns represent the various conditions that would occur with different numbers of aircraft simultaneously in the flight pattern. The larger patterns represent the busy periods while the smaller patterns represent fewer aircraft in the pattern. The largest pattern is added to the analysis in future years to represent the busy traffic pattern with the future operational levels.

The consolidated flight tracks for Runway 19 are presented in **Exhibit 2G**. The consolidated tracks for Runway 19 represent the flight patterns observed from the radar tracking program. They are similar in shape and location to those observed for Runway 01. Again, the largest touch-and-go track is added to simulate the growth in the average pattern due to forecast increases in operational levels over the next twenty years.

ASSIGNMENT OF FLIGHT TRACKS

The final step in developing input data for the INM model is the assignment of aircraft to specific flight tracks. Prior to this step, specific flight tracks, runway utilization and operational statistics for the various aircraft models using Glendale Municipal Airport were evaluated.

The radar flight track observations that were used to delineate the consolidated flight corridors were also used to identify the proportion of traffic using each consolidated flight track. This analysis resulted in a percentage of use for each flight track. These percentages were then used to assign the single engine propeller aircraft and light twin engine aircraft activity to the flight tracks. For the jet aircraft and twin turboprop aircraft, these percentages were adjusted slightly to reflect the use of longer, more stable approaches and more straight-out departures. Due to the flexibility of helicopter performance, the flight track assignment percentages were adjusted to reflect more early turns away from the runway and the use of the smallest training patterns.

To determine the specific number of aircraft assigned to any one flight track, a long series of calculations were performed. In general, the number of specific aircraft of one group was factored by runway utilization and flight track percentage. The process of track assignments continued until all operations, in all directions, by all types of aircraft using the airport had been evaluated.

INM OUTPUT

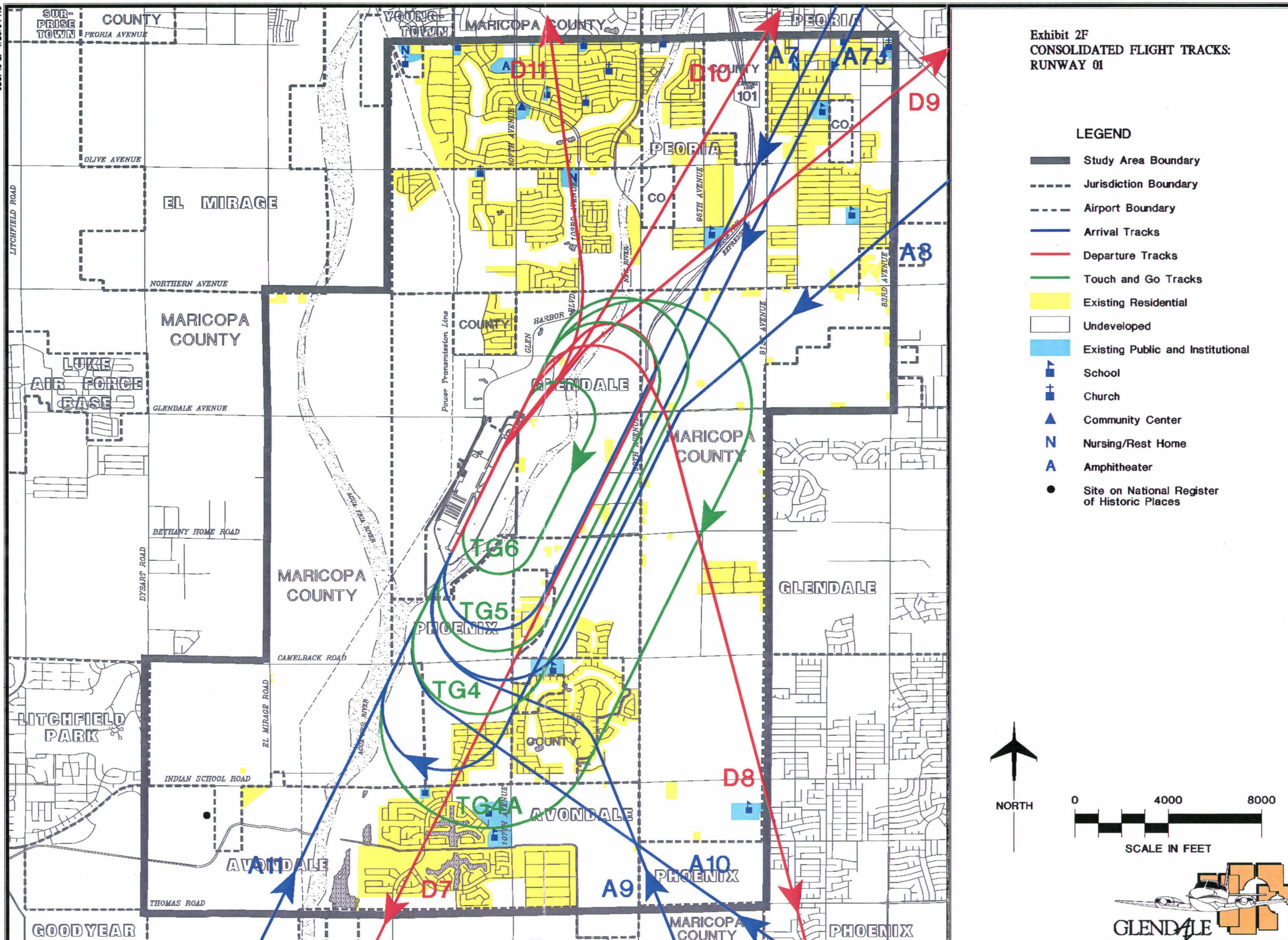
Output data selected for calculation by the INM were annual average noise contours in DNL. F.A.R. Part 150 requires that 65, 70 and 75 DNL contours must be mapped in the official Noise Exposure Maps. In addition, the 55 and 60 DNL noise contours are also mapped in this study as a guideline for future noise abatement and land use planning. This section presents the results of the contour analysis for current and forecast noise exposure conditions, as developed from the Integrated Noise Model.

1994 NOISE EXPOSURE CONTOURS

Exhibit 2H presents the plotted results of the INM contour analysis for 1994 conditions using input data that has been described in the preceding pages. The surface areas within each contour are presented in **Table 2F.**

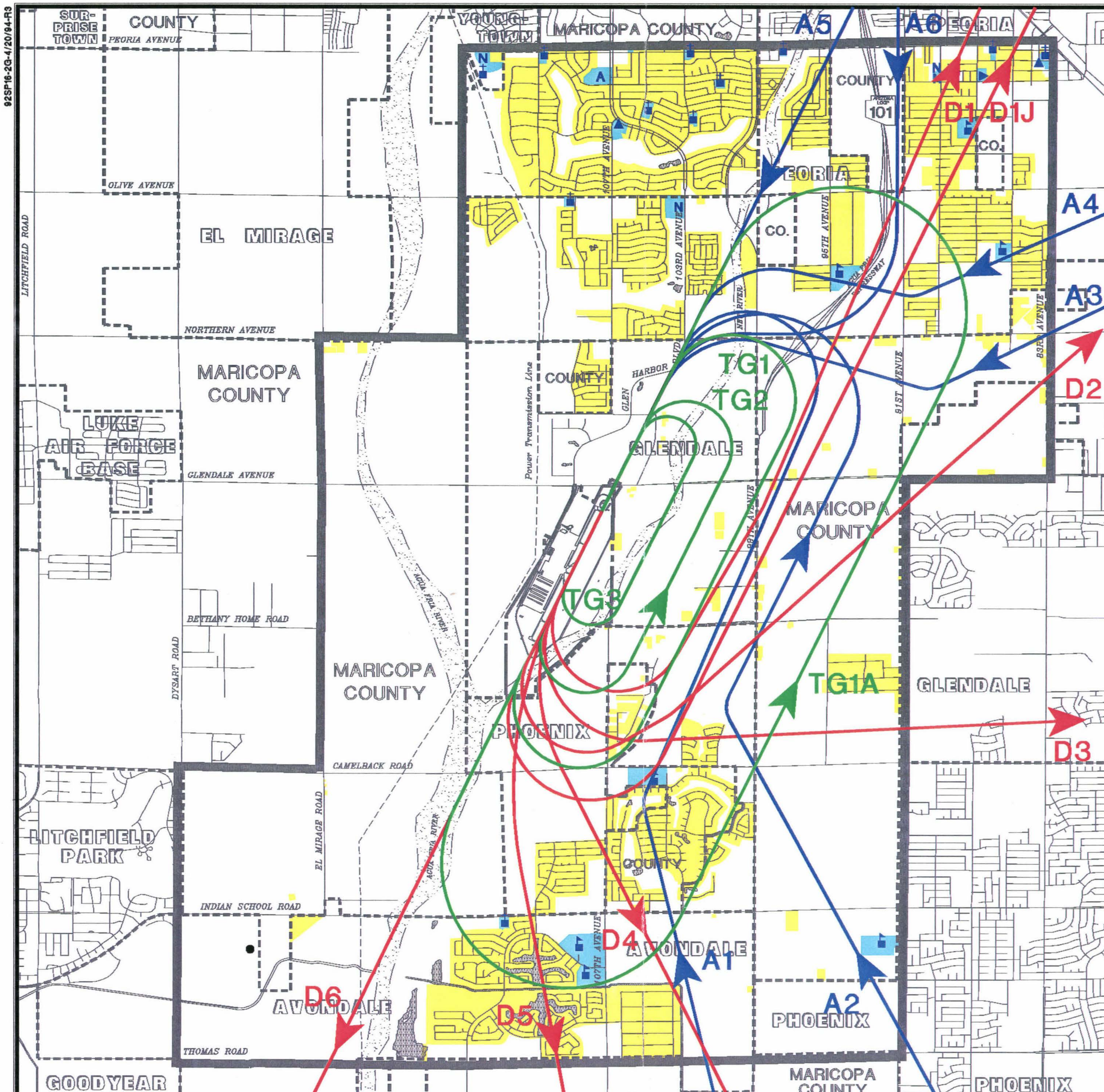
The 55 DNL contour shows the influence of some of the more dense flight patterns south and east of the airport. To the north the contour extends about a mile and a half from the airport to a point just south of Northern Avenue. It is rounded on the north end and symmetrical about the runway centerline. It does exhibit a slight bend to the east illustrating the influence of the eastern traffic patterns and turn procedures. To the south the 55 DNL contour extends just under a mile away from the airport. On the east and southeast edge of the contour there are several lobes illustrating the early turns to the east and the touch-and-go pattern activity. Portions of these lobes extend over the Camelback Farms area.

The remaining noise contours, 60, 65, 70, and 75 DNL, generally retain a common shape. They are elongated and generally symmetrical about the runway centerline. The 60 DNL contour extends beyond the airport property to the north and south over largely open, compatible area. The 65 DNL and higher noise contours remain mostly on airport property. **Table 2F** presents the areas within the noise contours.



92SP16-2F-4/20/94-R3
Exhibit 2F
CONSOLIDATED FLIGHT TRACKS:
RUNWAY 01
LEGEND
Study Area Boundary
Jurisdiction Boundary
Airport Boundary
Arrival Tracks
Departure Tracks
Touch and Go Tracks
Existing Residential
Undeveloped
Existing Public and Institutional
School
Church
Community Center
Nursing/Rest Home
Amphitheater
Site on National Register of Historic Places
NORTH
0
4000
8000
SCALE IN FEET
GLENDALE MUNICIPAL AIRPORT
SURPRISE TOWN
COUNTY
PEORIA AVENUE
YOUNGTOWN
MARICOPA COUNTY
PEORIA
OLIVE AVENUE
EL MIRAGE
LITCHFIELD ROAD
NORTHERN AVENUE
MARICOPA COUNTY
LUKE AIR FORCE BASE
GLENDALE AVENUE
BETHANY HOME ROAD
DYSART ROAD
CAMELBACK ROAD
EL MIRAGE ROAD
LITCHFIELD PARK
INDIAN SCHOOL ROAD
AVONDALE
THOMAS ROAD
GOODYEAR
GLENDALE
PHOENIX
AVONDALE
MARICOPA COUNTY
COUNTY
CO
101
GLEN HARBOR BLVD
Power Transmission Line
AGUA FRIA RIVER
95TH AVENUE
91ST AVENUE
83RD AVENUE
107TH AVENUE
D7
D8
D9
D10
D11
A7
A7J
A8
A9
A10
A11
TG4
TG4A
TG5
TG6

Exhibit 2G
CONSOLIDATED FLIGHT TRACKS: RUNWAY 19



LEGEND

- Study Area Boundary
- Jurisdiction Boundary
- Airport Boundary
- Arrival Tracks
- Departure Tracks
- Touch and Go Tracks
- Existing Residential
- Undeveloped
- Existing Public and Institutional
- School
- Church
- Community Center
- N Nursing/Rest Home
- A Amphitheater
- Site on National Register of Historic Places

NORTH

0 4000 8000
SCALE IN FEET

GLENDALE MUNICIPAL AIRPORT

92SP16-2G-4/20/94-R3

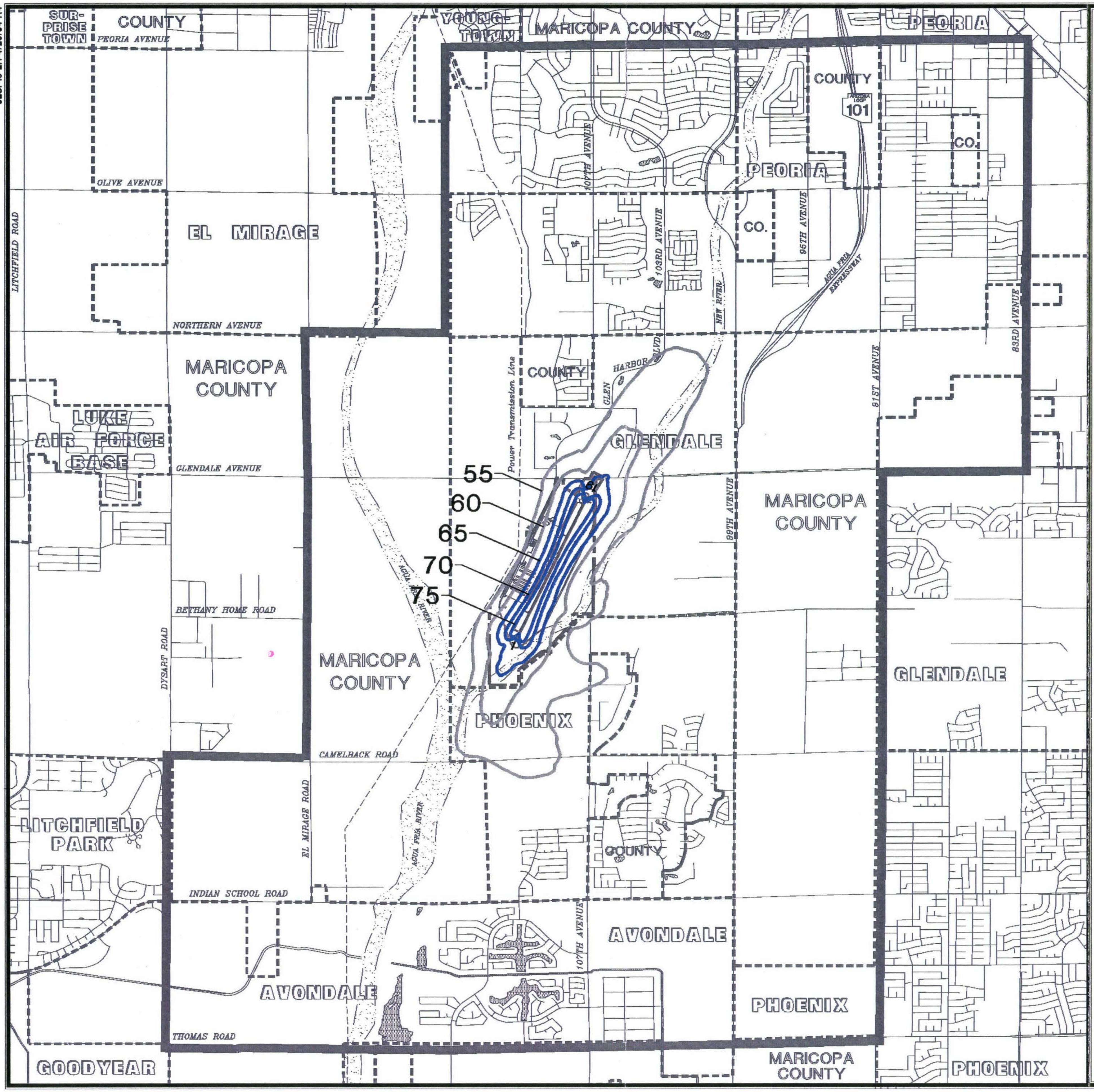


Exhibit 2H
1994 AIRCRAFT NOISE EXPOSURE

LEGEND

- Study Area Boundary
- Jurisdiction Boundary
- Airport Boundary
- DNL Contour-Marginal Impact
- DNL Contour-Significant Impact

NORTH

0 4000 8000

SCALE IN FEET

GLENDALE MUNICIPAL AIRPORT

TABLE 2F
1994 Noise Contour Surface Areas

DNL Contour	Square Miles	Acres	Acres Within 5 DNL Range	
55	1.95	1,248	55-60	768
60	0.75	480	60-65	250
65	0.36	230	65-70	115
70	0.18	115	70-75	58
75	0.09	58	75+	58

1999 NOISE EXPOSURE CONTOURS

The 1999 noise contours represent the estimated noise conditions based on the forecasts of future operations without any changes in operational procedures. The noise analysis has included a proposed runway extension of 750 feet at the south end of Runway 1-19, based on the current airport master plan. This analysis provides a near-future baseline which can subsequently be used to judge the effectiveness of proposed noise abatement procedures. **Exhibit 2J** presents the plotted results of the INM contour analysis for 1999 conditions using input data that has been described in the preceding pages.

Generally the 1999 noise contours are similar in shape to their 1994 counterparts. This is due to the use of similar modeling input assumptions for the consistency of the baseline case. The contours are slightly larger than the 1994 contours due to the forecast increase in operations.

The 55 DNL noise contour maintains a similar size and shape relationship with the 1994 contour to the north and west of the airport. To the east and southeast however, the 1999 55 DNL contour shows slightly more growth and additional influence from the concentrated flight patterns in the area. The contour expands over the Camelback Farms due to the increased operations. The remaining contours are just slightly larger than their 1994 counterparts and hold a similar shape. The surface areas of the 1999 noise exposure are presented for comparison in **Table 2G.**

2015 NOISE EXPOSURE CONTOURS

The 2015 noise contours represent the estimated noise conditions based on the forecasts of future operations without any changes in operational procedures. The noise analysis has included a proposed parallel runway east of Runway 1-19. This 4,000 foot runway will help meet the long term demand as identified in the airport master plan. The length of the runway and its location make it ideal to accommodate most of the touch-and-go traffic at the airport. Consequently, for this analysis all of the pattern traffic was assigned to this runway. Additionally, the largest traffic pattern flight tracks were included to properly simulate this volume of touch-and-go activity. (These are tracks TG4A and TG1A, shown in **Exhibits 2F** and **2G.**)

TABLE 2G Comparative Areas Of Noise Exposure			
	Area in Square Miles		
DNL Contour	1994	1999	2015
55	1.95	2.28	4.31
60	0.75	0.83	1.63
65	0.36	0.39	0.72
70	0.18	0.21	0.39
75	0.09	0.11	0.23

This analysis will provide a long term future baseline which can also be used to judge the effectiveness of proposed noise abatement procedures and land use planning recommendations. Exhibit 2K presents the plotted results of the INM contour analysis for 2015 conditions using input data that has been described in the preceding pages.

The 2015 noise contours tend to retain a shape similar to their current counterparts. However, they are significantly larger than either the 1994 or 1999 noise contours.

The increase in traffic broadens the expanse of the 55 DNL noise contour compared to the 1999 contour. The increase in traffic volume has rounded out the influence of some of the more dense flight patterns south and east of the airport. To the north the contour extends about two miles from the airport to a point north of Northern Avenue. It is still rounded on the north end and generally symmetrical about the runway centerline. It continues to show a slight bend to the east illustrating the influence of the eastern traffic patterns and procedures. To the south the 55 DNL contour extends just under two miles away from the airport. The lobes previously evident on the east and southeast edge of the contour are now smoother and more rounded, illustrating the early turns to the east and the increased touch-and-go pattern activity. The contour completely encompasses the Camelback Farms area as well as portions of Villa de Paz.

The remaining noise contours, 60, 65, 70, and 75 DNL, have also grown significantly but have done so over largely compatible or open areas. The 60 DNL contour exhibits influence from the major flight corridors to the south and extends just beyond Camelback Road. To the north, the 60 DNL contour is basically symmetrical around the runway centerline and extends to just south of Northern Avenue while remaining east of Glenn Harbor Boulevard. The 65 DNL and higher noise contours remain mostly on airport property with some exceptions over open areas. The surface areas of the 2015 noise exposure are presented for comparison in Table 2G.

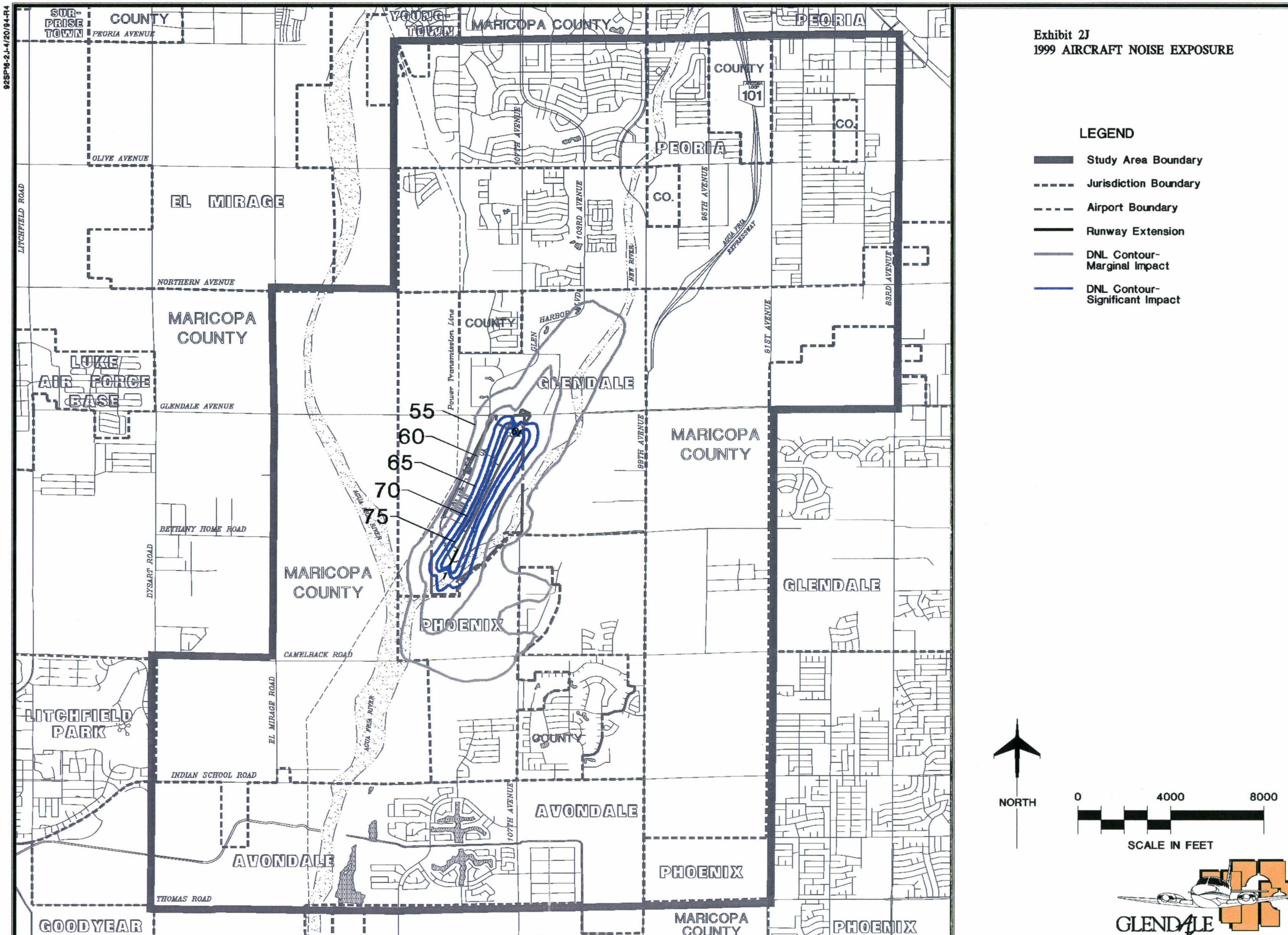


Exhibit 2J
1999 AIRCRAFT NOISE EXPOSURE

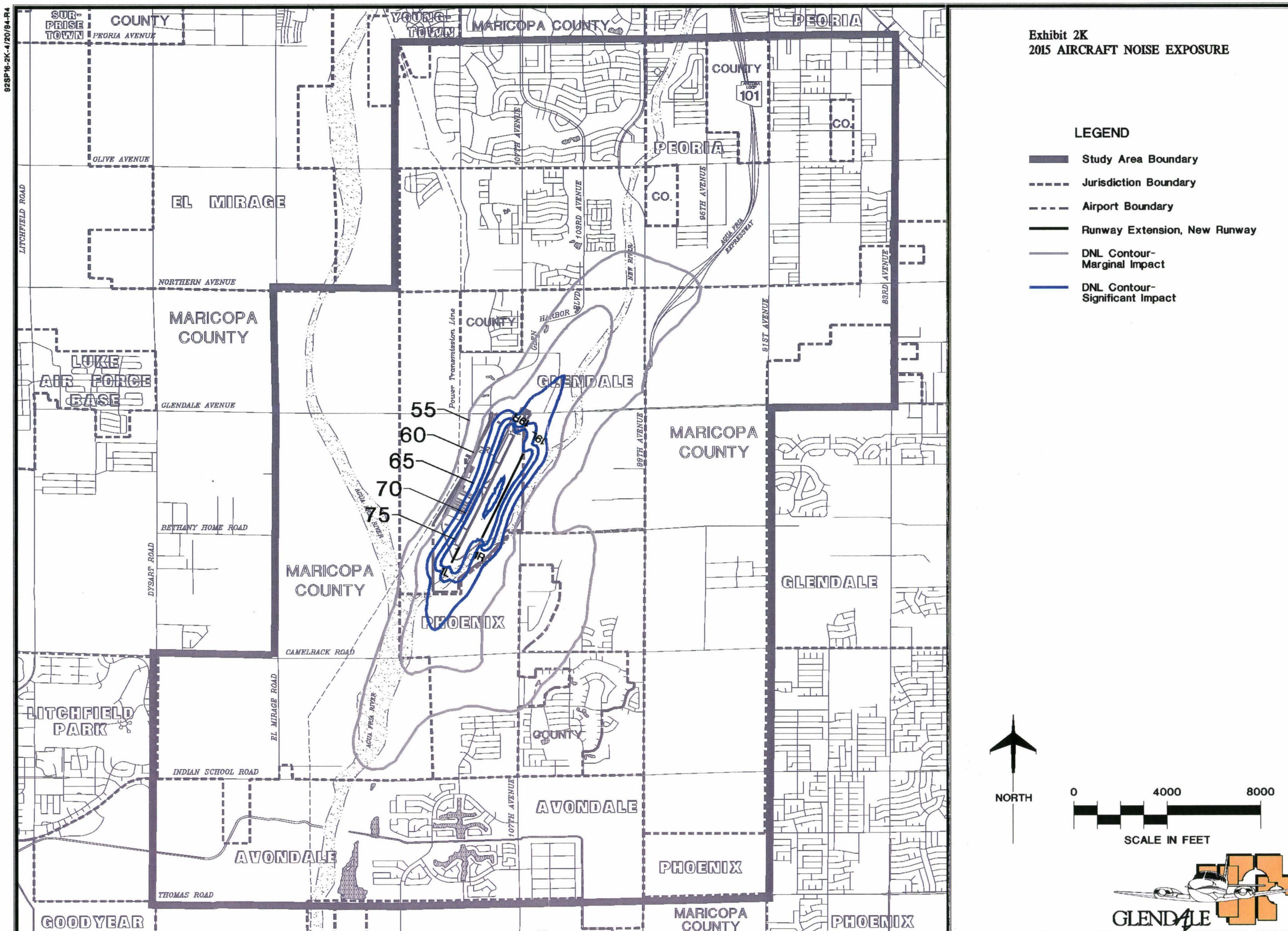


Exhibit 2K
2015 AIRCRAFT NOISE EXPOSURE
LEGEND
Study Area Boundary
Jurisdiction Boundary
Airport Boundary
Runway Extension, New Runway
DNL Contour-Marginal Impact
DNL Contour-Significant Impact
NORTH
0
4000
8000
SCALE IN FEET
GLENDALE MUNICIPAL AIRPORT
92SP16-2K-4/20/94-R4
SUR-PRISE TOWN
COUNTY
YOUNG-TOWN
MARICOPA COUNTY
PEORIA
EL MIRAGE
MARICOPA COUNTY
LUKE AIR FORCE BASE
GLENDALE
MARICOPA COUNTY
GLENDALE
PHOENIX
LITCHFIELD PARK
AVONDALE
AVONDALE
PHOENIX
GOODYEAR
MARICOPA COUNTY
PHOENIX
55
60
65
70
75
PEORIA AVENUE
OLIVE AVENUE
NORTHERN AVENUE
GLENDALE AVENUE
BETHANY HOME ROAD
CAMELBACK ROAD
INDIAN SCHOOL ROAD
THOMAS ROAD
LITCHFIELD ROAD
DYSART ROAD
EL MIRAGE ROAD
AGUA FRIA RIVER
Power Transmission Line
107TH AVENUE
103RD AVENUE
99TH AVENUE
95TH AVENUE
91ST AVENUE
83RD AVENUE
AGUA FRIA EXPRESSWAY
NEW RIVER
101

ADDITIONAL NOISE CONSIDERATIONS

The noise analysis thus far has presented the DNL noise exposure for the current average annual conditions and those expected five and twenty years into the future. These contours represent the noise levels on an average day based on the annual operations, average runway use, and average temperature for the airport. While this is the proper process required under F.A.R. Part 150, additional perspectives are often helpful in evaluating noise impacts and noise abatement solutions. Although there are numerous additional ways to evaluate the noise exposure, several stand out as particularly helpful in assessing the situation. The subsequent analysis evaluates the noise exposure for three additional scenarios beyond the average annual conditions. Also, a grid-point analysis is provided to evaluate single-event noise in various areas around the airport.

TRAFFIC FLOW VARIATIONS

While the average annual noise conditions are based on a percentage of runway use in a given direction from long term wind data recordings, in reality on a given day these percentages can vary considerably. In fact, during the noise measurement program there were days of nearly 100 percent traffic flow in a given direction. There were also days where the flow changed throughout the day based on changing winds. Discussions with air traffic control personnel indicate that days where the traffic flow is 100 percent in a given direction are fairly common. Consequently, an analysis of the noise exposure for a 100 percent north flow or south flow day could provide insights into the concerns at Glendale.

North Flow Noise Exposure

This noise analysis was developed based on the current (1994) conditions at Glendale. With the exception of the runway use percentages, all other noise model input remained the same as the 1994 NEM contour analysis. The runway use percentages were adjusted to reflect a 100 percent north flow with all departures, arrivals, and touch-and-go's on Runway 01.

The noise pattern resulting from this operational scenario is presented in **Exhibit 2L.** The overall shape of the noise contours resembles that of the individual aircraft noise footprints shown in **Exhibit 2C.** The contours bulge out to the north along the extended runway centerline. The characteristic intensity of the departure noise is illustrated by the magnitude of the contour north of the airport. On the north side, noise is about three to four DNL greater than for average annual conditions. On the south side the relatively quiet arrival operations create a very small and narrow noise pattern. Along the extended runway centerline, noise is five to eight DNL less than for average annual conditions.

South Flow Noise Exposure

This noise analysis evaluates a 100 percent south flow scenario. Like the previous scenario it is developed based on the current (1994) conditions at Glendale. With the exception of the runway use percentages, all other noise model input remained the same as the 1994 NEM contour analysis. The runway use percentages were adjusted to reflect a 100 percent south flow with all departures, arrivals, and touch-and-go's on Runway 19.

The noise pattern resulting from this operational scenario is presented in **Exhibit 2M.** The overall shape of the noise contours is less rounded than the 100 percent north flow contours. This is due to the tendency for traffic that departs to the south to turn early to the east for eastern and northern destinations. Consequently, the 55 DNL contours illustrate the influence of the turning flight tracks and expand over Camelback Farms and parts of Villa de Paz. Again, the contours bulge out towards the direction of flow along the extended runway centerline. To the north, the relatively quiet arrival operations create a very small and narrow noise pattern.

DAILY OPERATIONS VARIATIONS

Another variable in the noise exposure equation is the number of aircraft operations that occur in a single day. Operational levels fluctuate on a daily basis with some days very active while others are relatively calm. While the average day of operations lies somewhere between these extremes, they nevertheless do exist in reality. Examining the noise exposure due to a busy day of traffic at Glendale would provide additional insights into the noise concerns around the airport.

For this analysis, the INM input data for the 1994 baseline condition was again used. The total operational levels in the input data were adjusted to reflect the activity of an estimated busy, or peak, day at the airport. This operational level was developed from the peaking characteristics identified in the *Glendale Municipal Airport Master Plan and City Wide Heliport Study*, 1988. The analysis in that study indicated that a typical peak day at the airport consisted of about 0.52 percent of the annual operations. This factor was applied to the 1994 annual operations level to calculate the peak day's activity. For the average annual day in 1994 there are about 312 aircraft operations. The calculations for the peak day indicate some 592 daily operations, nearly a 90 percent increase over the average annual day. Additionally, the operations that would most likely generate the peak day's activity would probably tend towards a higher percentage of touch-and-go operations than the annual split would indicate. This was also factored into the analysis. The remaining input data, such as flight tracks, time of day, and runway use remains the same as the 1994 baseline analysis.

Peak Day Noise Exposure

Exhibit 2N presents the plotted results of the INM contour analysis for the peak day aircraft operational scenario using input data that has been described in the preceding paragraphs.

Generally the peak day noise contours are similar in shape and slightly larger than the 1994 baseline contours. The similarity in shape is due to the use of similar modeling input assumptions for the two cases. The contours are slightly larger than the 1994 contours due to the increase in operations on the peak day. Even though the daily operations nearly

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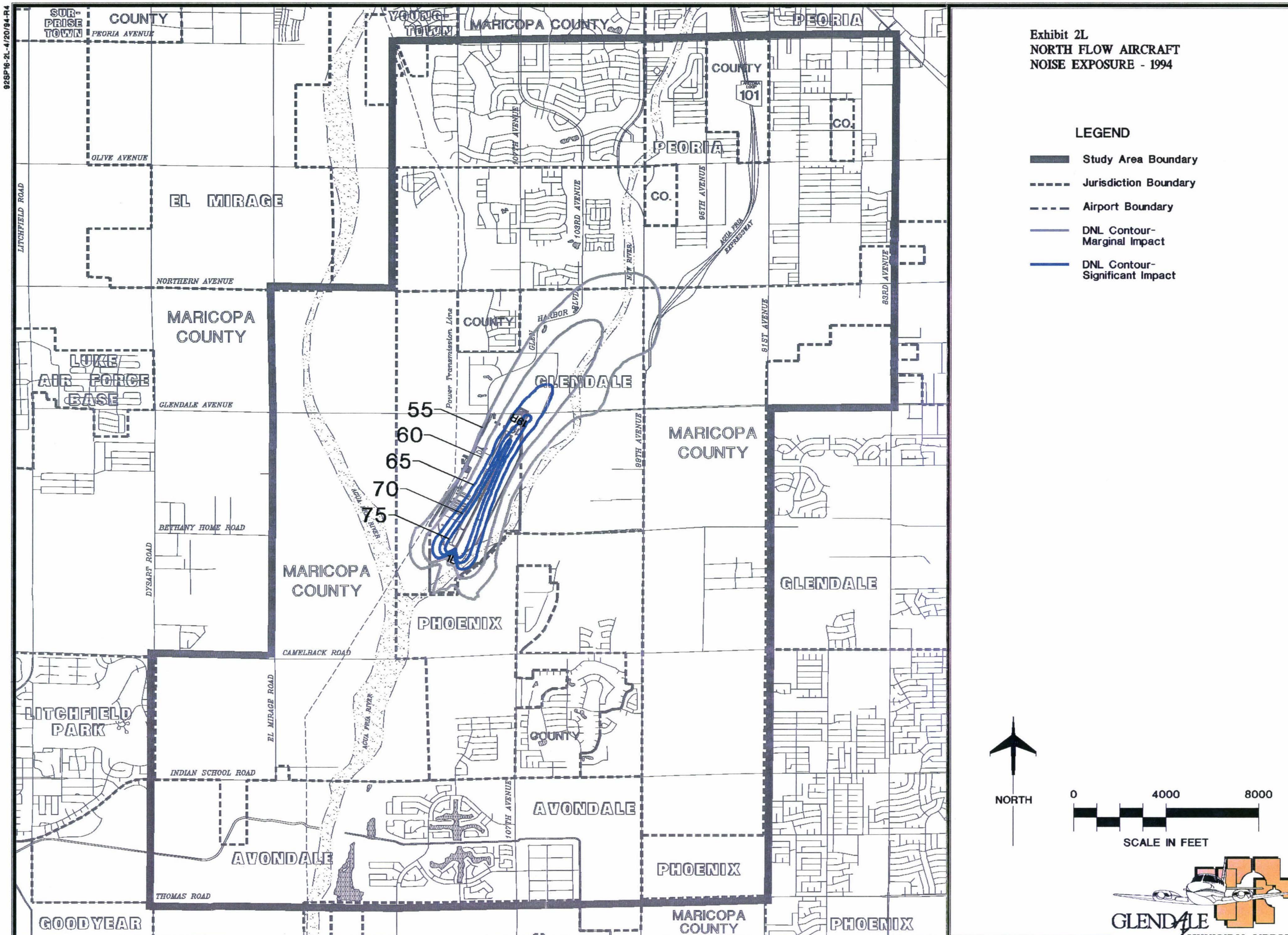

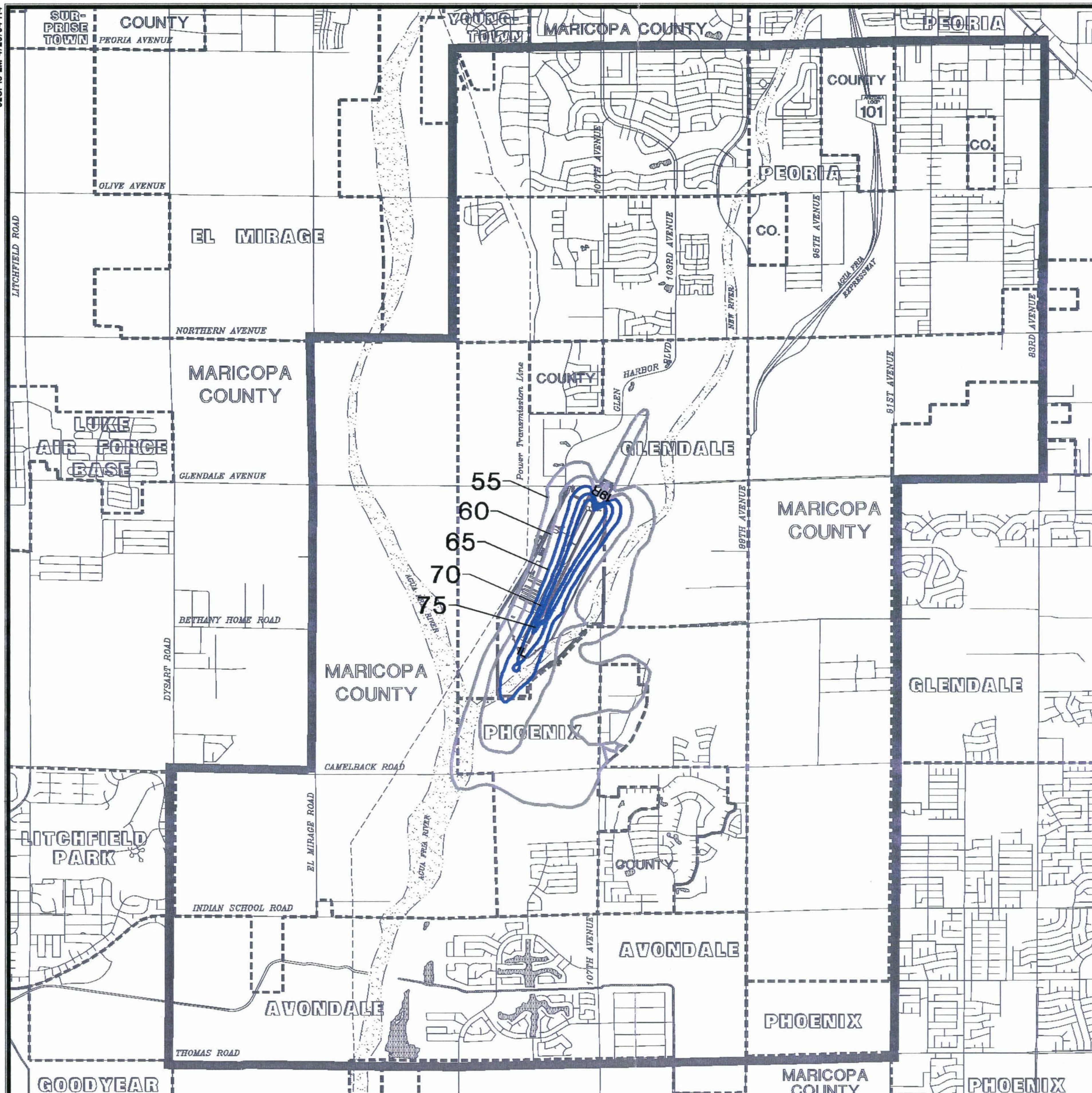

Exhibit 2M
SOUTH FLOW AIRCRAFT
NOISE EXPOSURE - 1994

LEGEND

- Study Area Boundary
- Jurisdiction Boundary
- Airport Boundary
- DNL Contour- Marginal Impact
- DNL Contour- Significant Impact

NORTH

0 4000 8000
SCALE IN FEET

GLENDALE MUNICIPAL AIRPORT

doubled on the peak day, the magnitude of the cumulative noise exposure pattern has only increased slightly by two to three DNL. This phenomenon relates back to the basics of the decibel unit as described in Appendix D of this document. The addition of an identical sound source raises the original level by only three decibels. Since the DNL noise metric is based on the decibel, even the doubling of the operations by identical aircraft would result in a three DNL expansion in the noise contours.

The noise contour surface areas for each scenario are presented in **Table 2H** for comparison with the 1994 baseline conditions.

TABLE 2H
Comparative Areas Of Noise Exposure

		Area In Square Miles		
DNL Contour	**1994 Baseline**	**North Flow**	**South Flow**	**Peak Day**
55	1.95	1.81	1.95	2.81
60	0.75	0.82	0.72	1.02
65	0.36	0.35	0.34	0.43
70	0.18	0.16	0.16	0.22
75	0.09	0.08	0.08	0.12

GRID POINT ANALYSIS

The evaluation of noise at specific locations of concern around an airport can be a valuable asset in the assessment of noise abatement procedures. Confining the analysis to specific points allows for the evaluation of additional noise metrics. This analysis evaluates the single event noise levels (SEL), the time above a given decibel level, and the DNL levels at specific locations around the airport.

The noise measurement locations were used for the basic grid pattern in the analysis. Additional points were added to ensure coverage of areas of interest. **Exhibit 2P** identifies the 29 points analyzed. The location of each point relative to the airport was programmed into the INM input file. The 1994 baseline modeling assumptions were used for the grid point analysis. For each grid point, the model provided the top 20 sound exposure levels (SELs), the peak SEL, the time in minutes above 65 dB, the time in minutes above 85 dB, and the DNL level at the site. The resultant output is summarized in **Table 2J**.

TABLE 2J
Grid Point Analysis Summary

	Peak Single Events Sound Exposure Level (SEL)		Single Event Range* Sound Exposure Level (SEL)				Time Above:	
Grid Point	With Jets	Without Jets	Departures	Arrivals	Touch-n-go's	DNL	85 dB (min.)	65 dB (min.)
1	99.3	78.3	68.8-78.3	65.4-73.3	—	43.6	0.0	0.3
2	107.2	82.0	65.7-82.0	—	61.0-68.6	42.1	0.0	0.4
3	102.4	77.9	64.5-77.9	—	59.6-70.1	38.6	0.0	0.2
4	107.0	82.4	68.3-82.4	70.1-74.5	68.1-74.3	44.5	0.0	0.6
5	107.6	82.6	71.1-82.6	73.2-75.7	67.7-75.1	48.4	0.0	1.1
6	107.9	85.4	74.6-85.4	78.2-79.9	68.3-79.0	47.9	0.0	1.4
7	106.2	82.8	66.1-82.8	—	65.5-75.8	42.9	0.0	0.7
8	101.6	79.0	65.6-79.0	—	63.6-74.3	40.5	0.0	0.4
9	110.3	88.3	75.0-88.3	78.3-78.5	72.6-84.2	49.7	0.0	3.1
10	110.4	88.0	77.0-88.0	77.4	73.7-85.7	50.6	0.0	4.6
11	104.3	82.5	73.5-82.5	—	79.2-67.5	44.8	0.0	1.3
12	97.5	78.3	70.2-74.7	—	67.8-78.3	43.9	0.0	1.7
13	102.2	82.6	73.3-79.4	—	72.2-82.6	48.4	0.0	8.4
14	115.1	91.2	84.4-88.7	—	82.4-91.2	58.2	0.1	21.8
15	102.1	82.9	82.8-82.9	—	77.6-82.9	52.1	0.1	29.7
16	102.3	91.0	81.7-91.0	81.3	76.2-88.4	54.1	0.1	18.9
17	104.0	87.7	76.0-87.1	82.3	74.2-87.7	53.1	0.1	13.6
18	105.8	86.7	73.8-86.7	—	69.1-79.7	48.2	0.0	1.8
19	108.3	83.7	73.1-82.1	77.0	70.7-83.7	50.5	0.0	2.8
20	100.1	75.2	67.4-74.3	72.9	64.2-75.2	42.9	0.0	0.6
21	106.8	81.6	65.2-81.6	—	58.7-69.1	41.3	0.0	0.4
22	109.0	84.6	76.0-84.6	80.5	71.9-82.1	51.2	0.0	2.6
23	105.8	81.7	73.5-81.7	70.7-72.3	61.6-72.0	43.6	0.0	0.5
24	109.3	85.6	75.0-85.6	70.3-78.1	61.2-71.9	40.9	0.0	0.2
25	106.3	82.9	74.4-82.9	78.7	62.6-73.7	46.3	0.0	1.0
26	109.4	87.5	69.8-87.5	—	64.8-72.0	46.5	0.0	0.7
27	106.6	82.6	75.5-82.6	70.8-74.3	59.3-70.1	44.4	0.0	0.6
28	107.8	82.6	66.2-82.6	—	60.7-65.3	43.5	0.0	0.4
29	101.9	77.9	66.4-77.9	—	60.7	40.9	0.0	0.2

Notes:
— indicates that the operation was not in the top 20 sound exposure levels computed by the INM
* does not include jet single events

The table provides peak SELs both with and without the jet aircraft levels. The G-IIB jet that is programmed into the model is relatively loud and relatively rare at Glendale. In order to present a more realistic understanding of the more common noise levels, the peak jet SELs are kept separate. The table also presents ranges of SELs based on operational type. These are extracted from the model's report of the top 20 SELs calculated for each site. Consequently, at some sites all operational types do not necessarily generate noise in the top 20 SEL levels. The jet SELs have also been removed from these ranges to present the most common noise levels. The time above two specific decibel levels is also presented. The 65 dB level roughly approximates the level at which outdoor speech would be interrupted, while the 85 dB level approximates indoor speech interference. The time above values include all aircraft operations.

In interpreting SEL data, it is important to remember that the SEL is a statistical adjustment of the raw measurement of a sound event. When considering aircraft noise, the SEL value is typically four to seven decibels higher than the peak decibel level (Lmax) for the event. For our purposes, we will consider the SEL value to exceed the Lmax by an average of five decibels.

In considering the SEL data, it is most helpful to consider the data without jets, since loud jet aircraft at Glendale are relatively rare. Excluding jets, the SEL

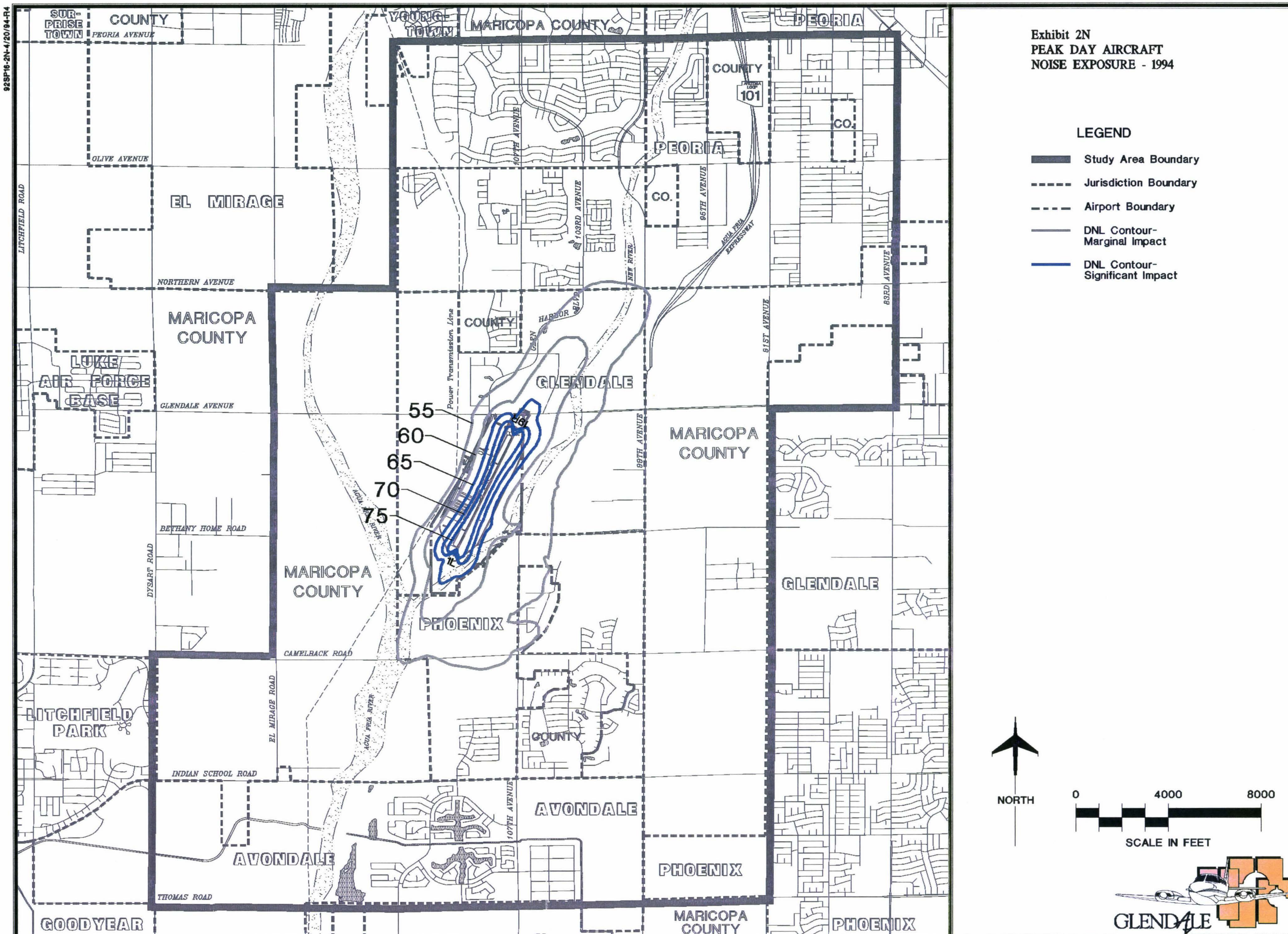

Exhibit 2N
PEAK DAY AIRCRAFT NOISE EXPOSURE - 1994

range at each grid point typically ranges from the high 60s or low 70s to the high 70s or 80s. An Lmax of 65 dB, or a SEL of 70, is loud enough to disrupt speech outdoors. An Lmax of 85 dB, or a SEL of 90, is loud enough to disrupt speech or television viewing indoors with the windows and doors closed. SELs above 70, without jets, are apparent at all grid points studied. SELs above 90 occur only at Points 14 and 16. These points also have the highest DNL levels at 58.2 and 54.1, respectively.

The "time above" data indicate that measurable amounts of time where the noise level exceeds 85 dB occur only at four points – 14, 15, 16, and 17. At all points, the time above 85 dB is only 0.1 minutes, or six seconds per day. These sites have the highest DNL levels, ranging from 52.1 to 58.2.

All 29 grid points register at least some time above 65 dB. Grid Points 14, 15, 16, and 17 have the highest values, ranging from 13.6 to 29.7 minutes per day. The time above 65 dB for the other points ranges from 0.2 to 8.2 minutes.

COMPARATIVE MEASUREMENT ANALYSIS

The variation between noise levels measured in the field and those calculated by computer is often of concern to persons unfamiliar with the modeling process. To assess the effectiveness of the computer model there are a number of analytical comparisons that can be made.

The simplest and most straight forward analysis would be a comparison of the measured versus the computer predicted cumulative DNL noise values for a particular site. In this case, it is important to remember what each of the two noise levels indicates. The computer-modeled DNL contours are analogous to the climate of an area and represent the noise levels on an average day of the period under consideration. In contrast, the field measurements reflect only the noise levels on the specific day of measurement. Additionally, the field measurements consider all of the noise events that exceed a prescribed threshold and duration (DNL(t)), while the computer model only calculates the noise due to the aircraft events. As previously discussed, the field measurements can easily be contaminated by ambient noise sources other than aircraft around the measurement sites. With this understanding in mind it is useful to evaluate the comparative aircraft DNL levels of the measurement sites.

Because of the difficulties in screening non-aircraft noise events at a measurement site, it is necessary to look beyond the simple DNL measurements and calculations to evaluate the performance of the computer model. The radar flight tracking data gathered during the field noise measurements provides the opportunity to correlate known aircraft overflights with specific noise events at each site. The flight tracking data provides the position, altitude, and time that an aircraft is over or near a measurement site. This allows for the correlation between a specific aircraft event and a specific noise event recorded by the noise monitor. This noise event data can then be compared to the noise levels computed by the INM for that site. This type of analysis reduces the concerns about contamination of the measured DNL data because it only focuses on measured events that are known to be aircraft-generated.

Each of these methods provides insight into the relationship between the computer noise predictions and the actual conditions around Glendale Municipal Airport. While each approach has shortcomings, together they provide a general measure of the INM computer simulation's relationship to the conditions around Glendale. The subsequent sections provide the comparisons between the predicted and measured data for each of the three methods.

DNL Comparison

This analysis provides a direct comparison of the measured and predicted average daily DNL values for each of the 24-hour noise measurement sites. In order to facilitate such a comparison it is necessary to ensure that the computer model input is representing the observed reality as accurately as possible within the capabilities of the model.

During the measurements the airport operated in both a south flow and a north flow. On some days the flow was in one direction nearly all day. On others the flow changed throughout the day. Consequently, in order to evaluate the INM based on this field data, it is necessary to look at not only the average annual noise contours, but also those representing all north flow and all south flow.

A number of unusually loud or long events were recorded at several of the sites. These events were clearly not aircraft overflights and represent the type of contamination that can be difficult to screen from the on-site measurements. Some of these events lasted as long as one to three minutes. At any point on the ground a typical aircraft overflight lasts 20 to 40 seconds. In order to minimize the amount of contamination for the comparison, these events were subtracted from the DNL(t) calculation at each of the measurement sites. All other events that even remotely resembled the characteristics of an aircraft overflight were included in the analysis.

A difference of three to four DNL is generally not considered a significant deviation between measured and calculated noise, particularly at levels above 65 DNL. Additional deviation is expected at levels below 65 DNL. For comparison, the average human ear cannot distinguish changes in sound levels of less than two or three decibels. The measured and predicted noise levels are presented for each aircraft noise measurement site in **Table 2K.**

TABLE 2K
Comparison Of Measured And INM Predicted Noise DNL Levels

	INM Predicted Levels				Difference
Measurement Site	North Flow	Baseline	South Flow	Measured Levels (DNL(t))	Measured from INM Baseline
1	53.9	50.6	45.0	48.2	-2.4
2	45.3	41.3	31.8	44.4	3.1
3	40.5	46.4	48.0	46.6	0.2
4	48.8	54.1	55.8	45.6	-8.5
5	51.3	48.4	44.0	47.7	-0.7
6	39.9	46.4	48.0	47.1	0.7
7	46.6	42.9	35.0	42.9	0.0
8	51.3	48.4	43.2	47.1	-1.3
9	45.9	50.5	52.1	48.8	-1.7
10	37.5	43.5	45.0	44.0	0.5
11	49.0	53.1	54.5	46.4	-6.7
12	52.8	49.7	44.2	46.5	-3.2
				Mean Difference	-1.7

For the most part the measurements reflect the predicted sound levels in the area surrounding the airport. The table presents the daily measured DNL(t) for each site. The predicted DNL values are shown for the north flow, south flow, and annual average conditions. The deviation between the average measured values and the annual average predicted values for nearly all of the sites was less than the desired three DNL. Only at three of the twelve sites did the measured DNL(t) value deviate from the average annual predicted value by more than 3 DNL. In two of these cases the measurements were lower than the INM predicted levels. At all but two of the sites, the measured values fell within the range bounded by the north flow and south flow numbers. The mean difference between the measured values and the INM annual average values is 1.7 dB. These values are generally acceptable given the potential for contamination of the measurements from noise sources other than aircraft operations.

Single Event Comparison

To further quantify the applicability of the noise model for Glendale, an assessment of the INM single event noise levels was conducted for each measurement site. The purpose of this analysis is to ensure that a reasonable relationship exists between the noise data found in the INM data base and the actual field measurements. While some variation is expected, it is important to verify that the model is not grossly understating the noise generated by aircraft operations at the measurement sites Overstatement of the noise by the model is less of a concern and is desired for a conservative planning approach.

During the radar tracking program, technicians traced arrivals and departures noting the time of day, the flight number, and altitude. At the same time, noise measurement equipment which was strategically placed in the airport environs recorded the noise generated by the individual aircraft overflights. The measurement equipment's internal clock recorded the actual time of day the overflight occurred. By comparison of the observed operation time with the recorded time of the noise measurement output, the measurement data could be related to a specific flight and operation type. This information was recorded, analyzed, and compared to the predicted SEL values for similar operations at each site.

Table 2L presents the results of the analysis. Ranges of SELs are presented for each type of aircraft operation. Where identified measured values were available for a given site, they are compared to the values predicted by the INM. Similar to the previously discussed grid point analysis, the INM provides the top 20 SELs at each site. In some situations certain operational types are not represented in the top 20 SEL levels for a particular site.

TABLE 2L
Comparison Of Measured And INM Predicted Noise Single Event Ranges

	Departure Range		Arrival Range		Touch-n-Go Range	
Measurement Site	**INM**	**Measured**	**INM**	**Measured**	**INM**	**Measured**
1	77.0-88.0	73.9-86.7	77.4	71.9-80.8	73.7-85.7	—
2	65.2-81.6	77.6	—	78.0	58.7-69.1	—
3	69.8-87.5	79.3-82.5	—	75.9	64.8-72.0	—
4	81.7-91.0	71.2-82.0	81.3	76.1-81.6	76.2-88.4	82.0
5	73.3-79.4	72.8-84.6	—	—	72.2-82.6	—
6	69.8-87.5	—	—	—	64.8-72.0	—
7	66.1-82.8	—	—	—	65.5-75.8	—
8	71.1-82.6	—	73.2-75.7	—	67.7-75.1	—
9	73.1-82.1	—	77.0	—	70.7-83.7	71.0-76.3
10	66.2-82.6	—	—	—	60.7-65.3	—
11	76.0-87.1	84.2-89.2	82.3	—	74.2-87.7	71.4-76.5
12	75.0-88.3	76.5	78.3-78.5	—	72.6-84.2	—

— indicates no measurements available for this operation at this site or the operation was not in the top 20 single event levels computed by the INM

The data presented in the table indicates a good relationship between the INM predicted SEL ranges and those observed in the noise measurement program. The measurements fall within the predicted ranges in all but two cases. In these, the deviations were within a reasonable range of tolerance.

The comparisons presented indicate that the INM-predicted values compare favorably with the overall noise measurements made around Glendale Municipal Airport. Generally, the measurements indicate that the model is providing a reasonably accurate and reliable picture of the overall aircraft noise around Glendale Municipal Airport.

SUMMARY

The information presented in this chapter defines the noise patterns for current and future aircraft activity, without additional abatement measures, at Glendale Municipal Airport. It does not, however, make an attempt to evaluate or otherwise include that

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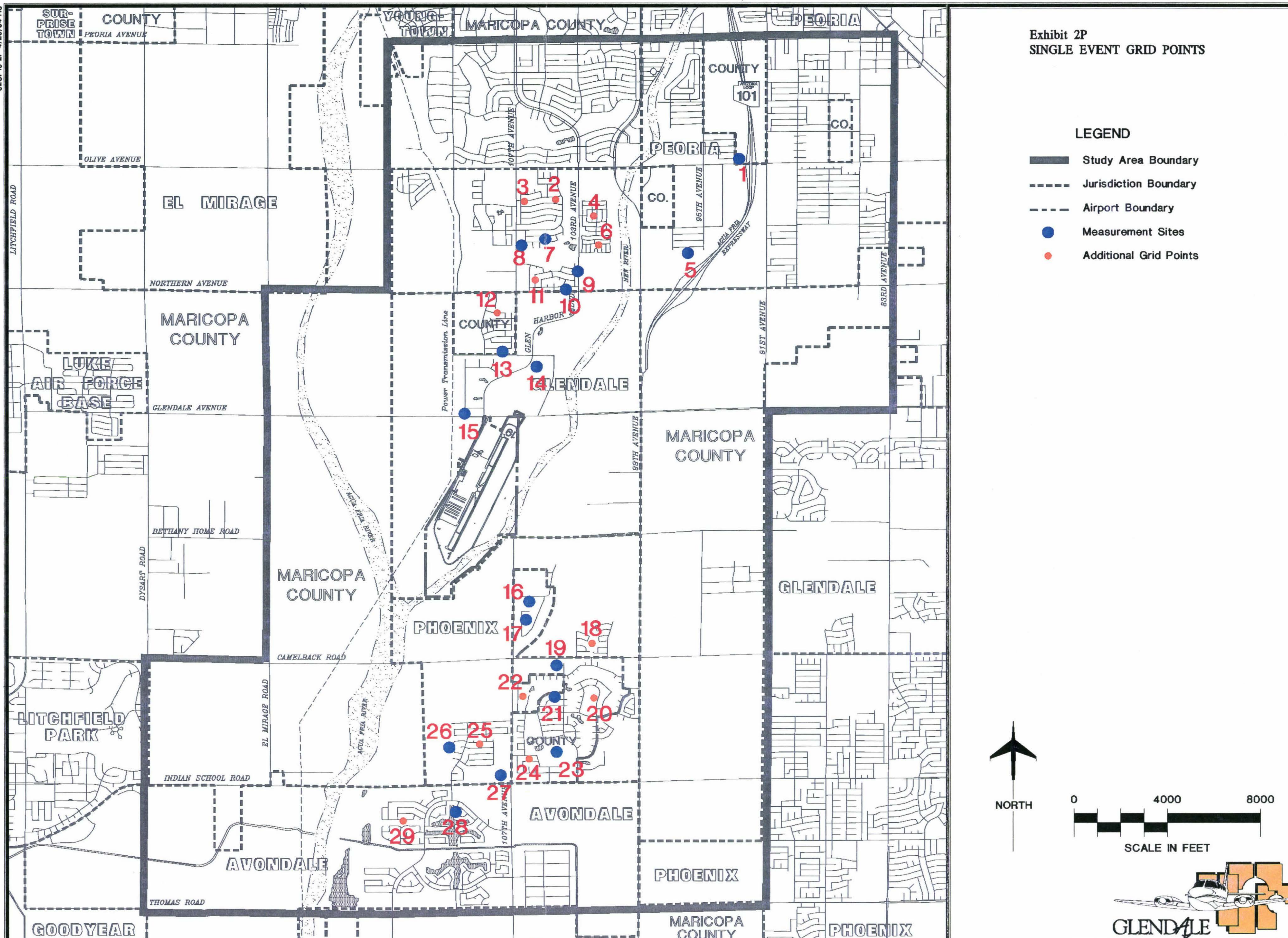


activity over which the airport has no control – such as other aircraft transiting the area and not stopping at the airport. Community-wide noise levels associated with non-airport activity will be discussed in Chapter Three.

The current contours are based on an average day's activity for the 1993 operational year and presented as the 1994 noise exposure contours. The five-year and twenty-year forecasts of noise exposure levels around the airport can be expected to increase slightly as the airport becomes busier in the future.

It is stressed that DNL contour lines drawn on a map do not represent absolute boundaries of acceptability or unacceptability in personal response to noise, nor do they represent the actual noise conditions present on any specific day, but rather the conditions of an average day derived from annual average information.

CHAPTER THREE
COMMUNITY NOISE

GLENDALE
MUNICIPAL AIRPORT

CHAPTER 3

GLENDALE MUNICIPAL AIRPORT
F.A.R. Part 150 Noise Compatibility Study

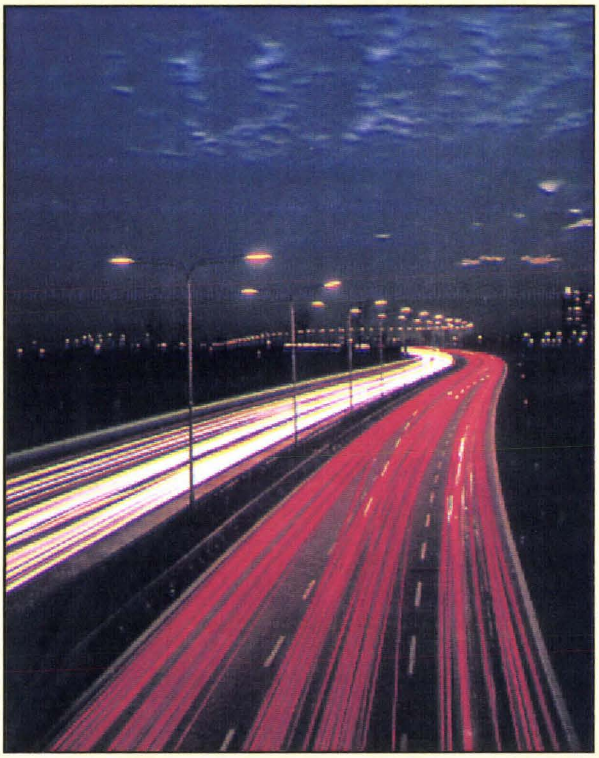
COMMUNITY NOISE

The aircraft noise exposure discussed in the previous chapter provides only a portion of the information necessary for the understanding of aircraft noise impacts within the study area. Non-aviation noise sources in the vicinity of an airport can also play a role in the determination of the extent of these impacts.

This chapter contains a general description of the non-aircraft noise levels in the airport vicinity as developed from a series of mathematical models. These resultant background noise levels identify areas which have significant differences between aircraft and non-aircraft noise and where land use compatibility programs may support the aviation noise abatement efforts.

BACKGROUND NOISE EVALUATIONS

Aircraft noise does not exist in a vacuum. Other noise sources include truck and automobile traffic on major roadways passing through the area and the noise associated with urban land uses of various types. The Environmental Protection Agency (EPA) recommended consideration of other noise sources in *Airport Noise Regulation Process*, Notice of Proposed Rulemaking (Federal Register, Vol. 41, p. 51522, November 22, 1976).



This study does not recommend procedures for abatement of non-aircraft or non-airport noise sources. However, consideration of background noise provides an overall perspective of how aircraft noise contours relate to community-wide noise patterns and can assist in the development of mitigation actions under other studies. Background noise analysis assists in the development of noise mitigation measures by indicating the areas of significant aircraft noise impacts, particularly where the noise falls on areas of non-compatible use. Background noise analysis further indicates areas suitable for noise shifting should trade-offs become necessary to reduce total impacts. The analysis does not imply the denial of aircraft noise in an area nor does it attempt to conceal the impacts of such noise.

Extensive research has found that noise of a cumulative nature affects the livability of a community, taking into account all noise sources associated with the area. This analysis calculates the noise patterns of surface transportation and urban land uses. The next step in the analysis combines these patterns to provide a composite pattern of all noise in the airport area not associated with the operation of aircraft at the airport. The analysis then combines the background noise pattern with the current aircraft noise exposure contours to provide a pattern of total noise exposure in the airport environs.

INDIGENOUS NOISE EXPOSURE

The indigenous noise levels associated with general urban area activity -- traffic on local streets, lawn mowers, air conditioning compressors, outdoor residential activity, etc. -- increase or decrease as a function of population density. Indigenous noise does not include noise related to aircraft, railroads, and traffic on major roadways. This study uses the functional relationship,

$$\mathbf{Ldn = 10 \log P + 22\ dB}$$

where P equals the population density per square mile, to calculate noise levels in urban residential areas. EPA-sponsored research derived this relationship (Galloway 1972). It applies only to fairly homogeneous residential areas and to locally generated noise, since the research data base excluded other major sources such as major roadways and aircraft. The prediction model and its data base have a standard deviation of about four decibels.

The process of determining indigenous noise levels requires the determination of population densities in the smallest geographical areas with reliable statistical data. For this analysis, recent aerial photography served as the basis for housing counts. The 1990 census data provided average household size by census tract. The average household size multiplied by the housing count gave an estimate of the population in a particular area around the airport. The population density in persons per square mile, calculated from this data and inserted into the predictive equation, gave an estimate of the noise levels for each residential area. In general, if the population density exceeds 1,995 persons per square mile, the noise level will exceed 55 DNL. The equation predicts that it would take 6,300 persons per square mile to exceed 60 DNL from indigenous sources. A density of some 19,950 persons per square mile would be required to generate noise levels in excess of 65 DNL.

The model does not predict noise levels applicable to non-residential areas. Commercial and industrial areas vary greatly in their noise levels, depending upon the specific type of activity occurring there. In general, manufacturing districts may experience noise levels ranging from 60 to 75 DNL, warehousing areas from 55 to 70 DNL, and commercial centers from 60 to 70 DNL. Much of the noise relates to the volume of traffic into and out of the area, although industrial process noise may contribute to the general outdoor noise level. Based on experience, this study uses 60-63 DNL for the generalization of background noise for the small industrial and commercial areas in the study area.

Exhibit 3A presents the noise contours resulting from this analysis. The airport lies in a largely rural area. A number of residential subdivisions lie to the north and south of the airport. To the north, the Country Meadows subdivision, portions of Sun City, and portions of Peoria contain population densities which would generate noise levels above 55 DNL. The southern most portion of Country Meadows subdivision, south of Northern avenue, has a population density that would generate a 60 DNL noise contour. To the south, the Garden Lakes, Villa de Paz, and Camelback Greens subdivisions all have population densities sufficient to generate a 55 DNL noise level. The western portion of Villa de Paz also has population densities sufficient to generate a 60 DNL noise contour level.

ROAD TRAFFIC NOISE EXPOSURE

As with aircraft, the basic methodology for determination of roadway noise contours involves the use of a mathematical model for noise prediction. This noise analysis uses a method developed by the U.S. Department of Housing and Urban Development (HUD) based on the Federal Highway Administration's SNAP and STAMINA models for detailed site-specific noise evaluations (Galloway and Schultz 1980). This study considered the HUD model appropriate for the intended application and for the level of detail available as input data.

This method does not attempt to incorporate any extraordinary attenuation of noise by closely-spaced buildings adjacent to roads. The model assumes an uninterrupted flow of noise from the source. The model provides sufficient detail for this ambient noise analysis. For more detailed information, other techniques provide better single-site analysis.

The model requires four types of data as input: traffic volume, traffic speed, time of day, and vehicle mix. Traffic volume information was provided from the 1990 Average Weekday Traffic Map from the Maricopa Association of Governments, Transportation and Planning Office, November 1991.

Posted speed limits formed the basis for the input data for traffic speed. For purposes of analysis, it was assumed that 15 percent of the total traffic occurs between 10:00 p.m. and 7:00 a.m. Lacking specific counts, the input data assigned 5 percent heavy truck traffic to the primary arterial roads in the area.

The model calculates automobile and truck traffic separately using a series of mathematical factors to derive adjusted traffic volumes along each segment of roadway. The model then uses these adjusted traffic volumes in a series of formulae which predict the distance from the center of the roadway to the specific DNL contours. The model uses a formula of the following general format to calculate the distances from the center of the roadway to the predicted noise contours:

$$\text{Log } D = (\text{Log}(AADT))/1.47 + K$$

where D equals the distance to a predicted noise contour, AADT equals the adjusted average daily traffic, and K equals a constant related to the specific noise level considered.

The calculation process produced a table of distances from roadway centerlines to specific noise contours resulting from the input data described above. The distances are presented in **Table 3A**. **Exhibit 3B** shows the noise contours for the roadways.

TABLE 3A
Roadway Noise Contours

	Segment			Distance From Centerline of Roadway to DNL Contour (feet)	
Road	From	To	Average Daily Traffic (ADT)	55	60
Peoria Ave.	83rd Ave.	Agua Fria Exp.	12,000	939	430
	Agua Fria Exp.	99th Ave.	10,000	829	–
	99th Ave.	107th Ave.	14,000	1,043	478
	107th Ave.	115th Ave.	6,000	586	–
Olive Ave.	83rd Ave.	Agua Fria Exp.	11,000	885	405
	Agua Fria Exp.	99th Ave.	10,000	829	–
	99th Ave.	107th Ave.	10,000	829	–
	107th Ave.	115th Ave.	6,000	586	–
Northern Ave.	83rd Ave.	91st Ave.	4,000	445	–
	91st Ave.	Agua Fria Exp.	5,000	518	–
	107th Ave.	115th Ave.	4,000	445	–
	115th Ave.	El Mirage Rd.	4,000	445	–
Glendale Ave.	83rd Ave.	91st Ave.	11,000	885	405
	91st Ave.	99th Ave.	9,000	772	–
	99th Ave.	El Mirage Rd.	11,000	885	405
Camelback Rd.	91st Ave.	99th Ave.	11,000	885	405
	99th Ave.	107th Ave.	8,000	713	–
	107th Ave.	El Mirage Rd.	8,000	713	–
Indian School Rd.	91st Ave.	99th Ave.	11,000	885	405
	99th Ave.	107th Ave.	13,000	991	454
	107th Ave.	El Mirage Rd.	9,000	772	–
	El Mirage Rd.	Dysart Rd.	7,000	651	–
Thomas Rd.	83rd Ave.	91st Ave.	4,000	445	–
83rd Ave.	Peoria Ave.	Olive Ave.	4,000	445	–
	Olive Ave.	Northern Ave.	5,000	518	–
	Northern Ave.	Glendale Ave.	8,000	713	–
91st Ave.	Peoria Ave.	Olive Ave.	4,000	445	–
	Olive Ave.	Northern Ave.	5,000	518	–
	Northern Ave.	Glendale Ave.	5,000	518	–
	Glendale Ave.	Camelback Rd.	5,000	518	–
	Camelback Rd.	Indian School Rd.	7,000	651	–
	Indian School Rd.	Thomas Rd.	10,000	829	–
Agua Fria Exp.	Peoria Ave.	Olive Ave.	5,000	518	–
	Olive Ave.	Northern Ave.	6,000	586	–
	Northern Ave.	Glendale Ave.	12,000	939	430
99th Ave.	Peoria Ave.	Olive Ave.	5,000	518	–
	Glendale Ave.	Camelback Rd.	22,000	1,418	650
	Camelback Rd.	Indian School Rd.	19,000	1,284	588
	Indian School Rd.	Thomas Rd.	14,000	1,043	478
107th Ave.	Camelback Rd.	Indian School Rd.	5,000	518	–
Dysart Rd.	Camelback Rd.	Indian School Rd.	9,000	772	–
	Indian School Rd.	Thomas Rd.	9,000	772	–

Source: Traffic counts from Maricopa Association of Governments 1990 Average Weekly Traffic counts, November, 1991. Noise analysis by Coffman Associates.

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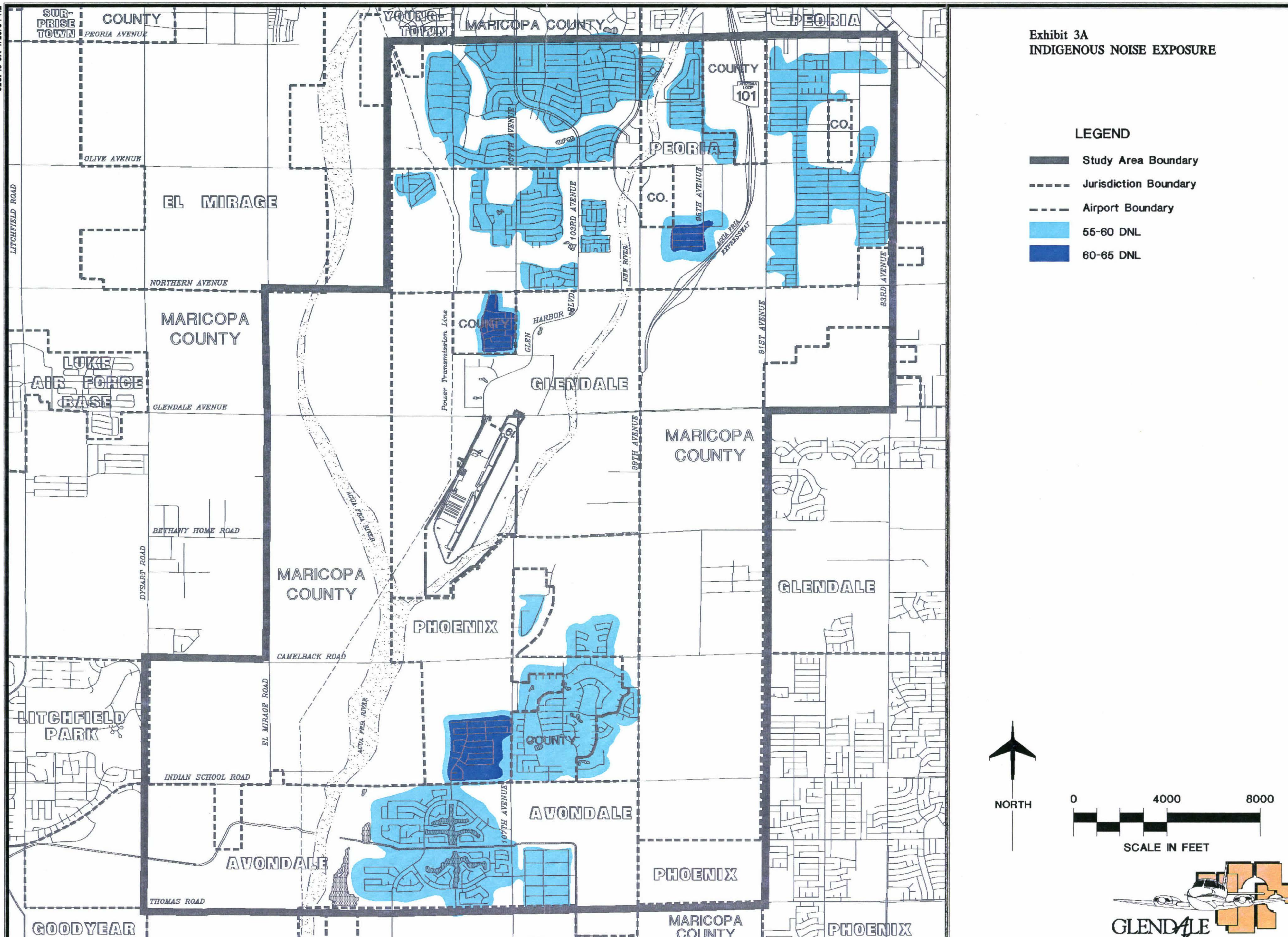

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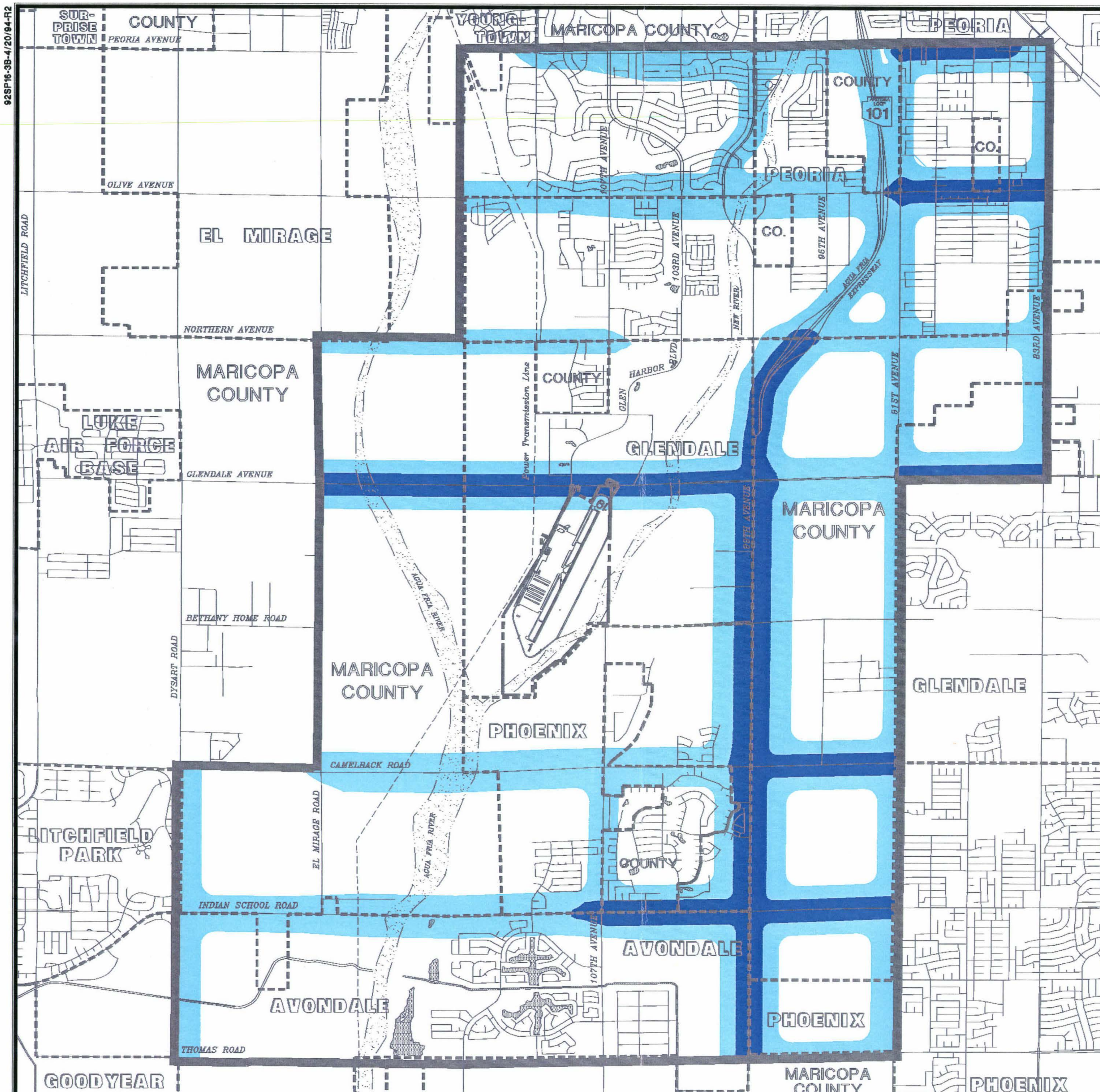


Exhibit 3B
SURFACE TRANSPORTATION
NOISE EXPOSURE

LEGEND

- Study Area Boundary
- Jurisdiction Boundary
- Airport Boundary
- 55-60 DNL
- 60-65 DNL

NORTH

0 4000 8000

SCALE IN FEET

GLENDALE MUNICIPAL AIRPORT

Traffic volumes on the major arterial roadways generate contours of 55 DNL throughout the study area. Only portions of 99th Avenue and Glendale Road had sufficient volume to generate a sustained 60 DNL contour large enough to show on the map. Small sections of other east-west arterials also generated a 60 DNL contour. None of the roadways had sufficient traffic volume to generate a 65 DNL contour large enough to map.

Traffic volume on the smaller collectors and local access roads did not generate a 55 or 60 DNL contour of sufficient size to show on the map.

AMBIENT NOISE EXPOSURE

Indigenous noise and roadway noise when combined form a picture of the ambient noise in the airport area. **Exhibit 3C** depicts the ambient noise levels. This map represents a composite pattern of noise exposure not originating with aircraft at Glendale Municipal Airport.

The exhibit demonstrates the exposure to non-aircraft noise sources within the area. In general, the composite background noise exposure above 60 DNL occurs primarily along major arterial streets. The 60 DNL contour along Indian School Road joins the 60 DNL contour generated in the western portion of Villa de Paz, west of 107th Avenue.

The 55 DNL contour from 99th Avenue, Camelback Road, and Indian School Road unites with the 55 DNL contour from Villa de Paz, Garden Lakes and Camelback Greens. The 55 DNL contour from Sun City, Country Meadows, and Peoria joins with the 55 DNL from Olive Avenue, 99th Avenue, Agua Fria xpressway, and 91st Avenue.

TOTAL NOISE

The combination of the noise exposure patterns from all sources of noise within the community develops the total or community-wide noise exposure pattern. **Exhibit 3D** depicts the result of adding the 1994 aircraft noise exposure contours to the ambient noise exposure map.

At the higher noise levels 65-75 DNL, aircraft clearly dominate as the noise source. The 60 DNL contour from the aircraft noise blends with the 60 DNL contour of Glendale Avenue north of the airport. The 55 DNL contour from the aircraft noise is cut by the 55 and 60 DNL contour from Glendale Avenue on the north while it joins the Camelback Road contour on the south side.

DIFFERENTIAL NOISE EXPOSURE

F.A.R. Part 150 recognizes that high ambient noise levels in the community may occasionally mask aircraft noise levels. Consequently, the regulation states: "No land use has to be identified as non-compatible where the self-generated noise from that use and/or the ambient noise from other non-aircraft and non-airport uses is equal to or greater than the noise from aircraft and airport sources." (F.A.R. Part 150, A150.101(e)(5)).

Part 150 guidelines describe 65 DNL as the threshold of significant impact on non-compatible land uses. No local noise source produced self-generated noise levels in excess of 65 DNL which would mask the aircraft noise exposure contours. At noise levels below 65 DNL, some portions of the area shown on Exhibit 3D have average ambient noise levels greater than or equal to the noise generated by aircraft.

Exhibit 3E shows where aircraft noise exceeds ambient noise around the Glendale Municipal Airport. Traffic noise on Glendale Avenue cuts the aircraft contours at both the 55 and 60 DNL levels. South of the airport the traffic noise on Camelback Road also cuts the aircraft noise contours at the 55 DNL level.

In comparing Exhibits 3D and 3E with the existing land use map in Chapter One (Exhibit 1G after page 1-24), it is clear that aircraft noise above 55 DNL does not affect any residential neighborhoods. Indeed, most of the neighborhoods have background noise levels above 55 DNL.

The exhibits in this chapter consider only the affect of existing noise levels. As new residential development occurs, the quiet background noise levels in currently undeveloped areas will increase. At the same time, based on the forecasts presented in Chapter Two, aircraft noise will increase. Future aircraft noise of 55 DNL may affect future (or even some existing) neighborhoods with background noise levels of 55 DNL or greater.

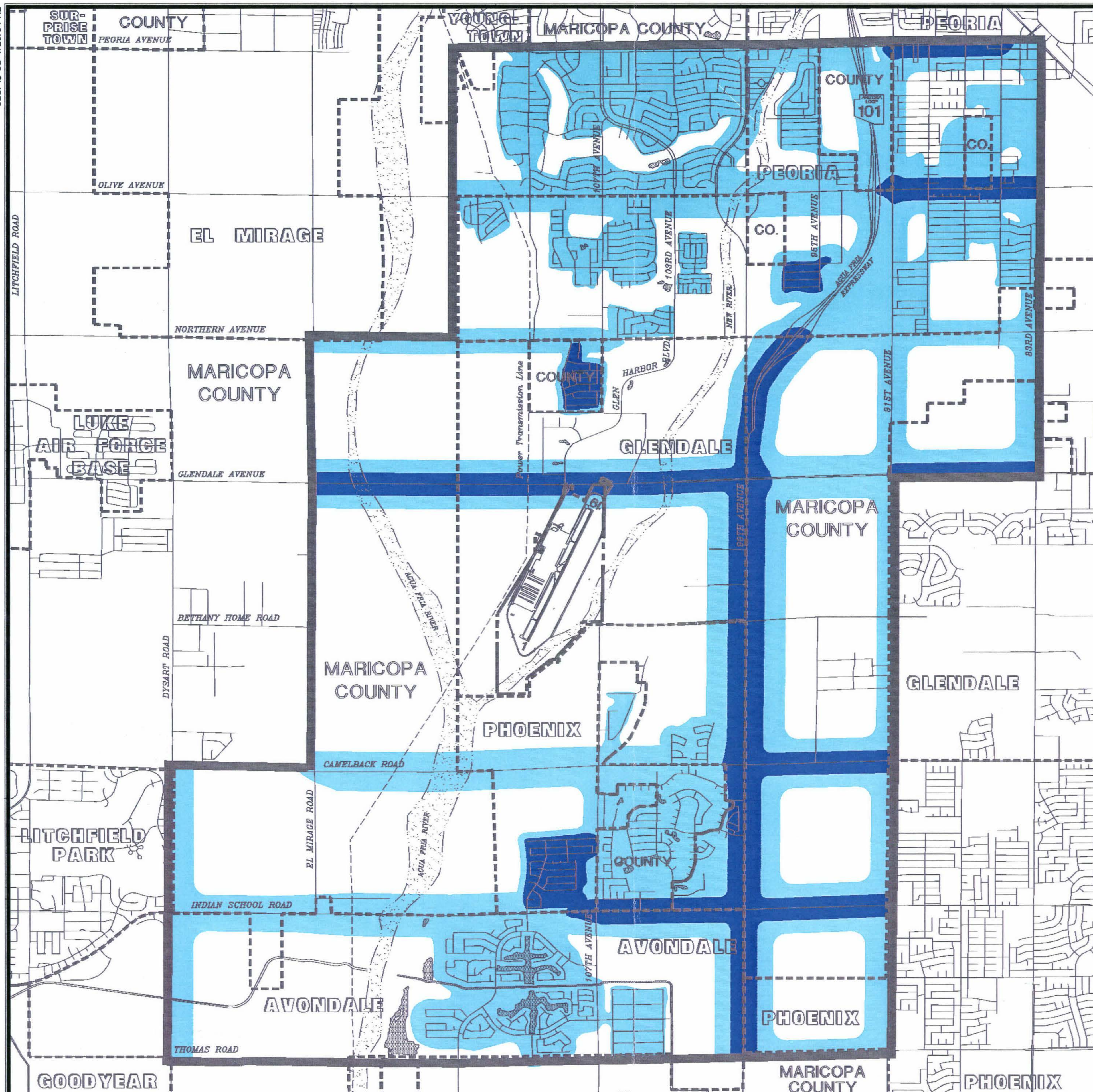
While background noise will help lessen the potential impact of the aircraft noise in neighborhoods, it will not necessarily mask it completely. It is possible that the aircraft noise could annoy some people in these areas. There are two explanations for this. First, if the background noise is 55 DNL, aircraft noise of 55 DNL will increase the total noise exposure by a DNL of three decibels. A three decibel increase in noise will be noticed by most people, some of whom may consider it annoying. In addition, the single overflight events within a 55 DNL contour are loud enough to potentially disrupt quiet outdoor activities, such as conversation, or even some indoor activities, such as TV viewing, if windows are open. This is true even in neighborhoods with background levels above 60 DNL.

The complaint history at Glendale indicates that some people even one to two miles from the airport, where the DNL levels are relatively low, have been seriously disturbed by noise. This indicates that background noise has not been loud enough to screen aircraft noise. For purposes of this Part 150 Study, where a conservative approach is prudent, background noise of less than 65 DNL will not be considered loud enough to completely mask aircraft noise.

SUMMARY

This chapter presented noise exposure patterns for individual ambient sources in the airport area (indigenous, and road). A combination of these patterns generated an overall pattern of ambient noise in the study area. The ambient pattern when combined with the current aircraft noise exposure pattern formed a pattern of noise exposure from all sources. Many parts of the study area, including most residential neighborhoods, have moderate background noise levels ranging between 55 and 60 DNL. While aircraft noise of 55 DNL or higher does not now affect these areas, it is possible that in the future, neighbor-

Exhibit 3C
AMBIENT NOISE EXPOSURE



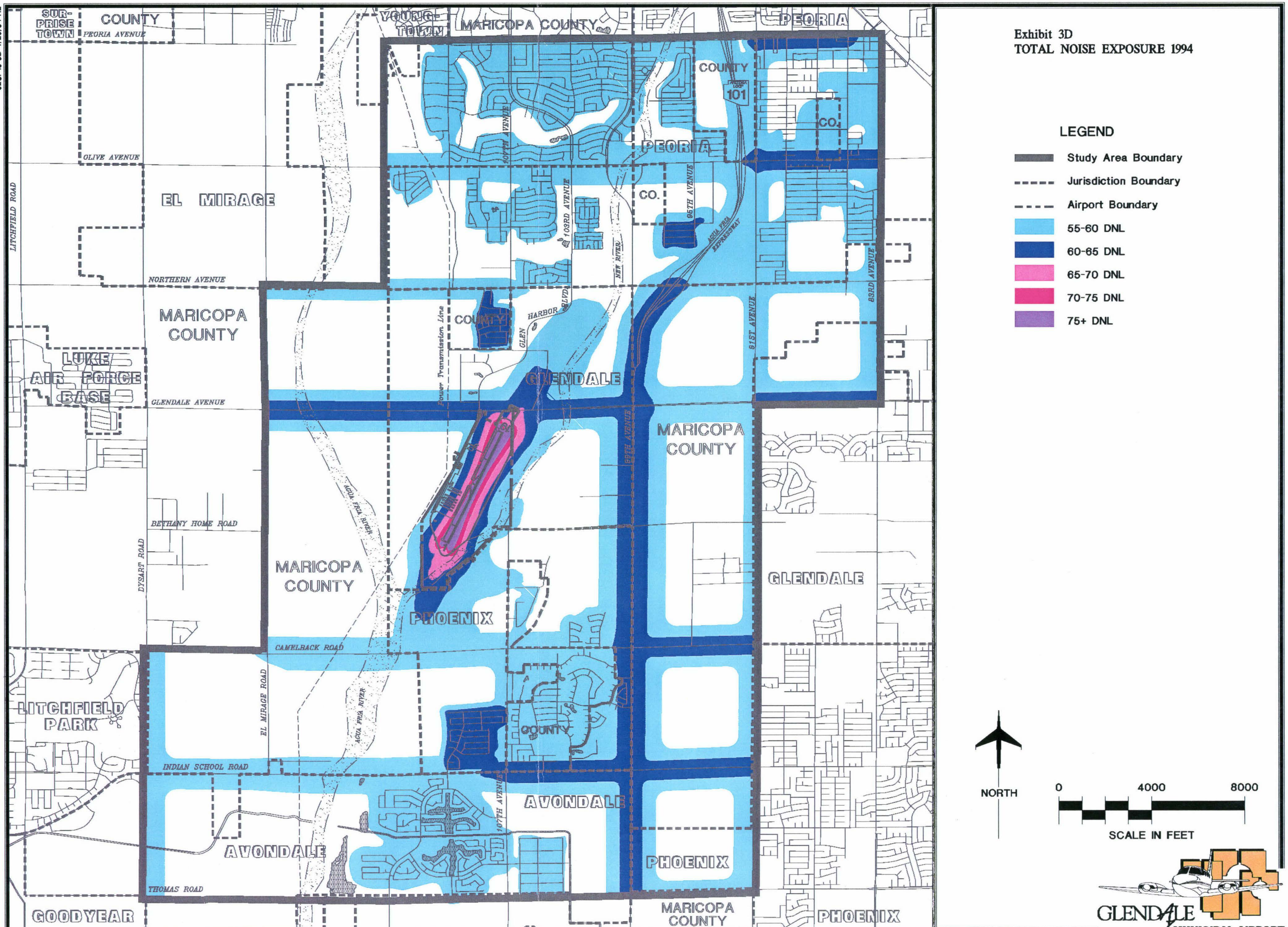
LEGEND

- Study Area Boundary
- Jurisdiction Boundary
- Airport Boundary
- 55-60 DNL
- 60-65 DNL

GLENDALE MUNICIPAL AIRPORT

92SP16-3C-4/20/94-R2

Exhibit 3D
TOTAL NOISE EXPOSURE 1994



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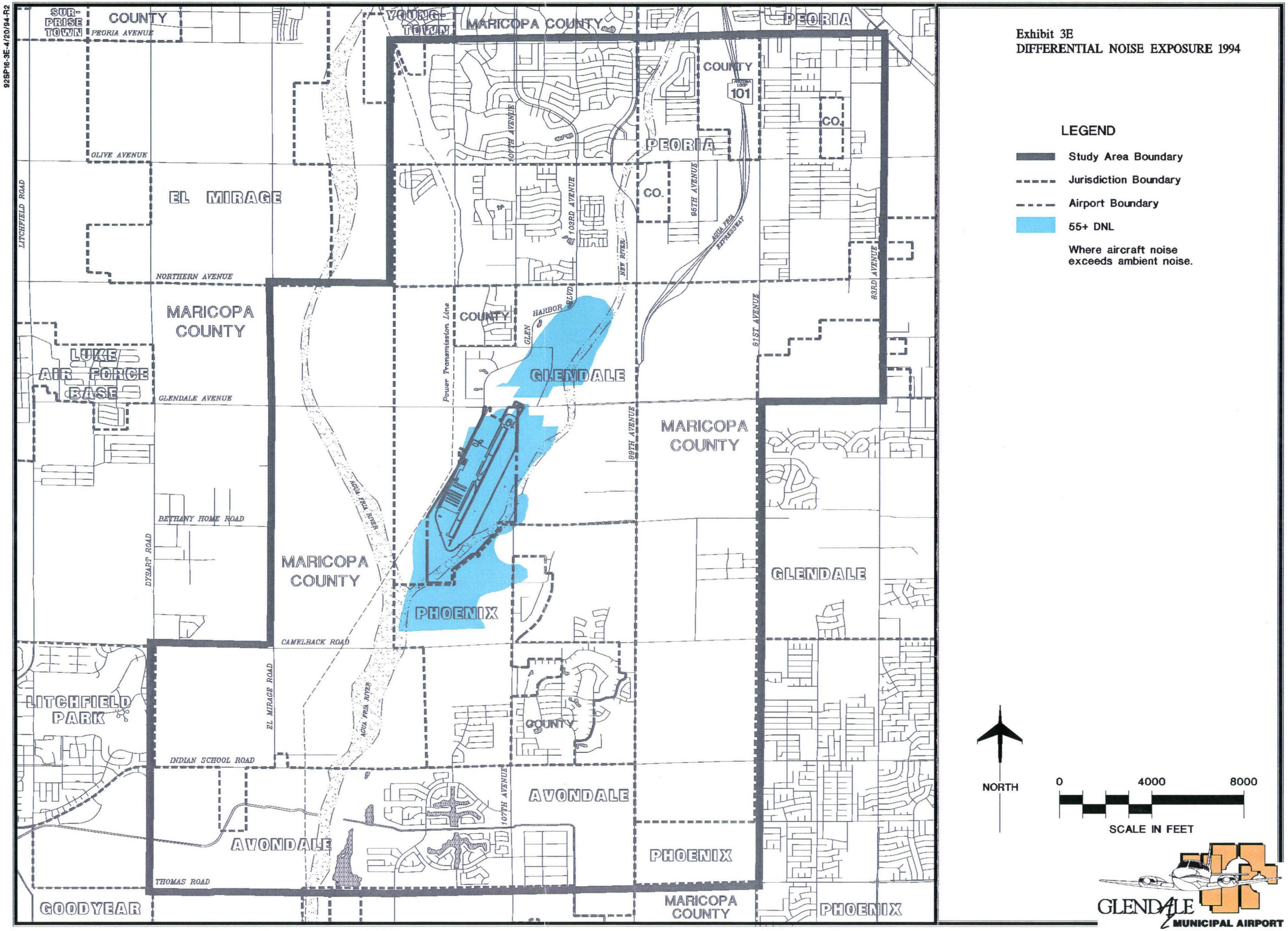


Exhibit 3E
DIFFERENTIAL NOISE EXPOSURE 1994
LEGEND
Study Area Boundary
Jurisdiction Boundary
Airport Boundary
55+ DNL
Where aircraft noise exceeds ambient noise.
NORTH
0
4000
8000
SCALE IN FEET
GLENDALE MUNICIPAL AIRPORT
92SP16-3E-4/20/94-R2
SURPRISE TOWN
COUNTY
PEORIA AVENUE
YOUNGTOWN
MARICOPA COUNTY
PEORIA
COUNTY
101
CO.
OLIVE AVENUE
EL MIRAGE
PEORIA
107TH AVENUE
103RD AVENUE
CO.
95TH AVENUE
AGUA FRIA EXPRESSWAY
NEW RIVER
LITCHFIELD ROAD
NORTHERN AVENUE
83RD AVENUE
MARICOPA COUNTY
COUNTY
HARBOR BLVD.
GLEN
Power Transmission Line
81ST AVENUE
LUKE AIR FORCE BASE
GLENDALE
GLENDALE AVENUE
MARICOPA COUNTY
99TH AVENUE
AGUA FRIA RIVER
BETHANY HOME ROAD
DYSART ROAD
MARICOPA COUNTY
GLENDALE
PHOENIX
CAMELBACK ROAD
LITCHFIELD PARK
EL MIRAGE ROAD
AGUA FRIA RIVER
COUNTY
INDIAN SCHOOL ROAD
107TH AVENUE
AVONDALE
AVONDALE
PHOENIX
THOMAS ROAD
GOODYEAR
MARICOPA COUNTY
PHOENIX

hoods may experience noise of that magnitude. While aircraft noise would be partially screened by the background noise, it would still be noticeable and could be annoying to some people. This is discussed in more detail in Chapter Four.

References

1. Galloway, W.S. et al. 1972. *Population Distribution of the United States as a Function of Outdoor Noise Levels*. EPA-550-9-74-009, June 1972.

2. Galloway, W.J. and T.J. Schultz 1980. *Interim Noise Assessment Guidelines*. HUD-CPD-586, U.S. Department of Housing and Urban Development, October 1980.

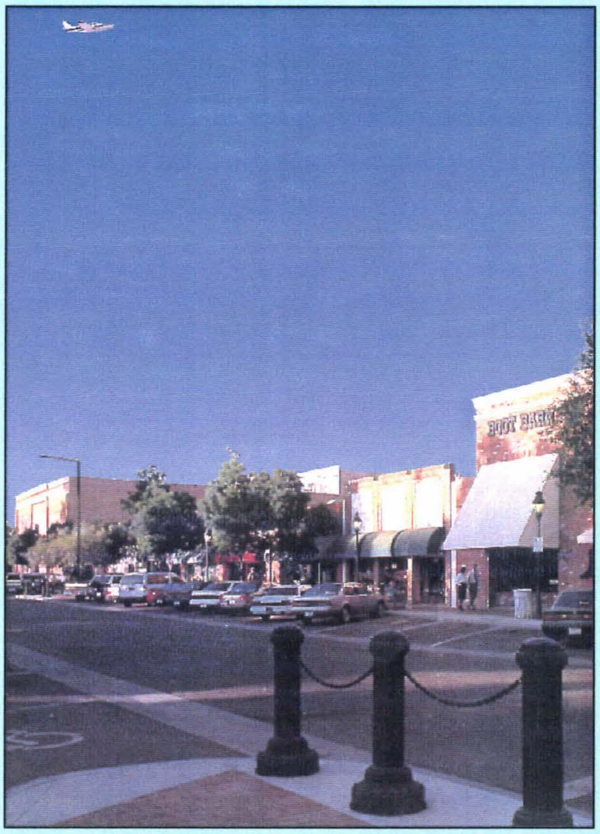
CHAPTER FOUR
NOISE IMPACTS

GLENDALE
MUNICIPAL AIRPORT

NOISE IMPACTS

The impacts of aircraft noise on existing and future land use and population are examined in this chapter. The major sections include:

- Effects of Noise Exposure,
- Land Use Compatibility,
- Current Noise Impacts,
- Future Noise Impacts.



EFFECTS OF NOISE EXPOSURE

Aircraft noise can affect people both physically and psychologically. It is difficult, however, to make sweeping generalizations about the impacts of noise on people because of the wide variations in individual reactions. While much has been learned in recent years, some physical and psychological responses to noise are not yet fully understood and continue to be debated by researchers.

EFFECTS ON HEARING

Hearing loss is the major health danger posed by noise. A study published by the U.S. Environmental Protection Agency (1974) found that exposure to noise of 70 Leq or higher on a continuous basis, over a very long time, at the human ear's most damage-sensitive frequency may result in a very small but permanent loss of hearing. (Leq is a pure noise dosage metric, measuring cumulative noise energy over a given time. It is similar to the DNL metric, except that DNL includes a 10 decibel penalty for nighttime noise.)

In *Aviation Noise Effects* (Newman and Beattie, 1985, pp. 33-42) three studies are cited which examined hearing loss among people living near airports. They found that, under normal circumstances, people in the community near an airport are at no risk of suffering hearing damage from aircraft noise.

The Occupational Safety and Health Administration (OSHA) has established standards for permissible noise exposure in the work place to guard against the risk of hearing loss. Hearing protection is required when noise levels exceed the legal limits. The standards, shown in **Table 4A**, establish a sliding scale of permissible noise levels by duration of exposure. The standards permit noise levels of up to 90 dBA for 8 hours per day without requiring hearing protection. The regulations also require employers to establish hearing conservation programs where noise levels exceed 85 Leq during the 8-hour workday. This involves the monitoring of work place noise, the testing of employees' hearing, the provision of hearing protectors to employees at risk of hearing loss, and the establishment of a training program to inform employees about the effects of work place noise on hearing and the effectiveness of hearing protection devices.

TABLE 4A
Permissible Noise Exposures, OSHA Standards

Duration per day, hours	Sound Level dBA slow response
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

Source: 29 CFR Ch. XVII, Section 1910.95 (b).

Noise measurements in the Glendale Municipal Airport area conducted for this Part 150 Study found that aircraft noise levels above 80 dBA off airport property occur only for several minutes a day. Experience at other airports has shown that even at sites with cumulative noise exposure levels near 75 DNL, the total time noise levels exceed 80 dBA typically ranges from 10 to 20 minutes, far below the critical hearing damage thresholds (Coffman Associates 1993, p. 2-11). This supports the conclusion that airport noise in areas off the airport property is far too low to be considered potentially damaging to hearing.

With respect to the risk of hearing loss, the authors of an authoritative summary of the research conclude: "Those most at risk [of hearing loss] are personnel in the transportation industry, especially airport ground staff. Beyond this group, it is unlikely that the general public will be exposed to sustained high levels of transportation noise sufficient to result in hearing loss. Transportation noise control in the community can therefore not be justified on the grounds of hearing protection." (See Taylor and Wilkins 1987.)

NON-AUDITORY HEALTH EFFECTS

It is sometimes claimed that aviation noise can harm the general physical and mental health of airport neighbors. Effects on the cardiovascular system, mortality rates, birth weights, achievement scores, and psychiatric admissions have been examined in the research literature. These questions remain unsettled because of conflicting findings based on differing methodologies and uneven study quality. It is quite possible that the contribution of noise to pathological effects is so low that it has not been isolated. While research is continuing, there is insufficient scientific evidence to support these concerns (Newman and Beattie 1985, pp. 59-62).

Taylor and Wilkins (1987, p. 4/10) offer the following conclusions in their review of the research.

> The evidence of non-auditory effects of transportation noise is more ambiguous, leading to differences of opinion regarding the burden of prudence for noise control. There is no strong evidence that noise has a direct causal effect on such health outcomes as cardiovascular disease, reproductive abnormality, or psychiatric disorder. At the same time, the evidence is not strong enough to reject the hypothesis that noise is in some way involved in the multicausal process leading to these disorders. . . . But even with necessary improvements in study design, the inherent difficulty of isolating the effect of a low dose agent such as transportation noise within a complex aetiological system will remain. It seems unlikely, therefore, that research in the near future will yield findings which are definitive in either a positive or negative direction. Consequently, arguments for transportation noise control will probably continue to be based primarily on welfare criteria such as annoyance and activity disturbance.

SLEEP DISTURBANCE

There is a large body of research documenting the effect of noise on sleep disturbance, but the long-range effects of sleep disturbance caused by nighttime airport operations are not well understood. It is clear that sleep is essential for good physical and emotional health, and noise can interfere with sleep, even when the sleeper is not consciously awakened. While the long-term effect of sleep deprivation on mental and physical function is not clear, it is known to be harmful. It is also known that sleepers do not fully adjust to noise disruption over time. Although they may awaken less often and have fewer conscious memories of disturbance, noise-induced shifts in sleep levels continue to occur.

Reviews of the laboratory research on sleep disturbance report that the level of noise which can cause awakenings or interfere with falling asleep ranges from 35 dBA to 80 dBA depending or sleep stage and variability among individuals (Newman and Beattie 1985, pp. 51-58; Kryter 1984, pp. 422-431). There is evidence that older people tend to be much more sensitive to noise-induced awakenings than younger people. Research has shown that, when measured through awakenings, people tend to become somewhat accustomed to noise. On the other hand, electroencephalograms, which reveal information about sleep stages, show little habituation to noise. Kryter describes these responses to noise as "alerting responses." He suggests that because they occur unconsciously, they may simply be reflexive responses, reflecting normal physiological functions which are probably not a cause of stress to the organism.

Most studies of sleep disturbance have been conducted under controlled laboratory conditions. The laboratory studies do not allow generalizations about the potential for sleep disturbance in an actual airport setting, and more importantly, the impact of these disturbances on the residents. Furthermore, the range of sound levels required to cause sleep disturbance, ranging from a whisper to a shout (35 dB to 80 dB), is so great as to defy straightforward generalization.

Fortunately, some studies have examined the effect of nighttime noise on sleep disturbance in actual community settings. Pearsons, et al. (1990) compared the data and findings of laboratory and field studies conducted in the homes of subjects. They found that noise-induced awakenings in home settings were much less prevalent than in laboratory settings. They also found that much higher noise levels were required to induce awakenings in the home than in the laboratory.

One report summarizes the results of eight studies conducted in homes (Fields 1986). Four studies examined aircraft noise, the others highway noise. In all of them, sleep disturbance was correlated with cumulative noise exposure metrics such as Leq and L10. All studies showed a distinct tendency for increased sleep disturbance as cumulative noise exposure increased. The reviewer notes, however, that sleep disturbance was very common, regardless of noise levels, and that many factors contributed to it. He points out that, "the prevalence of sleep disturbance in the absence of noise means that considerable caution must be exercised in interpreting any reports of sleep disturbance in noisy areas."

The findings of many of these sleep disturbance studies, while helping to answer basic research questions, are of little usefulness to policy makers and airport residents. For them, the important question is, "When does sleep disturbance caused by environmental noise become severe enough to constitute a problem in the community?" Kryter (1984, pp. 434-443) reviews in detail one important study that sheds light on this question. The Directorate of Operational Research and Analysis (DORA) of the British Civil Aviation Authority conducted an in-depth survey of 4,400 residents near London's Heathrow and Gatwick Airports over a four-month period in 1979 (DORA 1980). The study was intended to answer two policy-related questions: "What is the level of aircraft noise which will disturb a sleeping person?" and "What level of aircraft noise prevents people from getting to sleep?"

Analysis of the survey results indicated that the best correlations were found using cumulative energy dosage metrics, namely Leq. (Leq is derived in the same way as DNL, except that it does not have a penalty applied to nighttime noise events. It is thus a pure energy dosage metric.) Kryter notes that support for the use of the Leq metric is provided by the finding that some respondents could not accurately recall the time association of a specific flight with an arousal from sleep. This suggests that the noise from successive overflights increased the general state of arousability from sleep.

With regard to difficulty in getting to sleep, the study found 25 percent of the respondents reporting this problem at noise levels of 60 Leq, 33 percent at 65 Leq, and 42 percent at 70 Leq. The percentage of people who reported being awakened at least once per week by aircraft noise was 19 percent at 50 Leq, 24 percent at 55 Leq, and 28 percent at 60 Leq. The percentage of people bothered "very much" or "quite a lot" by aircraft noise at night when in bed was 22 percent at 55 Leq and 30 percent at 60 Leq. Extrapolation of the trend line would put the percentage reporting annoyance at 65 Leq well above 40 percent.

DORA concluded with the following answers to the policy-related questions: (1) A significant increase in reports of sleep arousal will occur at noise levels at or above 65 Leq; (2) A significant increase in the number of people reporting difficulty in getting to sleep will occur at noise levels at or above 70 Leq. Kryter disagrees with these findings. He believes that a more careful reflection upon the data leads to the conclusion that noise levels approximately 10 decibels lower would represent the appropriate thresholds -- 55 and 60 Leq.

At any airport, the 65 DNL contour developed from total daily aircraft activity will be larger than the 55 Leq developed from nighttime activity only. (At an airport with only nighttime use, the 65 DNL contour will be identical with the 55 Leq contour because of the effect of the 10 dB penalty in the DNL metric.) Thus, the 65 DNL contour defines a noise impact envelope which encompasses all of the area within which significant sleep disturbance may be expected based on Kryter's interpretation of the DORA findings discussed above.

A recent study was conducted by the British Civil Aviation Authority to examine the relationship of nighttime aircraft noise and sleep disturbance near four major airports -- Heathrow, Gatwick, Stansted, and Manchester (Ollerhead, et al. 1992). A total of 400 subjects were monitored for a total of 5,742 subject-nights. Nightly awakenings were found to be very common as part of natural sleep patterns. Researchers found that for aircraft noise events below 90 SEL, as measured outdoors, there was likely to be no measurable increase in rates of sleep disturbance. Where noise events ranged from 90 to 100 SEL, a very small rate of increase in disturbance was possible. Overall rates of sleep disturbance were found to be more closely correlated with sleep stage than with periods of peak aircraft activity. That is, sleep was more likely to be disrupted, from any cause, during light stages than during heavy stages.

Based on discussions with the Airport's staff, noise complaints based on nighttime activity at Glendale are rare. Traffic is significantly lower at night than during the day. There are approximately 312 daily aircraft operations at Glendale. It is estimated that approximately three percent (an average of 9.4 operations) occur at night, between the hours of 10:00 p.m. and 7:00 a.m.

STRUCTURAL DAMAGE

Structural vibration from aircraft noise in the low frequency ranges is sometimes a concern of airport neighbors. While vibration contributes to annoyance reported by residents near airports, especially when it is accompanied by high audible sound levels, it rarely carries enough energy to damage safely constructed structures. High-impulse sounds such as blasting, sonic booms, and artillery fire are more likely to cause damage than continuous sounds such as aircraft noise.

A document published by the National Academy of Sciences suggested that one may conservatively consider noise levels above 130 dB lasting more than one second as potentially damaging to structures (CHABA 1977). Aircraft noise of this magnitude occurs on the ramp and runway and seldom, if ever, occurs beyond the boundaries of a commercial or general aviation airport.

The risk of structural damage from aircraft noise was studied as part of the environmental assessment of the Concorde supersonic jet transport. The probability of damage from Concorde overflights was found to be extremely slight. Actual overflight noise from the Concorde at Sully Plantation near Dulles International Airport in Fairfax County, Virginia was recorded at 115 dBA. No damage to the historic structures was found, despite their age. Since the Concorde causes significantly more vibration than conventional commercial jet aircraft, the risk of structural damage caused by aircraft noise near airports is considered to be negligible (Hershey et al. 1975; Wiggins 1975).

OTHER ANNOYANCES

The psychological impact of aircraft noise is a more serious concern than direct physical impact. Studies conducted in the late 1960s and early 1970s found that the interruption of communication, rest, relaxation, and sleep are among the most important causes for complaints about aircraft noise. Surveys conducted in the last few years at some airports have found that interruption of evening television viewing and telephone conversations is a cause of annoyance for many people near airports.

The sound of approaching aircraft may cause fear in some people about the possibility of a crash. This fear is a factor motivating some complaints of annoyance in neighborhoods near airports around the country. (See Richards and Ollerhead 1973; FAA 1977; Kryter 1984, p. 533.) This effect tends to be most pronounced in areas directly beneath frequently used flight tracks.

The EPA has also found that continuous exposure to high noise levels can affect work performance, especially in high-stress occupations. Based on the FAA's land use compatibility guidelines, discussed below, these adverse affects are most likely to occur within the 75 DNL contour.

Individual human response to noise is highly variable and is influenced by many factors. These include emotional variables, feelings about the necessity or preventability of the noise, judgments about the value of the activity creating the noise, an individual's activity at the time the noise is heard, general sensitivity to noise, beliefs about the impact of noise on health, and feelings of fear associated with the noise. Physical factors influencing an individual's reaction to noise include the background noise in the community, the time of day, the season of the year, the predictability of the noise, and the individual's control over the noise source.

AVERAGE COMMUNITY RESPONSE TO NOISE

Although individual responses to noise can vary greatly, the average response among a group of people is much less variable. This enables us to make reasonable evaluations of the average impacts of aircraft noise on a community despite the wide variations in individual response.

Several studies have examined average community response to noise, focusing on the relationship between annoyance and noise exposure. (See DORA 1980; Fidell et al. 1989; Finegold et al. 1992; Great Britain Committee on the Problem of Noise 1963; Kryter 1970; Richards and Ollerhead 1973; Schultz 1978; U.S. EPA 1974.) These studies have produced similar results, finding that annoyance is most directly related to cumulative noise exposure, rather than single-event exposure. Annoyance has been found to increase along an S-shaped curve as cumulative noise exposure increases, as shown in **Exhibit 4A**.

The top panel of the exhibit shows a graph of annoyance versus noise level developed from research in the early 1970s (Richards and Ollerhead 1973). It distinguishes between people who are somewhat annoyed and those that are highly annoyed. The bottom panel shows a graph developed by Finegold et al. (1992) based on data derived from a number of studies (Fidell 1989). It shows the relationship between DNL levels and the percent of people who are highly annoyed. Known as the "updated Schultz Curve", because it is based on the work of Schultz (1978), it represents the best available source of data for the noise dosage-response relationship (FICON 1992, Vol. 2, p. 3-5).

The updated Schultz Curve shows that annoyance becomes noticeable at levels above 55 DNL, with 3.31 percent of a population expected to be highly annoyed. Starting at 65 DNL, the percentage of people expected to be highly annoyed increases steeply from 12.29 percent up to 70.16 percent at 85 DNL. Note that this relationship includes only those reporting to be "highly annoyed". Based on the findings of Richards and Ollerhead (1973), the percentages likely would be considerably higher if they included people who were either moderately or highly annoyed.

For research purposes, annoyance is usually measured through blind social surveys using random sampling techniques where people are asked to describe their feelings about the noise. Consistently, the best correlations have been found using cumulative noise exposure, or noise dosage, metrics. Indeed, cumulative noise metrics have been found to consistently provide the best explanatory power for all manner of noise effects, excluding the drastic effects of high-impulse sounds. The reason is that human response to broadband sound such as aircraft noise is related to two different dimensions of the sound -- energy level and frequency of occurrence. To put it in common sense terms, a person will tolerate a rare and very loud noise event, but as the number of events increases, the person's tolerance decreases. Across the country, one often hears this kind of comment from airport area residents: "I know jets have flown in and out of the airport for years, but they never really bothered me until the flights started increasing." Cumulative noise exposure metrics have been developed to quantify the combined effects of sound energy level and the frequency of occurrence.

A variety of cumulative noise exposure metrics have been used in research studies over the years. In the United States, the DNL metric has been widely used. DNL accumulates the total noise occurring during a 24-hour period, with a 10 decibel penalty applied to noise occurring between 10:00 p.m. and 7:00 a.m. DNL correlates well with average community response to noise and is required by FAA for use in F.A.R. Part 150 noise compatibility studies.

LAND USE COMPATIBILITY

The degree of annoyance which people suffer from aircraft noise varies depending on their activities at any given time. People rarely are as disturbed by aircraft noise when they are shopping, working, or driving as when they are at home. Transient hotel and motel residents seldom express as much concern with aircraft noise as do permanent residents of an area.

The concept of "land use compatibility" has arisen from this systematic variation in human tolerance to aircraft noise. Studies by governmental agencies and private researchers, have defined the compatibility of different land uses with varying noise levels. The FAA has established guidelines for defining land use compatibility for use in F.A.R. Part 150 studies.

F.A.R. PART 150 GUIDELINES

The FAA adopted land use compatibility guidelines when it promulgated F.A.R. Part 150 in the early 1980s. (The Interim Rule was adopted on January 19, 1981. The final rule was adopted on December 13, 1984, published in the Federal Register on December 18, and became effective on January 18, 1985.) These were based on earlier studies and guidelines developed by federal agencies (FICUN 1980). These land use compatibility guidelines are only advisory; they are not regulations. Part 150 explicitly states that determinations of noise compatibility and regulation of land use are purely local responsibilities. (See Section A150.101(a) and (d) and explanatory note in Table 1 of F.A.R. Part 150.) **Exhibit 4B** lists the F.A.R. Part 150 land use compatibility guidelines.

FAA uses the Part 150 guidelines as the basis for defining areas within which noise compatibility projects may be eligible for federal funding through the noise set-aside of the Airport Improvement Program (AIP). In general, noise compatibility projects must be within the 65 DNL contour to be eligible for federal funding. According to the AIP Handbook, "Noise compatibility projects usually must be located in areas where noise measured in day-night average sound level (DNL) is 65 decibels (dB) or greater." (Order 5100.38A, Chapter 7, paragraph 710.b.) Funding is permitted outside the 65 DNL contour only where the airport sponsor has determined that noncompatible land uses exist at lower noise levels and the FAA has explicitly concurred with that determination.

The FAA guidelines in **Exhibit 4B** show that mobile home parks and outdoor music shells and amphitheaters are incompatible with noise above 65 DNL. Schools and residential uses other than mobile homes also are generally incompatible with noise between DNL 65 and DNL 75, but the guidelines note that, where local communities determine that these uses are permissible, sound attenuation measures should be used.

Nature exhibits and zoos are considered incompatible at levels exceeding 70 DNL. Several other uses including hospitals, nursing homes, churches, auditoriums, concert halls, livestock breeding, amusements, resorts, and camps are considered incompatible at levels above 75 DNL.

Many uses are considered compatible in areas subject to noise between 65 DNL

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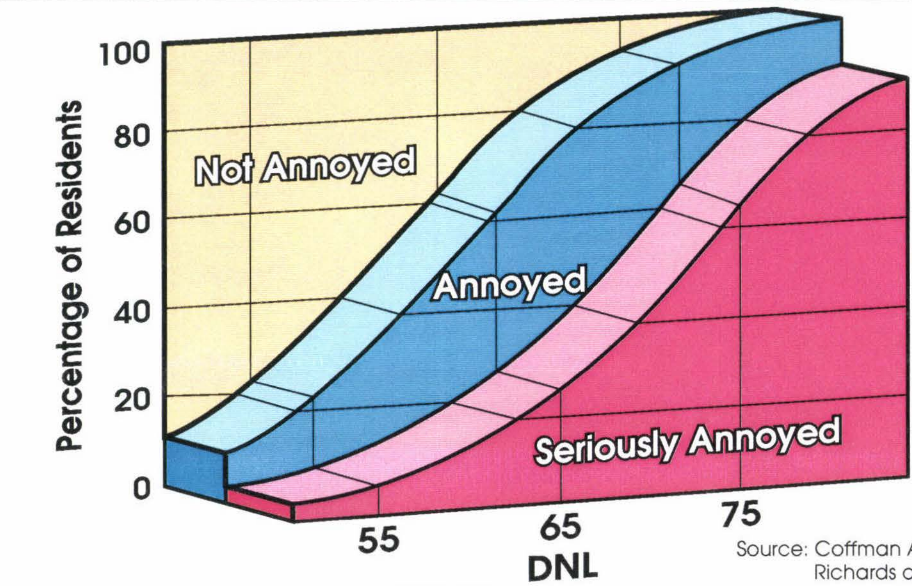
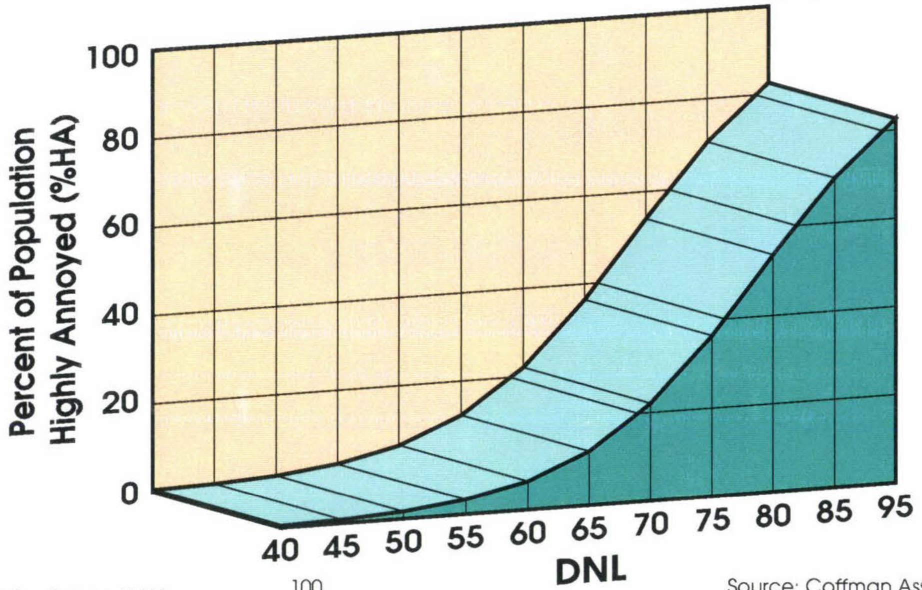


Source: Coffman Associates. Based on Richards and Ollerhead 1973.



Equation for Curve: $\% \text{ HA} = \dfrac{100}{1 + e\,(11.13 - .141 \text{ Ldn})}$

Source: Coffman Associates. Based on Finegold et al. 1992.

CAUSES OF ANNOYANCE	INFLUENCES ON PERSON'S REACTION
❑ Sleep interference ❑ Speech interference ❑ Interruption of TV viewing radio and stereo listening ❑ Disruption of quiet relaxation ❑ Fear of low-flying aircraft	❑ Predictability and familiarity of noise ❑ Feelings about activity causing noise ❑ Personal sensitivity to noise ❑ Ability to control ❑ Background noise

GLENDALE MUNICIPAL AIRPORT

Exhibit 4A
ANNOYANCE CAUSED BY AIRCRAFT NOISE IN RESIDENTIAL AREAS

LAND USE	Yearly Day-Night Average Sound Level (DNL) in Decibels					
RESIDENTIAL	Below 65	65-70	70-75	75-80	80-85	Over 85
Residential, other than mobile homes and transient lodgings	Y	N[1]	N[1]	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N[1]	N[1]	N[1]	N	N
PUBLIC USE						
Schools	Y	N[1]	N[1]	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Government services	Y	Y	25	30	N	N
Transportation	Y	Y	Y[2]	Y[3]	Y[4]	Y[4]
Parking	Y	Y	Y[2]	Y[3]	Y[4]	N
COMMERCIAL USE						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail-building materials, hardware and farm equipment	Y	Y	Y[2]	Y[3]	Y[4]	N
Retail trade-general	Y	Y	25	30	N	N
Utilities	Y	Y	Y[2]	Y[3]	Y[4]	N
Communication	Y	Y	25	30	N	N
MANUFACTURING AND PRODUCTION						
Manufacturing, general	Y	Y	Y[2]	Y[3]	Y[4]	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y[6]	Y[7]	Y[8]	Y[8]	Y[8]
Livestock farming and breeding	Y	Y[6]	Y[7]	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
RECREATIONAL						
Outdoor sports arenas and spectator sports	Y	Y[5]	Y[5]	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts, and camps	Y	Y	Y	N	N	N
Golf courses, riding stables, and water recreation	Y	Y	25	30	N	N

The designations contained in this table do not constitute a Federal determination that any use of land covered by the program is acceptable under Federal, State, or local law. The responsbility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.

See other side for notes and key to table.

Exhibit 4B

F.A.A. LAND USE COMPATIBILITY GUIDELINES

KEY

Y (Yes)	Land Use and related structures compatible without restrictions.
N (No)	Land Use and related structures are not compatible and should be prohibited.
NLR	Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.
25, 30, 35	Land Use and related structures generally compatible; measures to achieve NLR of 25, 30, or 35 dB must be incorporated into design and construction of structure.

NOTES

1 Where the community determines that residential or school uses must be allowed, measures to achieve outdoor to indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide a NLR of 20 dB, thus, the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.

2 Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

3 Measures to achieve NLR of 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

4 Measures to achieve NLR of 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

5 Land use compatible provided special sound reinforcement systems are installed.

6 Residential buildings require a NLR of 25.

7 Residential buildings require a NLR of 30.

8 Residential buildings not permitted.

Source: ***F.A.R. Part 150,*** *Appendix A, Table 1.*

Exhibit 4B (Continued)
F.A.A. LAND USE COMPATIBILITY GUIDELINES

and 75 DNL if prescribed levels of sound attenuation can be achieved through soundproofing. These include hospitals, nursing homes, churches, auditoriums, and concert halls.

LAND USE GUIDELINES AT GLENDALE

For purposes of the F.A.R. Part 150 Noise Compatibility Study at Glendale, the FAA's land use compatibility guidelines will be used as the basis for making determinations about land use compatibility in the airport area.

While the FAA considers the 65 DNL as the threshold of significant impact on noise-sensitive uses, the noise analysis at Glendale goes down to the 55 DNL level. For purposes of this Part 150 Study, Glendale is considering noise between 55 and 65 DNL to be of marginal impact on the following noise-sensitive land uses.

- Residential, including mobile home parks;
- Schools;
- Hospitals and nursing homes;
- Churches, auditoriums, and concert halls,
- Outdoor music shells and amphitheaters.

While these uses are not officially considered as "noncompatible", they should be considered "noise-sensitive". It is not uncommon to find that some occupants of these uses are disturbed by noise levels below 65 DNL. This is especially true in suburban or rural areas with quiet background sound levels, such as the Glendale study area. While research has shown that significantly fewer people are affected as noise decreases below 65 DNL, aircraft noise continues to be a problem for at least some people at even extremely low DNL levels. This is indicated in the graphs relating annoyance with DNL levels shown in Exhibit 4A.

The local experience at Glendale indicates that noise levels below 65 DNL should be considered in this Part 150 Study. Noise complaints have been received from neighborhoods, including Country Meadows, Villa de Paz, and Garden Lakes, that are well beyond the 65 DNL contour.

CURRENT NOISE IMPACTS

CURRENT LAND USE IMPACTS

Exhibit 4C, 1994 Noise Exposure and Land Use Impacts, shows the location of noise-sensitive land uses and the 1994 noise contours at Glendale Municipal Airport. Noise-sensitive uses shown on the exhibit are based on the F.A.R. Part 150 land use compatibility guidelines and include uses considered incompatible with noise above 65 DNL and marginally compatible with noise above 55 DNL.

The 55 DNL contour extends approximately 7,000 feet off the north end of Runway 18-36 and 4,500 to 5,500 feet off the south end. Distinct hooks are apparent in the contour on the south side, reflecting the touch-and-go traffic in the pattern. The 60 DNL contour extends about 3,500 feet off each runway end. The 65 DNL contour extends a small distance outside the airport property on the northeast side. The 70 and 75 DNL contours are almost completely contained on airport property.

A total of 12 dwelling units are inside the 55 DNL contour. Only one is inside the 65 DNL contour. The impacted homes are scattered north and northeast of the airport. No noise-sensitive institutions are impacted by noise above 55 DNL.

Table 4B lists the noise-sensitive land uses impacted by aircraft noise in 1992.

TABLE 4B
Noise-Sensitive Land Uses Impacted By Airport Noise - 1994
Glendale Municipal Airport

	DNL Contour Range					Totals	
LAND USE	55-60	60-65	65-70	70-75	75+	55+	65+
Residential							
Single-family dwellings	1	1	0	0	0	2	0
Mobile homes	5	4	1	0	0	10	1
Total dwelling units	6	5	1	0	0	12	1
Noise-Sensitive Institutions	0	0	0	0	0	0	0

Source: Coffman Associates analysis

CURRENT POPULATION IMPACTS

Methodology

In assessing community noise impacts, the number of people impacted and the level of noise impacting them must be considered. While lower noise levels cover a larger area and usually affect more people, they are less annoying than higher noise levels. To assess the intensity of the impact, it is helpful to have a way of jointly considering both population and noise level. The level-weighted population (LWP) methodology provides such an approach. It was developed in 1977 under the auspices of the National Research Council Committee on Hearing, Bioacoustics and Biomechanics (CHABA, 1977). The methodology is based on many studies of community response to noise. Those studies revealed that the percentage of a residential population that was highly annoyed by noise increased as the noise level increased. The LWP methodology defines average response factors based on the findings of these studies. For instance, within the 65-70 DNL range, 62.5 percent of the population is assumed to be highly annoyed by noise, within the 70-75 DNL range, 87.5 percent, and within the 75 DNL contour, 100 percent.

The first step in computing level-weighted population is to estimate the population residing within each 5 DNL range (55-60 DNL, 60-65 DNL etc.). The population is multiplied by the corresponding LWP response factors. The results are summed to provide the total level-weighted population, an estimate of the number of persons who are highly annoyed by noise at their residences.

The LWP methodology helps in evaluating the impact of noise on a population because it accounts for both

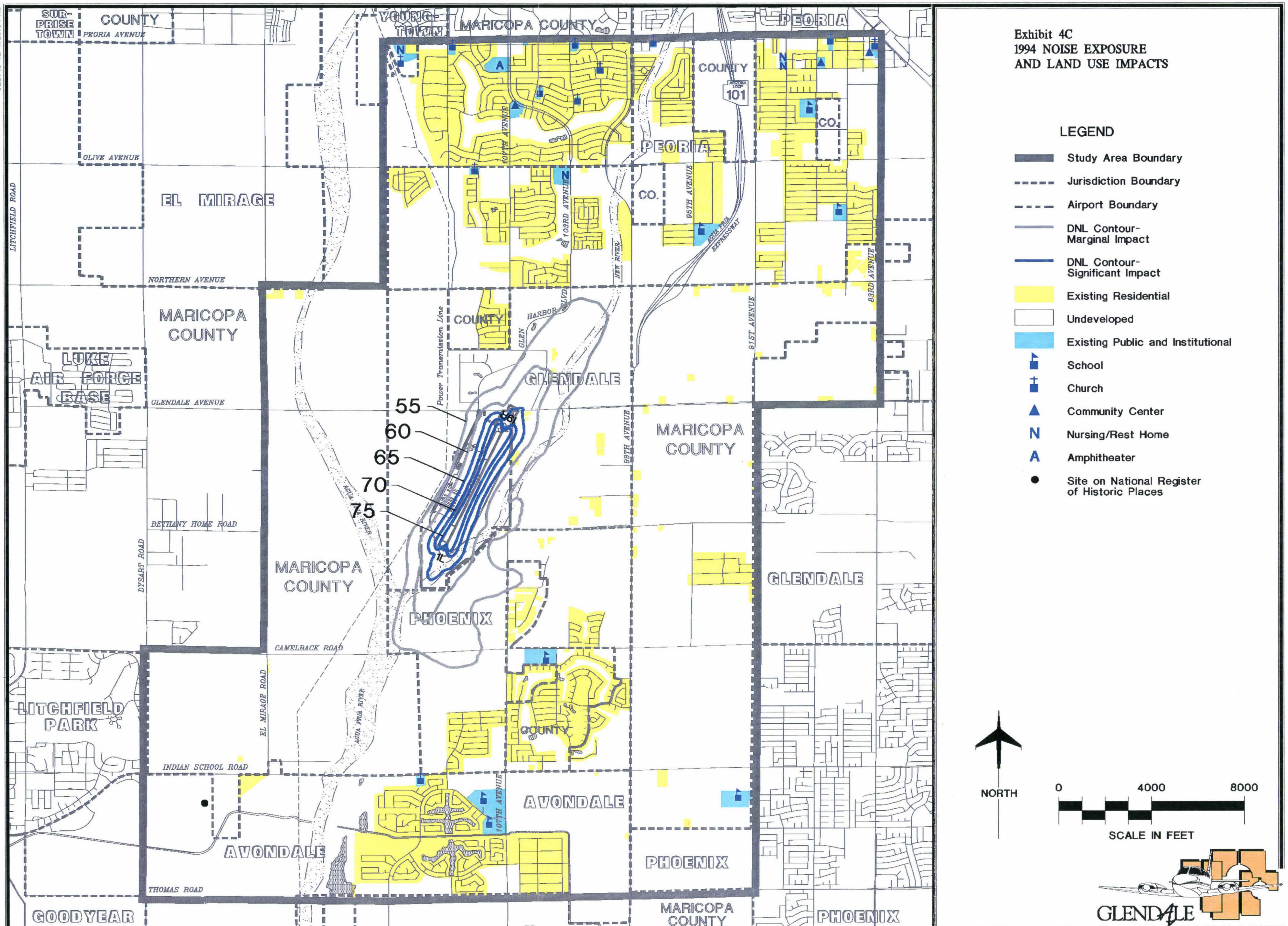

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Exhibit 4C
1994 NOISE EXPOSURE
AND LAND USE IMPACTS
LEGEND
Study Area Boundary
Jurisdiction Boundary
Airport Boundary
DNL Contour-
Marginal Impact
DNL Contour-
Significant Impact
Existing Residential
Undeveloped
Existing Public and Institutional
School
Church
Community Center
Nursing/Rest Home
Amphitheater
Site on National Register
of Historic Places
NORTH
0
4000
8000
SCALE IN FEET
GLENDALE MUNICIPAL AIRPORT
SUR-PRISE TOWN
COUNTY
PEORIA AVENUE
YOUNG-TOWN
MARICOPA COUNTY
PEORIA
EL MIRAGE
OLIVE AVENUE
LITCHFIELD ROAD
NORTHERN AVENUE
MARICOPA COUNTY
LUKE AIR FORCE BASE
GLENDALE AVENUE
BETHANY HOME ROAD
DYSART ROAD
MARICOPA COUNTY
CAMELBACK ROAD
EL MIRAGE ROAD
AGUA FRIA RIVER
LITCHFIELD PARK
INDIAN SCHOOL ROAD
AVONDALE
THOMAS ROAD
GOODYEAR
107TH AVENUE
103RD AVENUE
99TH AVENUE
95TH AVENUE
91ST AVENUE
83RD AVENUE
NEW RIVER
AGUA FRIA EXPRESSWAY
101
CO.
COUNTY
GLEN HARBOR BLVD
Power Transmission Line
GLENDALE
55
60
65
70
75
PHOENIX
MARICOPA COUNTY
GLENDALE
AVONDALE
PHOENIX
MARICOPA COUNTY
PHOENIX

the number of persons affected and the intensity of the impact. Since the percentage of people who are highly annoyed increases with increasing noise levels, the LWP values may differ between operating scenarios even though the total population within the noise impact boundary is equal.

An example below illustrates the LWP methodology. Scenarios A and B show the effects of two airport operating scenarios. While the population subject to noise above 55 DNL is the same for both, Scenario B has a lower LWP because fewer people are impacted by the higher noise levels.

Level-Weighted Population Methodology - Example

	Example A				Example B			
DNL Range	LWP Factor		Population	LWP	LWP Factor		Population	LWP
55-60	.125	x	3,000	= 375	.125	x	5,000	= 625
60-65	.375	x	3,000	= 1,125	.375	x	3,500	= 1,313
65-70	.625	x	2,000	= 1,250	.625	x	1,000	= 625
70-75	.875	x	1,400	= 1,225	.875	x	400	= 350
75+	1.000	x	600	= 600	1.000	x	100	= 100
Total			10,000	4,575			10,000	3,013

1994 Population Impacts

Table 4C shows the population, expressed in both absolute numbers and level-weighted population (LWP), impacted by existing noise (1994). The total population impacted by noise above 55 DNL is 27. This corresponds to a LWP value of 7.

Most of the impacted population (14) is between the 55 and 60 DNL contours. Eleven are between the 60 and 65 DNL contours and two are between the 65 and 70 DNL contours. No one is impacted by noise above 70 DNL.

TABLE 4C
Population Impacted by Existing Noise - 1994
Glendale Municipal Airport

DNL CONTOUR					Total Above 55		Total Above 65	
55-60	60-65	65-70	70-75	75+	Population	LWP[1]	Population	LWP[1]
14	11	2	0	0	27	7	2	1

[1] Level-weighted population - an estimate of the number of people actually annoyed by aircraft noise. It is derived by multiplying the population in each DNL contour range by the appropriate LWP response factor: 55-60 DNL = .125; 60-65 DNL = .375; 65-70 DNL = .625; 70-75 DNL = .875; 75+ DNL = 1.000.

Source: Coffman Associates analysis

POTENTIAL GROWTH RISK

Before evaluating the impact of future aircraft noise, the likelihood of future residential development in the area must be understood. Development trends in the vicinity of the airport are critically important in noise compatibility planning. Future residential growth can constrain the operation of the airport if it occurs beneath aircraft flight tracks and within areas subject to high noise levels. The following paragraphs describe population growth and potential residential development within the study area in order to determine the potential growth risk. The focus of discussion includes population projections, residential growth, residential land use trends, residential development projects, and other noise-sensitive development.

POPULATION PROJECTIONS

To briefly reiterate from Chapter One, population projections for the Study Area, Maricopa County and the State of Arizona are expected to continue to rise throughout the planning period. Based on the data presented in Table 1B and Table 1C, the population within the Study Area is expected to increase almost 250 percent between 1990 and 2020, resulting in an average annual increase of 4.25 percent. New residential developments located within the Study Area are expected to accommodate the anticipated population growth. The majority of this growth is expected to occur prior to 2010. During the same period, Maricopa County is anticipated to grow by nearly 94 percent (2.23 percent average annual increase) and the State of Arizona by slightly more than 85 percent (2.09 percent average annual increase).

RESIDENTIAL LAND USE TRENDS

Based on land use planning policies and building trends of local jurisdictions, substantial residential development is expected in the near and long-term within the study area.

The West Valley, in which the study area is located, is attracting greater development interests and pressures as the metropolitan area grows. Residential developments are gradually replacing the area's farm fields and pasture land. All of the communities with jurisdiction over the study area project that much of the remaining farmland will be developed for residential uses. The only exceptions to this are the land along the rivers and canals which are proposed for parks and open space, the land in Glendale north and east of the airport which is proposed for industrial land uses, and various planned commercial areas. Exhibit 1H in Chapter One, illustrates the anticipated future land uses of the study area.

Within the study area, the City of Glendale General Plan projects low-density residential land uses on much of the land east of 95th Avenue, between Northern and Camelback Roads. Currently much of this land is in agricultural use and there are no known plans for its development.

The City of Peoria Comprehensive Plan projects predominantly low-density residential land uses within their portion of the study area, except in the northeast corner and along the New River. While much of this area has already been developed, there remains significant land throughout the Peoria portion of the study area which is potentially available for residential land uses, including that associated with the Country Meadows and Suncliff developments, as well as closer to downtown.

The General Plan for the City of Phoenix projects both rural and low-density residential development on land south and southeast of the airport within the study area. Development plans have been submitted and preliminarily approved on much of the land closest to Glendale Municipal Airport.

The City of Avondale's North Avondale Specific Plan projects continuing residential development on land south and southwest of the airport within the study area. Some of this land is currently being considered by the City for residential development.

Maricopa County does not have a long-term land use plan that encompasses the entire study area; instead, they rely on the cities which are expected to annex the various sections of land. The County's White Tanks Agua Fria Policy and Development Guide does incorporate some of the study area west of the Agua Fria River, for which residential land uses have been projected.

By comparing the Generalized Existing Land Use exhibit (1G), Future Land Use Plan exhibit (1H) and Generalized Zoning exhibit (1J), it is apparent that there is a significant amount of land within the study area which is potentially available for residential development. This includes undeveloped areas not subject to flood hazards that are zoned for residential use and all undeveloped or under-developed land in the study area. Future residential development will be influenced by the zoning in an area, the physical constraints of individual sites, availability of sewer and water, and the market for residences in various locations around the study area.

Exhibit 4D depicts potential residential development within the study area. Land areas potentially available for future residential use are classified in four groups depending on how likely they are to be developed.

<u>High Probability</u> - This category includes land within the study area involving (1) approved projects, or (2) proposed projects which are expected to be approved. Also included are areas where significant infill is occurring within previously approved projects. Areas in this category are located primarily south of the airport in Phoenix and Avondale.

<u>Medium-High Probability</u> - This category includes (1) areas of existing subdivisions where moderate infill is occurring, or (2) areas which have had development either proposed and delayed or proposed though not officially reviewed by the local jurisdiction. This includes areas that are believed to be readily serviceable, are appropriate for the potential uses, and which are near or influenced by growth within and adjacent the study area.

Areas in this category are located primarily south of the airport, again in Phoenix and Avondale, though some areas are located north of the airport, in Peoria.

<u>Medium-Low Probability</u> - This category includes areas where there is

interest in residential development due to the proximity of other nearby development centers and/or services. Areas is this category are located on all sides of the airport with the heaviest concentrations to the east and southwest.

Areas subject to significant environmental hazards are considered unlikely to be developed and are not indicated on the map as having any development potential at all, despite the presence of residential zoning. This includes the Agua Fria and New River floodways.

With regard to holding capacity within the study area, a total of 41,867 dwelling units could potentially be constructed in undeveloped areas if they are fully developed in accordance with current land use planning. According to projections developed by the Maricopa Association of Governments (MAG) for traffic analysis zones in the study area, the average population per dwelling unit in the study area will be about 2.32 in the year 2020. Thus, an additional 97,131 people could reside in the study area at "build-out" (the point where there is no more land available for residential development). This increase is consistent with the population projections for the study area which indicated a population gain of 66,284 persons between 1990 and 2020, assuming build-out is not attained by the year 2020.

RESIDENTIAL DEVELOPMENT PROJECTS

The following information describes residential projects in various stages of planning and development within the study area.

- ***Barclays Suncliff:*** This is an approved, partially developed project located in Peoria, south of Olive Avenue and east of 115th Avenue. In addition to those homes already completed, the approved amended plat provides for 218 additional single-family residences.

- ***Country Meadows Estates:*** Located in Peoria north of Northern Avenue and west of 107th Avenue, this approved development will result in the construction of 53 single-family residences.

- ***Country Meadows Units Five, Six and Seven:*** Located west of 107th Avenue and south of Olive Avenue, in the City of Peoria, these approved single-family residential developments will result in 356 homes and are rapidly reaching buildout.

- ***Country Meadows Unit Eleven:*** Located in Peoria east of 107th Avenue and south of Butler Drive, this approved development in the City of Peoria will result in 16 single-family residences.

- ***Monroe Park Estates:*** Located on Monroe Street east of 87th Avenue, this single-family development is approved for 102 lots.

- ***Castle Rock:*** This 170-unit townhome development in Peoria is located at the southeast corner of Monroe Street and 91st Avenue.

- ***Westgreen Townhouses:*** This townhome development is located on the northeast corner of Olive Avenue and 91st Avenue in the City of Peoria. Only partially developed,

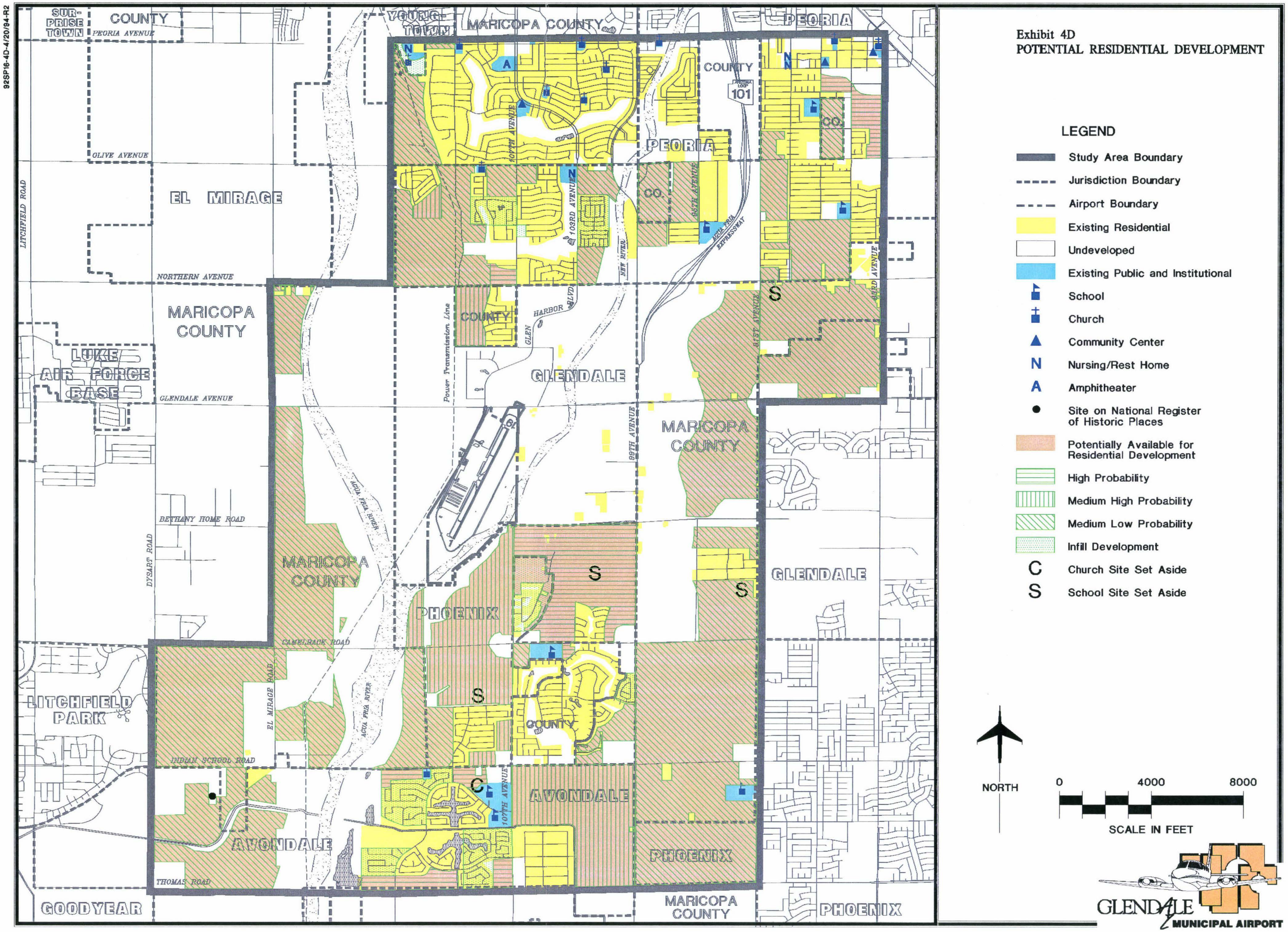
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Exhibit 4D
POTENTIAL RESIDENTIAL DEVELOPMENT
LEGEND
Study Area Boundary
Jurisdiction Boundary
Airport Boundary
Existing Residential
Undeveloped
Existing Public and Institutional
School
Church
Community Center
Nursing/Rest Home
Amphitheater
Site on National Register of Historic Places
Potentially Available for Residential Development
High Probability
Medium High Probability
Medium Low Probability
Infill Development
Church Site Set Aside
School Site Set Aside
NORTH
0
4000
8000
SCALE IN FEET
GLENDALE MUNICIPAL AIRPORT
SURPRISE TOWN
COUNTY
PEORIA AVENUE
YOUNGTOWN
MARICOPA COUNTY
PEORIA
COUNTY
101
CO.
OLIVE AVENUE
EL MIRAGE
LITCHFIELD ROAD
NORTHERN AVENUE
MARICOPA COUNTY
LUKE AIR FORCE BASE
GLENDALE AVENUE
GLENDALE
HARBOR BLVD
GLEN
Power Transmission Line
103RD AVENUE
107TH AVENUE
99TH AVENUE
95TH AVENUE
91ST AVENUE
83RD AVENUE
NEW RIVER
AGUA FRIA EXPRESSWAY
AGUA FRIA RIVER
MARICOPA COUNTY
BETHANY HOME ROAD
DYSART ROAD
MARICOPA COUNTY
PHOENIX
CAMELBACK ROAD
EL MIRAGE ROAD
LITCHFIELD PARK
INDIAN SCHOOL ROAD
COUNTY
AVONDALE
AVONDALE
PHOENIX
THOMAS ROAD
GOODYEAR
MARICOPA COUNTY
PHOENIX
GLENDALE

at buildout it is anticipated to have 80 additional units.

- *Sun-Air Estates:* Located in Peoria at 95th Avenue and Palmer Drive, the latest phase of this approved duplex development is expected to provide almost 250 additional units.

- *Camelback Ranch:* This pending planned residential development is located in the City of Phoenix immediately south of the airport. Currently, approximately 2,400 residential units are proposed, including 1,828 single-family and 572 multi-family units.

- *D-C Ranch:* Located in the City of Phoenix, east of Camelback Ranch, south of the Grand Canal and north of Camelback Road, this development, as currently proposed, would result in 2,470 residential units, the majority being single-family detached and patio/townhomes. The City is aware of plans to revise the approved density by replacing some multi-family units with single-family residences, thereby reducing overall density.

- *Camelback Farms:* Located in Phoenix, adjacent to 107th Avenue, this large-lot single-family residential development is approved for 35 parcels, many of which are currently under construction.

- *Camelback Greens:* Located in the City of Phoenix, north of Camelback Road and west of 99th Avenue, this single-family development is currently under construction and will consist of 228 homes with several homes already completed.

- *The Winds of Campbell:* Located within the Villa de Paz community, this Phoenix approved single-family residential development will consist of 102 homes, the majority of which have already been completed.

- *Laurelwood at Villa de Paz:* Located south of Campbell Road within the Villa de Paz community, this single-family residential development in the City of Phoenix will consist of 100 homes when completed.

- *Garden Lakes:* This master planned community in the City of Avondale is located between Indian School and Thomas Roads, east of 107th Avenue. It provides for single-family residences at various densities, from low to high. Within the 21 approved residential development sections, 2,016 lots have or will be developed; the remaining residential development section, for which no plans have yet been submitted, will contain approximately 300 additional residences. Buildout of this development is expected within the near future.

OTHER NOISE SENSITIVE DEVELOPMENT

Dwellings are not the only noise-sensitive land uses that might be developed in the future. Other uses include schools, churches, nursing homes, hospitals, amphitheaters, group homes and dormitories, and prisons.

Currently, major noise-sensitive institutions planned within the study area involve primarily schools and churches. The General Plans for the various jurisdictions involved in the study area generally locate schools within the areas projected for future residential development. In addition, a school site has been tentatively located within the proposed Camelback Ranch Planned Community, south of Camelback Road, and a church site located in the Garden Lakes Planned Community, west of the existing high school. Other school sites being considered by the involved school districts include an elementary school at approximately 101st Avenue and Missouri, a high school in the area of 91st Avenue between Bethany Home Road and Camelback Road, and a high school at 91st Avenue and Northern, near Hickman Farms. Westview High School, on 107th Avenue south of Indian School, is scheduled for expansion. These sites are depicted on **Exhibit 4D**.

FUTURE LAND USE IMPACTS

1999 LAND USE IMPACTS

Exhibit 4E shows the forecast 1999 noise contours together with existing noise-sensitive land use and potential future residential land use. They are similar to the 1994 contours but are somewhat larger, reflecting the anticipated increase in operations at the airport.

Noise-sensitive land uses impacted by noise in 1999 are shown in **Table 4D**. A total of 21 existing dwellings, including 11 single-family homes and 10 mobile homes, are impacted by noise above 55 DNL. This includes 16 dwellings impacted by noise between 55 and 60 DNL and four between 60 and 65 DNL. One home is impacted by noise between 65 and 70 DNL. None are impacted by noise above 70 DNL. No noise-sensitive institutions are impacted by noise above 55 DNL.

In addition to existing land uses, **Table 4D** includes potential future dwellings that could be developed within the noise contours based on the growth risk analysis presented above. The potential exists for 1,115 additional dwellings to be developed within the 55 DNL contour, including 28 in the 60-65 DNL range. All the rest are between 55 and 60 DNL.

2015 LAND USE IMPACTS

Exhibit 4F shows the noise projected for the year 2015. These contours are considerably larger than the 1999 contours because of the anticipated increase in operations. The 55 DNL contour extends approximately 10,000 feet off each end of the runway. The 2015 contours also account for the future construction of a parallel runway, Runway 18L-36R. This tends to broaden the contours somewhat.

Noise-sensitive land uses impacted by noise in 2015 are shown in **Table 4D**. In the 55 to 60 DNL range, 135 existing dwellings are impacted. Five dwellings are in the 60 to 65 DNL range, four are within the 65-70 DNL range, none are within the 70-75 DNL range, and two are within the 75 DNL contour.

Based on the growth risk analysis, the potential exists for 3,082 new dwellings to be developed within the 55 DNL contour by 2015. This includes 2,366 between 55 and 60 DNL, 708 between 60 and 65 DNL, and 8 between 65 and 70 DNL.

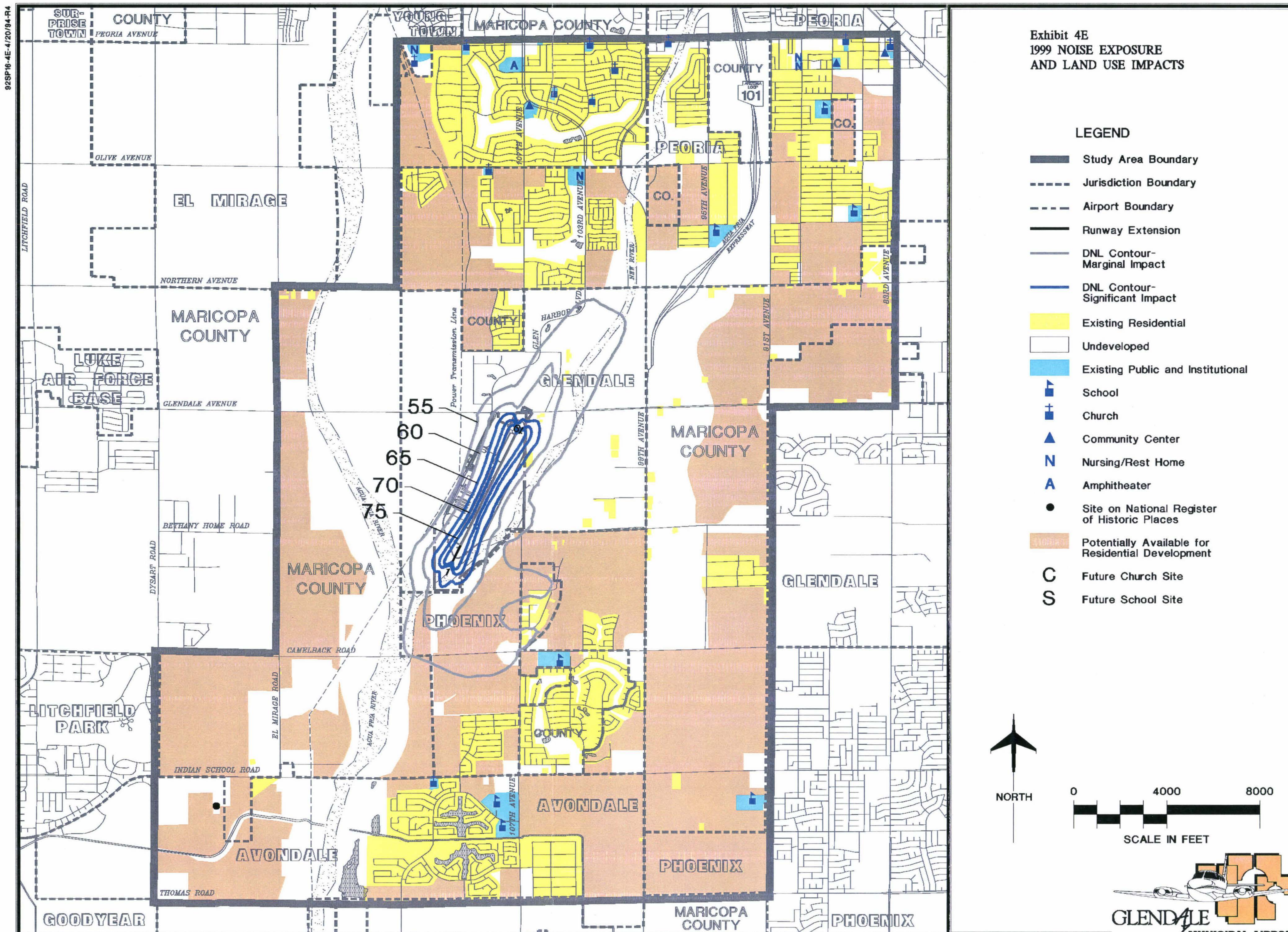
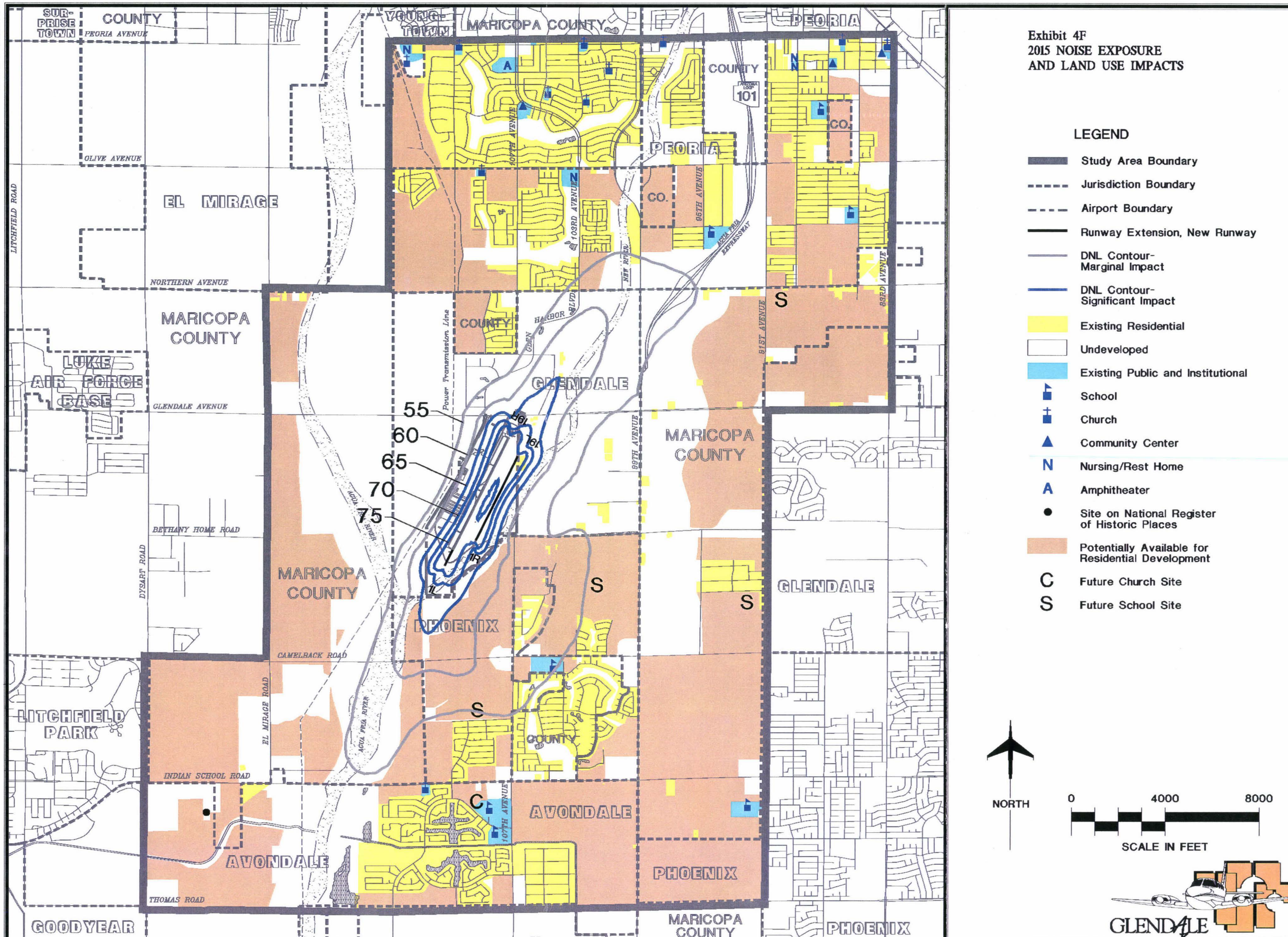


Exhibit 4E
1999 NOISE EXPOSURE AND LAND USE IMPACTS

92SP16-4F-4/20/94-R4



One existing school is impacted by noise between 55 and 60 DNL. One potential future school site is within the 55 DNL noise contour.

TABLE 4D
Noise-Sensitive Land Uses Impacted by Aircraft Noise - 1999 and 2015
Glendale Municipal Airport

	DNL CONTOUR					TOTALS	
LAND USE	55-60	60-65	65-70	70-75	75+	55+	65+
1999 NOISE							
Existing Residential							
Single-family dwellings	10	1	0	0	0	11	0
Mobile homes	6	3	1	0	0	10	1
Total existing dwellings	16	4	1	0	0	21	1
Potential Additional Residential							
Single-family dwellings	617	28	0	0	0	645	0
Multi-family residential	470	0	0	0	0	470	0
Total Additional Residential	1,087	28	0	0	0	1,115	0
Total Potential Future Residential	1,103	32	1	0	0	1,136	1
Existing Noise-Sensitive Institutions	0	0	0	0	0	0	0
Potential Future Noise-Sensitive Institutions	0	0	0	0	0	0	0
2015 NOISE							
Existing Residential							
Single-family dwellings	130	1	1	0	0	132	1
Mobile homes	5	4	3	0	2	14	5
Total existing dwellings	135	5	4	0	2	146	6
Potential Additional Residential							
Single-family dwellings	1,755	524	8	0	0	2,287	8
Multi-family dwellings	611	184	0	0	0	795	0
Total Additional Dwellings	2,366	708	8	0	0	3,082	8
Total Potential Future Residential	2,501	713	12	0	2	3,282	84
Existing Noise-Sensitive Institutions (School)	1	0	0	0	0	1	0
Potential Future Noise-Sensitive Institutions (School)	1	0	0	0	0	1	0

Source: Coffman Associates analysis

FUTURE POPULATION IMPACTS

Table 4E shows the impact of 1999 and 2015 noise on local population. The population impacts parallel the pattern observed for land use impacts. The number of existing residents impacted by noise increases through the years because of the forecast increase in operations and because of the potential for new residential development in the area.

1999 POPULATION IMPACTS

In 1999, 54 people (10 LWP) residing in currently developed areas are impacted by noise above 55 DNL. The potential exists for an additional 3,520 people to reside within the 55 DNL contour if all potential developable land is built-out. This includes 88 additional people in the 60-65 DNL range. The rest would be within the 55-60 DNL range.

2015 POPULATION IMPACTS

In the year 2015, 401 people (62 LWP) in existing developed areas would be impacted by noise above 55 DNL. This includes 12 in the 60-65 DNL contour range, nine in the 65-70 DNL range, none in the 70-75 DNL range, and five in the 75 DNL contour.

The potential exists for 9,443 additional residents to reside in new residential areas within the 55 DNL contour. This includes 7,180 in the 55-60 DNL range, 2,237 in the 60-65 DNL range, and 25 in the 65-70 DNL range.

TABLE 4E
Population Impacted by Noise - 1999 and 2015
Glendale Municipal Airport

	DNL CONTOUR					Total Above 55		Total Above 65	
	55-60	60-65	65-70	70-75	75+	Pop.	LWP	Pop.	LWP
1999 NOISE									
Existing	43	9	2	0	0	54	10	2	1
Potential Additional	3,432	88	0	0	0	3,520	462	0	0
Total Potential Future	3,475	97	2	0	0	3,574	472	2	1
2015 NOISE									
Existing	376	12	9	0	5	401	62	14	11
Potential Additional	7,180	2,237	25	0	0	9,443	1,752	25	16
Total Potential Future	7,556	2,249	34	0	5	9,843	1,814	39	27

[1] Level-weighted population - an estimate of the number of people actually annoyed by aircraft noise. It is derived by multiplying the population in each DNL contour range by the appropriate LWP response factor: 55-60 = .125; 60-65 DNL = .375; 65-70 DNL = .625; 70-75 DNL = .875; 75+ DNL = 1.000.

Note: Numbers have been rounded.

Source: Coffman Associates analysis.

SUMMARY

In comparison with many other suburban general aviation airports, noise impacts in the Glendale Municipal Airport area are not severe. The low levels of impacts are due, in large part, to the presence of large areas of undeveloped land near the airport. Most residential development in the area is at some distance from the airport and is not subject to significant cumulative noise exposure levels. (Some of these areas are subject to overflights which can cause disturbances. These "single event" impacts, while not as significant as impacts caused by consistently high cumulative noise exposure, are important in the local area. They will be the subject of consideration in the noise abatement alternatives analysis in Chapter Five.)

Land use and population impacts are expected to increase in the future in part because of increased activity at the airport. The biggest cause of the increased risk of land use and population impacts, however, is the potential for future residential development near the airport, especially to the south and southeast. The total population impacted by noise above 55 DNL could increase from 27 in 1994 to 9,843 in 2015 if the future airport activity and local development follow the projections of this analysis. The total number of people within the 65 DNL contour could be as high as 39 in 2015.

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APPENDIX A
GLOSSARY

GLENDALE
MUNICIPAL AIRPORT

A-WEIGHTED SOUND LEVEL - A sound pressure level, often noted as dBA, which has been frequency filtered or weighted to quantitatively reduce the effect of the low frequency noise. It was designed to approximate the response of the human ear to sound.

AMBIENT NOISE - The totality of noise in a given place and time -- usually a composite of sounds from varying sources at varying distances.

APPROACH LIGHT SYSTEM (ALS) - An airport lighting facility which provides visual guidance to landing aircraft by radiating light beams in a directional pattern by which the pilot aligns the aircraft with the extended centerline of the runway on the final approach for landing.

ATTENUATION - Acoustical phenomenon whereby a reduction in sound energy is experienced between the noise source and receiver. This energy loss can be attributed to atmospheric conditions, terrain, vegetation, and man-made and natural features.

AZIMUTH - Horizontal direction expressed as the angular distance between true north and the direction of a fixed point (as the observer's heading).

BASE LEG - A flight path at right angles to the landing runway off its approach end. The base leg normally extends from the downwind leg to the intersection of the extended runway centerline. See "traffic pattern."

CROSSWIND LEG - A flight path at right angles to the landing runway off its upwind end. See "traffic pattern."

DAY-NIGHT AVERAGE SOUND LEVEL - See DNL.

DECIBEL (dB) - The physical unit commonly used to describe noise levels. The decibel represents a relative measure or ratio to a reference power. This reference value is a sound pressure of 20 micropascals which can be referred to as **1 decibel** or the weakest sound that can be heard by a person with very good hearing in an extremely quiet room.

DISPLACED THRESHOLD - A threshold that is located at a point on the runway other than the designated beginning of the runway.

DISTANCE MEASURING EQUIPMENT (DME) - Equipment (airborne and ground) used to measure, in nautical miles, the slant range distance of an aircraft from the DME navigational aid.

DNL - The 24-hour average sound level, in decibels, for the period from midnight to midnight, obtained after the addition of ten decibels to sound levels for the periods between midnight and 7 a.m. and between 10 p.m. and midnight, local time, as averaged over a span of one year. It is the FAA standard metric for determining the cumulative exposure of individuals to noise. Also see "Leq."

DOWNWIND LEG - A flight path parallel to the landing runway in the direction opposite to landing. The downwind leg normally extends between the crosswind leg and the base leg. Also see "traffic pattern."

DURATION - Length of time, in seconds, a noise event such as an aircraft flyover is experienced. (May refer to the length of time a noise event exceeds a specified dB threshold level.)

EASEMENT - The legal right of one party to use a portion of the total rights in real estate owned by another party. This may include the right of passage over, on, or below the property; certain air rights above the property, including view rights; and the rights to any specified form of development or activity, as well as any other legal rights in the property that may be specified in the easement document.

EQUIVALENT SOUND LEVEL - See Leq.

FINAL APPROACH - A flight path in the direction of landing along the extended runway centerline. The final approach normally extends from the base leg to the runway. See "traffic pattern."

FIXED BASE OPERATOR (FBO) - A provider of services to users of an airport. Such services include, but are not limited to, hangaring, fueling, flight training, repair and maintenance.

GLIDE SLOPE (GS) - Provides vertical guidance for aircraft during approach and landing. The glide slope consists of the following:

1. Electronic components emitting signals which provide vertical guidance by reference to airborne instruments during instrument approaches such as ILS, or

2. Visual ground aids, such as VASI, which provide vertical guidance for VFR approach or for the visual portion of an instrument approach and landing.

GLOBAL POSITIONING SYSTEM - See "GPS."

GPS - GLOBAL POSITIONING SYSTEM - A system of 24 satellites used as reference points to enable navigators equipped with GPS receivers to determine their latitude, longitude, and altitude. The accuracy of the system can be further refined by using a ground receiver at a known location to calculate the error in the satellite range data. This is known as Differential GPS (DGPS).

GROUND EFFECT - The attenuation attributed to absorption or reflection of noise by man-made or natural features on the ground surface.

HOURLY NOISE LEVEL (HNL) - A noise summation metric which considers primarily those single events which exceed a specified threshold or duration during one hour.

INSTRUMENT APPROACH - A series of predetermined maneuvers for the orderly transfer of an aircraft under instrument flight conditions from the beginning of the initial approach to a landing, or to a point from which a landing may be made visually.

INSTRUMENT FLIGHT RULES (IFR) - Rules governing the procedures for conducting instrument flight. Also a term used by pilots and controllers to indicate type of flight plan.

INSTRUMENT LANDING SYSTEM (ILS) - A precision instrument approach system which normally consists of the following electronic components and visual aids:

1. Localizer.
2. Glide Slope.
3. Outer Marker.
4. Middle Marker.
5. Approach Lights.

Ldn - (See DNL). Ldn used in place of DNL in mathematical equations only.

Leq - Equivalent Sound Level. The steady A-weighted sound level over any specified period (not necessarily 24 hours) that has the same acoustic energy as the fluctuating noise during that period (with no consideration of a nighttime weighting.) It is a measure of cumulative acoustical energy. Because the time interval may vary, it should be specified by a subscript (such as Leq_8) for an 8-hour exposure to workplace noise) or be clearly understood.

LOCALIZER - The component of an ILS which provides course guidance to the runway.

MERGE - Combining or merging of noise events which exceed a given threshold level and occur within a variable selected period of time.

MISSED APPROACH COURSE (MAC) - The flight route to be followed if, after an instrument approach, a landing is not effected, and occurring normally:

1. When the aircraft has descended to the decision height and has not established visual contact, or

2. When directed by air traffic control to pull up or to go around again.

NOISE CONTOUR - A continuous line on a map of the airport vicinity connecting all points of the same noise exposure level.

NONDIRECTIONAL BEACON (NDB) - A beacon transmitting nondirectional signals whereby the pilot of an aircraft equipped with direction finding equipment can determined his bearing to and from the radio beacon and home on or track to or from the station. When the radio beacon is installed in conjunction with the Instrument Landing System marker, it is normally called a Compass Locator.

NONPRECISION APPROACH - A standard instrument approach procedure providing runway alignment but no glide slope or descent information.

PRECISION APPROACH - A standard instrument approach procedure providing runway alignment and glide slope or descent information.

PRECISION APPROACH PATH INDICATOR (PAPI) - A lighting system providing visual approach slope guidance to aircraft during a landing approach. It is similar to a VASI but provides a sharper transition between the colored indicator lights.

PROFILE - The physical position of the aircraft during landings or takeoffs in terms of altitude in feet above the runway and distance from the runway end.

PROPAGATION - Sound propagation refers to the spreading or radiating of sound energy from the noise source. Propagation characteristics of sound normally involve a reduction in sound energy with an increased distance from source. Sound propagation is affected by atmospheric conditions, terrain, and man-made and natural objects.

RUNWAY END IDENTIFIER LIGHTS (REIL) - Two synchronized flashing lights, one on each side of the runway threshold, which provide rapid and positive identification of the approach end of a particular runway.

RUNWAY USE PROGRAM - A noise abatement runway selection plan designed to enhance noise abatement efforts with regard to airport communities for arriving and departing aircraft. These plans are developed into runway use programs and apply to all turbojet aircraft 12,500 pounds or heavier. Turbojet aircraft less than 12,500 pounds are included only if the airport proprietor determines that the aircraft creates a noise problem. Runway use programs are coordinated with FAA offices as outlined in Order 1050.11. Safety criteria used in these programs are developed by the Office of Flight Operations. Runway use programs are administered by the Air Traffic Service as "Formal" or "Informal" programs.

RUNWAY USE PROGRAM (FORMAL) - An approved noise abatement program which is defined and acknowledged in a Letter of Understanding between FAA - Flight Standards, FAA - Air Traffic Service, the airport proprietor, and the users. Once established, participation in the program is mandatory for aircraft operators and pilots as provided for in F.A.R. Section 91.87.

RUNWAY USE PROGRAM (INFORMAL) - An approved noise abatement program which does not require a Letter of Understanding and participation in the program is voluntary for aircraft operators/pilots.

SEL - Sound Exposure Level. SEL expressed in dB, is a measure of the effect of duration and magnitude for a single-event measured in A-weighted sound level above a specified threshold which is at least 10 dB below the maximum value. In typical aircraft noise model calculations, SEL is used in computing aircraft acoustical contribution to the Equivalent Sound Level (Leq), the Day-Night Sound Level (DNL), and the Community Noise Equivalent Level (CNEL).

SINGLE EVENT - An occurrence of audible noise usually above a specified minimum noise level caused by an intrusive source such as an aircraft overflight, passing train, or ship's horn.

SLANT-RANGE DISTANCE - The straight line distance between an aircraft and a point on the ground.

SOUND EXPOSURE LEVEL - See SEL.

TACTICAL AIR NAVIGATION (TACAN) -An ultra-high frequency electronic air navigation system which provides suitably-equipped aircraft a continuous indication of bearing and distance to the TACAN station.

TERMINAL RADAR SERVICE AREA (TRSA) - Airspace surrounding designated airports wherein ATC provides radar vectoring, sequencing, and separation on a full-time basis for all IFR and participating VFR aircraft. Service provided in a TRSA is called Stage III Service.

THRESHOLD - Decibel level below which single event information is not printed out on the noise monitoring equipment tapes. The noise levels below the threshold are, however, considered in the accumulation of hourly and daily noise levels.

TIME ABOVE (TA) - The 24-hour TA noise metric provides the duration in minutes for which aircraft-related noise exceeds specified A-weighted sound levels. It is expressed in minutes per 24-hour period.

TOUCHDOWN ZONE LIGHTING (TDZ) -Two rows of transverse light bars located symmetrically about the runway centerline normally at 100 foot intervals. The basic system extends 3,000 feet along the runway.

TRAFFIC PATTERN - The traffic flow that is prescribed for aircraft landing at or taking off from an airport. The components of a typical traffic pattern are the upwind leg, crosswind leg, downwind leg, base leg, and final approach.

UNICOM - A nongovernment communication facility which may provide airport information at certain airports. Locations and frequencies of UNICOM's are shown on aeronautical charts and publications.

UPWIND LEG - A flight path parallel to the landing runway in the direction of landing. See "traffic pattern."

VECTOR - A heading issued to an aircraft to provide navigational guidance by radar.

VERY HIGH FREQUENCY OMNIDIRECTIONAL RANGE STATION (VOR) - A ground-based electric navigation aid transmitting very high frequency navigation signals, 360 degrees in azimuth, oriented from magnetic north. Used as the basis for navigation in the national airspace system. The VOR periodically identifies itself by Morse Code and may have an additional voice identification feature.

VERY HIGH FREQUENCY OMNIDIRECTIONAL RANGE STATION/TACTICAL AIR NAVIGATION (VORTAC) - A navigation aid providing VOR azimuth, TACAN azimuth, and TACAN distance-measuring equipment (DME) at one site.

VICTOR AIRWAY - A control area or portion thereof established in the form of a corridor, the centerline of which is defined by radio navigational aids.

VISUAL APPROACH - An approach wherein an aircraft on an IFR flight plan, operating in VFR conditions under the control of an air traffic control facility and having an air traffic control authorization, may proceed to the airport of destination in VFR conditions.

VISUAL APPROACH SLOPE INDICATOR (VASI) - An airport lighting facility providing vertical visual approach slope guidance to aircraft during approach to landing by radiating an directional pattern of high intensity red and white focused light beams which indicate to the pilot that he is **on path** if he sees red/white, **above path** if white/white, and **below path** if red/red. Some airports serving large aircraft have three-bar VASI's which provide two visual guide paths to the same runway.

VISUAL FLIGHT RULES (VFR) - Rules that govern the procedures for conducting flight under visual conditions. The term **VFR** is also used in the United States to indicate weather conditions that are equal to or greater than minimum VFR requirements. In addition, it is used by pilots and controllers to indicate type of flight plan.

VOR - See "Very High Frequency Omnidirectional Range Station."

VORTAC - See "Very High Frequency Omnidirectional Range Station/Tactical Air Navigation."

YEARLY DAY-NIGHT AVERAGE SOUND LEVEL - See Ldn.

APPENDIX B
ZONING PROVISIONS BY JURISDICTION FOR NOISE SENSITIVE LAND USES

GLENDALE
MUNICIPAL AIRPORT

Appendix B
ZONING PROVISIONS BY JURISDICTION FOR NOISE SENSITIVE LAND USES

This Appendix provides a review of the key noise sensitive land uses permitted within each zoning district of the cities of Glendale, Peoria, Phoenix, and Avondale, and Maricopa County. These zoning districts are further discussed and illustrated in **Chapter One, Inventory.**

TABLE B1
Zoning Provisions for Noise Sensitive Uses
City of Glendale

	Noise Sensitive Uses		
Zoning District	Permitted	Conditional	Minimum Lot Size (s.f.)
A-1 Agricultural	Single-family, School	Group Homes, Guest House, Living quarters for employees	40 acres
SR-30 Suburban Residence	Single-family, school, Guest House, Group Homes	Churches, Home child Care Center, Schools, Guest House	30,000
SR-17 Suburban Residence	Same as SR-30	Same as SR-30	17,000
SR-12 Suburban Residence	Same as SR-30	Same as SR-30	12,000
R1-10 Single Residence	Single-family, Public schools, Group homes	Churches, Home child care center, Private schools	10,000
R1-8 Single Residence	Same as R1-10	Same as R1-10	8,000
R1-7 Single Residence	Same as R1-10	Same as R1-10	7,000
R1-6 Single Residence	Same as R1-10	Same as R1-10	6,000
R1-4 Single Residence	Same as R1-10	Home child care center, Churches, Private schools	4,000
R-2 Mixed Residence	Single-family, Duplex, Multi-family, Public schools, Group Homes, Supervisory Care Facilities	Child care center, Private schools, Churches	10,000
R-3 Multiple Residence	Single-family, Multi-family, Boardinghouse, Public Schools, Group Homes	Child care center, Churches, Private schools, Shelter care facilities, Nursing Homes, Congregate care facility	6,000
R-4 Multiple Residence	Single-family, Multi-family, Public schools, Boardinghouse, Group Homes, Supervisory Care Facility	Child care center, Churches, Private schools, Shelter care facilities, Nursing Homes, Congregate care Facility	6,000
R-5 Multiple Residence	Multi-family, Boardinghouse, Group homes, Supervisory Care Facility	Child care center, Churches, Private schools, Shelter care facilities, Nursing homes, Congregate care facility	43,560
R-O Residential Office	Single-family, Group homes	Home child care center, Churches	6,000
C-O Commercial Office	Libraries, Museums	Child care center, Single-family, Churches	10,000
G-O General Office	Hospitals, Libraries, Museums	Child care center	43,560
PR Pedestrian Retail	Residential (on second floor)	Child care center, Museums, Theaters, Auditoriums, Places of public assembly	N/A
SC Shopping Center	Child care center, Churches	Theaters	5 acres
C-1 Neighborhood Commercial	Child care center, Churches	—	N/A
C-2 General Commercial	Child care center, Churches, Theater	Shelter-care facilities, Emergency Medical Care facility	N/A
C-3 Heavy Commercial	—	—	N/A
B-P Business Park	Child care center	—	N/A
M-1 Light Industrial	—	Drive-in theater	6,000
M-2 Heavy Industrial	—	—	6,000

N/A - Not Applicable or Not Appropriate

TABLE B2
Zoning Provisions for Noise-Sensitive Uses
City of Peoria

	Noise-Sensitive Uses		
Zoning District	**Permitted**	**Conditional**	**Minimum Lot Size (s.f.)**
R1-35 Single-family Residential	Single-family	Schools, Places of worship, Day care group homes	35,000
R1-18 Single-family Residential	Same as R1-35	Same as R1-35	18,000
R1-12 Single-family Residential	Same as R1-35	Same as R1-35	12,000
R1-10 Single-family Residential	Same as R1-35	Same as R1-35	10,000
R1-8 Single-family Residential	Same as R1-35	Same as R1-35	8,000
R1-6 Single-family Residential	Same as R1-35	Same as R1-35	6,000
RM-1 Multi-family Residential	Single-family, Duplex, Multi-family	Nursing or convalescent home, Hospitals, Sanitariums, Colleges, Rooming house, Preschool/Day care centers, Day care group homes	4,000 (single-family) 3,000 (duplex) 9-25 du/ac (multi-family)
RMH-1 Mobile Home Subdivision	Single-family	Same as R1-8, Day care group homes	7,000
RMH-2 Recreational Vehicle Resort	Recreational vehicles	—	10 acres
O-1 Office	Places of worship, Nursing or convalescent home, Orphanage, Hospital, Pre-school/Day care centers	—	N/A
C-1 Convenience Commercial	—	—	N/A
PC-1 Planned Neighborhood Commercial	—	—	3 acres
PC-2 Planned Community Commercial	Theaters	—	20 acres
C-2 Intermediate Commercial	—	Day care nurseries, pre-school, or day care facilities	N/A
C-3 Central Commercial	—	—	N/A
C-4 Highway Commercial	—	Mobile home park	N/A
C-5 Major Arterial Commercial	Hospitals, Convalescent care, Retirement Centers	Hospitals, Convalescent care, Retirement centers	10 acres
BPI Business Park Industrial	Museum	Day care center	N/A

TABLE B2 (Continued)
Zoning Provisions for Noise-Sensitive Uses
City of Peoria

	Noise-Sensitive Uses		
Zoning District	Permitted	Conditional	Minimum Lot Size (s.f.)
PI-1 Planned Light Industrial	—	—	N/A
I-1 Light	—	—	N/A
I-2 General Industrial	—	—	N/A'
AG General Agricultural	Places of worship, Schools, Employee housing	Day care group homes	5 acres
SR-43 Suburban Ranch	Single-family	Places of worship, Day card group homes, Mobile homes, Schools	43,650
FP Flood Plain	—	Single-family, Multi-family	N/A
SU Special Use	—	—	N/A
PUD Planned Unit Development Option	Single-family, Parks	Schools, Places of worship, Day care group homes	N/A

N/A - Not Applicable or Not Appropriate

TABLE B3
Zoning Provisions for Noise Sensitive Uses
City of Phoenix

	Noise-Sensitive Uses			
Zoning District	Permitted	Conditional	Minimum Lot Size (s.f.)	Density Units/Acre
S-1 Suburban District Ranch or Farm Residence	Single-family, Schools, Places of worship	Convents, Group foster homes	43,560	
S-2 Suburban District Ranch or Farm Commercial	Same as S-1	—	3 acres	
RE-43 Residential Estate	Single-family, Places of worship	Group foster homes, Group homes for handicapped, Convents, Pocket Shelters, Schools	43,560	
RE-24 Residential Estate	Same as RE-43	Same as RE-43	24,000	
R1-14 One-family Residential	Same as RE-24	Same as RE-24	14,000	
RE-35 Single Family Residence	Single-family, Places of worship	Convents, Pocket shelter, Schools, Group homes for handicapped		1.1 du/ac
R1-18 Single Family Residence	Same as RE-35	Same as RE-35		1.95 du/ac
R1-10 Single Family Residence	Same as RE-35	Same as RE-35		3.5 du/ac
R1-8 Single Family Residence	Same as RE-35	Same as RE-35		4.3 du/ac
R1-6 Single Family Residence	Same as RE-35	Same as RE-35		5.3 du/ac
R-2 Multiple Family Residence	Single-family, Multi-family, Places of worship	Convents, Pocket shelter, Schools, Group homes for handicapped		10.0 du/ac
R-3 Multiple Family Residence	Same as R-2	Same as R-2, Group home, Group foster care home		14.5 du/ac
R-3A Multiple Family Residence	Same as R-2	Same as R-3		22 du/ac
R-4 Multiple Family Residence	Same as R-2	Same as R-3		20 du/ac
R-5 Multiple Family Residence	Same as R-2	Same as R-3, Personal care home, Nursing home		43.5 du/ac
R-4A Multi-Family Residence, General	Same as RE-24, R-3 and R-4, Group Foster Home, Group Home	Nursing home, Personal care home, Convents, Group homes for the handicapped	6,000	
R-O Residential Office, Restricted Commercial	Single-family	—	24,000	

TABLE B3 (Continued)
Zoning Provisions for Noise Sensitive Uses
City of Phoenix

	Noise-Sensitive Uses			
Zoning District	Permitted	Conditional	Minimum Lot Size (s.f.)	Density Units/Acre
H-R, High Rise Overlay	Same as underlying R-4, R-4A, R-5, C-O, C-1, C-2, C-3	—	Same as underlying district	
H-R1, High Rise Overlay	Same as H-R	—	Same as underlying district	
C-O Commercial Office, Restricted Commercial	Schools	—	6,000	
G-O General Office Option	Schools	—	43,560	
M-O Major Office Options	Schools, Day care center	—	5 acres	
C-1 Commercial, Neighborhood Retail	Same as R1-6, R-3, R-4, R-5, Hospitals, Libraries, Nursery Schools, Recovery home	Nursing home	N/A (non-residential uses)	14.5 du/ac (residential uses)
C-2 Commercial, Intermediate Commercial	Same as C-1, Nursing home	—	N/A (non-residential uses)	14.5 du/ac (residential uses)
C-3 Commercial, General Commercial	Same as C-2	—	N/A (non residential uses)	14.5 du/ac (residential uses)
Commerce Park	Places of worship, Caretakers quarters, Commercial schools	—		0.5-1.0 FAR
A-1 Light Industrial	Same as RE-24, R-3, R-4, R-5, C-1, C-2 and C-3	Residential	N/A	
A-2 Industrial	Hospitals, Nursing homes, Libraries, Nursery Schools, Recovery homes	—	N/A	
RH Resort District	—	—	7.5 acres	
PC Planned Community	Residential (requires further approvals)	—	N/A	
PSC Planned Shopping Center	Theaters	—	N/A	
RSC Regional Shopping Center	Same as C-2	Same as C-2	110 acres	
P-1 Passenger Automobile Parking, Limited	—	—	N/A	
P-2 Parking	—	—	N/A	

N/A - Not Applicable or Not Appropriate
du/ac - Density Units Per Acre
FAR - Floor Area Ratio

TABLE B4
Zoning Provisions for Noise-Sensitive Uses
City of Avondale

	Noise-Sensitive Uses		
Zoning District	**Permitted**	**Conditional**	**Minimum Lot Size (s.f.)**
AG Agricultural	Single-family, Schools	Churches, Convents, Mobile home subdivisions, Guest house	5 acres
R1-35 Single-family Residential	Same as AG	Same as AG	35,000
R1-15 Single-family Residential	Same as AG	Same as AG	15,000
R1-8 Single-family Residential	Same as AG	Mobile home subdivisions, Guest houses	8,000
R1-6 Single-family Residential	Same as AG	Same as R1-8	6,000
R1-5 Single-family Residential	Same as AG	Same as R1-8	5,000
R-2 Multi-family Residential	Single-family, Duplexes, Multi-family	Churches, Convents, Parish Houses, Guest houses, Mobile Home Subdivisions, Boarding/Rooming houses, Nursery schools, Day care centers, Nursing homes, Group recovery homes	2 acres
R-3 Multi-family Residential	Multi-family	Same as R-2	6,000
R-4 Multi-family Residential	Multi-family	Same as R-2	6,000
R-5 Mobile Home Park	Mobile homes	—	10 acres
C-O Commercial Office	Churches	—	6,000
C-1 Convenience Commercial	Churches, Day care and nursery schools	Hospitals, Institutions for medical rehabilitation and care, Homes for the aged, Comprehensive child care facility, Group recovery home	N/A
C-2 Community Commercial	Churches, Day care and nursery schools, Hospitals, Institutions for medical rehabilitation, Homes for the aged, Comprehensive child care facility, Group recovery home, Theaters	—	N/A
CP Commerce Park	Day care and nursery schools, Comprehensive child care facility, Caretakers residence	Hospitals and other health care facilities, Mobile home residence	N/A
A-1 General Industrial	Same as CP	Mobile home residence	N/A
PAD Planned Area Development	Same as underlying zoning district	—	N/A

N/A -- Not Applicable or Not Appropriate

TABLE B5
Zoning Provisions for Noise-Sensitive Uses
Maricopa County

	Noise-Sensitive Uses		
Zoning District	Permitted	Conditional	Minimum Lot Size (s.f.)
Rural-190	Single-family, Churches, Schools, Libraries, Museums	Group homes	190,000
Rural-70	Same as Rural-190	Same as Rural-190	70,000
Rural-43	Same as Rural-190	Same as Rural-190	43,560
R1-35 Single-family Residential	Single-family, Churches, Schools, Libraries, Museums	Group homes	35,000
R1-18 Single-family Residential	Same as R1-35	Same as R1-35	18,000
R1-10 Single-family Residential	Same as R1-35	Same as R1-35	10,000
R1-8 Single-family Residential	Same as R1-35	Same as R1-35	8,000
R1-7 Single-family Residential	Same as R1-35	Same as R1-35	7,000
R1-6 Single-family Residential	Same as R1-35	Same as R1-35	6,000
R-2 Limited Multiple-family Residential	Same as R1-35, Duplexes, Multi-family	Same as R1-35	4,000/du
R-3 Multiple-family Residential	Same as R-2	Group Homes	3,000/du
R-4 Multiple-family Residential	Same as R-2	Same as R-3	2,000/du
R-5 Multiple-family Residential	Same as R-2	Same as R-3	1,000/du
SC Senior Citizen Overlay	Single-family, Duplex, Multi-family	—	5 acres
MHR Manufactured House Residential Overlay	Manufactured Housing	—	Same as the primary zoning district
C-S Planned Shopping Center	Uses permitted in original Rural or Residential underlying zone	—	5 acres
C-O Commercial Office	—	—	12,000
C-1 Neighborhood Commercial	Schools, Day nurseries, Nursery schools, Churches	—	6,000
C-2 Intermediate Commercial	Same as C-1, Theaters	—	6,000
C-3 General Commercial	Same as C-2	—	6,000
IND-1 Planned Industrial	—	—	35,000
IND-2 Light Industrial	Caretakers residence	—	6,000
IND-3 Heavy Industrial	—	—	6,000
PD Planned Development Overlay	Same as zoning district PD has been combined with	—	Same as zoning district PD has been combined with

N/A -- Not Applicable or Not Appropriate
du -- Density Unit

APPENDIX C
FORECASTS

GLENDALE
MUNICIPAL AIRPORT

Appendix C
FORECASTS

INTRODUCTION

The proper planning of a facility of any type begins with a definition of the needs that the facility would be expected to serve over the specified planning period. For Glendale Municipal Airport this involves the development of a set of forecasts that best define the potential for future aviation demand. Forecasts of general aviation activity at the airport can then be used as a basis for determining the types and sizes of aviation facilities needed to meet the aviation needs of the area through the year 2015. The forecasts also serve as the basis for estimating future aircraft noise exposure.

The primary objective of a forecasting effort is to define the magnitude of change that can be expected over time. Because of the cyclical nature of the economy, it is virtually impossible to predict with certainty the year-to-year fluctuations in activity when looking twenty years into the future. A trend, however, can be established which delineates long-term growth potential. While a single line is often used to express the anticipated growth, it is important to remember that actual growth may fluctuate above and below this line. Forecasts serve only as guidelines, and planning must remain flexible to respond to unforeseen conditions.

Aviation activity is affected by many external influences, as well as by the aircraft and facilities available. Few industries have seen as dramatic a change as the aviation industry since the first powered flight. Major technological advancements, as well as regulatory and economic actions, have resulted in erratic growth patterns which have had significant impacts upon aviation activity.

FORECASTING APPROACH

The systematic development of aviation forecasts involves both analytical and judgmental processes. A series of mathematical relationships are tested to establish statistical and logical rationale for projected growth. The judgement of the forecast analyst is also important in the final determination of the preferred forecast.

Given the recent completion of the Master Plan and the newly prepared Maricopa Association of Governments (MAG) Regional Aviation System Plan Update, these two studies will provide the basis for developing aviation forecasts at Glendale Municipal Airport. In addition, the impact of Airline Training Center of Arizona's withdrawal from the facility will be considered. The forecasts developed in this chapter constitute a refinement of potential aviation activity through the twenty-year planning period. These items are further discussed below and are illustrated on **Exhibit C1**.

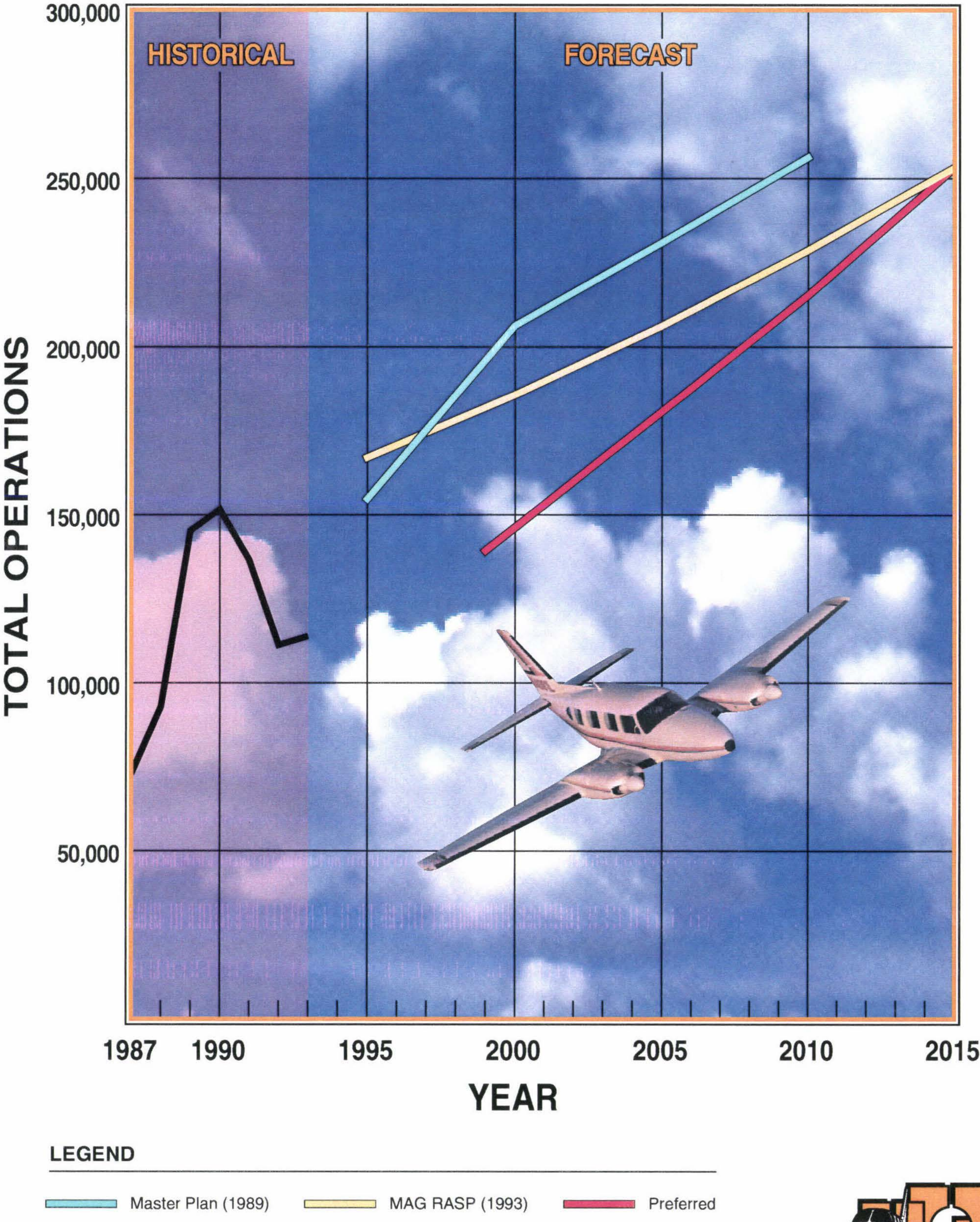
Glendale Municipal Airport is considered a general aviation airport facility. General aviation is defined as that portion of civil aviation which encompasses all facets of aviation except commercial and military operations. There are two types of general aviation operations at an airport: local and itinerant. A local operation is a take-off or landing performed by an aircraft that operates in the local traffic pattern within sight of the airport, including the execution of simulated approaches and touch-and-go operations. Local operations are typically associated with training activities. Itinerant operations are those operations performed by an aircraft with a specific origin or destination away from the airport.

1989 MASTER PLAN

During the preparation of the 1989 Master Plan for Glendale Municipal Airport, aviation forecasts were developed for the twenty-year planning period ending in 2010. These estimates of the number of future operations and based aircraft were determined by an analysis of historical trends and professional judgement.

The assessment of historical trends requires the collection of data on aviation indicators at both the local and national levels. Among those studied in 1989 were aviation-related factors such as historical operations and based aircraft, as well as more general socioeconomic indicators relating to population, employment and income. In addition, the study considered the forecasts produced for the National Plan of Integrated Airport Systems (NPIAS) 1986-95, the Arizona Aviation Needs Study and the 1986 Maricopa Association of Governments (MAG) Regional Aviation System Plan Update (RASP). Each of these studies had been prepared prior to the development of the new airport. These trends were then projected outward, through the twenty-year planning period. The results of these analyses provided a range of total operations and numbers of based aircraft which would be likely to occur at Glendale Municipal Airport.

In discussing the socioeconomic factors applicable to Glendale, the Master Plan determined that economic trends were positive. Average personal income both



GLENDALE MUNICIPAL AIRPORT

Exhibit C-1
COMPARISON OF FORECAST OPERATIONS

92SP16-C-1-2/10/94

in the country and in the state was anticipated to rise throughout the planning period. To counter that, on a national scale, based aircraft, another indicator of general aviation demand, was expected to decline, slowing the rate of growth at Glendale. The 1980's saw a decline in the number of aircraft sales as manufactures shifted from producing single-engine piston to turbine powered aircraft; this resulted in a rise in aircraft prices. There was also a decline in the total number of pilots and students in the nation.

In its evaluation, the Master Plan concluded that new facilities commonly serve as an inducement for aircraft owners to relocate; however, it also considered the impact of the general slowing in the regional based aircraft growth rate and competition from other, nearby general aviation airports.

Once the numbers of based aircraft were estimated, the total number of aircraft operations could also be determined. In preparing these numbers, the Master Plan considered an earlier MAG RASP which had estimated that between 450 and 550 operations could be anticipated per based aircraft. The conservative end of this range was considered more appropriate for the Glendale Municipal Airport. **Table C1** indicates the forecasts for total based aircraft and operations as provided in the Master Plan.

TABLE C1
1989 Master Plan Forecasts
Glendale Municipal Airport

	1990	1995	2000	2005	2010
Based Aircraft	**202**	**280**	**375**	**420**	**466**
Local Operations	71,100	92,400	113,500	117,800	123,300
Itinerant Operations	40,000	61,600	92,800	113,200	133,000
Annual Operations	**111,100**	**154,800**	**206,300**	**231,000**	**256,300**

SOURCE: 1989 Master Plan, Glendale Municipal Airport.

Given the newness of the airport, local operations were anticipated to predominate in the first years of the planning period. As the airport became more established, it was anticipated that itinerant operations would increase at a more rapid rate than the local operations. Toward the end of the planning period, competition from other, newer airports in the vicinity of Glendale Municipal Airport would be expected to lower the annual itinerant operations growth rate and airport activity would begin to moderate. Military operations were not considered a significant factor in the overall operations numbers.

Regarding the based aircraft fleet mix, the Master Plan anticipated that in the future there would be a higher percentage of larger, more sophisticated aircraft operating out of Glendale Municipal Airport. Given the changes in the numbers and types of aircraft being manufactured on a national level, it was anticipated there would a decline in the ratio of single-engine piston aircraft to other aircraft. A smaller decline was anticipated for the multi-engine piston aircraft, and an increase in the ratio was predicted for turbine, helicopters, and other aircraft (balloons, ultralights). The projected fleet mix for Glendale Municipal Airport is indicated on **Table C2.**

TABLE C2
1989 Master Plan Fleet Mix Forecast
Glendale Municipal Airport

Type	1990	1995	2000	2005	2010
Single-engine piston	165	226	298	332	366
Multi-engine piston	17	23	31	34	37
Turboprop	17	24	33	37	42
Turbojet	0	3	6	8	9
Rotorcraft-Piston	2	1	1	1	1
Rotorcraft-Jet	1	3	6	8	11
TOTAL	**202**	**280**	**375**	**420**	**466**

SOURCE: 1989 Master Plan; Glendale Municipal Airport.

According to the master plan forecasts, single-engine piston aircraft would gradually decline from comprising almost 82 percent to just under 79 percent of total based aircraft. Turboprop aircraft, on the other hand, were expected to increase slightly from comprising 8.4 percent to 9.1 percent of based aircraft. Over the planning period, turbojet and rotorcraft aircraft were anticipated to increase to each represent approximately two percent of total based aircraft at Glendale Municipal Airport.

MAG REGIONAL AVIATION SYSTEM PLAN UPDATE

In December 1993, the Maricopa Association of Governments (MAG) adopted an update of the Regional Aviation System Plan (RASP) which developed a strategic implementation plan for meeting the long-term air transportation needs of the region. Included in the study's objectives was a forecast of operation levels and numbers of based aircraft at each of the public airports located within Maricopa County. Under this forecasting effort the number of aircraft operations was projected from the anticipated number of based aircraft at each facility.

To determine the number of based aircraft, the study first projected the total number of based aircraft within the County, by considering trends and socioeconomic factors, these aircraft were then distributed to individual airports in part based on the likelihood of future accommodation, airport facilities and location of aircraft owners. This method of determining the number of based aircraft in a regional system is considered prudent. The distribution was also consistent with actual conditions and with forecasts which had been prepared in more detailed individual airport master planning efforts.

Table C3 provides a breakdown of forecast based aircraft and associated annual operations, as determined by the MAG RASP Update (December 1993). Phase II of the study did not distinguish between local and itinerant operations, nor did it forecast the types of based aircraft for the individual airports.

TABLE C3
MAG RASP Update Forecasts
Glendale Municipal Airport

	1990	1995	2000	2005	2010	2015
Based Aircraft	202	227	256	288	325	362
Annual Operations	150,950	167,500	185,800	206,200	228,700	253,300

SOURCE: MAG Regional Aviation System Plan Update; December 1993.

AIRLINE TRAINING CENTER OF ARIZONA

Airline Training Center of Arizona (ATCA) is a flight training facility for pilots preparing for their commercial pilot's license. ATCA located at Glendale Municipal Airport in 1989 with a total of 12 based aircraft. It is estimated by the air traffic control tower, that in 1990, ATCA accounted for nearly 60 percent of total operations at Glendale Municipal Airport. In October 1991, ATCA moved its based aircraft from Glendale Municipal Airport to nearby Phoenix-Goodyear Airport, continuing to practice touch-and-go operations at Glendale on a regular basis, but dropping to approximately 50 percent of total operations. More recently, as the economy has generally declined, ATCA has accounted for only 20 percent of total operations at Glendale Municipal Airport. In late summer of 1993, ATCA significantly reduced its activity into Glendale Municipal Airport, no longer practicing touch-and-go operations or maintaining a number of aircraft in the pattern. It is the tower's estimate that ATCA operations now account for no more than 10 percent of total operations at Glendale Municipal Airport. ATCA's current operations consist of full landings, back taxiing and takeoffs, exiting the local pattern; these are considered itinerant operations.

In general, ATCA operates two types of training aircraft into Glendale Municipal Airport: single-engine piston (e.g. Beech Bonanza) and twin-engine piston's (e.g. Beech Baron). The majority of ATCA operations, 95%, were with single-engine piston aircraft.

In addition to ATCA, pilot training at Glendale Municipal Airport is also provided by the Fixed Base Operator (FBO) and a helicopter training school.

Given the existence of the air traffic control tower and low, overall operations, Glendale Municipal Airport has the potential for attracting additional training activity from other area airports. According to airport management, there have been inquiries from other pilot training schools to utilize the airport for training operations.

GENERAL INFORMATION

Historical aircraft operations data was obtained from airport records for the calendar years 1986 through 1993. This data is summarized in **Table C4.**

Total general aviation operations at Glendale Municipal Airport have fluctuated between 1986, when the airport relocated, and 1993. Activity at the airport was at its highest in 1990 with 151,662 operations and 179 based aircraft. In 1993, the airport experienced approximately 32 percent itinerant operations and 68 percent local operations. With the departure of ATCA, operations have declined significantly.

Since the opening of the new airport, the amount of operations per based aircraft has fluctuated from a low of 434 in 1987 to 732 in 1993. In between, primarily while ATCA was operating out of Glendale Municipal Airport, the number increased to a high of 870 in 1989. According to information presented in the table, the number of operations per based aircraft appears to be on the rise.

Military activity accounts for less than one percent of the total general aviation activity at Glendale Municipal Airport. The majority of these operations are by rotorcraft (e.g. Blackhawk and Apache helicopters). Other military aircraft (e.g. A10's and F-16's) participate in airshows at the airport.

TABLE C4
Historical Based Aircraft and Operations
Glendale Municipal Airport

Year	Based Aircraft[1,4]	Itinerant Operations[3]	Local Operations[3]	Annual Operations[3]	Operations Per Based Aircraft
1986	150[2]	12,647[5]	19,584[5]	32,231[5]	N/A
1987	168[2]	26,492	46,480	72,972	434
1988	153	33,712	59,251	92,963	608
1989	167	40,955	104,325	145,280	870
1990	179	42,627	109,035	151,662	847
1991	167	40,736	95,936	136,672	818
1992	160	36,640	76,197	112,837	705
1993	143	36,868	77,021	113,889	796

SOURCES:
1 Monthly Airport Administration Reports; Glendale Municipal Airport; December 1993.
2 1989 Master Plan; Glendale Municipal Airport.
3 Aircraft Operations Report; Glendale Municipal Airport; December 1993.

NOTES:
4 Average annual based aircraft counts.
5 Partial year (July 1 through December 31).

ASSUMPTIONS

It is necessary in preparing aviation demand forecasts to make some assumptions regarding future airport improvements and the affects they will have on the use of the facility. In preparing this forecast for Glendale Municipal Airport the following assumptions were made.

- The MAG RASP forecasts for the long-term are valid, indicating that by 2015, Glendale Municipal Airport will have approximately 362 based aircraft and 253,300 operations. With the recent reduction in ATCA operations, however, these numbers are too high over the short-term.
- In accordance with the MAG RASP, Runway 01-19 will be extended to 6,100 feet and widened to 100 feet between 1994 and 2000.
- In accordance with the MAG RASP, a parallel runway will be constructed between 2006 and 2015.
- Some flight training will continue to occur at Glendale Municipal Airport given its location and relatively low activity levels. This likelihood is even greater with construction of the parallel runway.
- Operations by military aircraft will continue to account for less than one percent of total operations at Glendale Municipal Airport.
- The operational split between itinerant and local operations is expected to place a greater emphasis on itinerant operations as more business aircraft utilize the airport facility, reducing training flights. In 1999, it is anticipated that local operations will account for only 65 percent of total air traffic at Glendale Municipal Airport, down from the current level of 68 percent. By 2005, the percentage of local operations is expected to decrease to 60 percent of the total.
- The airport "Strategic Plan," currently being finalized by the City of Glendale, will be approved and implemented beginning in early 1994. The purpose of this plan is to increase the economic viability of the airport by increasing based aircraft and aircraft operations.

This Strategic Plan is an important component of the forecasting analysis. The implementation of this program will enable the airport to become a self-supporting operation in the near future. Strategies which have been included in the plan include a concentrated marketing effort (including additional advertising and activities) to attract new businesses; competitive tiedown fees and lease rates; providing additional, competitively priced hangars and shades; construction of a displaced threshold on the north end of the runway.

PREFERRED FORECASTS

Table C5 provides a summary of the preferred forecasts for Glendale Municipal Airport through the planning period. In general, aircraft operations are expected to slightly decline over the short-term, reflecting the reduction in use by ATCA; however, once the strategic plan has been implemented and the runway extension completed, both the numbers of based aircraft and operations are expected to steadily increase. By the year 2000, the growth rate in the numbers of based aircraft are expected to stabilize until around 2006, at which time the parallel runway is expected to be constructed.

TABLE C5
Preferred Forecasts
Glendale Municipal Airport

		Forecasts			
Operations	**1993**	**1999**	**2005**	**2010**	**2015**
General Aviation					
Itinerant	36,868	48,800	72,280	86,100	101,320
Local	77,021	90,500	108,420	129,200	151,980
Total	**113,889**	**139,300**	**180,700**	**215,300**	**253,300**
Based Aircraft					
Single Engine	135	175	228	247	272
Twin Engine	6	12	25	35	42
Turbo Prop	0	4	8	14	19
Jet	0	3	7	11	15
Helicopter	2	5	10	12	14
Total	**143**	**199**	**278**	**319**	**362**

APPENDIX D
SUPPLEMENTAL INFORMATION ON NOISE ANALYSIS

GLENDALE
MUNICIPAL AIRPORT

Appendix D
SUPPLEMENTAL INFORMATION ON NOISE ANALYSIS

The following discussion provides some background information on the measurement of sound and the noise analysis methodologies utilized in Chapter 2 of this study.

NOISE - UNWANTED SOUND

Noise is often defined as unwanted sound. For example, rock-n-roll on the stereo of the resident of apartment 3A is music to her ears, but it is intolerable racket to the next door neighbor in 3B. One might think that the louder the sound, the more likely it is to be considered noise. This is not necessarily true. In our example, the resident of apartment 3A is surely exposed to higher sound levels than her neighbor in 3B, yet she considers the sound as pleasant while the neighbor considers it "noise". While it is possible to measure the sound level objectively, characterizing it as "noise" is a subjective judgement.

The characterization of a sound as "noise" depends on many factors, including the information content of the sound, the familiarity of the sound, a person's control over the sound, and a person's activity at the time the sound is heard.

MEASUREMENT OF SOUND

A person's ability to hear a sound depends on its character as compared with all other sounds in the environment. Three characteristics of sound to which people respond are subject to objective measurement: magnitude or loudness; the frequency spectrum; and the time variation of the sound.

LOUDNESS

The unit used to measure the magnitude of sound is the decibel. Decibels are used to measure loudness in the same way that "inches" and "degrees" are used to measure length and temperature. However, unlike these linear scales, the decibel scale is logarithmic. By definition, a sound which has ten times the mean square sound pressure of the reference sound is 10 decibels (dB) greater than the reference sound. A sound which has 100 times (10 x 10 or 10^2) the mean square sound pressure of the reference sound is 20 dB greater (10 x 2).

The logarithmic scale is convenient because the mean square sound pressures of normal interest extend over a range of 100 trillion to one. This huge number (a 1 followed by 14 zeros or 10^{14}) is much more conveniently represented on the logarithmic scale as 140 dB (10 x 14).

The use of the logarithmic decibel scale requires different arithmetic than we use with linear scales. For example, if two equally loud but independent noise sources operate simultaneously, the measured mean square sound pressure from both sources will be twice as great as either source operating alone. When expressed on the decibel scale, however, the sound pressure level from the combined sources is only 3 dB higher than the level produced by either source alone. Furthermore, if we have two sounds of different magnitude from independent sources, then the level of the sum will never be more than 3 dB above the level produced by the greater source alone.

The equation below describes the mathematics of sound level summation:

$$S_t = 10 \log \sum_i 10^{S_i/10}$$

where S_t is the total sound level, in decibels, and S_i is the sound level of the individual sources.

A simpler process of summation is also available and often used where a level of accuracy of less than one decibel is not required. **Table D1** lists additive factors applicable to the difference between the sound levels of two sources.

TABLE D1
Additive Factors for Summation of Two Sound Levels

Difference in Sound Level (dB)	Add to Larger Level (dB)
0	3.0
1	2.5
2	2.1
3	1.8
4	1.5
5	1.2
6	1.0
7	0.8
8	0.6
9	0.5
10	0.4
12	0.3
14	0.2
16	0.1
Greater than 16	0

Source: HUD 1985, p.51.

The noise values to be added should be arrayed from lowest to highest. The additive factor derived from the difference between the lowest and next highest noise level should be added to the higher level. An example is shown below.

Example of Sound Level Summation

Sound Levels to be Added	Summation Process	
59 dB	Add 2.5 to 60 = 62.5	
60 dB		Add 1.5 to 66.5 = 68
66.5 dB		

59 dB + 60 dB + 66.5 dB = 68 dB

Logarithmic math also produces interesting results when averaging sound levels. As the example below shows, the loudest sound levels are the dominant influence in the averaging process. In the example, two sound levels of equal duration are averaged. One is 100 dB the other 50 dB. The result is not 75 as it would be with linear math but 97 dB. This is because 100 dB contains 100,000 times the sound energy as 50 dB.

Example Of Sound Level Averaging

Assume two sound levels of equal duration: 100 dB and 50 dB. What is the average sound level?

$$\frac{100dB + 50dB}{2} = 97dB$$

100 dB is 100,000 times more energy than 50 dB!

Another interesting attribute of sound is the human perception of loudness. Scientists researching human hearing have determined that most people perceive a 10 dB increase in sound energy over a given frequency range as roughly a doubling of the loudness. Recalling the logarithmic nature of the decibel scale, this means that most people perceive a ten-fold increase in sound energy as a two-fold increase in loudness (Kryter 1984, p. 188). Furthermore, when comparing sounds over the same frequency range, most people cannot distinguish between sounds varying by less than two or three decibels.

Exhibit D1 presents examples of various noise sources at different noise levels, comparing the decibel scale with the relative sound energy and the human perception of loudness. In the exhibit, 60 dB is taken as the reference or "normal" sound level. A sound of 70 dB, involving ten times the sound energy, is perceived as twice as loud. A sound of 80 dB contains 100 times the sound energy and is perceived as four times as loud as 60 dB. Similarly, a sound of 50 dB contains ten times less sound energy than 60 dB and is perceived as half as loud.

FREQUENCY WEIGHTING

Two sounds with the same sound pressure level may "sound" quite different (e.g. a rumble versus a hiss) because of differing distributions of sound energy in the audible frequency range. The distribution of sound energy as a function of frequency is known as the "frequency spectrum". The spectrum is important to the measurement of sound because the human ear is more sensitive to sounds at some frequencies than others. People hear best in the frequency range of 1,000 to 5,000 cycles per second (Hertz) than at very much lower or higher frequencies. If the magnitude of a sound is to be measured so that it is proportional to its perception by a human, it is necessary to weight more heavily that part of the sound energy spectrum humans hear most easily.

Over the years, many different sound measurement scales have been developed, including the A-weighted scale (and also the B, C, D, and E-weighted scales). A-weighting, developed in the 1930s, is the most commonly used scale for approximating the frequency spectrum to which humans are sensitive. Because of its universality, it was adopted by the U.S. Environmental Protection Agency and other government agencies for the description of sound in the environment.

The zero value on the A-weighted scale is the reference pressure of 20 micro-newtons per square meter (or micro-pascals). This value approximates the smallest sound pressure that can be detected by a human. The average sound level of a whisper at a distance of 1 meter is 40 dB; the sound level of a normal voice at 1 meter is 57 dB; a shout at 1 meter is 85 dB; the threshold of pain is 130 dB.

TIME VARIATION OF SOUND LEVEL

Generally, the magnitude of sound in the environment varies in a random fashion with time. Of course, there are many exceptions. For example, the sound of a waterfall is steady with time, as is the sound of a room air conditioner or the sound inside a car or airplane cruising at a constant speed. But in most places, the loudness of outdoor sound is constantly changing because it is influenced by sounds from many sources.

While the continuous variation of sound levels can be measured, recorded, and presented, comparisons of sounds at different times or at different places is very difficult without some way of reducing the temporal detail.

One way of doing this is to calculate the value of a steady-state sound which contains the same amount of sound energy as the time-varying sound under consideration. This value is known as the Equivalent Sound Level (Leq). An important advantage of the Leq metric is that it correlates well with the effects of noise on humans. On the basis of research, scientists have formulated the "equal energy rule". It is the total sound energy perceived by a human that accounts for the effects of the sound on the person. In other words, a very loud noise lasting a short time will have the same effect as a quieter noise lasting a longer time if the total energy of both sound events (the Leq value) is the same.

KEY DESCRIPTORS OF SOUND

Four descriptors or metrics are useful for quantifying sound (Newman and Beattie 1985, pp. 9-15). All are based on the logarithmic decibel (dB) scale and incorporate A-weighting to account for the frequency response of the ear.

Sound Level

The sound level (L) in decibels is the quantity read on an ordinary sound level

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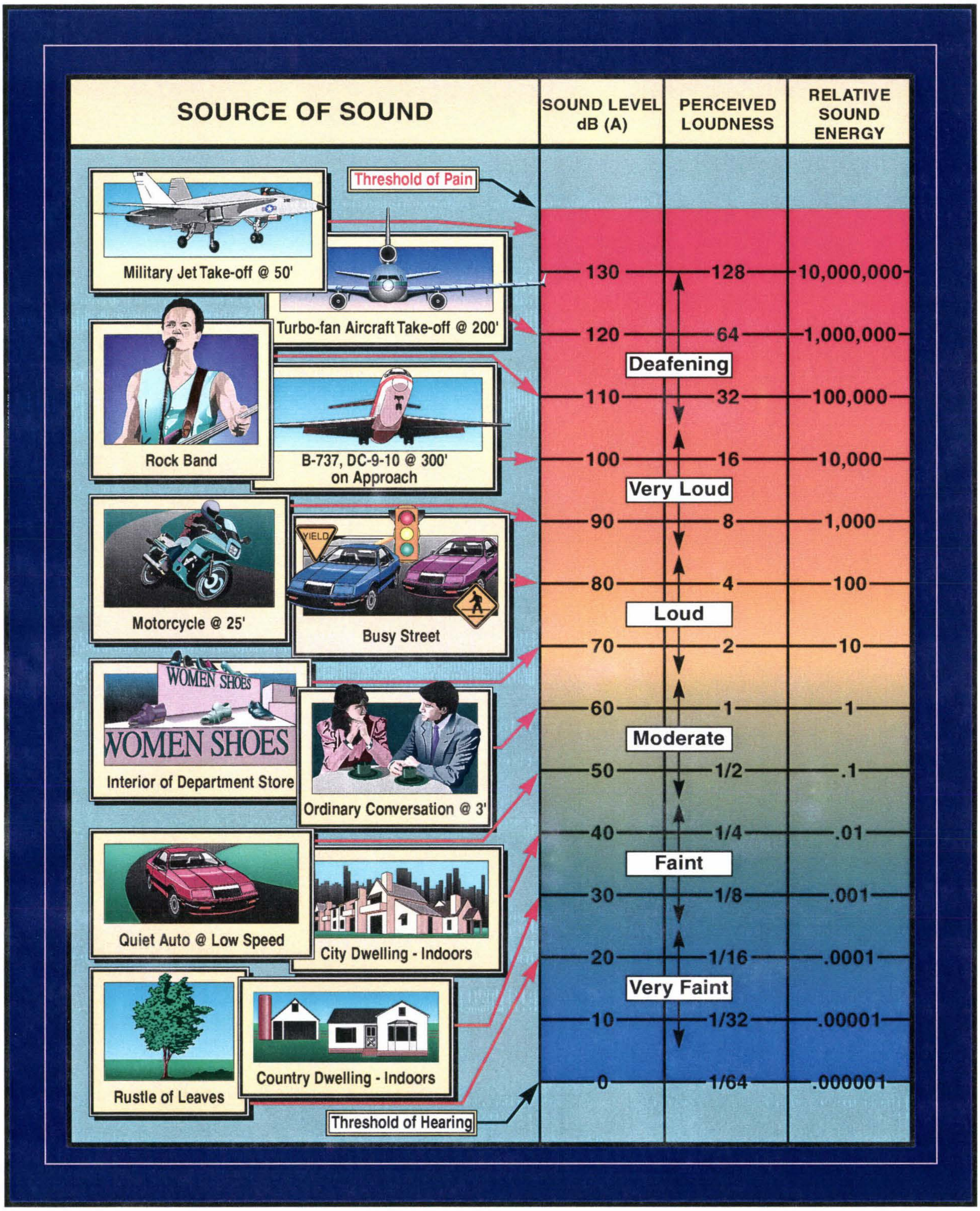

Source: Coffman Associates 1990

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Exhibit D1
TYPICAL SOUND LEVELS

meter. It fluctuates with time following the fluctuations in magnitude of the sound. Its maximum value (Lmax) is one of the descriptors often used to characterize the sound of an airplane overflight. However, Lmax only gives the maximum magnitude of a sound -- it does not convey any information about the duration of the sound. Clearly, if two sounds have the same maximum sound level, the sound which lasts longer will cause more interference with human activity.

Sound Exposure Level

Both loudness and duration are included in the sound exposure level (SEL), which adds up all sound occurring in a stated time period or during a specific event, integrating the total sound over a one-second duration. The SEL is the quantity that best describes the total noise from an aircraft overflight. Based on numerous sound measurements, the SEL from a typical aircraft overflight is usually four to seven decibels higher than the Lmax for the event.

Equivalent Sound Level

The equivalent sound level (Leq) is simply the logarithm of the average value of the sound exposure during a stated time period. It is typically used for durations of one hour, eight hours, or 24 hours. In this study, use of the Leq term applies to 24-hour periods unless otherwise noted. It is often used to describe sounds with respect to their potential for interfering with human activity, e.g. speech interference.

Day-Night Sound Level

A special form of Leq is the day-night sound level (abbreviated as DNL and referred to as Ldn in equations). DNL is calculated by adding up all the sound exposure during daytime (0700 - 2200 hours) plus 10 times the sound exposure occurring during nighttime (2200 - 0700 hours) and averaging this sum by the number of seconds during a 24-hour day. The multiplication factor of 10 applied to nighttime sound is often referred to as a 10 dB penalty. It is intended to account for the increased annoyance attributable to noise during the night when ambient levels are lower and people are trying to sleep.

Exhibit D2 shows how the sound occurring during a 24-hour period is weighted and averaged by the DNL descriptor (or metric). In that example, the sound occurring during the period, including aircraft noise and background sound, yields a DNL value of 71. As a practical matter, this is a reasonably close estimate of the aircraft noise alone because, in this example, the background noise is low enough to contribute only a little to the overall DNL value during the period of observation.

Where the basic element of sound measurement is Leq, DNL is calculated from:

$$\mathrm{Ldn} = 10\log\frac{1}{24}\left(\sum_{d=1}^{15}10^{[\mathrm{Leq}(d)]/10} + \sum_{n=1}^{9}10^{[\mathrm{Leq}(n)+10]/10}\right)$$

where DNL is represented mathematically as Ldn, and Leq(d) and Leq(n) are the daytime and nighttime hour values combined. This expression is convenient where Leq values for only a few hours are available and the values for the remainder of the day can be predicted from a knowledge of day/night variation in levels. The hourly Leq values are summed for the 15 hours from 0700 to 2200 and added to the sum of hourly Leq figures for the 9 nighttime hours with a 10 dB penalty added to the nighttime Leqs.

Another way of computing DNL is described in this equation:

$$L_{dn} = 10\log \frac{1}{86400}\left(\int_{day} 10^{LA/10}\,dt + \int_{night} 10^{(LA+10)/10}\,dt\right)$$

where LA is the time-varying, A-weighted sound level, measured with equipment meeting the requirements for sound level meters (as specified in a standard such as ANSI S1.4-1971), and dt is the duration of time in seconds. The averaging constant of 86,400 is the number of seconds in a day. The integrals are taken over the daytime (0700 - 2200) and the nighttime (2200 - 0700) periods, respectively. If the sound level is sampled at a rate of once per second rather than measured continuously, the equation still applies if the samples replace LA and the integrals are changed to summations.

Use of the DNL metric to describe aircraft noise is required for all airport noise studies developed under the regulations of F.A.R. Part 150. In addition, DNL is preferred by all federal agencies as the appropriate single measure of cumulative sound exposure. These agencies include the FAA, the Federal Highway Administration, Environmental Protection Agency, Department of Defense, and Department of Housing and Urban Development.

One might think of the DNL metric as a summary measure of the total "noise climate" of an area. DNL accumulates the noise energy from passing aircraft in the same way that a precipitation gauge accumulates rain from passing storms. This analogy is presented in **Exhibit D3.** Rain usually starts as a light sprinkle, building in intensity as the squall line passes over, then diminishing as the squall moves on. At the end of a 24-hour period, a rain gauge indicates the total rainfall received for that day, although the rain fell only during brief, sometimes intense, showers. Over a year, total precipitation is summarized in inches. When snow falls, it is converted to its equivalent measure as water. Although the total volume of precipitation occurring during the year may be billions or trillions of gallons of water, its volume is expressed in inches because it provides for easier summation and description. We have learned how to use total annual precipitation to describe the climate of an area and make predictions about the environment.

Aircraft noise is similar to precipitation. The noise level from a single overflight begins quietly and builds in intensity as the aircraft draws closer. The sound of the aircraft is loudest as it passes over the receiver, diminishing as it passes. The total noise occurring during the event is accumulated and described as a Sound Exposure Level (SEL). Over a 24-hour period, the SELs can be summed, adding a special 10-decibel factor for nighttime noise, yielding a DNL value. The DNL developed over a long period of time, say a year, defines the noise environment of the area, allowing us to make predictions about the average

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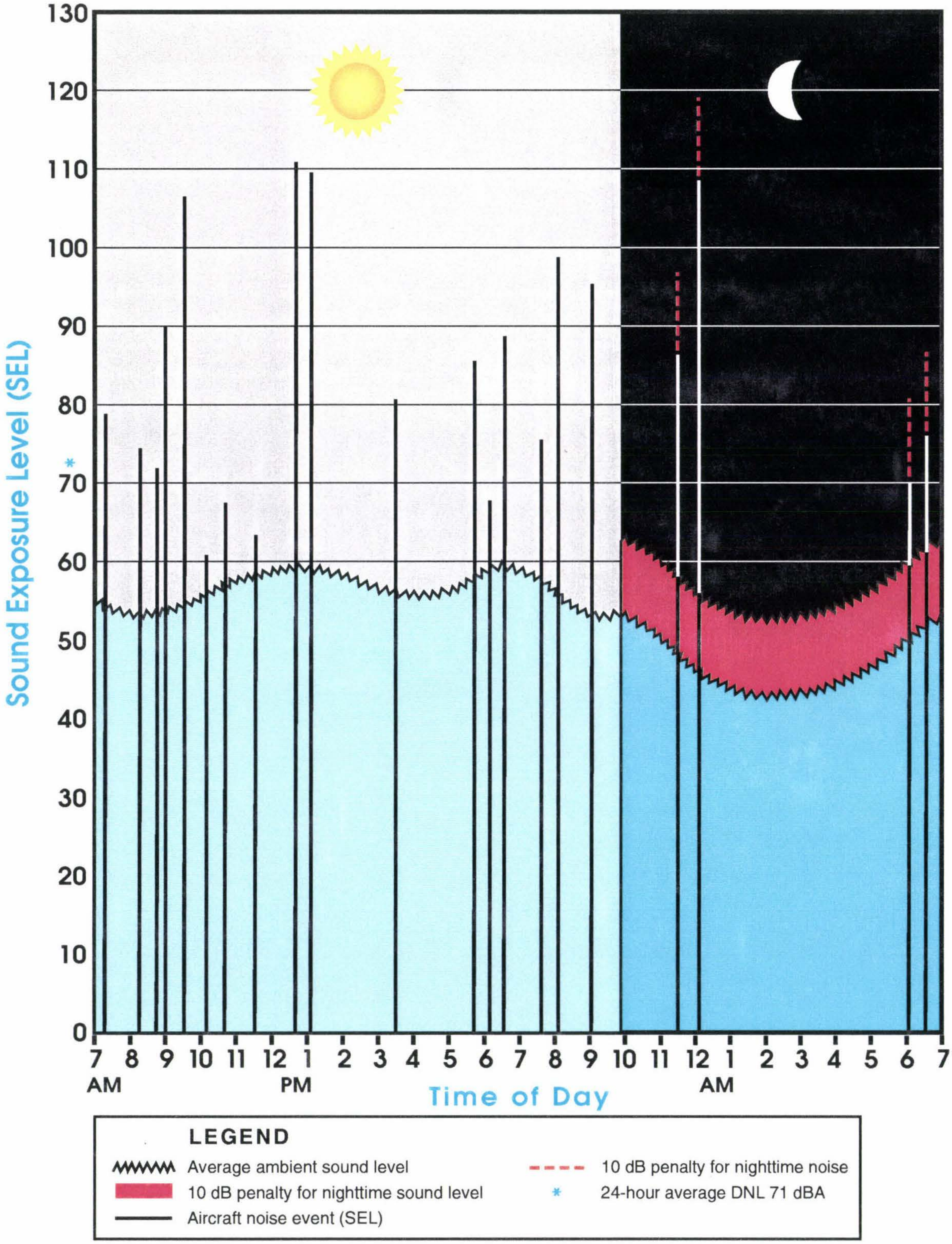

Source: Coffman Associates 1990

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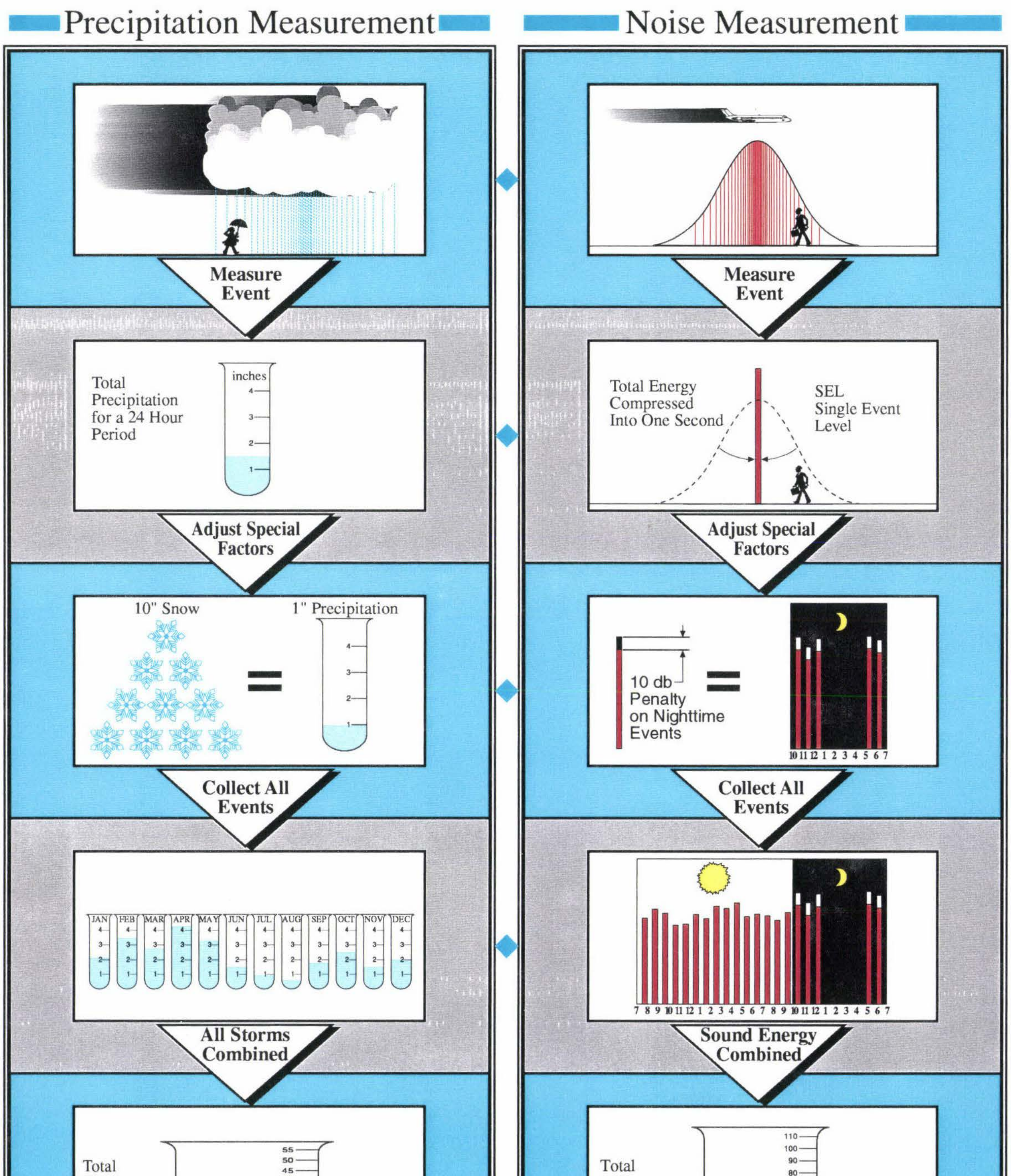
Exhibit D2
TYPICAL NOISE PATTERN AND DNL SUMMATION



Source: Coffman Associates 1990

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Exhibit D3
PRECIPITATION AND NOISE MEASUREMENT COMPARISON

response of people living in areas exposed to various DNL levels.

HELPFUL RULES-OF-THUMB

Despite the complex mathematics involved in noise analysis, several simple rules-of-thumb can help in understanding the noise evaluation process.

- *A 10 decibel change in noise is equal to a tenfold change in sound energy. For example, the noise from ten aircraft is ten decibels louder than the noise from one aircraft of the same type, operated in the same way.*
- *Most people perceive an increase of 10 decibels as a relative doubling of the sound level.*
- *The DNL metric assumes one nighttime operation (between 10:00 p.m. and 7:00 a.m.) is equal in impact to ten daytime operations by the same aircraft.*
- *A doubling of operations results in a three decibel noise increase if accomplished by the same aircraft operated in the same way.*

References

1. Kryter, K.D. 1984. *Physiological, Psychological, and Social Effects of Noise,* NASA Reference Publication 1115.

2. Newman, Steven J. and Kristy R. Beattie, 1985. *Aviation Noise Effects.* Prepared for U.S. Department of Transportation, Federal Aviation Administration, Office of Environment and Energy, Washington, D.C., Report No. FAA-EE-85-2, March 1985.

3. HUD (U.S. Department of Housing and Urban Development) 1985. *The Noise Guidebook,* HUD-953-CPD Washington, D.C., Superintendent of Documents, U.S. Government Printing Office, March 1985.

APPENDIX E
COORDINATION, CONSULTATION, AND PUBLIC INVOUVEMENT

GLENDALE
MUNICIPAL AIRPORT

Appendix E
COORDINATION, CONSULTATION, AND PUBLIC INVOLVEMENT

As part of the planning process, the public, airport users, and local, state, and Federal agencies were given the opportunity to review and comment on the Noise Exposure Maps and supporting documentation. Materials prepared by the consultant were submitted for local review, discussion, and revision at several points during the process. The Planning Advisory Committee (PAC) reviewed and commented on these submissions and was requested to provide direction for future study efforts. Most comments were made orally during the meetings, but many comments were followed by written confirmation. All comments were appropriately incorporated into this document or otherwise addressed. A list of the members of the PAC is on page E-3.

The PAC met two times during the preparation of the Noise Exposure Maps.

On December 13, 1993 a meeting was held to introduce the participants, describe the study process, discuss goals and objectives, distribute committee workbooks and study initiation brochures, review Chapter One, Inventory, and hear comments and views pertaining to conditions at the airport. Many comments and questions were raised at the meeting. Comments about existing land use and future development were offered. Additional comments and concerns were raised about noise levels in the recent past when Airline Training Center of Arizona (ATCA) was operating frequently at Glendale. The noise measurement program which had recently been completed was discussed. Several questions and comments related to the role of the PAC, procedures for keeping and reviewing meeting notes, and a preference for night meetings in the future. The scheduled public information meeting for the evening of December 13 was also announced. Some PAC members expressed a desire to see better publicity about future public information meetings.

The second PAC Meeting was held on March 9, 1994. Working papers on aviation noise, community noise, and noise impacts were presented and discussed. Many questions and comments were raised about the aviation noise analysis. These included questions about the DNL noise metric, forecasts of operations and aircraft types, noise measurements, and flight tracks used for noise modeling. There was considerable discussion about the possibility of modeling past operations and flight tracks based on ATCA's use of the airport. It was agreed to do this at the next step in the study, as a technical appendix or as part of the noise abatement alternatives chapter. The next step of the study, involving the analysis of noise abatement and land use management alternatives was also discussed.

In addition to the Planning Advisory Committee Meetings, the general public was invited to three public information workshop. Structured as open houses, with display boards and information posted throughout the meeting room, these meetings were intended to encourage two-way communication between the airport staff and consultants and local citizens.

The first public information meeting was held on December 13, 1993. The material presented was the same as was discussed at the Planning Advisory Committee meeting earlier in the day. A second public information meeting was held on January 27, 1994, presenting the same information. The third public information meeting was held on March 10, 1994. Information on aircraft noise, community noise, and noise impacts was presented.

In addition to these formal meetings, many written and verbal contacts were made between project management staff and officials of local, state, and Federal agencies and representatives of various aviation user groups. These were related to the day-to-day management of the project, as well as the resolution of specific questions and concerns arising from the working papers.

For more information on project coordination, consultation, and public involvement, please refer to the supplemental volume to the *Noise Exposure Maps* entitled *Supporting Information on Project Coordination and Local Consultation*. That supplement includes copies of meeting announcements, summary notes from the meetings, sign-in sheets, and all written comments received on the Noise Exposure Maps study.

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Ms. Joyce V. Clark Councilmember	Glendale City Council	5850 W. Glendale Avenue, Glendale, AZ 85301	435-4249
Mr. Raymond Thomas	Glendale Aviation Advisory Commission	4829 W. Cinnabar Avenue, Glendale, AZ 85302	937-5764
Mr. Mike Garrison	Glendale Aviation Advisory Commission	8634 N. 56th Drive, Glendale, AZ 85302	436-4539
Mr. Ray Jacobs Senior Planner	Glendale Planning Department	5850 W. Glendale Avenue, Glendale, AZ 85301	435-4169
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Mr. Bobby Brown Tower Chief	Midwest A.T.C.	6801 N. Glen Harbor Boulevard, Suite 201, Glendale, AZ 85307	931-5555
Mr. David Kessler, AICP Airport Planner	Federal Aviation Administration - Western Pacific Region	P. O. Box 92007 Worldway Postal Center, Los Angeles, CA 90009	310-297-1534
Mr. George Sullivan Air Traffic Manager	Federal Aviation Administration - TRACON	2800 Sky Harbor Blvd., Phoenix, AZ 85034	379-3684
Captain Mike Egan Chief Air Traffic Controller	Department of the Air Force, 58 OSS/OSA	7254 N. Fighter Country Avenue, Suite #1, Luke AFB, AZ 85309-1215	856-7138 or 856-7130
Mr. Richard Turner Acting Director	Maricopa County Planning and Development	301 W. Jefferson, Phoenix, AZ 85003	506-3951

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Mr. E.H. Haupt, Manager Airports and Environmental Services	National Business Aircraft Association (NBAA)	1200 18th Street NW Suite 200 Washington, DC 20036	202-783-9253
Mr. Jim Timm	Arizona Pilot's Association	220 E. Ellis Drive Tempe, AZ 85282	839-9187
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