Chapter Two
AVIATION NOISE

This chapter describes the noise exposure maps for Williams Gateway Airport. Noise contour maps are presented for three study years: 1999, 2004, and 2020. The 1999 noise contour map shows the current noise levels based on estimated operations for the latest twelve months of activity provided by the air traffic control tower. The 2004 map is based on forecast operation levels from the recently completed Master Plan Study. The 1999 and 2004 maps are the basis for the official "Noise Exposure Maps" required under F.A.R. Part 150.

One additional noise contour map has been developed to present a long term view of potential future noise exposure at Williams Gateway. Based on forecasts developed in the Master Plan Study for the year 2020, they can be helpful in providing guidance for long term land use planning. That subject is dealt with at a later point in the Part 150 Study process.

These noise contour maps are considered as baseline analyses. They assume operations based on the existing procedures at Williams Gateway. 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. A Technical Information Paper included in the last section of this document, *The Measurement and Analysis of Sound*, presents helpful background information on noise measurement and analysis.

AIRCRAFT NOISE MEASUREMENT PROGRAM

A noise measurement program was conducted over a five-day period from May 14, 1999 through May 18, 1999. 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.

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 collected on single event measurements is used as an indicator of typical dBA and Sound Exposure Levels (SEL) within the study area as well as comparative ambient noise measurements in areas affected by aircraft noise.

ACOUSTICAL MEASUREMENTS

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

Instrumentation

Four sets of acoustical instrumentation, the components of which are listed in **Table 2A**, were used to measure noise. Each set consisted of a high quality microphone connected to a 24-hour environmental noise monitor unit. Each unit was calibrated to assure consistency between measurements at different locations. A 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

1	Metrosonics dB-604 Portable Noise Monitors
1	Gen Rad Model 1962 - 9600 ½ Electrical - Condenser Microphone
1	Gen Rad Model 1972 - 9600 Preamplifier/Adapter
1	Gen Rad Model 1987 Minical Sound-Level Calibrator
3	Larson Davis 820 Portable Noise Monitors and Preamplifiers
3	Larson Davis Model 2559 - ½ Microphones
1	Model CA250 Sound Level Calibrator
1	Portable Computer

Measurement Procedures

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 a threshold of 60 dB at each 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.

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 average spring weather for Williams Gateway. Conditions were generally clear throughout the program. Winds were generally light and from

the north in the mornings, switching to the south in the afternoons. Daily temperatures ranged from highs over 100 degrees to lows in the 60s and 70s.

Aircraft Noise

Measurement Sites

Noise measurement sites are shown on **Exhibit 2A**. They were selected on the basis of background information, local observation during the field effort, and suggestions from the Airport

Management based on noise complaint history. Specific selection criteria include the following:

- Emphasis on areas of marginal or greater than marginal aircraft noise exposure according to earlier evaluations.

- 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 fulfill the above criteria and provide a representative sampling of the varying noise conditions in the airport vicinity. One site was measured for 72-hours, one for 48-hours, and two sites for 24-hour periods. Noise monitors were placed in two other locations during the monitoring period. However, technical difficulties with the equipment prevented the equipment from retaining the data in the monitors' data banks.

• 72-HOUR MEASUREMENT SITE

Site A is located at 157 Joshua Tree Lane in Gilbert. This home is approximately 13,000 feet northwest of the airport. The area is a single-family residential area of contemporary homes on small lots. The site is in an area that would likely receive regular arrival and departure overflight noise from all three runways.

The equipment was set up at the rear of the house. During the equipment setup, two helicopters flew over the area and registered a peak noise event (Lmax) of 76.4 dBA on the noise monitor.

The 24-hour equivalent sound level (Leq) for the first day at Site A was 43.8, 45.8 for the second day, and 47.3 for the third day. The DNL level for this site was computed for the first day at 45.2, 49.0 for the second day, and 50.8 for the third day. The mode noise level, that is, the most commonly recorded level, was 44.0 for the 72-hour measurement period.

• 48-HOUR MEASUREMENT SITE

Site B is located at 8744 Waterford in Mesa. This home is approximately 4,500 feet south of the airport. The area is a single-family residential area of contemporary homes on large lots. There is a large open area immediately west of a workshop located behind the home. The site is in an area that would likely receive regular touch-and-go over-flights.

The equipment was set up at the rear of the house in the large open area with a clear view to the airport. A single engine piston aircraft flow over the site during the monitor setup and registered a peak noise level of 66.6 dBA.

The 24-hour Leq for the first day at Site B was 49.3 and 50.0 for the second day. The DNL level for this site was computed to be 54.8 for the first day and 55.0 for the second day of the measurement period. The mode noise level was 44.0 for the 48-hour measurement period.

• 24-HOUR MEASUREMENT SITES

Site C is located at 7063 E. Medina Avenue approximately 16,000 feet north of the airport. The area is a large single-family residential area of contemporary homes on small lots.

The equipment was set up at the rear of the house. A swimming pool was located approximately 20 feet from the noise monitor location. A large dog was also present during the monitor setup. There were no aircraft overflights during the monitor setup.

The 24-hour Leq for Site C was 52.5. The DNL level for this site was computed to be 54.3 for the measurement period. The most commonly recorded level was 56.0 for the 24-hour measurement period which would indicate a fairly high background noise level.

Site D is located at 9302 East Plant Avenue. This home is approximately 14,000 feet northeast of the airport. The area is a single-family residential area of contemporary homes on small lots.

The home is located on a corner lot with an open view to the airport. The equipment was set up in the side yard of the house. There is a paved road approximately 20 feet from the noise monitor location. There were no aircraft overflights during the monitor setup, however there were several delivery/construction trucks observed during the setup of the noise monitoring equipment.

The 24-hour Leq for Site D was 55.3. The DNL level for this site was computed to be 55.9 for the measurement period. The most common record level was 44.0 for the 24-hour period.

MEASUREMENT RESULTS SUMMARY

The noise data collected during the measurement period are presented in **Table 2B**. The information includes the average 24-hour 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 extra weight is attached to nighttime noise.

Three 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

TABLE 2B
Measurement Results Summary
Williams Gateway Airport

	Site A			Site B		Site C	Site D
	Day 1	Day 2	Day 3	Day 1	Day 2	Day 1	Day 1
Measurement Dates	5/16 - 5/17	5/17 - 5/18	5/18 - 5/19	5/14 - 5/15	5/15 - 5/16	5/15 - 5/16	5/17 - 5/18
Cumulative Data							

LEQ(24)	43.8	45.8	47.3	49.3	50.0	52.5	55.3
DNL(24)	45.2	49.0	50.8	54.8	55.0	54.3	55.9
DNL(t)	45.0	48.2	50.2	51.7	51.7	54.2	53.1
DNL(b)	31.7	41.3	41.9	51.9	52.3	37.9	52.7
MODE dB	44.0	44.0	44.0	44.0	44.0	56.0	44.0
L(50)	44.0	44.0	44.0	45.0	45.0	56.0	45.0
Single Event Data							
L(max)	82.1	80.3	69.9	65.3	73.3	89.2	83.5
SEL(max)	87.0	87.5	91.7	81.6	82.9	94.1	97.7
Max Duration (sec)	42.3	209	363	35	44	66	229
Number of Single Events above 60 dB (Lmax)	62	86	71	35	36	216	170
Number of Single Events Above							
SEL 70 dB SEL	35	56	35	25	27	128	94
SEL 80 dB	5	7	5	4	4	20	31
SEL 90 dB	0	0	2	0	0	2	7
SEL100 dB	0	0	0	0	0	0	0

Source: Coffman Associates Analysis

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. DNL(b) provides a measure of the residual background noise resulting from subtracting the DNL(t) value from the DNL(24) value.

In addition, the L(50) values for each site are presented. These values represent the sound levels above which 50 percent of the samples were recorded. All of the cumulative data 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.

The program resulted in a total of one 72-hour period, one 48-hour period, and two 24-hour periods from four sites around the airport. A total of 676 single events were recorded during the program and 168 average hourly sound levels were calculated and recorded.

presented represents the average values for the duration of the measurements at each site.

The table also presents data on other measures of noise that may be useful for comparisons. These include:

- Maximum recorded noise level in dB (Lmax);
- Maximum recorded sound exposure level (SELmax);
- Longest single-event duration in seconds (Dur max);
- Most frequently recorded decibel level (Mode dB);
- Number of single events above sound exposure levels (SEL) 70, 80, 90, and 100.

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 latest versions of the INM are quite sophisticated, accounting for such variables as airfield elevation, temperature, headwinds, and local topography in predicting noise levels at a given location. INM Version 5.2a was used to prepare noise exposure maps for the Williams Gateway noise analyses.

Inputs to the INM include runway configuration, flight track locations, aircraft fleet mix, stage length (trip length) for departures, and numbers of daytime and nighttime operations by aircraft type. The INM provides a database for the commercial, military, and general aviation aircraft which commonly operate at Williams Gateway. **Exhibit 2B** depicts the INM input assumptions.

The INM computes typical flight profiles for aircraft operating at the assumed airport location, based upon the field elevation and lapse rate temperature, and flight procedure data provided by aircraft manufacturers. The INM will also accept user-provided input, although the FAA reserves the right to accept or deny the use of such data depending upon its statistical validity.

The INM predicts noise levels at a set of grid points surrounding an airport. The numbers and locations of grid points are established during the INM run to determine noise levels in the areas where operations are concentrated, depending upon the tolerance and level of refinement specified by the user. The noise level values at the grid points are used to prepare noise contours, which connect points of equal noise exposure. INM will also calculate the noise levels at a user-specified location, such as noise monitoring sites.

INM INPUT

AIRPORT AND STUDY AREA DESCRIPTION

The runways were input into the INM in terms of latitude and longitude, as well as elevation. As previously mentioned, the INM computes typical flight profiles for aircraft operating at the airport location, based upon the field elevation, lapse rate temperature, and flight procedure data provided by aircraft manufacturers. The Williams Gateway Airport field elevation is 1,382 feet above mean sea level (MSL). The lapse rate temperature, the change in temperature with altitude, is calculated by multiplying the International Standard Atmosphere (ISA) temperature lapse rate of 0.003566 degrees Fahrenheit by the airport field elevation (1,382 feet MSL) and subtracting this value from the INM's standard day temperature of 59 degrees. This equates to a lapse rate temperature of 54.1 degrees Fahrenheit for Williams Gateway.

It is also possible to incorporate a topographic database into the INM, which allows the INM to account for the changes in distances from aircraft in flight to elevated receiver locations. However, the topographic data, while obtained from the U.S. Geographical Survey, are of relatively low resolution, and experience has shown that these data can produce erroneous results in predicting noise levels where airports are located on relatively flat terrain. Thus the topographic database was not employed for this study, as the terrain surrounding Williams Gateway is essentially level where most people live. Exceptions may occur for homes located on hills, but the magnitude of the expected differences in noise levels at those receivers is expected to be less than 1 dB.

ACTIVITY DATA

For this analysis, current aircraft operations (takeoffs and landings) data and forecasts of future (2004 and 2020) activity prepared for this study and presented in Chapter Two of the 1999 Master Plan Study were used for noise modeling. The operations forecast prepared for the Master Plan Study are prepared under the assumption that no constraining factors (limited hangar space, runway capacity, etc.) will inhibit the growth of airport operations. **Table 2C** summarizes the existing and forecast operation levels.

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.

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**, **Exhibit 2D,** and **Exhibit 2E** illustrate this concept graphically. The footprints represent the noise pattern generated by one departure and one arrival of the given aircraft type. The aircraft illustrated are some of those commonly found at Williams Gateway. Additionally, noise footprints for aircraft that are anticipated to operate at Williams Gateway in the future are illustrated.

TABLE 2C
Operations Summary
Williams Gateway Airport

		FORECASTS	
Operations	**Existing 1999[1]**	**2004[2]**	**2020[2]**

Itinerant	63,171	73,800	135,400
Local	165,752	158,400	202,800
Estimated Nighttime	10,450	10,681	15,557
Total	239,373	242,881	353,757

[1] Estimate based on actual operations from July 1998 through June 1999. Used as a projection of 1999 operations for noise modeling.

[2] Williams Gateway Master Plan Update, Chapter Two, Table 2V, p. 2-29

The military, turbojet, and turboprop fleet mix were developed based on airport landing reports and on air traffic control tower (ATCT) observations as well as the airport staff.

The twin and single-engine piston aircraft mix were developed by using the percentages of based aircraft by type to divide up the operations at the airport.

Table 2D summarizes the fleet mix data input into the noise analysis by annual aircraft operations.

DATABASE SELECTION

The FAA aircraft substitution 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 INM describes several different versions of the B-727 and B-737 aircraft. INM designators 727Q15 and 727EM2 represent the B-727-200 and hushkitted B-727 aircraft. The model's 737QN was used for the 737-100/200, with the 737300 used for B-737-300, and the 737400 used for the B-737-400 series. The 757RR and 767300 designators were used to represent the B-757 and B-767aircraft, respectively, in the fleet mix. The A300 and A320 designators were used to represent the A-300 and A-320 operations, respectively. The DC-10 series aircraft was modeled with the DC1040 INM designator. These choices are in accordance with the Pre-Approved Substitution List published by the FAA Office of Environment and Energy (AEE) branch in Washington.

The FAA's substitution list recommends the BEC58P, the Beech Baron, to represent the light twin-engine aircraft such as the Piper Navajo, Beech Duke, 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. The DHC6 represents the heavier turboprop and twin-engine piston aircraft such as the Super King Air aircraft.

The INM provides data for most of the business turbojet aircraft in the national fleet. The LEAR35 effectively represents the Lear 30 and

50 series, the Sabreliner 65, the Falcon 10, 50, and 200, and the Hawker 700 and 800 series. The CNA500 represents the Cessna Citation I and SP and the Mitsubishi Diamond MU300. The LEAR25 designator represents the Lear 2x series aircraft, the Sabreliner 40-60-70-75, the HS125, and the Jetstar 1.

General aviation helicopter operations are modeled using the Jet Ranger. The Jet Ranger helicopter data was extracted from the FAA's Heliport Noise Model (HNM).

Military operations are a major portion of the traffic at Williams Gateway. To model these operations, the KC135B was selected to represent the KC-135 and the C130 represents the C-130. The single jet engine attack aircraft were represented by the F16A. The LEAR25 represents the Lear 25 series military aircraft and is also the approved substitute for the T-38 aircraft. The INM designator DHC6 represents the C-12 aircraft in the military fleet.

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 10 decibel 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 (ATCT) at Williams Gateway operates from 6:00 a.m. to 9:00 p.m. seven days a week. Consequently, ATC counts for nighttime operations are not available. However, ATCT staff estimate nighttime aircraft operations at approximately 4.6 percent of the total annual operations. The nighttime operations by aircraft type are presented in **Table 2D**. This percentage was applied to both future forecast scenarios.

RUNWAY USE

Runway usage data is another essential input to the INM. For modeling purposes, wind data analysis usually determines runway use percentages. Aircraft will normally land and takeoff into the wind. 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 Williams Gateway, the parallel runway configuration offers

TABLE 2D
Fleet Mix And Operational Data

	INM Designator	EXISTING 1999 Itinerant	EXISTING 1999 Local	FORECAST 2004 Itinerant	FORECAST 2004 Local	FORECAST 2020 Itinerant	FORECAST 2020 Local
Daytime Operations							
AIR CARRIER/CARGO							
Stage 2							
B-727-200	727Q15	53	0	0	0	0	0
B-737-200	737QN	182	0	0	0	0	0
DC-8	DC8QN	82	0	0	0	0	0
Stage 3							
Regional Jet	CL601	0	0	270	0	3,632	0
B-727-EM2 (Hush kit)	727EM2	0	0	280	0	0	0
B-737-300	737300	0	0	1,512	0	15,890	0
B-757	757RR	0	0	1,350	0	11,350	0
B-767	767300	0	0	1,188	0	11,350	0
A-300	A300	0	0	0	0	560	0
DC-10	DC1040	0	0	810	0	908	0
Propeller							
Single Engine Piston	GASEPV	0	0	520	0	1,040	0
Large Turboprop	SF340	0	0	270	0	2,270	0
AIR TAXI							
Light Single-Fixed	GASEPF	1,045	0	555	0	795	0
Light Single-Var.	GASEPV	1,045	0	555	0	795	0
Light Twin	BEC58P	1,045	0	740	0	1,060	0
Twin Turboprop	CNA441	999	0	925	0	1,325	0
Large Turboprop	DHC8	32	0	0	0	0	0
Large Multi Piston Engine	DC3	62	0	0	0	0	0
Stage 2 Business Jet	LEAR25	384	0	370	0	0	0
Stage 3 Business Jet	LEAR35	276	0	555	0	1,325	0
GENERAL AVIATION							
Light Single-Fixed	GASEPF	12,640	109,000	18,510	114,000	21,230	155,800
Light Single-Var.	GASEPV	15,067	11,000	10,314	12,400	16,348	14,000
Light Twin	BEC58P	16,870	3,114	17,770	4,000	24,082	5,000
Twin Turboprop	CNA441	3,475	0	9,465	0	12,645	0
Jets							
LEAR-35	LEAR35	869	0	947	0	1,265	0
Citation	CNA500	869	0	947	0	1,265	0
Rotorcraft:							
Jet Ranger	JRNGR	869	0	947	0	1,265	0
MILITARY							
KC-135	KC135B	0	7,492	0	7590	0	7,590
C-130	C130	0	999	0	990	0	990
Single Engine Attack Jet	F16A	0	10,488	0	13860	0	13,860
T-38	LEAR25	2,497	0	3,020	3580	3,020	3,580
Lear 25	LEAR25	2,497	0	1,980	0	1,980	0
C-12	DHC6	2,313	23,659	0	1980	0	1,980
Subtotal Daytime		63,171	165,752	73,800	158,400	135,400	202,800

TABLE 2D (Continued)
Fleet Mix And Operational Data

	EXISTING	FORECAST

		1999		2004		2020	
	INM Designator	Itinerant	Local	Itinerant	Local	Itinerant	Local
Nighttime							
Light Single-Fixed	GASEPF	2,,717	0	2,777	0	4,045	0
Light Single-Var.	GASEPV	2,613	0	2,670	0	3,889	0
Light Twin	BEC58P	1,672	0	1,709	0	2,489	0
Twin Turboprop	CNA441	418	0	482	0	700	0
Stage 2 Business Jet	LEAR25	52	0	53	0	78	0
Stage 3 Business Jet	LEAR35	52	0	53	0	78	0
Large Turbo prop	SF340	52	0	53	0	78	0
Large Multi Piston Engine	DC3	638	0	641	0	933	0
A-320	A320	960	0	961	0	1,400	0
B-737-400	737400	209	0	214	0	311	0
B-757	757RR	1,066		1,068		1,556	
Subtotal Nighttime		10,450	0	10,681	0	15,557	100.0
Total		73,621	165,752	84,481	158,400	150,957	202,800

only two directions of choice. The airport management at Williams Gateway has designated Runway 30 L/C/R as the "calm wind runway." Winds five (5) knots and below are considered calm winds. Pilots in aircraft under 12,500 pounds in weight will generally only take up to a 5 knot tail wind on departure. Consequently, this is the direction of choice in most conditions where winds allow a northwest flow. According to wind data, the designation of Runway 30 L/C/R as the calm wind runway is favored up to 70 percent of the time.

Runway utilization can be reflected by showing the percentage of time that air traffic activities occur in either a northwest or southeast flow configuration. When the airport operates in a north flow configuration, arriving and departing traffic use Runway 12 L/C/R. When a south flow configuration is used, arriving and departing traffic use Runway 30 L/C/R.

Continuous records of the runway usage at Williams Gateway Airport were not directly available; however, the ATCT staff provided an estimate of runway use. Runway 12L-30R was closed during the inventory phase of the study which is reflected in the 1999 existing conditions runway use depicted in **Table 2E**. In the short term the ATCT indicated that 20 percent of the military and commercial/cargo arrivals, 4 percent of the departures, and 80 percent of the touch and go activity would shift to Runway 12L-30R when it reopened. Planned terminal development on the east side of the airport and relocating the instrument landing system (ILS) to Runway 30R is projected to change the runway use. The military and commercial/air cargo is projected to increase to 80 percent arrivals, 80 percent of the departures, and 75 percent of the touch-and-go on Runway 12L-30R. Runway 12R-30L is projected to remain the general aviation runway in during the study. **Tables 2E and 2F** summarize the runway use percentages for the existing and future conditions.

FLIGHT PROFILES

One of the variables which affects single event noise levels at a given measurement location is the actual flight profile of the aircraft as it passes overhead. In the INM, a flight profile is comprised of three parameters: thrust, speed and altitude. The thrust value bears a direct linear relationship to the expected noise level, as the INM contains tables of noise levels as a function of thrust values for each aircraft type. The speed of the aircraft affects the Sound Exposure Level (SEL) by affecting the duration of the noise event; *i.e.*, the slower the aircraft, the longer the noise event, and the higher the SEL value. The INM applies a standard correction for speed differences using a logarithmic function.

Altitude affects the predicted noise levels in that an aircraft which is closer to an observer is generally louder than an aircraft which is farther away. The INM tables of noise levels and thrust values are also tied to specific distances, from which the INM interpolates the noise level at the observer, again using a logarithmic function. In general, the small variations in speeds and altitudes typically observed close to the airport have relatively small effects on predicted noise levels. Differences in thrust settings can have more pronounced effects.

There is no data currently available which report the thrust values used by a given aircraft type. Actual thrust settings may vary as a result of specific local conditions during a flight, such as load, weather, and airline-specific flight procedures. The INM estimates the thrust settings from standard flight procedures reported by the aircraft manufacturers.

The INM database provides separate departure profiles (altitude at a specified distance from the airport with associated velocity and thrust settings) for each type of aircraft using the airport. In the case of commercial jet aircraft, the INM typically stores several standard profiles that account for variations in departure weight. These profiles are delineated in the database by destination stage lengths (travel distance). This accounts for the increased aircraft takeoff weight due to the additional fuel required to fly longer distances. A majority of the commercial/cargo destinations are within 1,000 nautical miles (considered Stage 2 in the INM). Therefore these aircraft were modeled with Stage 2 lengths.

The standard arrival profile normally used in INM analysis is a three-degree approach (or approximately 300 feet per nautical mile). The instrument approach to Runway 30C is set to 2.5-degrees; therefore, all baseline year aircraft approaches assigned to Runway 30C were programmed with a 2.5 degree approach slope. Since the ILS glide slope is expected to be aligned to three degrees in November 1999, all potential future Runway 30C aircraft operations were programmed with a standard three degree glide slope. The standard approach included in the model was deemed acceptable for use in modeling approaches to all other runways.

TABLE 2E
Existing Runway Use

Runway	General Aviation	Commercial/Cargo/ Business Jet	Military
Arrivals (Existing Condition)			
12L	0.0%	0.0%	0.0%
30R	0.0%	0.0%	0.0%
12C	6.0%	25.0%	21.0%
30C	14.0%	60.0%	49.0%
12R	24.0%	5.0%	9.0%
30L	56.0%	10.0%	21.0%
Departures (Existing Condition)			
12L	0.0%	0.0%	0.0%
30R	0.0%	0.0%	0.0%
12C	5.0%	21.0%	15.0%
30C	10.0%	49.0%	35.0%
12R	25.0%	9.0%	15.0%
30L	60.0%	21.0%	35.0%
Touch-And-Go's (Existing Condition)			
12L	0.0%	0.0%	0.0%
30R	0.0%	0.0%	0.0%
12C	6.0%	30.0%	30.0%
30C	14.0%	70.0%	70.0%
12R	24.0%	0.0%	0.0%
30L	56.0%	0.0%	0.0%

The military F-16 aircraft occasionally practice an overhead approach maneuver at Williams Gateway. This maneuver requires the pilot to fly a standard approach from the southeast until reaching the runway threshold, do a climbing 360-degree turn to 9,000 feet MSL, cutback the thrust at 9,000 feet MSL, and do 360-degree approach back to the same runway. Because the F-16 aircraft do not touchdown on the runway, this procedure was designed as an overflight in the INM. Thrust levels, turn procedures, and altitudes were provided by the chief pilot from the Tucson Air National Guard Unit.

FLIGHT TRACKS

Local and regional air traffic control procedures, input from the ATCT staff, and actual radar flight track data were used to develop consolidated flight

TABLE 2F
Future Runway Use

Runway	General Aviation	Commercial/Cargo/ Business Jet	Military
Arrivals (Short Term Future)			
12L	**5.0%**	**10.0%**	**10.0%**
30R	**15.0%**	**10.0%**	**10.0%**
12C	**6.0%**	**25.0%**	**11.0%**
30C	**14.0%**	**40.0%**	**39.0%**
12R	**24.0%**	**5.0%**	**9.0%**
30L	**35.0%**	**10.0%**	**21.0%**
Departures (Short Term Future)			
12L	**2.0%**	**2.0%**	**2.0%**
30R	**2.0%**	**2.0%**	**2.0%**
12C	**5.0%**	**21.0%**	**15.0%**
30C	**6.0%**	**45.0%**	**6.0%**
12R	**25.0%**	**9.0%**	**15.0%**
30L	**60.0%**	**21.0%**	**60.0%**
Touch-And-Go's (Short Term Future)			
12L	11.0%	30.0%	30.0%
30R	10.0%	50.0%	50.0%
12C	6.0%	30.0%	30.0%
30C	14.0%	20.0%	20.0%
12R	24.0%	0.0%	0.0%
30L	35.0%	0.0%	0.0%
Arrivals (Long Term Future)			
12L	3.0%	24.0%	24.0%
30R	7.0%	56.0%	56.0%
12C	5.0%	6.0%	6.0%
30C	15.0%	14.0%	14.0%
12R	21.0%	0.0%	0.0%
30L	49.0%	0.0%	0.0%
Departures (Long Term Future)			
12L	3.0%	24.0%	24.0%
30R	7.0%	56.0%	56.0%
12C	5.0%	6.0%	6.0%
30C	15.0%	14.0%	14.0%
12R	21.0%	0.0%	0.0%
30L	49.0%	0.0%	0.0%
Touch-And-Go's (Long Term Future)			
12L	3.0%	25.0%	25.0%
30R	7.0%	60.0%	60.0%

12C	5.0%	5.0%	5.0%
30C	15.0%	10.0%	10.0%
12R	21.0%	0.0%	0.0%
30L	49.0%	0.0%	0.0%

tracks. The result is consolidated flight tracks describing the average corridors that lead to and from the Williams Gateway Airport.

For developing flight tracks for input into the INM, five days of radar flight track data, from April 23 and May 15-18, 1999, were used. Initially, the five days of radar data were to correspond with the noise monitoring period. However, it was learned after the noise monitoring was scheduled that the 161st Air Refueling unit that frequently trains at the airport was activated and sent overseas. Because these aircraft have been a source of complaint, it was deemed necessary to obtain radar flight track data of these operations to better understand how they operate at Williams Gateway Airport. A review of noise complaint data and landing reports indicated that KC-135 aircraft were operating April 23, 1999. The remaining flight track data corresponds with the noise monitoring period. **Exhibit 2F** depicts the five days of radar flight track data for Williams Gateway Airport.

As seen on **Exhibit 2F**, there are three areas were the radar flight track data is heavily concentrated: around Williams Gateway Airport; around Chandler Municipal Airport to the southwest; and Phoenix Sky Harbor activity to the northwest. Radar flight track data is concentrated on both sides of the parallel runways as well as a solid stream on the extended runway centerline to the southeast.

Exhibit 2G depicts the consolidated departure flight tracks developed for the aircraft for input into the INM. INM consolidated flight tracks are developed by piloting the centerline of a concentrated group of tracks and then dispersing the consolidated track into multiple sub-tracks that conform to the radar flight track data. The yellow, red, and green colored lines on **Exhibit 2G** are the radar track data. The wider blue lines represent the centerline or spine of each group of radar track data. The thinner blue lines are the sub-tracks from each track spine.

Arrival tracks at Williams Gateway Airport are generally concentrated on the runway centerline of each runway due to the precision needed to safely land an aircraft. However, the small general aviation aircraft are able to make shorter approaches to the airport. **Exhibit 2H** depicts the arrival stream and consolidated flight tracks at Williams Gateway Airport. Because Runway 30C has an instrument approach system, the arrival stream has a tighter concentration of aircraft on the extended runway centerline than the other runways.

Touch-and-go activity is done by all aircraft types at Williams Gateway Airport. Generally, larger turbojet aircraft flown by the commercial airlines and military operate in a much larger touch-and-go pattern than the smaller general aviation aircraft due to the operational capabilities of each aircraft type. In addition, large turbojet aircraft tend to practice instrument landings requiring a long stable approach to the runway end. General aviation aircraft are generally concentrated near the airport in an oval-shaped pattern on either side of the airport. **Exhibit 2J** depicts the radar and INM consolidated touch-and-go flight tracks at Williams Gateway Airport.

The magenta flight track on **Exhibit 2J** depicts the F-16 maneuver previously discussed. This track provides a long stable approach from the southeast, two 360-degree turns and a departure route away from Williams Gateway for the F-16 maneuver.

The radar flight track data was taken during a period when Runway 12L-30R was closed. It was assumed that Runway 12L-30R would operate similar to Runway 12C-30C for future scenarios.

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 Williams Gateway Airport were evaluated.

The radar flight track data was used to determine flight track percentages for each aircraft type. The radar flight tracks that formed the consolidated tracks and sub-tracks were first counted. Then each consolidated track was then assigned a percentage based on the total number of tracks for each runway.

To determine the specific number of aircraft assigned to any one flight track, a long series of calculations was performed. This included a number of specific aircraft of one group factored by runway utilization and flight track percentage.

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 60 DNL noise contour is also mapped in this study as a guideline for future noise abatement and land use planning. This is consistent with previous noise studies at Williams Gateway. This section presents the results of the contour analysis for current and forecast noise exposure conditions, as developed from the Integrated Noise Model.

1999 NOISE EXPOSURE CONTOURS

Exhibit 2K presents the plotted results of the INM contour analysis for 1999 conditions using input data described in the preceding pages. The areas within each contour are presented in **Table 2G**.

The shape and extent of the contours reflect the underlying flight track assumptions. The outermost noise contour represents the 60 DNL. The 60 DNL contour is asymmetrical off the ends of the runway reflecting the uneven distribution of traffic to the northwest and southeast. The long slender shape of the contour to the southeast reflects the dominance of arrivals to Runways 30 L/C/R. The bulges in the contours to the northwest reflect the departure turns. The next contour is the 65 DNL contour, and it also is influenced by runway use and flight tracks. The inner noise contours from 70 DNL to 75 DNL generally encompass the parallel runway system.

The 60 DNL contour extends about 8,000 feet from the airport property over Warner Road to the north. To the south the 60 DNL contour extends about 11,000 feet away from airport property. The western edge of the contour parallels the runways and covers small portions of the Williams Campus. The eastern side of the contour remains on airport property.

The 65 DNL noise contour is smaller and similar in general shape to the 60 DNL contour to the north. To the north, the 65 DNL contour extends 3,000 feet from the airport property, just short of Power Road. On the south side, the 65 DNL contour extends about 5,000 feet south of the airport property to just short of Germann Road. The east and west edges of the contour remain on airport property.

The 70 and 75 DNL noise contours remain close to the runway. The 70 DNL contour has a small extension along the extended runway centerline off airport property to the north and south. The 75 DNL contour remains on airport property.

2004 NOISE EXPOSURE CONTOURS

The 2004 noise contours represent the estimated noise conditions based on the forecasts of future operations with Runway 12L-30R open. This analysis provides a near-future baseline which can subsequently be used to judge the effectiveness of proposed noise abatement procedures. **Exhibit 2L** presents the plotted results of the INM contour analysis for 2004 conditions using input data that has been described in the preceding pages.

Generally the 2004 noise contours are similar in shape to their 1999 counterparts. This is due to the use of similar modeling input assumptions for the consistency of the baseline case. The contours are slightly wider and more elongated than the 1999 contours due to the reopening of Runway 12L-30R and forecast increase in operations.

The surface areas of the 2004 noise exposure are presented for comparison in **Table 2G**.

2020 NOISE EXPOSURE CONTOURS

The 2020 noise contours represent the estimated noise conditions based on the forecasts of future operations. Runway use percentages, depicted on **Table 2F** on page 2-15, were adjusted to reflect the planned development of terminal facilities on the east side of the airport. The analysis provides 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 2M** presents the plotted results of the INM contour analysis for 2020 conditions using input data described in the preceding pages.

The 2020 noise contours are similar to the 2004 noise contours. The increase in turbojet activity on Runway 12L-30R creates more of a spike shape to the 60 and 65 DNL contours to the southeast. This activity also pushes the noise contours further east toward the General Motors proving grounds. The contours extend off the extended runway centerline slightly more than the 1999 and 2004 noise contours.

TABLE 2G
Comparative Areas Of Noise Exposure
Williams Gateway Airport

	Area In Square Miles		

DNL Contour	1999	2004	2020
60	6.8	7.7	7.8
65	3.7	4.4	4.2
70	2.1	2.7	2.5
75	1.1	1.5	1.2

COMPARATIVE MEASUREMENT ANALYSIS

A comparison of the measured versus the computer-predicted cumulative DNL noise values for each measurement site has been developed. 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.

DNL Comparison

This analysis provides a direct comparison of the measured and predicted average daily DNL values for each 72-hour, 48-hour, and 24-hour noise measurement site. 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. The flow tended to vary throughout the day during the program. Consequently, in order to evaluate the INM based on this field data, it is reasonable to look at the average annual noise contours developed as a requirement of F.A.R. Part 150.

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 2H**.

For the most part, the measurements reflect the predicted sound levels in the area surrounding the airport. As seen in **Table 2H**, in all but one case the predicted sound levels fall within the three to four decibel deviation. Measured values at Site A were below the INM predicted values ranging from 6.4 to 11.6 DNL. As previously discussed, Site A is located on the extended runway centerline northwest of the airport and is likely to see low overflights from aircraft on approach. However, due to the reduced level of military training during the monitoring period, the measured noise levels in this area are less than predicted.

TABLE 2H
Noise Measurement vs. Predicted DNL Values

	Site #A Day 1	Site #A Day 2	Site #A Day 3	Site #B Day 1	Site #B Day 2	Site #C Day 1	Site #D Day 1
INM-Predicted Values	56.6	56.6	56.6	54.1	54.1	53.3	53.5
Measured Values	45.0	48.2	50.2	51.7	51.7	54.2	53.1
Difference	+11.6	+8.4	+6.4	+2.5	+2.5	-0.9	+0.2

Source: Coffman Associates Analysis

It must be recognized that field measurements made over a one to three-day period are applicable only to that period of time and may not -- in fact, in many cases, do not -- reflect the average conditions at the site over a much longer period of time. The relationship between field measure-ments and computer-generated noise exposure forecasts is analogous to the relationship between weather and climate. The computer-modeled contours represent noise levels on an average day of the year. In contrast, the measurements reflect only the noise levels present at the time of measurement. In other words, the modeling process derives overall average annual conditions (climate), while field measurements reflect daily fluctuations (weather).

SUMMARY

The information presented in this chapter defines the noise patterns for current and future aircraft activity, without additional abatement measures, at Williams Gateway Airport. It does not, however, make an attempt to evaluate or otherwise include that activity over which the airport has no control -- such as other aircraft transiting the area and not stopping at the airport.

The current contours are based on an average day's activity for the June 1998 to May 1999 operational period and are presented as the 1999 noise exposure contours. The 2004 and 2020 forecasts of noise exposure levels around the airport can be expected to increase slightly as the airport becomes busier in the future. In the long-term (20-year) future, the noise exposure is expected to have a wider dispersion with the shift of a majority of the larger turbojet activity to Runway 12L-30R.

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.