AIR INSTALLATION COMPATIBLE USE ZONE STUDY

KEESLER AIR FORCE BASE, MISSISSIPPI

MAY 2010

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LIST OF ACRONYMS

45 AS	45th Airlift Squadron
53 WRS	53rd Weather Reconnaissance Squadron
81 TRW	81st Training Wing
403 WG	403rd Wing
815 AS	815th Airlift Squadron
AFB	Air Force Base
AFI	Air Force Instruction
AGL	above ground level
AICUZ	Air Installation Compatible Use Zone
AS	Airlift Squadron
APZ	accident potential zone
cps	cycles per second
CZ	clear zone
dB	decibel
dBA	A-weighted sound level measured in decibels
DNL	Day-Night Average A-weighted Sound Level
DoD	Department of Defense
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
HUD	Housing and Urban Development
Hz	Hertz
INM	Integrated Noise Model
MSA	Metropolitan Statistical Area
NLR	Noise Level Reduction
SEL	Sound Exposure Level
SLUCM	Standard Land Use Coding Manual
the Base	Keesler Air Force Base
UCLA	University of California at Los Angeles
UFC 3-260-01	Unified Facilities Criteria 3-260-01, *Airfield and Heliport Planning and Design*
U.S.	United States
UFC	Unified Facilities Criteria
USEPA	United States Environmental Protection Agency

SECTION 1
PURPOSE AND NEED

1.1 INTRODUCTION

This study is an update of the 1994 Keesler Air Force Base (AFB), Mississippi, Air Installation Compatible Use Zone (AICUZ) Study. The update presents and documents changes to the AICUZ amendment for the period 1995-2009 and is based on aircraft operations at Keesler AFB as of July 2009. This AICUZ Study is part of the United States (U.S.) Air Force's AICUZ Program (described below), and reaffirms Air Force policy of assisting local, regional, state, and federal officials in the areas neighboring Keesler AFB (the Base) by promoting compatible development within the AICUZ area of influence; and protecting Air Force operational capability from the effects of land use incompatible with aircraft operations. Specifically, the report documents changes in aircraft operations since the last study and provides noise contours and compatible use guidelines for land areas neighboring Keesler AFB based on July 2009 operations. This information is provided to assist local communities and to serve as a tool for future planning and zoning activities. Changes that have occurred at Keesler AFB since the 1994 AICUZ Study include:

- The conversion to the C-130J aircraft and the addition of associated operations by the 403rd Wing (403 WG);
- The elimination of the C-130H aircraft and related operations by the 403 WG;
- The elimination of C-12 operations by the 81st Training Wing (81 TRW);
- An increase in the number of based C-21 and C-130 aircraft operations;
- The addition, elimination, and modification of aircraft flight tracks to correspond with changes in flying operations; and
- Technical improvements to the NOISEMAP computer modeling program.

1.2 PURPOSE AND NEED

The purpose of the long-standing AICUZ Program is to promote compatible land development in areas subject to aircraft noise and accident potential. As the nearby Cities of Biloxi and D'Iberville and Harrison County prepare and modify land use development plans, recommendations from this updated AICUZ Study should be included in the planning process to prevent incompatible land use that could compromise the ability of Keesler AFB to fulfill its mission. Accident potential and aircraft noise should be major considerations in the planning process.

Air Force AICUZ guidelines reflect land use recommendations for the clear zones (CZ), accident potential zones (APZ) I and II, and the four noise zones exposed to noise levels at or above 65 decibels (dB) Day-Night Average A-Weighted Sound Level (DNL). These guidelines were established on the basis of studies prepared and sponsored by several federal agencies, including the United States Department of Housing and Urban Development (HUD), United States Environmental Protection Agency (USEPA), U.S. Air Force, and state and local agencies. The guidelines recommend land uses that are compatible with airfield

operations while allowing maximum beneficial use of adjacent properties. The Air Force has no desire to recommend land use regulations that render property economically useless. It does, however, have an obligation to the inhabitants of the Keesler AFB area of influence and the citizens of the U.S. to point out ways to protect the public investment in the installation and the people living in areas adjacent to the installation. The AICUZ area of influence includes the area within the DNL 65 dB and greater noise exposure area and the area within the CZs and APZs.

1.3 PROCESS, PROCEDURE, AND NOISE METRICS

Preparation and presentation of this Keesler AFB AICUZ Study are part of the continuing Air Force participation in the local planning process. Guidance for the Air Force AICUZ Program is contained in Air Force Instruction (AFI) 32-7063, *Air Installation Compatible Use Zone Program*, which implements DoD Instruction 4165.57, *Air Installations Compatible Use Zones*. This AICUZ Study is accompanied by a Citizen's Brochure, which is a separate document that summarizes the Study.

As local communities prepare land use plans and zoning ordinances, the Air Force recognizes it has the responsibility to provide input on its activities relating to the community. This study is presented in the spirit of mutual cooperation and assistance by Keesler AFB to assist in the planning process for land use around the Base.

The AICUZ program uses the latest technology to define noise levels in areas near Air Force installations with a flying mission. Aircraft operational data used in this study were collected at Keesler AFB in July 2009. The Air Force reviewed and validated as accurate and current the data in November 2009. Aircraft flight data were obtained to derive average daily operations by runway and type of aircraft. Analysis of Keesler AFB's flying operations included the types of aircraft, flight patterns utilized, variations in altitude, power settings, number of operations, and hours of operations. These data were supplemented by flight track information (where we fly), flight profile information (how we fly), and ground runup information (both pre-flight and aircraft maintenance engine runups). After verification for accuracy, the data were input into the NOISEMAP computer program (Version 7.32) to produce DNL noise contours that represent aircraft operational conditions at Keesler AFB in July 2009. The resulting noise contours were then plotted on an area map and overlaid with the CZ and APZ areas for the airfield. Thereafter, NOISEMAP was again utilized to generate the land use data calculations reflected in this AICUZ Study. Note that the NOISEMAP model has been refined over time and Version 7.32 was the most current version of the model available at the time of the study.

1.4 COMPUTERIZED NOISE EXPOSURE MODELS

The Air Force adopted the NOISEMAP computer program to describe noise impacts created by aircraft operations. NOISEMAP is one of two USEPA-approved computer programs; the other is the Integrated Noise Model (INM) used by the Federal Aviation Administration (FAA) for noise analysis at civil airports. The NOISEMAP and INM programs are similar; however, NOISEMAP is specifically designed to model aircraft noise operations at military airfields.

NOISEMAP is a suite of computer programs and components developed by the Air Force to predict noise exposure in the vicinity of an airfield due to aircraft flight and ground runup operations. The components of NOISEMAP are:

- BASEOPS is the input module for NOISEMAP and is used to enter detailed aircraft flight track and profile and ground maintenance operational data.
- NOISEFILE is a comprehensive dataBase of measured military and civil aircraft noise data. Aircraft operational information is matched with the noise measurements in the NOISEFILE after the detailed aircraft flight and ground maintenance operational data have been entered into BASEOPS.
- NMAP is the computational module in NOISEMAP. NMAP takes BASEOPS input and uses the NOISEFILE database to calculate noise levels caused by aircraft events at specified grid points in the airbase vicinity. The output of NMAP is a series of georeferenced data points, specific grid point locations, and corresponding noise levels.
- NMPLOT is the program for viewing and editing the sets of georeferenced data points. NMPLOT plots the NMAP output in a noise contour grid that can be exported as files that can be used in mapping programs for analyzing the noise impacts.

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SECTION 2
INSTALLATION DESCRIPTION

2.1 DESCRIPTION OF KEESLER AIR FORCE BASE

Keesler AFB is located in the center of the City of Biloxi in Harrison County in southern Mississippi. The Base is on approximately 3,554 acres of land (see Figure 2-1). Keesler AFB has one runway.

2.2 MISSION

The 81 TRW, the host unit at Keesler AFB and which reports to the Second Air Force at Keesler AFB, has the Air Force's largest Technical Training Group, and is the Air Force's computer and electronics training "Center of Excellence." The wing trains more than 40,000 students annually. Training includes weather, basic electronics, communications electronic systems, communications computer systems, air traffic control, airfield management, command post, air weapons control, precision measurement, education and training, financial management and comptroller, information management, manpower and personnel. Keesler AFB also provides advanced training for doctors, nurses, and technicians in medical specialties.

The 45th Airlift Squadron (45 AS) is a tenant unit and accomplishes advanced training for pilots in the C-21 aircraft. The Air Force Reserve Command's 403 WG is a tenant unit at Keesler AFB and its two flying units (53rd Weather Reconnaissance Squadron's [53 WRS] and 815th Airlift Squadron [815 AS]) fly the C-130 aircraft.

2.3 ECONOMIC IMPACT

The Economic Impact Region for Keesler AFB is the geographic area subject to significant base-generated economic impacts, and is generally defined as the area within a 50-mile radius of the Base. This area comprises the Gulfport-Biloxi Metropolitan Statistical Area (MSA), which includes Harrison, Hancock, and Stone counties. The cities of Biloxi and D'Iberville are both located in Harrison County.

2.3.1 Local Economic Characteristics

As shown in Table 2-1, the Gulfport-Biloxi MSA had an estimated population of approximately 236,000 persons in 2008, a decrease of over 10,000 from 2000. The MSA was severely impacted by Hurricane Katrina in August 2005, resulting in extensive property destruction and an out-migration of people. Prior to the hurricane, the area had experienced steady to moderate population growth. Table 2-1 also presents the population for Harrison County, and the Cities of Biloxi and D'Iberville. Biloxi, specifically, suffered severe property damage and destruction, resulting in an initial significant loss in population from out-migration following Hurricane Katrina. However, many of the former residents have returned and Biloxi, and the Gulfport-Biloxi MSA is expected to increase in population in the future as a result of new development/redevelopment and resulting employment opportunities.

Table 2-1 Historic and Current Population

Area	1990	2000	2008 (est.)
Gulfport-Biloxi MSA	NA	246,190	235,763
Harrison County	165,365	189,601	178,460
Biloxi	46,319	50,644	45,670
D'Iberville	6,566	7,608	7,928

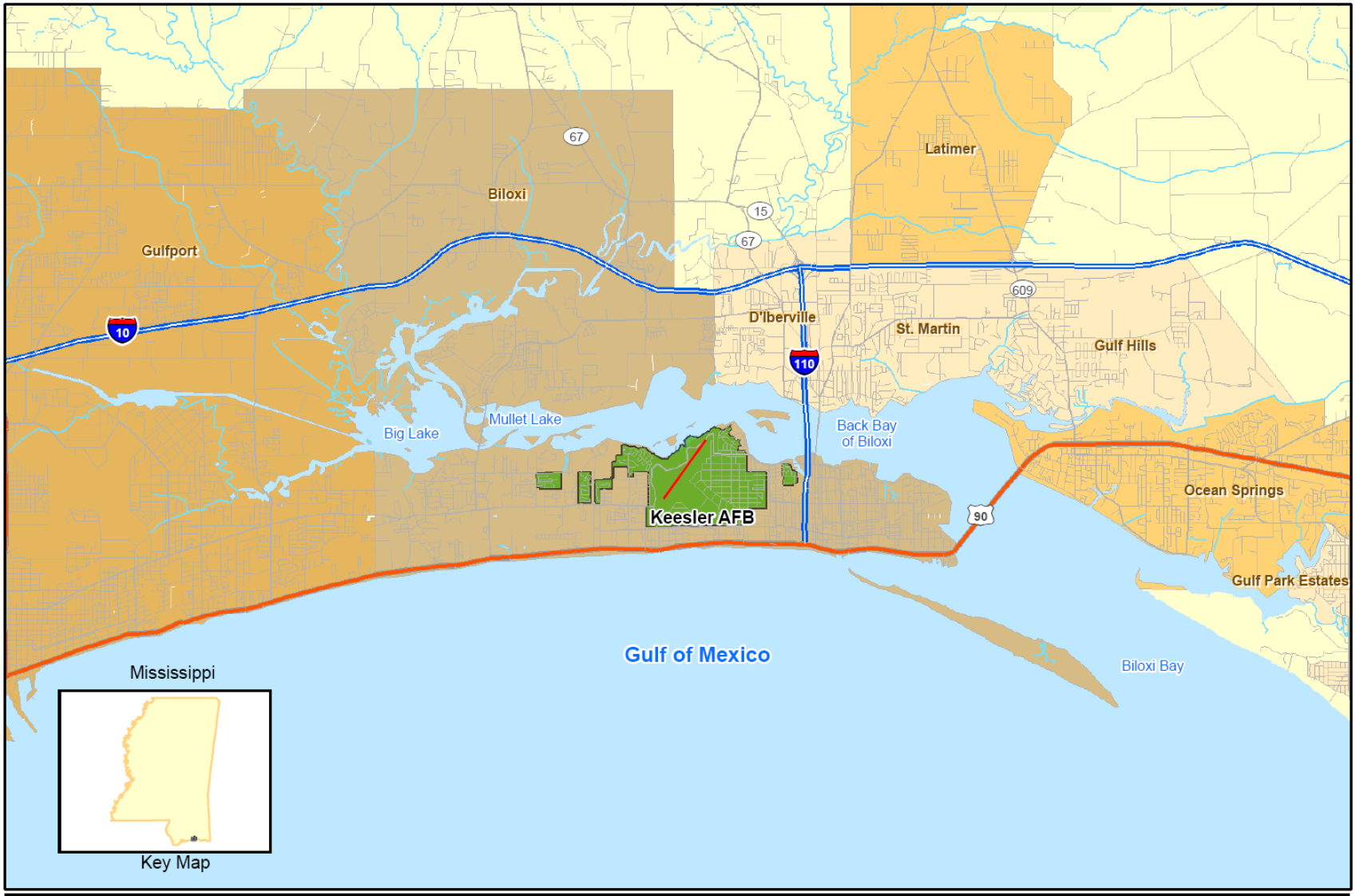
Source: U.S. Census Bureau, Population Estimates Program, December 2008.

Total non-farm employment in Harrison County was estimated to be nearly 122,000 persons in 2007, a decrease of approximately 4,000 from 2004 as a result of property destruction and associated loss of employment caused by Hurricane Katrina. Table 2-2 shows the distribution of non-farm employment in Harrison County by industry group in 2007. The Government/Government Enterprises and Accommodations and Food Services sectors (gaming, lodging accommodations/food services) comprise almost 40 percent of employment in the county, with retail trade also being a major employment sector. Keesler AFB and the gaming industry are the major employers in the county. The November 2009 unemployment rate in Harrison County was 7.7 percent.

Table 2-2 Harrison County Full-and-Part-Time Non-Farm Employment by North American Industry Classification System, 2007

Industry	Employees
Government/Government Enterprises	28,279
Accommodations and Food Services	18,121
Retail Trade	13,696
Construction	10,368
Health Care	8,103
Administrative and Waste Services	7,639
Other Services (except Public Administration)	5,828
Manufacturing	4,878
Real Estate	4,435
Professional, Scientific, Administrative & Technical Services	4,167
Arts, Entertainment, & Recreation	3,562
Finance & Insurance	3,267
Transportation & Warehousing	3,053
Wholesale Trade	2,106
Information	1,412
Utilities	948
Education	878
Management of Companies	699
Forestry, Fishing, and Agriculture Support	484
Total	**121,923**

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Accounts, 2008.



Keesler Air Force Base 2010 AICUZ

Legend

- Interstate
- Highway
- Runway
- Keesler Air Force Base

0 0.5 1 2 Miles

N

Figure 2-1

Location Map

Keesler Air Force Base
Biloxi, MS

2.3.2 Base Impact

The geographic area subject to significant Base-generated economic impacts is defined as the area within a 50-mile radius of Keesler AFB. As shown in Table 2-3, Keesler AFB directly employs almost 11,000 military and civilian personnel. In addition, 3,700 civilian jobs are created indirectly off-Base in support of Keesler AFB. The annual payroll of the installation is over $351 million (Table 2-4), while purchasing costs for contractors and vendors exceeds $107 million. As a result of payroll expenditures, annual expenses, and the estimated value of indirect jobs in the local area, Keesler AFB has an estimated annual economic impact of over $589 million. The majority of this economic impact is attributed to the payroll and contracts provided by the installation.

Table 2-3 Personnel by Classification, Keesler AFB

Classification	Total
Active Duty Military/Student Personnel	7,365
Total Military	**7,365**
Civil Service	1,591
Non-Tax Funded Civilian	447
Contract Civilians	823
Base Exchange Employees	222
Other	400
Total Civilian Personnel	**3.483**
Grand Total	**10,848**

Source: Keesler AFB Fact Sheet, FY 2008.

Table 2-4 Annual Payroll, Keesler AFB

Category	($)
Total Annual Payroll	$351,549,507
Annual Expenses for Construction Services and Procurement	$107,264,169
Estimated Value of Indirect Jobs Created	$130,197,479
Total	**$589,011,155**

Source: Keesler AFB Fact Sheet, FY2008.

SECTION 3
AIRCRAFT OPERATIONS

3.1 INTRODUCTION

To describe the relationship between aircraft operations and land use at and around the airfield, it is necessary to fully evaluate the exact nature of flying activities. The July 2009 inventory of Keesler AFB aircraft operations included where aircraft fly, how high they fly, how many times they fly over a given area, and the time of day they operate.

Subsection 3.2 discusses aircraft operations at Keesler AFB. Subsection 3.3 discusses runway and flight track utilization for all operations by aircraft type. Subsection 3.4 describes aircraft maintenance activity. Subsection 3.5 discusses aircraft flight profiles, and Subsection 3.6 presents climatological data.

3.2 AIRCRAFT OPERATIONS

An aircraft operation is defined as one takeoff/departure, one approach/landing, or half a closed pattern. A closed pattern consists of two portions, a takeoff/departure and an approach/landing, i.e., two operations. A sortie is a single military aircraft flight from the initial takeoff through the termination landing. The minimum number of aircraft operations for one sortie is two operations, one takeoff/departure and one approach/landing.

Table 3-1 summarizes the projected average busy day aircraft operations for Keesler AFB based on information provided by Base staff, flying organizations, and air traffic control personnel. Aircraft types operating at the Base consist of military aircraft. In addition to the aircraft based at Keesler AFB, numerous types of transient military aircraft conduct operations at the Base. Seven transient military and civilian aircraft were selected to represent the numerous types of aircraft that operate at Keesler AFB for noise modeling purposes, with selection preference based on the uniqueness of a particular aircraft or those with the greatest number of operations. Operations for the transient military and civilian aircraft types were combined with the selected aircraft based on similar characteristics (*e.g.*, number and type of engines, size of aircraft, airspeed, *etc*.). Table 3-1 reflects a total of approximately 71 average busy day aircraft operations based on collected operations data. About two percent of the total daily operations occur at night (2200 hours – 0700 hours).

Table 3-1 Average Busy Day Aircraft Operations for 2009

Category/ Aircraft Type	Daily Arrival/ Departure Operations	Daily Closed Pattern Operations	Total Daily Operations
Keesler AFB Aircraft			
C-21 (45 AS)	10.80	0.48	11.28
C-130 (53 WRS)	7.11	22.79	29.90
C-130 (815 AS)	18.00	8.00	26.00
Subtotal	**35.91**	**31.27**	**67.18**
Transient Aircraft			
C-12	0.26	0.00	0.26
C-130	0.20	0.00	0.20
C-21	0.24	0.00	0.24
Single Engine Piston	0.13	0.00	0.13
Twin Engine Turboprop	0.39	0.59	0.98
T-6	0.33	0.09	0.42
UH-60	0.38	1.56	1.94
Subtotal	**1.93**	**2.24**	**4.17**
Total	**37.84**	**33.51**	**71.35**

Note: An operation is one takeoff/departure or one arrival/landing. A closed pattern consists of two operations, one takeoff and one landing.

Although the number of military and civil aircraft operations at an installation usually varies from day to day, NOISEMAP requires input of the specific numbers of daily flight and aircraft maintenance engine runup operations. The Air Force does not follow the FAA's use of the "average annual day" in which annual operations are averaged over an entire 365-day year. Neither does the Air Force use the "worst-case day" since it typically does not represent the typical noise exposure. Instead, the Air Force uses the "average busy day" concept in which annual operations for an aircraft type are averaged over the number of flying days per year by that aircraft type. Non-flying days (*e.g.*, weekends or holidays) are not used in computing the "average busy day" operations. Flying activity occurs at Keesler AFB 365 days per year for transient aircraft, 230 days per year for 45 AS C-21, 208 days per year for 53 WRS C-130 aircraft, and 260 days for 815 AS C-130s.

3.3 RUNWAY AND FLIGHT TRACK UTILIZATION

Runway 03/21 (7,630 feet long and 150 feet wide) is oriented 033°–213°. The airfield elevation is 33 feet above mean sea level. Due to displaced thresholds at each end of the runway, Runways 03 and 21, respectively, have 6,031 feet and 6,630 feet available for landing. Aircrews will not land prior to the displaced runway threshold. However, the opposite end displaced threshold is available for landing rollout. Portions of the runway prior to the displaced thresholds can be used for takeoff roll; however, the area past the opposite threshold will not be use for takeoff. The effective runway length for touch-and-go operations is 5,031 feet.

Aircraft operating at Keesler AFB use the following flight patterns:

- Straight-out departure;
- Straight-in approach;
- Precision and non-precision instrument approaches;

- Overhead traffic patterns at about 1,500 feet above ground level (AGL), 2,000 feet AGL for Keesler AFB C-21s and fighter-type aircraft;
- Rectangular traffic patterns at 1,000 feet AGL, 1,500 feet AGL for Keesler AFB C-21 aircraft; and,
- Beam approaches in which the aircraft perpendicularly crosses the runway at 500 feet AGL and maneuvers to land.

Flight patterns specific to Keesler AFB result from several considerations, including:

- Takeoff patterns routed to avoid noise-sensitive areas as much as possible;
- Criteria governing the speed, rate of climb, and turning radius for each type of aircraft;
- Efforts to control and schedule missions to keep noise levels low, especially at night; and
- Coordination with the FAA to minimize conflict with civil aircraft operations.

Planning for areas surrounding an airfield considers three primary aircraft operational/ land use determinants: (1) aircraft accident potential to land users; (2) aircraft noise; and (3) hazards to operations from land uses (*e.g.*, height of structures). Each of these concerns is addressed in conjunction with mission requirements and safe aircraft operations to determine the optimum flight track for each aircraft type. The flight tracks depicted in Figures 3-1 through 3-3 are the result of such planning and depict the representative flight tracks used for noise modeling. The flight track locations represent the various types of arrivals, departures, and closed patterns accomplished at Keesler AFB. The location for each track is representative for the specific track and may vary due to air traffic control, weather, and other reasons (*e.g.*, one pilot may fly the track on one side of the depicted track, while another pilot may fly the track slightly to the other side). Runway 03 is used about 30 percent of the time while Runway 21 is used about 70 percent of the time.

3.4 AIRCRAFT MAINTENANCE RUNUP OPERATIONS

To the maximum extent possible, aircraft maintenance engine runup locations have been established in areas to minimize noise for people on base, as well as for those in surrounding communities. Aircraft maintenance engine runup operations are accomplished by based flying units and their associated maintenance functions.

Average busy day aircraft maintenance runup operations were calculated similarly to flight operations described in Subsection 3.1. Weekly, monthly, or annual estimates of runups provided by Keesler AFB aircraft maintenance personnel were divided by the typical number of days runups are performed over the respective period. Approximately 0.06 percent of the aircraft maintenance runups at Keesler AFB occur at night (2200 hours – 0700 hours).

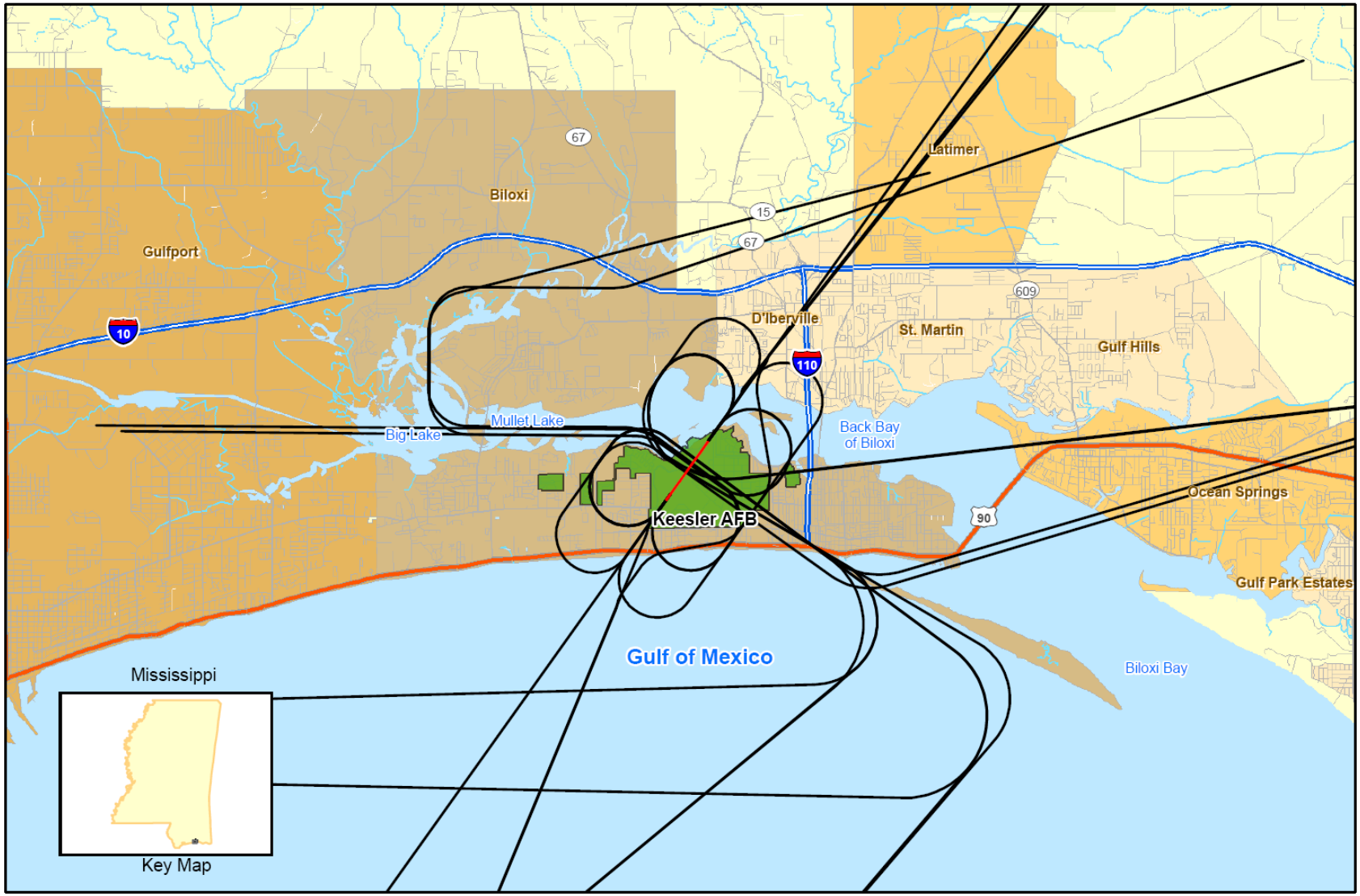
3.5 AIRCRAFT FLIGHT PROFILES

For purposes of this AICUZ Study, aircraft "flight profiles" denote the aircraft power settings, altitudes above runway level, and airspeeds along each flight track. Aircraft flight profiles for Keesler AFB C-21 and C-130 aircraft were obtained from Keesler AFB personnel.

Generic flight profiles from the BASEOPS database were used to model operations for the other military aircraft types. Noise data from the NOISEFILE database were used to model operations for all aircraft types.

3.6 CLIMATOLOGICAL DATA

Weather conditions, measured by temperature and relative humidity, are an important factor in the propagation of noise. The average temperature and humidity for each month of the year are input into BASEOPS, which then calculates the sound absorption coefficient for each month. Ranking the twelve monthly sound absorption coefficients from smallest to largest, BASEOPS chooses the sixth smallest sound absorption coefficient to represent the typical weather conditions at the Base. The month with the sixth smallest sound absorption coefficient for Keesler AFB is the month with an average monthly temperature of 68 degrees Fahrenheit and 75 percent relative humidity.



Keesler Air Force Base 2010 AICUZ

Legend

- Interstate
- Highway
- Runway
- Flight Tracks
- Keesler Air Force Base

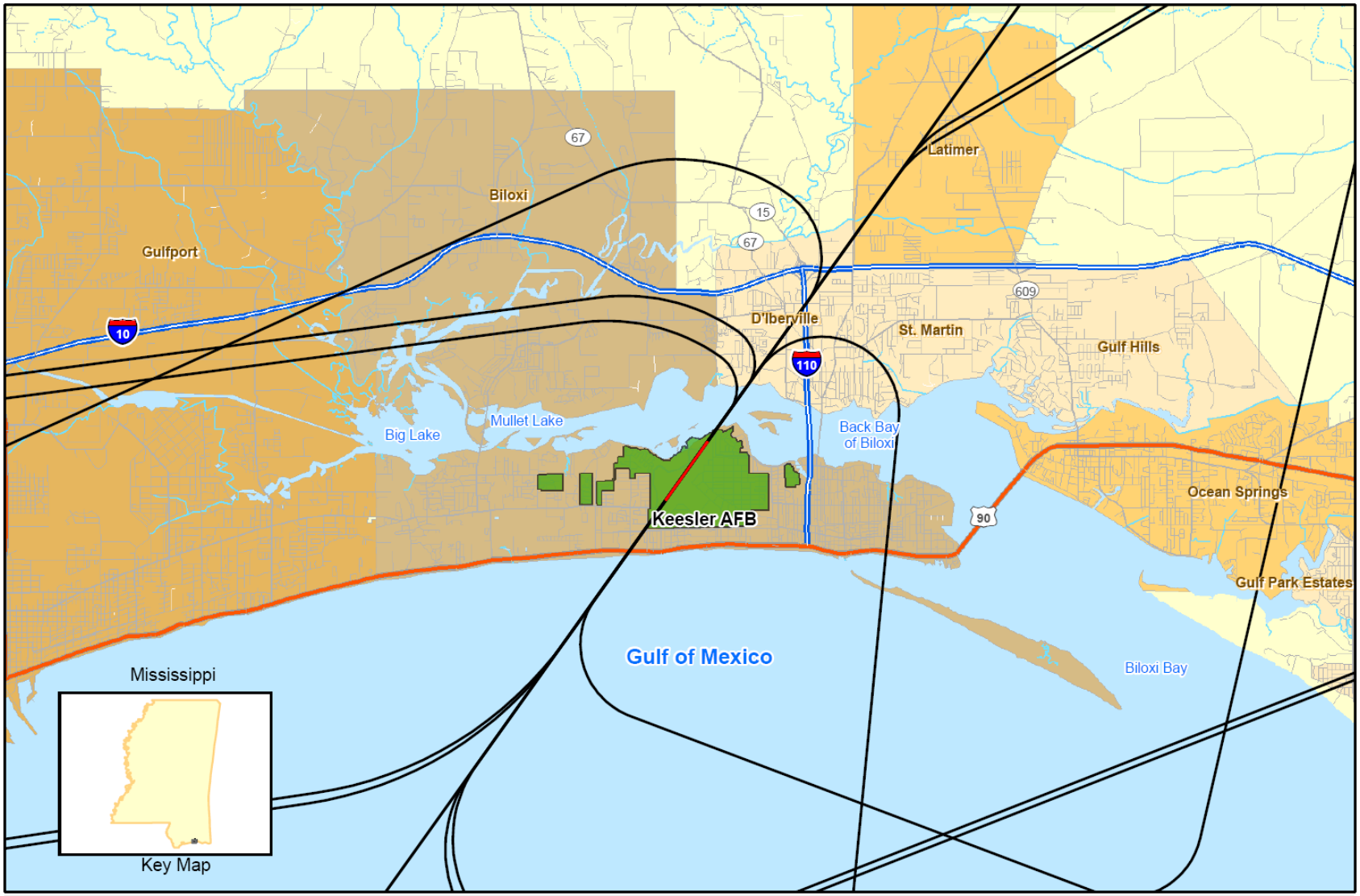
0 0.5 1 2 Miles

N

Figure 3-1

Arrival Flight Tracks

Keesler Air Force Base
Biloxi, MS



Keesler Air Force Base 2010 AICUZ

Legend

- Interstate
- Highway
- Runway
- Flight Tracks
- Keesler Air Force Base

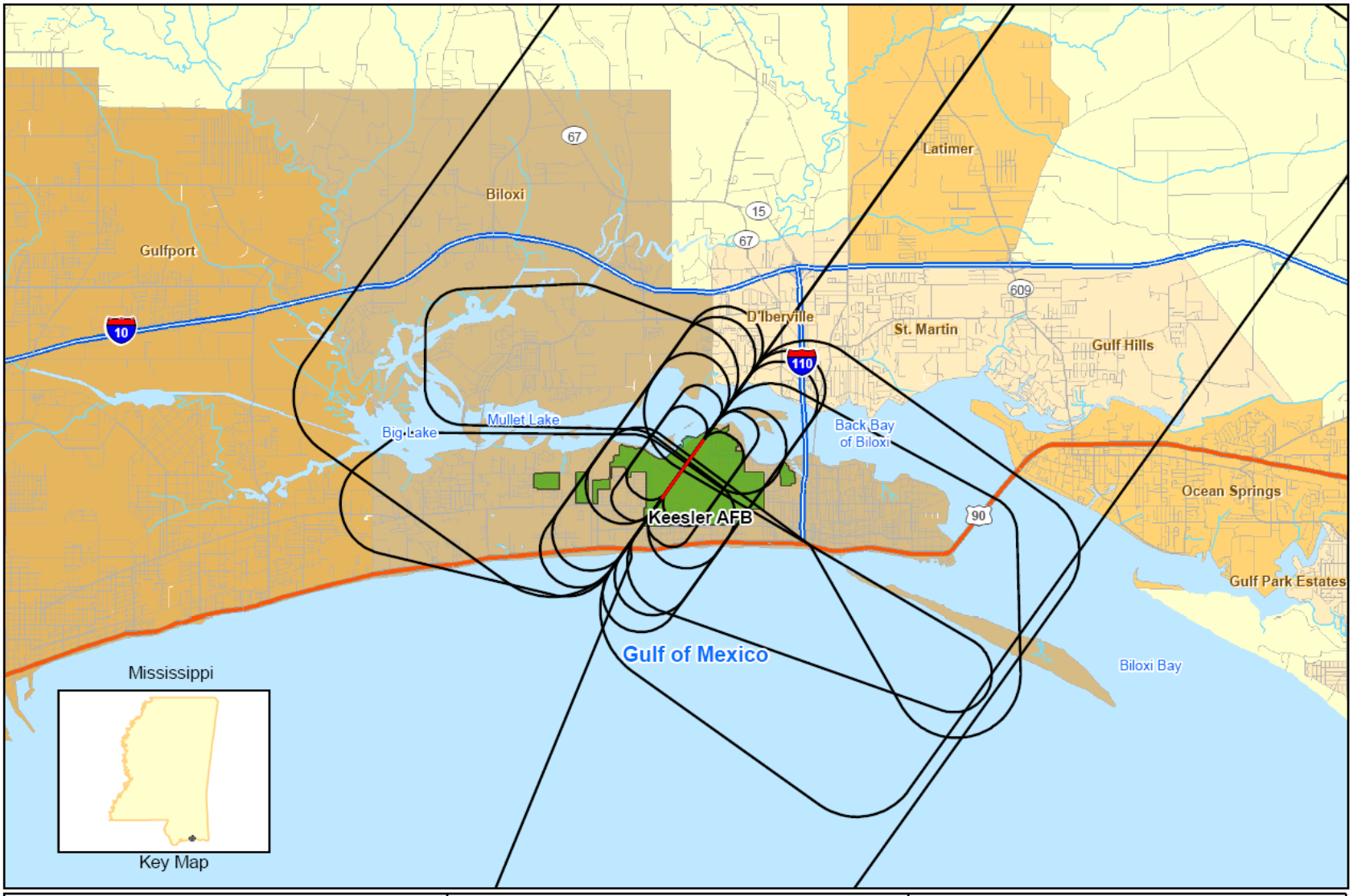
0 0.5 1 2 Miles

N

Figure 3-2

Departure Flight Tracks

Keesler Air Force Base
Biloxi, MS



Keesler Air Force Base 2010 AICUZ

Legend
- Interstate
- Highway
- Runway
- Flight Tracks
- Keesler Air Force Base

0 0.5 1 2 Miles

N

Figure 3-3

Closed Pattern Flight Tracks

Keesler Air Force Base
Biloxi, MS

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SECTION 4
EFFECTS OF AIRCRAFT OPERATIONS

4.1 INTRODUCTION

This section has two purposes:

- Describe the imaginary surfaces associated with obstructions to air navigation, noise exposure, CZs, and APZs; and,
- Present applicable land use compatibility guidelines and the Air Force's participation in the land use planning process.

4.2 RUNWAY AND LANDING ZONE AIRSPACE IMAGINARY SURFACES

Obstructions to air navigation are considered to be:

- Natural objects or man-made structures that protrude above the planes or imaginary surfaces, and/or;
- Man-made objects that extend more than 500 feet AGL at the site of the structure.

4.2.1 Explanation of Terms

The following elevation, runway length, and dimensional criteria apply:

- Controlling Elevation - whenever surfaces or planes within the obstruction criteria overlap, the controlling (or governing) elevation becomes that of the lowest surface or plane.
- Runway Length - Keesler AFB has one Class B runway. Runway 03/21 is 7,630 feet long and 150 feet wide. Class B runways are designed and built for sustained heavy aircraft landings and takeoffs.
- Established Airfield Elevation - the established elevation for the Keesler AFB airfield is 33 feet above mean sea level.
- Dimensions - all dimensions are measured horizontally unless otherwise noted.

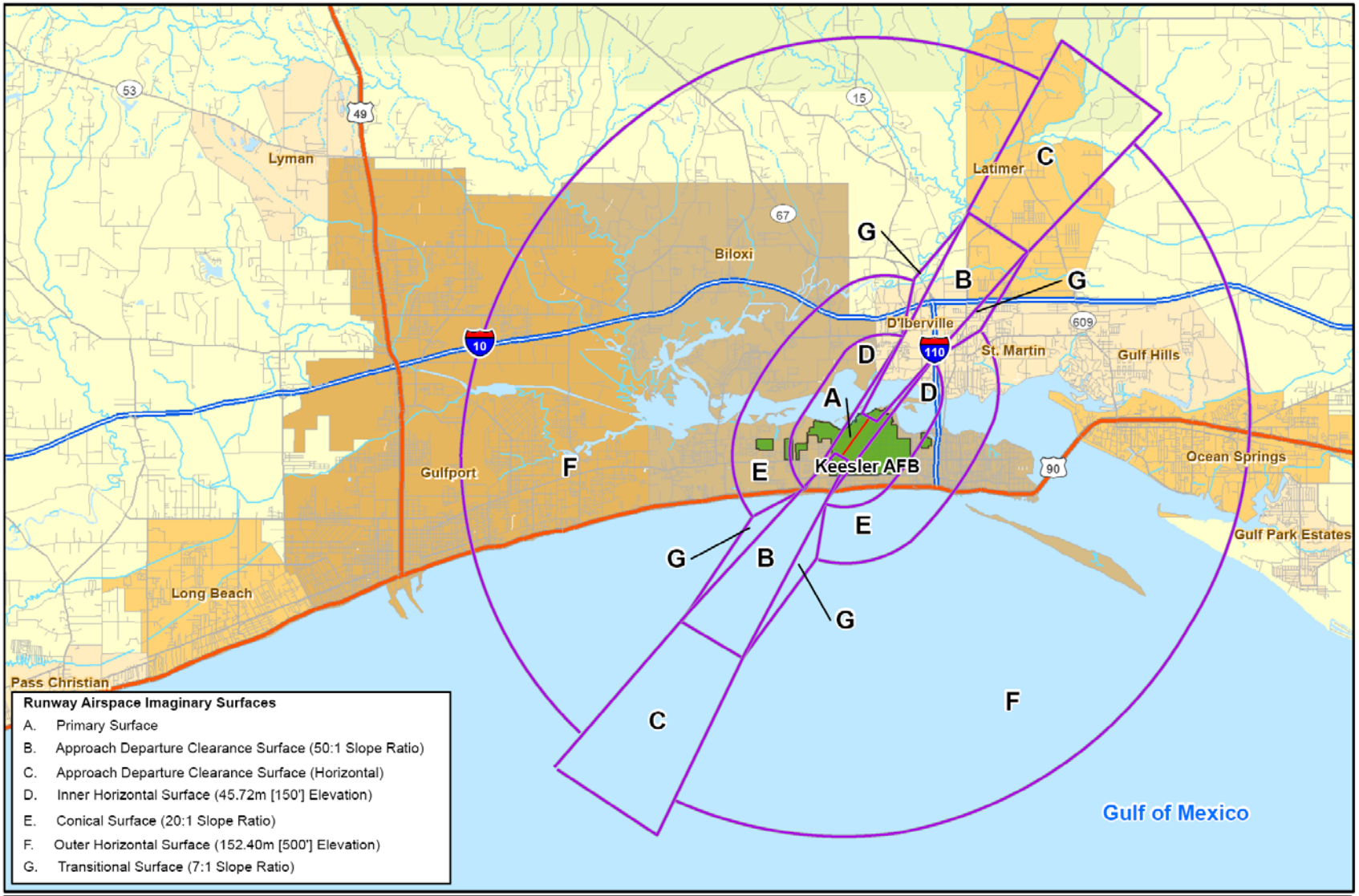
4.2.2 Runway Airspace Imaginary Surfaces

The area surrounding a runway that must be kept clear of objects that might damage an aircraft is bounded by imaginary surfaces that are defined in Unified Facilities Criteria (UFC) 3-260-01, *Airfield and Heliport Planning and Design*. An existing object (including a mobile object) is, and a future object would be, an obstruction to air navigation if it is higher than any of the heights or surfaces listed in UFC 3-260-01, which is based on the military airport imaginary surfaces in Federal Aviation Regulation (FAR) Part 77, *Objects Affecting Navigable Airspace*, Subpart C. Figure 4-1 depicts the runway airspace imaginary surfaces for the Keesler AFB Class B runway 03/21. The following paragraphs contain definitions of the runway airspace imaginary surfaces for Air Force Class B runways:

- Primary Surface - An imaginary surface symmetrically centered on the runway, extending 200 feet beyond each runway end that defines the limits of the obstruction

clearance requirements in the vicinity of the landing area. The width of the primary surface is 2,000 feet, or 1,000 feet on each side of the runway centerline.

- Clear Zone Surface - An obstruction-free surface (except for features essential for aircraft operations) on the ground symmetrically centered on the extended runway centerline beginning at the end of the runway and extending outward 3,000 feet. The CZ width is 3,000 feet (1,500 feet to either side of runway centerline).
- Accident Potential Zone Surfaces—APZ I begins at the outer end of the CZ and is 5,000 feet long and 3,000 feet wide. APZ II begins at the outer end of APZ I and is 7,000 feet long and 3,000 feet wide.
- Approach-Departure Clearance Surface - This imaginary surface is symmetrically centered on the extended runway centerline, beginning as an inclined plane (glide angle) 200 feet beyond each end of the primary surface, and extending for 50,000 feet. The slope of the approach-departure clearance surface is 50:1 until it reaches an elevation of 500 feet above the established airfield elevation. It then continues horizontally at this elevation to a point 50,000 feet from the starting point. The width of this surface at the runway end is 2,000 feet, flaring uniformly to a width of 16,000 feet at the end point.
- Inner Horizontal Surface - This imaginary surface is an oval plane at a height of 150 feet above the established airfield elevation. The inner boundary intersects with the approach-departure clearance surface and the transitional surface. The outer boundary is formed by scribing arcs with a radius 7,500 feet from the centerline of each runway end and interconnecting these arcs with tangents.
- Conical Surface - This is an inclined imaginary surface extending outward and upward from the outer periphery of the inner horizontal surface for a horizontal distance of 7,000 feet to a height of 500 feet above the established airfield elevation. The slope of the conical surface is 20:1. The conical surface connects the inner and outer horizontal surfaces.
- Outer Horizontal Surface - This imaginary surface is located 500 feet above the established airfield elevation and extends outward from the outer periphery of the conical surface for a horizontal distance of 30,000 feet.
- Transitional Surface - This imaginary surface extends outward and upward at right angles to the runway centerline and extended runway centerline at a slope of 7:1. The transitional surface connects the primary and the approach-departure clearance surfaces to the inner horizontal, the conical, and the outer horizontal surfaces.



Keesler Air Force Base 2010 AICUZ

Legend
- Interstate
- Highway
- Runway
- Keesler Air Force Base

0 1 2 4 Miles

N

Figure 4-1

Class B Air force Runway Airspace Imaginary Surfaces

Keesler Air Force Base Biloxi, MS

4.3 RESTRICTED AND/OR PROHIBITED LAND USES

The land areas outlined by these criteria should be regulated to prevent uses that might otherwise be hazardous to aircraft operations. The following uses should be restricted and/or prohibited:

Releases into the air of any substance that would impair visibility or otherwise interfere with the operation of aircraft (e.g., steam, dust, or smoke);

- Light emissions, either direct or indirect (reflective), that would interfere with pilot vision;
- Electrical emissions that would interfere with aircraft communications systems or navigational equipment;
- Uses that would attract birds or waterfowl, including but not limited to, operation of sanitary landfills, waste transfer facilities, maintenance of feeding stations, sand and gravel dredging operations, storm water retention ponds, created wetland areas, or the growing of certain vegetation; and
- Structures within 10 feet of aircraft approach-departure and/or transitional surfaces.

4.4 NOISE EXPOSURE

NOISEMAP Version 7.32 was used to calculate and plot the DNL noise contours based on the average busy day aircraft operations data described in Subsections 3.1 through 3.6. Figure 4-2 shows the 2010 noise contours. Figures 4-2 through 4-4 show the DNL noise contours plotted in 5 dB increments, ranging from DNL 65 dB to DNL at or above 80 dB.

Different sounds have different frequency content. When describing sound and its effect on a human population, A-weighted (dB) sound levels are typically used to account for the response of the human ear. The term "A-weighted" refers to a filtering of the sound signal to emphasize frequencies in the middle of the audible spectrum and to de-emphasize low and high frequencies in a manner corresponding to the way the human ear perceives sound. This filtering network has been established by the American National Standards Institute. The A-weighted noise level has been found to correlate well with people's judgments of the noisiness of different sounds, and has been in use for many years as a measure of community noise. Note that DNL represents noise levels averaged over a 24-hour period, not a single event noise.

Table 4-1 shows the off-DoD property noise exposure within the DNL 65 dB and greater noise exposure area for aircraft operations at Keesler AFB in terms of acreage and estimated affected population. The population data used in preparing this estimate was obtained from the U.S. Census Bureau's 2000 census. To estimate affected population, it was assumed that population was equally distributed within a census tract area. Using this assumption, the total acreage and population in each census tract surrounding Keesler AFB was collected and assessed. Using the noise contour information, the number of acres of land in each noise zone (*i.e.*, DNL 65-69 dB, 70-74 dB, 75-79 dB, and 80 dB and greater) was divided by the number of acres of land in each census tract to determine what portion of the census tract was contained within each noise zone. To determine population, the population total in each block-group was then multiplied by this ratio to estimate affected population. From

Table 4-1, a total of 12 acres and 58 persons occur in the off-DoD property area within the DNL 65 dB and greater noise exposure area.

Table 4-1 Area and Population Within DNL 65 dB and Greater Noise Exposure Area (Off-DoD Property)

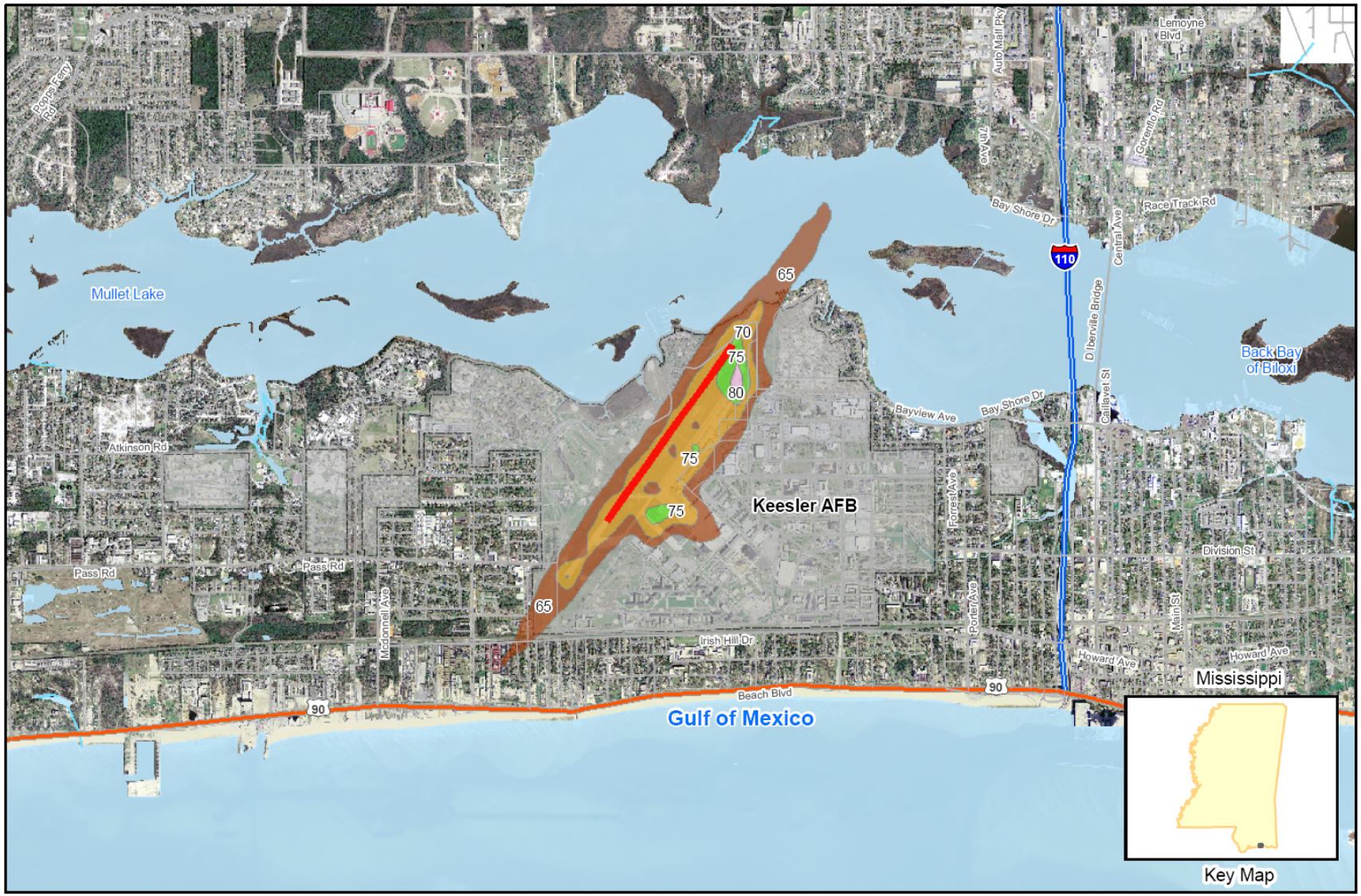
DNL Noise Zone	Acres	Population
65–69 dB	12	58
70–74 dB	0	0
75–79 dB	0	0
80+ dB	0	0
Total	**12**	**58**

4.5 COMPARISON WITH 1994 AICUZ STUDY NOISE CONTOURS

The 2010 AICUZ Study noise contours are similar in both shape and extent of coverage when compared to the noise contours in the 1994 AICUZ Study. Figure 4-3 depicts the 1994 AICUZ Study contours and Figure 4-4 compares the 2010 and 1994 contours. The off-DoD property exposure for this AICUZ Study is approximately 542 fewer acres than the 1994 AICUZ Study. Table 4-2 lists the total noise exposure for the four noise zones in each study. The noise contours for the 2009 AICUZ Study (see Figure 4-2) were produced by NOISEMAP Version 7.32, while the contours in Figure 4-3 were produced by the version of NOISEMAP that was current when the 1994 AICUZ Study was prepared. NOISEMAP Version 7.32, the version of the model that was current when the noise modeling for this AICUZ was performed, contains improved algorithms that calculate the noise and is more accurate than previous versions. For this reason, the noise exposure in this 2009 AICUZ Study (see Figure 4-2) is less than the exposure for the 1994 AICUZ Study depicted in Figure 4-3.

Table 4-2 Total Acres Within the 2010 AICUZ Study and 1994 AICUZ Study Noise Zones (Off-DoD Property)

	Acres	
DNL Noise Zone	2010 AICUZ Study Noise Contours	1994 AICUZ Study Noise Contours
65–69 dB	12	469
70–74 dB	0	77
75–79 dB	0	8
80+ dB	0	0
Total	**12**	**554**



Keesler Air Force Base 2010 AICUZ

Legend

- DNL 65 - 69 dB
- DNL 70 - 74 dB
- DNL 75 - 79 dB
- DNL 80+ dB
- Interstate
- Highway
- Runway
- Keesler Air Force Base

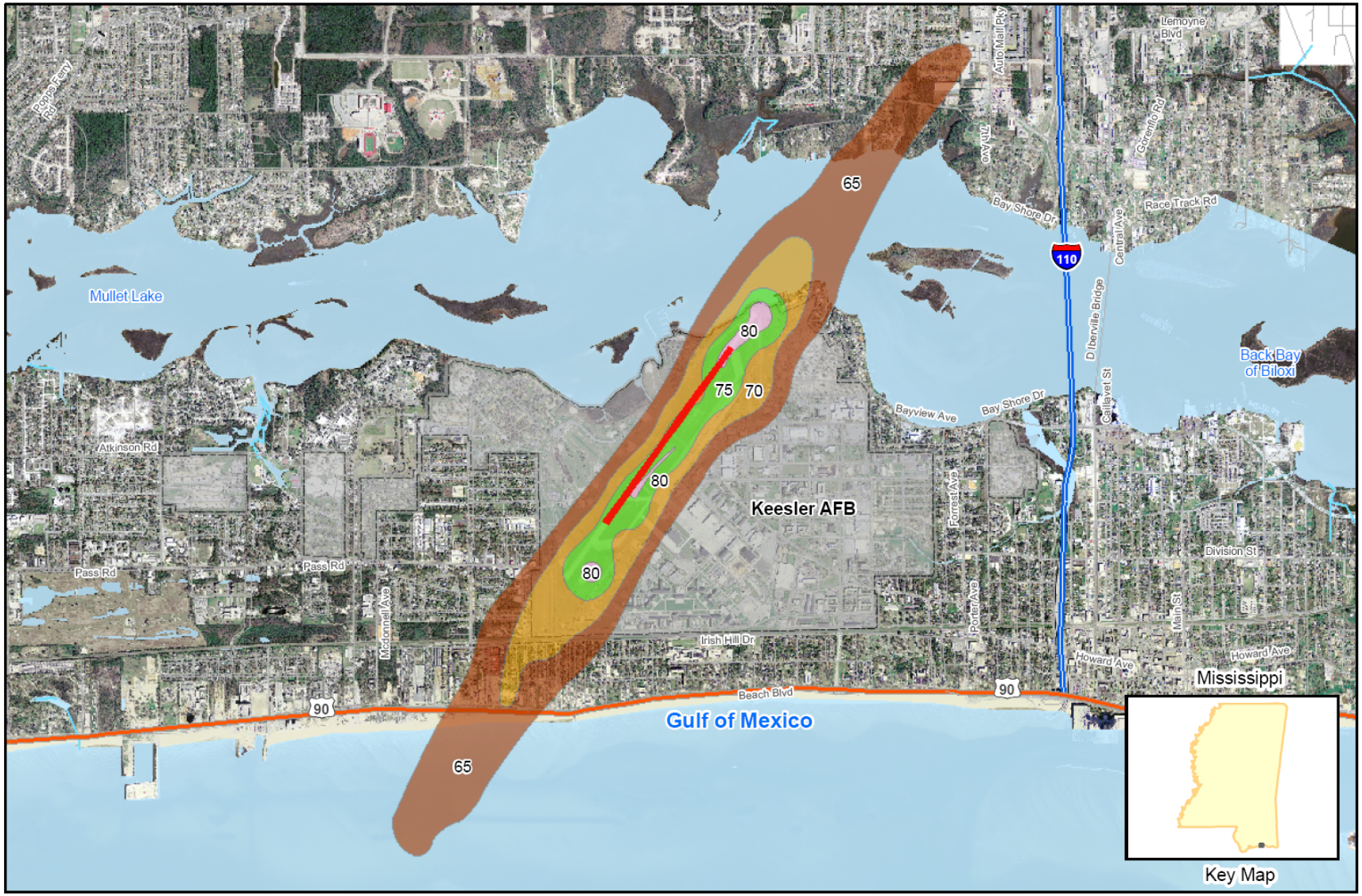
0 1,500 3,000 Feet

N

Figure 4-2

2010 AICUZ Study Noise Contours

Keesler Air Force Base Biloxi, MS



Keesler Air Force Base 2010 AICUZ

Legend

- DNL 65 - 69 dB
- DNL 70 - 74 dB
- DNL 75 - 79 dB
- DNL 80+ dB
- Interstate
- Highway
- Runway
- Keesler Air Force Base

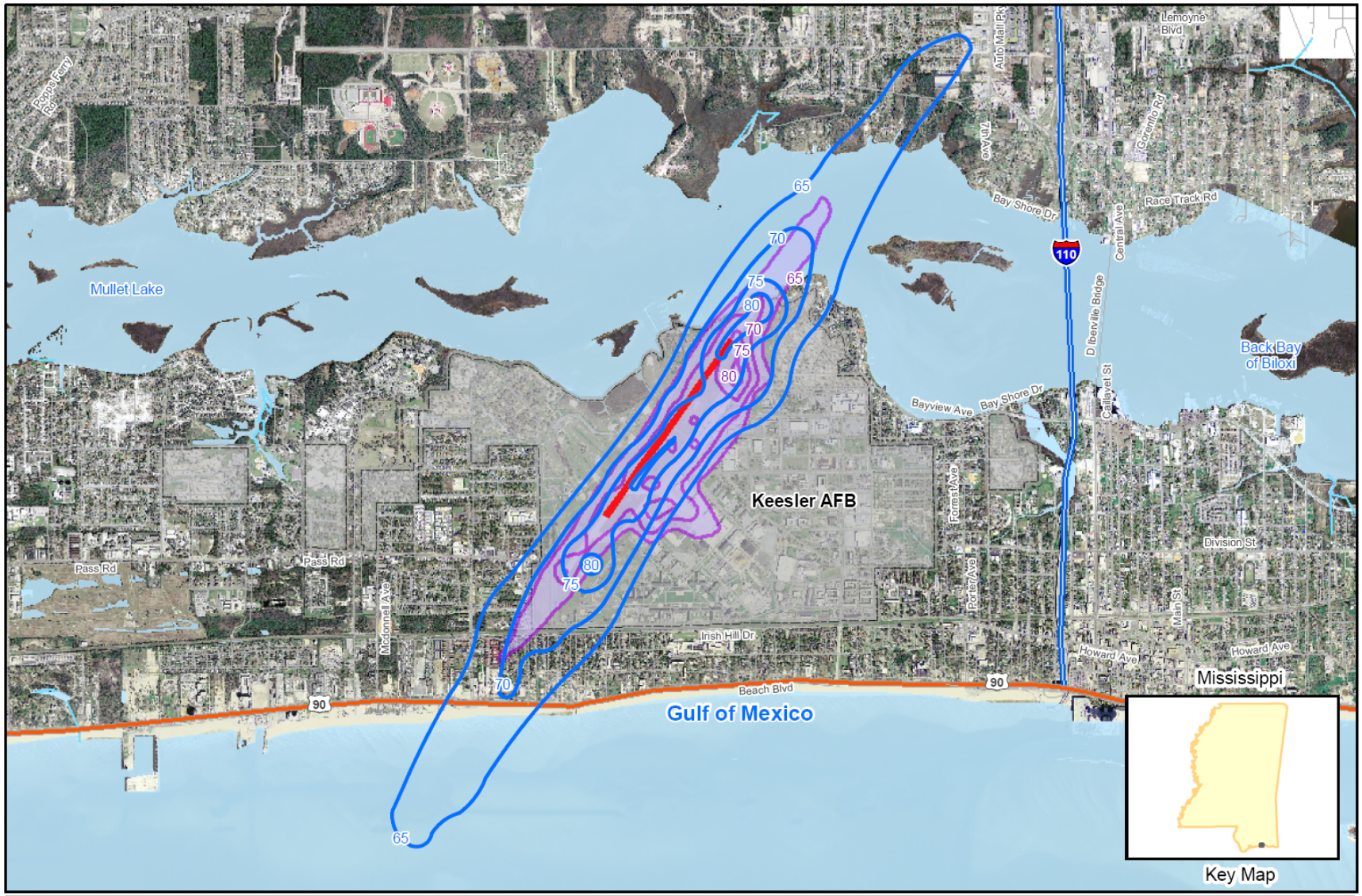
0 1,500 3,000 Feet

N

Figure 4-3

1994 AICUZ Study Noise Contours

Keesler Air Force Base Biloxi, MS



Keesler Air Force Base 2010 AICUZ

Legend

- 2010 Noise Contour
- 1994 Noise Contour
- Interstate
- Highway
- Runway
- Keesler Air Force Base

0 1,250 2,500 Feet

N

Figure 4-4

Comparsion of 2010 AICUZ Study and 1994 AICUZ Study Noise Contours

Keesler Air Force Base Biloxi, MS

4.6 CLEAR ZONES AND ACCIDENT POTENTIAL ZONES FOR RUNWAYS

The purpose of this subsection is to describe the basis for CZs and APZs and apply the zones to the Keesler AFB runways. Figure 4-5 depicts the CZs and APZs for Keesler AFB.

4.6.1 Basis for Clear Zones and Accident Potential Zones

Areas around airports are exposed to the possibility of aircraft accidents even with well-maintained aircraft and highly trained aircrews. Despite stringent maintenance requirements and countless hours of training, past history makes it clear that accidents may occur.

The risk of people on the ground being killed or injured by aircraft accidents is small. However, an aircraft accident is a high-consequence event and, when a crash does occur, the result is often catastrophic. Because of this, the Air Force does not attempt to base its safety standards on accident probabilities. Instead it approaches this safety issue from a land use planning perspective. Designation of safety zones around the airfield and restriction of incompatible land uses can reduce the public's exposure to safety hazards. The AICUZ Program includes three safety zones: the CZ, APZ I, and APZ II. These zones were developed from analysis of over 830 major Air Force accidents that occurred within 10 miles of an Air Force installation between 1968 and 1995. Figure B-3 in Appendix B summarizes the location of these accidents.

The CZ has the highest accident potential of the three zones, as 27 percent of accidents studied occurred in this area. Due to the relatively high accident potential, the Air Force adopted a policy of acquiring real estate interests in the CZ through purchase or easement when feasible.

APZ I is an area that possesses somewhat less accident potential than the CZ, with 10 percent of the accidents studied occurring in this zone. APZ II has less accident potential than APZ I, with 6 percent of the accidents studied occurring in this zone. While the potential for aircraft accidents in APZs I and II does not warrant land acquisition by the Air Force, land use planning and controls are strongly encouraged in these areas for the protection of the public.

4.6.2 Clear Zones and Accident Potential Zones for the Keesler AFB Runway

Figure 4-5 depicts the CZs and APZs for the Keesler AFB runway. The discussion in this subsection applies to both runways.

Each runway end at Keesler AFB has a 3,000 foot by 3,000 foot CZ and two APZs. Accident potential on or adjacent to the runway or within the CZ is so high that the necessary land use restrictions would prohibit reasonable economic use of land. As previously stated, Air Force policy advises the Base to consider efforts to acquire land in the CZ in fee, by easement, or by donation, if feasible.

Accident Potential Zone I is less critical than the CZ, but still possess a significant risk factor. This 3,000 foot by 5,000 foot area has land use compatibility guidelines sufficiently flexible to allow reasonable economic use of the land, such as industrial/manufacturing, transportation, communication/utilities, wholesale trade, open space, recreation, and agriculture. However, uses that concentrate people in small areas are incompatible.

Accident Potential Zone II is less critical than APZ I, but still possesses potential for accidents. Accident Potential Zone II, also 3,000 feet wide, is 7,000 feet long extending to 15,000 feet from the runway threshold. Acceptable uses include those of APZ I, as well as low density single family residential and those personal and business services and commercial/retail trade uses of low intensity or scale of operation. High density functions such as multi-story buildings, places of assembly (*e.g.*, theaters, churches, schools, restaurants, *etc.*), and high density office uses are incompatible.

High population densities should be limited to the maximum extent possible in APZ II. The optimum density recommended for residential usage (where it does not conflict with noise criteria) in APZ II is one dwelling per acre. For most non-residential usage, buildings should be limited to one story and the lot coverage should not exceed 20 percent.

4.6.3 Land Use Compatibility Guidelines for Runways

Subsection 4.6.3.1 introduces the AICUZ concept, and Subsection 4.6.3.2 presents the land use compatibility guidelines applicable to Keesler AFB.

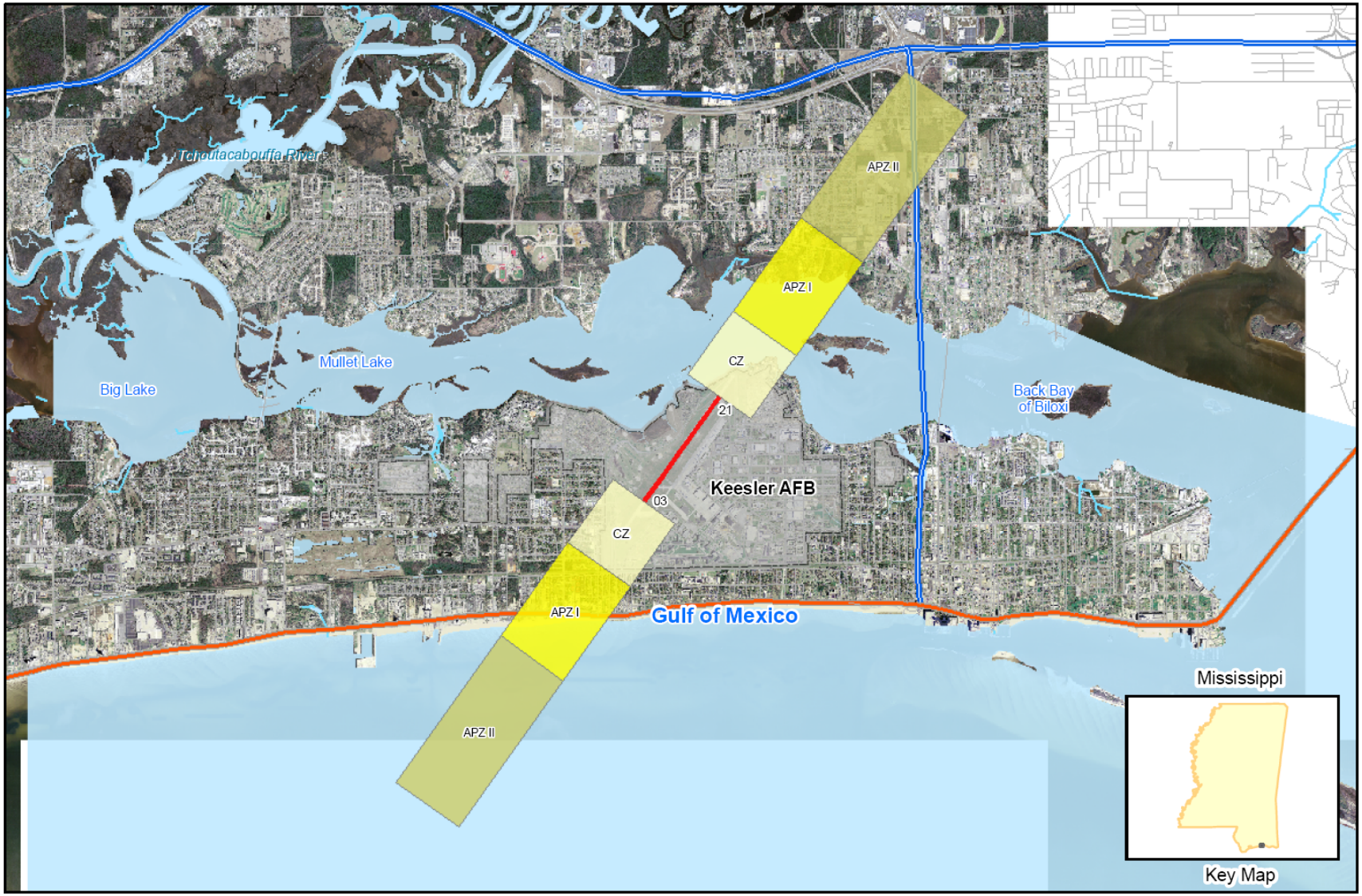
4.6.3.1 Introduction

The DoD developed the AICUZ Program for military airfields. Using this program at its installations, the DoD works to protect aircraft operational capabilities and to assist local government officials in protecting and promoting the health, safety, and quality of life of the public. The goal is to promote compatible land use development around military airfields by providing information on aircraft noise exposure and accident potential.

AICUZ guidelines describe three basic types of constraints that affect, or result from, flight operations. The first constraint involves areas the FAA and Department of Defense (DoD) identified for height limitations (see Subsection 4.2).

The second constraint involves noise zones based on the DNL metric and the DoD NOISEMAP methodology. Using the NOISEMAP program, which is similar to FAA's INM, the Air Force produces noise contours showing noise levels generated by aircraft operations. The AICUZ study contains noise contours plotted in 5 dB increments, ranging from DNL 65 dB to 80+ dB.

The third constraint involves CZs and APZs based on statistical analysis of past DoD aircraft accidents. DoD analysis has determined that areas immediately beyond the ends of runways and along approach and departure flight paths have greater potential for aircraft accidents (see Appendix B).



Keesler Air Force Base 2010 AICUZ

Legend

- Clear Zone
- APZ I
- APZ II
- Keesler Air Force Base
- Interstate
- Highway
- Runway

0 2,250 4,500 Feet

N

Figure 4-5

Clear Zones and Accident Potential Zones

Keesler Air Force Base Biloxi, MS

4.6.3.2 Land Use Compatibility Guidelines for Runways

Each AICUZ study contains land use guidelines. Table 4-3 identifies land uses and possible noise exposure and accident potential combinations for Keesler AFB. These noise guidelines are essentially the same as those published by the Federal Interagency Committee on Urban Noise in the June 1980 publication, *Guidelines for Considering Noise in Land Use Planning and Control*. The U.S. Department of Transportation publication, *Standard Land Use Coding Manual (SLUCM)*, has been used to identify and code land use activities. The CZ and APZ guidelines in Table 4-3 apply to runways. The designations are a combination of criteria listed in the legend and notes at the end of the table. For example, Y[1] means land use and related structures are compatible without restriction at a suggested maximum density of 1-2 dwelling units per acre, possibly increased under a Planned Unit Development where lot coverage is less than 20 percent.

Table 4-3 Land Use Compatibility Guidelines

Land Use		Accident Potential Zones			Noise Zones			
SLUCM No.	Name	Clear Zone	APZ I	APZ II	65-69	70-74	75-79	80+
10	**Residential**							
11	Household units							
11.11	Single units; detached	N	N	Y[1]	A[11]	B[11]	N	N
11.12	Single units; semidetached	N	N	N	A[11]	B[11]	N	N
11.13	Single units; attached row	N	N	N	A[11]	B[11]	N	N
11.21	Two units; side-by-side	N	N	N	A[11]	B[11]	N	N
11.22	Two units; one above the other	N	N	N	A[11]	B[11]	N	N
11.31	Apartments; walk up	N	N	N	A[11]	B[11]	N	N
11.32	Apartments; elevator	N	N	N	A[11]	B[11]	N	N
12	Group quarters	N	N	N	A[11]	B[11]	N	N
13	Residential hotels	N	N	N	A[11]	B[11]	N	N
14	Mobile home parks or courts	N	N	N	N	N	N	N
15	Transient lodgings	N	N	N	A[11]	B[11]	C[11]	N
16	Other residential	N	N	N[1]	A[11]	B[11]	N	N
20	**Manufacturing**							
21	Food & kindred products; manufacturing	N	N[2]	Y	Y	Y[12]	Y[13]	Y[14]
22	Textile mill products; manufacturing	N	N[2]	Y	Y	Y[12]	Y[13]	Y[14]
23	Apparel and other finished products made from fabrics, leather, and similar materials; manufacturing	N	N	N[2]	Y	Y[12]	Y[13]	Y[14]
24	Lumber and wood products (except furniture); manufacturing	N	Y[2]	Y	Y	Y[12]	Y[13]	Y[14]
25	Furniture and fixtures; manufacturing	N	Y[2]	Y	Y	Y[12]	Y[13]	Y[14]
26	Paper & allied products; manufacturing	N	Y[2]	Y	Y	Y[12]	Y[13]	Y[14]
27	Printing, publishing, and allied industries	N	Y[2]	Y	Y	Y[12]	Y[13]	Y[14]
28	Chemicals and allied products; manufacturing	N	N	N[2]	Y	Y[12]	Y[13]	Y[14]
29	Petroleum refining and related industries	N	N	Y	Y	Y[12]	Y[13]	Y[14]

Table 4-3 Land Use Compatibility Guidelines (Continued)

Land Use		Accident Potential Zones			Noise Zones			
SLUCM No.	Name	Clear Zone	APZ I	APZ II	65-69	70-74	75-79	80+
30	**Manufacturing**							
31	Rubber and misc. plastic products, manufacturing	N	N[2]	N[2]	Y	Y[12]	Y[13]	Y[14]
32	Stone, clay and glass products manufacturing	N	N[2]	Y	Y	Y[12]	Y[13]	Y[14]
33	Primary metal industries	N	N[2]	Y	Y	Y[12]	Y[13]	Y[14]
34	Fabricated metal products; manufacturing	N	N[2]	Y	Y	Y[12]	Y[13]	Y[14]
35	Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks manufacturing	N	N	N[2]	Y	A	B	N
39	Miscellaneous manufacturing	N	Y[2]	Y[2]	Y	Y[12]	Y[13]	Y[14]
40	**Transportation, Communications and Utilities**							
41	Railroad, rapid rail transit and street railroad transportation	N[3]	Y[4]	Y	Y	Y[12]	Y[13]	Y[14]
42	Motor vehicle transportation	N[3]	Y	Y	Y	Y[12]	Y[13]	Y[14]
43	Aircraft transportation	N[3]	Y[4]	Y	Y	Y[12]	Y[13]	Y[14]
44	Marine craft transportation	N[3]	Y[4]	Y	Y	Y[12]	Y[13]	Y[14]
45	Highway & street right-of-way	N[3]	Y	Y	Y	Y[12]	Y[13]	Y[14]
46	Automobile parking	N[3]	Y[4]	Y	Y	Y[12]	Y[13]	Y[14]
47	Communications	N[3]	Y[4]	Y	Y	A[15]	B[15]	N
48	Utilities	N[3]	Y[4]	Y	Y	Y	Y[12]	Y[13]
49	Other transportation communications and utilities	N[3]	Y[4]	Y	Y	A[15]	B[15]	N
50	**Trade**							
51	Wholesale trade	N	Y[2]	Y	Y	Y[12]	Y[13]	Y[14]
52	Retail trade-building materials, hardware and farm equipment	N	Y[2]	Y	Y	Y[12]	Y[13]	Y[14]
53	Retail trade-general merchandise	N	N[2]	Y[2]	Y	A	B	N
54	Retail trade-food	N	N[2]	Y[2]	Y	A	B	N
55	Retail trade-automotive, marine craft, aircraft and accessories	N	Y[2]	Y[2]	Y	A	B	N
56	Retail trade-apparel and accessories	N	N[2]	Y[2]	Y	A	B	N
57	Retail trade-furniture, home furnishings and equipment	N	N[2]	Y[2]	Y	A	B	N
58	Retail trade-eating and drinking establishments	N	N	N[2]	Y	A	B	N
59	Other retail trade	N	N[2]	Y[2]	Y	A	B	N
60	**Services**							
61	Finance, insurance and real estate services	N	N	Y[6]	Y	A	B	N
62	Personal services	N	N	Y[6]	Y	A	B	N
62.4	Cemeteries	N	Y[7]	Y[7]	Y	Y[12]	Y[13]	Y[14,21]
63	Business services	N	Y[8]	Y[8]	Y	A	B	N
64	Repair services	N	Y[2]	Y	Y	Y[12]	Y[13]	Y[14]
65	Professional services	N	N	Y[6]	Y	A	B	N
65.1	Hospitals, nursing homes	N	N	N	A*	B*	N	N
65.1	Other medical facilities	N	N	N	Y	A	B	N
66	Contract construction services	N	Y[6]	Y	Y	A	B	N
67	Governmental services	N	N	Y[6]	Y*	A*	B*	N
68	Educational services	N	N	N	A*	B*	N	N
69	Miscellaneous services	N	N[2]	Y[2]	Y	A	B	N

Table 4-3 Land Use Compatibility Guidelines (Continued)

70	**Cultural, Entertainment and Recreational**							
71	Cultural activities (including churches)	N	N	N[2]	A*	B*	N	N
71.2	Nature exhibits	N	Y[2]	Y	Y*	N	N	N
72	Public assembly	N	N	N	Y	N	N	N
72.1	Auditoriums, concert halls	N	N	N	A	B	N	N
72.11	Outdoor music shell, amphitheaters	N	N	N	N	N	N	N
72.2	Outdoor sports arenas, spectator sports	N	N	N	Y[17]	Y[17]	N	N
73	Amusements	N	N	Y[8]	Y	Y	N	N
74	Recreational activities (including golf courses, riding stables, water recreation)	N	Y[8,9,10]	Y	Y*	A*	B*	N
75	Resorts and group camps	N	N	N	Y*	Y*	N	N
76	Parks	N	Y[8]	Y[8]	Y*	Y*	N	N
79	Other cultural, entertainment and recreation	N	Y[9]	Y[9]	Y*	Y*	N	N
80	**Resources Production and Extraction**							
81	Agriculture (except livestock)	Y[16]	Y	Y	Y[18]	Y[19]	Y[20]	Y[20,21]
81.5 to 81.7	Livestock farming and animal breeding	N	Y	Y	Y[18]	Y[19]	Y[20]	Y[20,21]
82	Agricultural related activities	N	Y[5]	Y	Y[18]	Y[19]	N	N
83	Forestry activities and related services	N[5]	Y	Y	Y[18]	Y[19]	Y[20]	Y[20,21]
84	Fishing activities and related services	N[5]	Y[5]	Y	Y	Y	Y	Y
85	Mining activities and related services	N	Y[5]	Y	Y	Y	Y	Y
89	Other resources production and extraction	N	Y[5]	Y	Y	Y	Y	Y

LEGEND

SLUCM - Standard Land Use Coding Manual, U.S. Department of Transportation.

Y - (Yes) - Land use and related structures are compatible without restriction.

N - (No) - Land use and related structures are not compatible and should be prohibited.

Y[x] - (yes with restrictions) - Land use and related structures generally compatible; see notes 1-21.

N[x] - (no with exceptions) - See notes 1-21.

NLR - (Noise Level Reduction) - NLR (outdoor to indoor) to be achieved through incorporation of noise attenuation measures into the design and construction of the structures.

A, B, or C - Land use and related structures generally compatible; measures to achieve NLR of A (DNL 25 dB), B (DNL 30 dB), or C (DNL 35 dB) need to be incorporated into the design and construction of structures.

A*, B*, and C* - Land use generally compatible with NLR. However, measures to achieve an overall noise level reduction do not necessarily solve noise difficulties and additional evaluation is warranted. See appropriate footnotes.

***** - The designation of these uses as "compatible" in this zone reflects individual federal agency and program consideration of general cost and feasibility factors, as well as past community experiences and program objectives. Localities, when evaluating the application of these guidelines to specific situations, may have different concerns or goals to consider.

NOTES

1. *Suggested maximum density of 1-2 dwelling units per acre possibly increased under a Planned Unit Development where maximum lot coverage is less than 20 percent.*
2. *Within each land use category, uses exist where further definition may be needed due to the variation of densities in people and structures. Shopping malls and shopping centers are considered incompatible in any accident potential zone (CZ, APZ I, or APZ II).*
3. *The placing of structures, buildings, or above ground utility lines in the clear zone is subject to severe restrictions. In a majority of the clear zones, these items are prohibited. See AFI 32-7063 and UFC 3-260-01 for specific guidance.*
4. *No passenger terminals and no major above ground transmission lines in APZ I.*
5. *Factors to be considered: labor intensity, structural coverage, explosive characteristics, and air pollution.*
6. *Low-intensity office uses only. Meeting places, auditoriums, etc., are not recommended.*
7. *Excludes chapels.*

Table 4-3 Land Use Compatibility Guidelines Legend (Continued)

8. Facilities must be low intensity.
9. Clubhouse not recommended.
10. Areas for gatherings of people are not recommended.
11A. Although local conditions may require residential use, it is discouraged in DNL 65-69 dB and strongly discouraged in DNL 70-74 dB. An evaluation should be conducted prior to approvals, indicating a demonstrated community need for residential use would not be met if development were prohibited in these zones, and there are no viable alternative locations.
11B. Where the community determines the residential uses must be allowed, measures to achieve outdoor to indoor NLR for DNL 65-69 dB and DNL 70-74 dB should be incorporated into building codes and considered in individual approvals.
11C. NLR criteria will not eliminate outdoor noise problems. However, building location and site planning, and design and use of berms and barriers can help mitigate outdoor exposure, particularly from near ground level sources. Measures that reduce outdoor noise should be used whenever practical in preference to measures which only protect interior spaces.
12. Measures to achieve the same NLR as required for facilities in the DNL 65-69 dB range 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.
13. Measures to achieve the same NLR as required for facilities in the DNL 70-74 dB range 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.
14. Measures to achieve the same NLR as required for facilities in the DNL 75-79 dB range 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.
15. If noise sensitive, use indicated NLR; if not, the use is compatible.
16. No buildings.
17. Land use is compatible provided special sound reinforcement systems are installed.
18. Residential buildings require the same NLR required for facilities in the DNL 65-69 dB range.
19. Residential buildings require the same NLR required for facilities in the DNL 70-74 dB range.
20. Residential buildings are not permitted.
21. Land use is not recommended. If the community decides the use is necessary, personnel should wear hearing protection devices.

4.7 PARTICIPATION IN THE PLANNING PROCESS

The Air Force provides results of the AICUZ Study to local communities to assist them in preparing their local land use plans. This subsection discusses how the Base participates in the community planning process. Subsection 6.3 addresses the local community's involvement that would enhance compatible land use.

Keesler AFB is greatly concerned with building or height standards that create airspace obstructions, residential and commercial development, and other development or activities located near the Base but sensitive to noise. The Air Force has a vital interest in minimizing increasing incompatible land use that can adversely impact its mission and operations. This is an important reason the Air Force works to encourage and educate communities on incompatible land use and, thereby, promote voluntary efforts or changes toward compatible land uses. Utilizing Table 4-3, which describes categories of compatible land use in the varied zones (CZ, APZ I and II), Keesler AFB evaluates existing impacts on aircraft operations and surrounding land uses along with the potential effects new development or changes in land use might have on the Base's existing or future operational capabilities.

The point of contact for AICUZ matters at Keesler AFB is Public Affairs (228.377.2783). In addition to working with local governing entities and planning professionals, the Keesler AFB Public Affairs Office works to address complaints and concerns expressed by off-airfield neighbors.

Keesler AFB conducts active outreach to the community by meeting with various community groups and speaking with individuals as needed. The Keesler AFB Civil Engineer and Public Affairs Offices work together providing public meetings and informational workshops to disseminate information about Base operations, forecasts, plans, and mitigation strategies.

SECTION 5
LAND USE ANALYSIS

5.1 INTRODUCTION

Land use planning and control is a dynamic, rather than a static process. Specific characteristics of land use choices will always reflect, to some degree, changing conditions of the economic, social, and physical environment of a community, as well as changing public concern. The planning process accommodates this fluidity in which decisions are normally not based on boundary lines, but rather on more generalized area designations.

Keesler AFB was originally established in 1941 on land deeded by the City of Biloxi for a U.S. Army Air Corps Technical Training Base to support the WW2 training buildup. At the time of the establishment of the Base the surrounding land use consisted primarily of pre-war single-family residences and vacant land. Current land use in the vicinity of the Keesler AFB is vastly different with the development of the gaming industry, condominiums, and extensive supportive commercial development. The ravages of Hurricane Katrina in 2005 were responsible for the destruction of thousands of homes in the Biloxi/D'Iberville area, including over 1,000 houses on the Base. Destruction of structures and infrastructure around Keesler AFB was rampant, with the effects of destruction still visible today. However, significant progress has been made in redevelopment and replacement of demolished buildings. As a result of the damages inflicted by the hurricane, there has been alteration of some land uses and implementation of new development and land use standards and regulations.

Geographic information systems and detailed digital orthophotography enable the Air Force to more accurately analyze its flight tracks and noise contours for land use planning purposes. These methods reveal the extent of Keesler AFB's region of influence with respect to Solano County and the surrounding communities.

For the purpose of this AICUZ study, the existing and future land uses depicted on the figures within this section have been generalized into one of the following six categories:

Residential: Residential dwellings, such as single-family and multi-family residences and mobile homes, developed at a density greater than one dwelling unit per acre.

Commercial: Offices, retail stores, restaurants, and other commercial establishments.

Industrial: Manufacturing, warehousing, and other similar uses.

Public/Quasi-Public: Publicly-owned lands and/or land to which the public has access, including military reservations and training grounds, public buildings, schools, churches, cemeteries, and hospitals.

Recreational: Land areas designated for recreational activity, including parks, wilderness areas and reservations, conservation areas, and areas designated for sporting events, hiking, camping, etc.

Open/Agricultural/Low Density: Undeveloped land, farms, pasture land, and residential development with a density of one dwelling unit per acre or less.

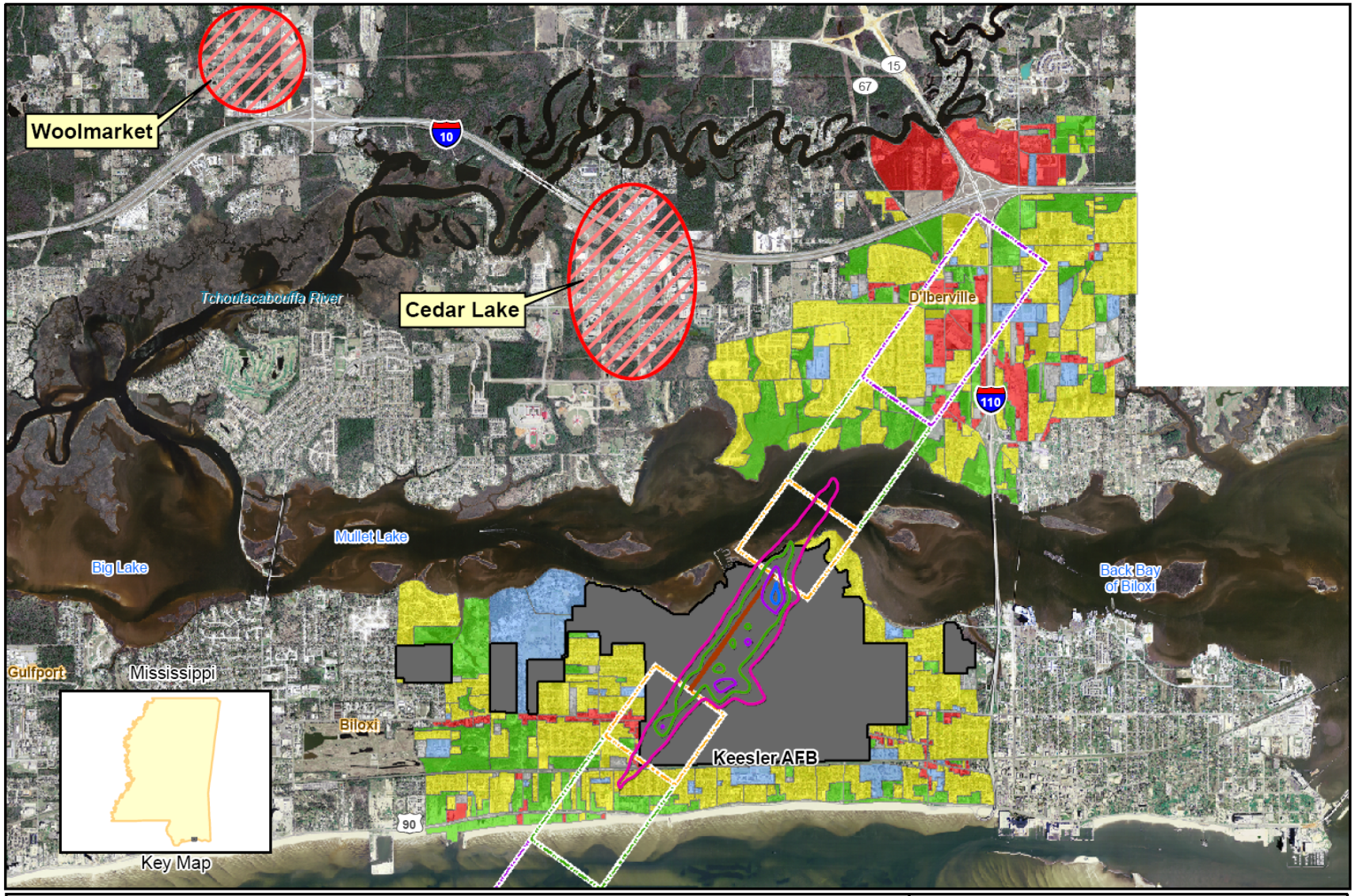
5.2 EXISTING LAND USE

Figure 5-1 shows the existing land use pattern in the area surrounding Keesler AFB. The Base is located in the City Limits of Biloxi, near the center of the Biloxi Peninsula, and between the Mississippi Sound and the Back Bay of Biloxi. The Base generally separates East Biloxi from West Biloxi. The Back Bay of Biloxi separates East and West Biloxi from North Biloxi and the City of D'Iberville. Irish Hill Drive borders the length of the Base on the south.

Land use in the immediate vicinity of the Base includes a mixture of residential, commercial and public uses. Older established single-family residences in a grid block pattern comprise the dominant land use east of the Base. Three multi-family developments, several industrial and commercial businesses, a trailer park, and a cemetery are located near the southeast corner of the Base on Judge Sekul Avenue. A commercial node consisting of retail outlets, small offices and the Biloxi Police Department is located at the Irish Hill Drive/Howard Avenue/Porter Avenue intersection. Kensington Park, an upper-scale residential subdivision, borders the northeast corner of the Base. A large apartment complex occurs farther east toward I-110 on Benachi Avenue and a municipal wastewater treatment plant is located on Iroquois Street just west of I-110. In addition, there are several churches within the area east of the Base.

South of the Base, between Irish Hill Drive and the beachfront, older single-family residences predominate compactly-developed, small lots in a grid block pattern. The Biloxi Junior High School and Michel Middle School are located on Irish Hill Drive directly across from the Base west of the main gate on White Avenue. The Lopez Elementary School is located on St. John's Avenue south of Irish Hill Drive. A Veteran's cemetery is located on Irish Hill Drive just east of the Base's main gate at White Avenue. Major commercial development in the form of tourist-oriented businesses (*e.g.*, casino/hotel, motels) in addition to personal service businesses and condominiums predominate along U.S. Highway 90 (Beach Boulevard), the only principal arterial that extends east-west across the Biloxi Peninsula from Ocean Springs to Gulfport. This area was heavily damaged during Hurricane Katrina with extensive destruction to buildings, including a number of historic structures and supporting infrastructure. A significant number of building permits, primarily for condominium and commercial development, have been issued by the City of Biloxi for redevelopment within this area following the hurricane destruction. However, there are still numerous vacant lots and buildings, primarily along Beach Boulevard. There are two historic districts (West Beach and West Central) and numerous historic structures straddling Beach Boulevard between I-110 and the Base. Many historic buildings within this area were destroyed or extensively damaged by Hurricane Katrina.

Development to the west and southwest of the Base is more recent and predominated by single-family residences, with several apartment complexes within the area. Immediately adjacent west of the Base is the Jeff Davis Elementary School, located at St. Ann Avenue and Rodeo Drive. There are a number of churches within the immediate environs of the Base. Commercial development west of the Base is concentrated along Pass Road, the major arterial providing access to West Biloxi and Keesler AFB from Gulfport. Smaller scale neighborhood retail and personal services comprise the majority of this commercial development.



Keesler Air Force Base 2010 AICUZ

Legend

- Residential
- Commerical
- Industrial
- Public/Quasi-Public
- Open/Agriculture/Recreation/ Low Density
- Interstate
- Runway
- Regional Activity Center
- CZ/APZ Boundary
- Keesler Air Force Base
- DNL 65 dB Contour
- DNL 70 dB Contour
- DNL 75 dB Contour
- DNL 80 dB Contour
- Clear Zone
- APZ I
- APZ II

N

0 2,250 4,500 Feet

Figure 5-1

Generalized Existing Land Use

Keesler Air Force Base Biloxi, MS

The largest public uses within this area are the Veteran's Administration Medical Center, the associated Biloxi National Cemetery on Veteran's Avenue north of Pass Road, and the adjacent Hiller Park recreation area. Major new development has occurred farther to the west with the recent completion of the Mississippi Coast Coliseum and the Edgewater Village Regional Shopping Center on Beach Boulevard, approximately 2.5 miles west of Keesler AFB. The historic Beauvoir Jefferson Davis home is adjacent to the coliseum.

North Biloxi is connected to West Biloxi by Popps Ferry Road, which bridges the Back Bay of Biloxi. North Biloxi, because of available land, lower development costs and less susceptibility to flood and hurricane damage, has become the primary growth area of Biloxi. Extensive residential development consisting of modern subdivisions has occurred, accompanied by supportive commercial development and public-serving facilities. Major new commercial development, including big-box retail, has occurred at the I-10 and Cedar Lake Road interchange. The new Biloxi High School is located on Jam Lane south of Popps Ferry Road. New subdivision development is currently occurring within this area, with large tracts of vacant land still available for development. However, supportive infrastructure has not kept pace with development within the area.

Existing land use within the environs of Keesler AFB in D'Iberville consists primarily of residential and commercial development. Interstate 110 bisects D'Iberville and intersects with I-10 at the northern end of the city. Commercial development extends along the length of the city's primary arterial and collector streets west of I-110. These include Auto Mall Parkway and D'Iberville Blvd., with a major commercial node at the intersection of these two roads. In addition to extensive commercial development, other major land uses along Auto Mall Parkway include the D'Iberville City Hall, library, U.S. post office, and two large apartment complexes. Residential subdivisions occupy the majority of the area west from the Auto Mall Parkway commercial corridor to the western city limits. Within this area there are several major public uses, including the D'Iberville Middle and Elementary Schools on Brodie Road, and a large city recreational complex adjacent to the north of these schools. In addition, there are several churches within the area.

East of I-110 commercial development predominates along the major transportation corridors. These include Central Avenue, D'Iberville Blvd, and Lemoyne Blvd. Commercial uses along these corridors include primarily local retail/personal service businesses representing an older commercial area. The D'Iberville High School and associated athletic complex is located on Lamey Bridge Road north of its intersection with Lemoyne Blvd. A large recently developed apartment complex is adjacent to the north of the high school.

The most recent commercial development in D'Iberville has occurred at the interchange of I-10 and I-110. The 700,000 square foot Promenade Shopping Center opened in the northwest quadrant of the interchange in the fall of 2009. The shopping center contains a number of retail chain stores. Previously, the northeast quadrant of this interchange was developed with big-box retailer stores and associated retail chain stores. These two developments represent a major regional shopping center.

The City of D'Iberville was also severely impacted by Hurricane Katrina, with damage occurring primarily the area of "Old Town" east of I-110 and adjacent to the Back Bay of Biloxi. This area is currently sparsely developed with small residences and large expanses of vacant lots.

Table 5-1 summarizes the amounts of off-Base land by land use category that lie within the DNL 65 dB and greater noise exposure area. There are eight acres of residential areas, three acres of commercial, and one acre of industrial areas that occur within the Keesler AFB DNL 65 dB or greater noise exposure area.

Table 5-1 Generalized Existing Land Use Within DNL 65 dB and Greater Noise Exposure Area (Off-DoD Property)

Category	Acreage
Residential	8
Commercial	3
Industrial	1
Public/Quasi-public	0
Recreational	0
Open/Agricultural/Low Density	0
Total	**12**

Table 5-2 summarizes the amounts of off-Base land by land use category that lie within the Keesler AFB CZ and APZs. Land uses within the APZ1 occur in both Biloxi and D'Iberville, while those land uses within APZII occur only in D'Iberville. There are 380 acres of residential land in APZ1 and APZ II.

Table 5-2 Generalized Existing Land Use Within the Keesler AFB Clear Zones and Accident Potential Zones (Off-DoD Property)

Category	Acreage
Residential	431
Commercial	113
Industrial	21
Public/Quasi-public	38
Recreational/Open/Agricultural/Low Density	237
Total	**840**

5.3 CURRENT ZONING

Figure 5-2 shows the current zoning of the Keesler AFB environs for Biloxi and D'Iberville. The City of Biloxi began operating under a new Land Development Ordinance in 2003, which is currently being updated in conjunction with the introduction of a new comprehensive plan. The City of D'Iberville is also updating its zoning ordinance concurrent with the preparation of a new comprehensive plan.

Zoning in the immediate vicinity of Keesler AFB in Biloxi generally reflects existing land use. The existing residential areas to the east, south, and west of the Base are primarily zoned Single-Family Residential, High and Medium Density (RS-5, RS-7.5) with minimum lot sizes of 5,000 and 7,500 square feet respectively. Churches, parks, recreational areas, and some other public uses are also allowed in these districts. Selected areas along the beachfront are zoned Multiple-Family, Medium and High Density (RM-20, RM-25), with a development density of 20-25 units/acre. There is also an extensive area along Irish Hill Drive immediately west of the Base zoned RM-20.

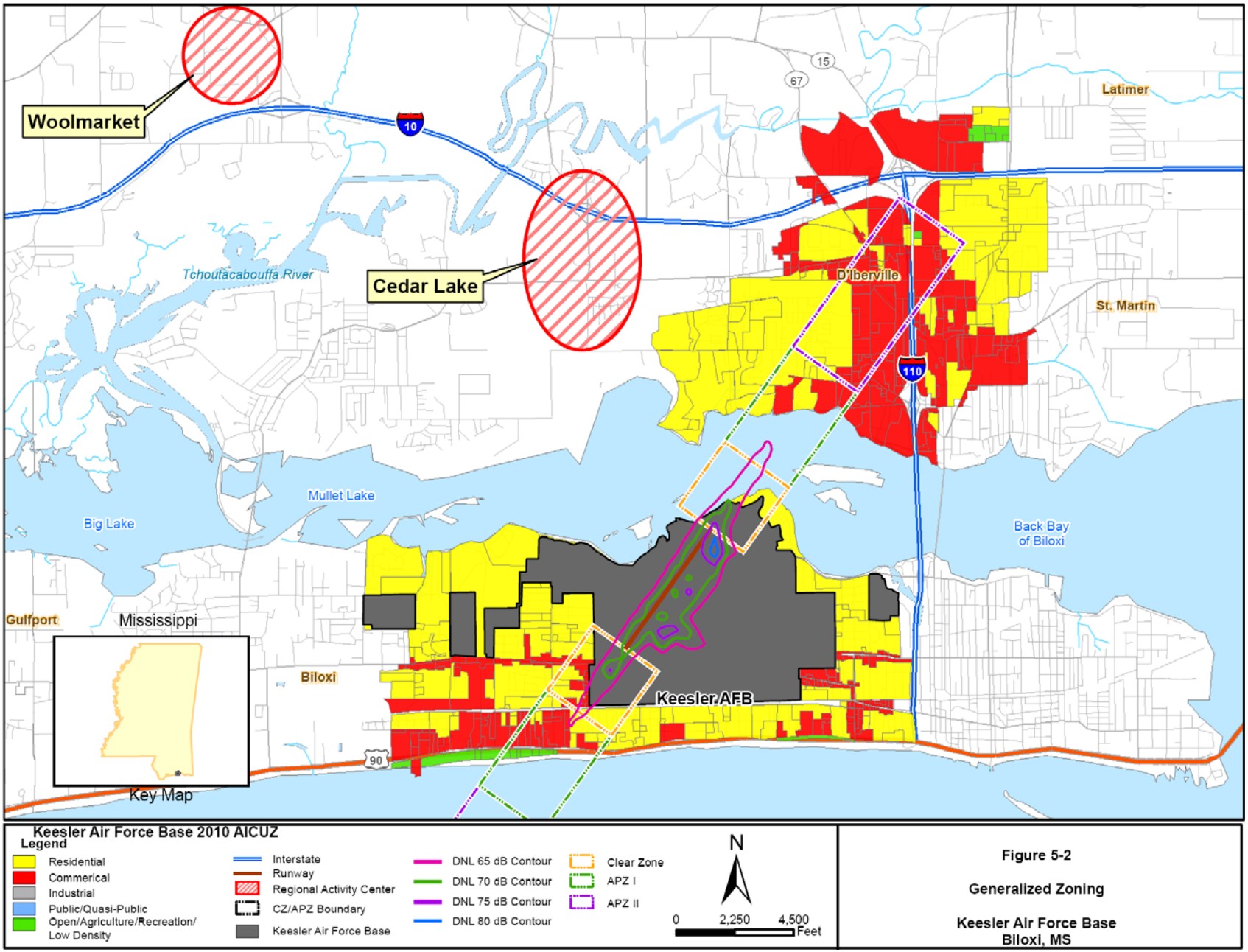


Figure 5-2

Generalized Zoning

Keesler Air Force Base
Biloxi, MS

The existing commercial areas along Beach Blvd., Pass Road, and Irish Hill Drive/Howard Ave./Porter Ave. are zoned B-2, Community Business, providing for personal business services and retail uses. The majority of the area west of Veterans Avenue and south of Pass Road to the beachfront is zoned B-3, Hospitality Business, to provide for tourist accommodations in the form of hotels, motels, and supporting uses. Several adjoining parcels within this area along Beach Blvd. are zoned WF-Waterfront to accommodate diverse uses including residential, commercial, amusement, and dockside gaming activities. The two historic districts within the area bordering Beach Blvd. have protective development regulations under an Architectural/Historic Overlay District.

The majority of the area in North Biloxi is zoned Single-Family Residential, High and Medium Density (RS-5 and RS-7.5), with several isolated areas zoned Multiple-Family Residential, Medium and High Density (MR-20, MR-25). Commercial zoning (B-4, General Business, and B-5, High Volume Business) predominates in the areas surrounding the I-10 interchanges at Cedar Lake Road and Highway 67.

The Biloxi Land Development Ordinance also contains airport navigation and noise abatement standards in the form of a Municipal Area Height/Airspace Overlay District and Airport Noise Overlay District. This is the geographic area of land adjacent to Keesler AFB as identified within or under the various airspace surfaces, and areas being subject to noise exposure of 65 dB or greater. The overlay districts contain safety provisions, recommended construction methods, and standards for noise abatement.

Existing land use in the City of D'Iberville generally reflects zoning designations. The major commercial corridors of Auto Mall Parkway, D'Iberville Blvd., Lemoyne Blvd., and Central Avenue are all zoned C-2, General Commercial. This commercial zoning designation also extends up Lamey Bridge Road towards I-10. Single-family and multiple-family housing are also permitted as a "conditional use" in the C-2 District. The four quadrants of the I-10/I-110 interchange have special Interstate-related zoning designations reflecting primarily commercial uses. These quadrants are zoned ID (Interstate District) A, B, C and D respectively. The purposes of the Interstate District are (1) to serve high traffic retail, service and light industrial type trades which serve a market population beyond the community or neighborhood level, and (2) to attract economic development and employment opportunities.

A second area in D'Iberville with a special zoning designation is the extreme southern portion of the city between Brodie Road and the Back Bay, west of I-110, and between Racetrack Road and the Back Bay east of I-110. These two areas are respectively zoned WF (Waterfront) 1 and 2. The purposes of this district include (1) the creation of an environment promoting the preservation and protection of the waterfront, and (2) accommodation of a number of diverse uses, including residential, commercial, amusement, and gaming activities. Gaming establishments, hotels, motels and condominiums are permitted as a "conditional use" upon approval buy the Planning Commission. No structure is to exceed 110 feet in height, or as otherwise required by the FAA. A master plan is required to be submitted for the granting of a permit for gaming establishments.

The majority of the residentially zoned areas are zoned R-1, Single-Family; R-2, Single Family; and R-3, General Residence. Required minimum lot sizes vary from 10,000 square feet under R-1 zoning to 4,000 square feet under R-3 zoning. Two-family and townhouse units are permitted as a "conditional use" in the R-3 District.

Table 5-3 summarizes the amounts of off-Base land by zoning category that lie within the Keesler AFB DNL 65 dB and greater noise exposure area. There are eight acres of residentially zoned land and four acres of commercially zoned land that occur within the DNL 65 dB noise level area. Figure 5-2 overlays the 2010 noise contours and CZs and APZs on a map displaying the current generalized zoning in the vicinity of Keesler AFB.

Table 5-3 Generalized Zoning Within DNL 65 dB and Greater Noise Exposure Area (Off-DoD Property Outside CZs and APZs)

Category	Acreage
Residential	8
Commercial	4
Industrial	0
Public/Quasi-public	0
Recreational/Open/Agricultural/Low Density	0
Total	**12**

Source: Solano County General Plan

Table 5-4 summarizes the amounts of off-Base land by zoning category that lie within the Keesler AFB CZ and APZs. There are 22 acres of residentially zoned land and 13 acres of commercially zoned land within the CZ; 187 of residentially zoned land and 136 acres of commercially zoned land in the APZ1; and 139 acres of residentially zoned land and 327 acres of commercially zoned land in APZII.

Table 5-4 Generalized Zoning Within the Keesler AFB Clear Zones and Accident Potential Zones (Off-DoD Property)

Category	Acreage
Residential	348
Commercial	476
Industrial	0
Public/Quasi-public	0
Recreational/Open/Agricultural/Low Density	16
Total	**840**

Source: Solano County General Plan

5.4 FUTURE LAND USE

The future land use plans for Biloxi and D'Iberville are combined into one map as shown in Figure 5-3. Both plans represent updates from pre-Katrina comprehensive land use plans, and are currently in the latter stages of preparation for subsequent adoption by the respective cities. Post-Katrina plan updates were envisioned as necessary to re-examine the community's planning and land use/development guidelines, standards and regulations in light of Katrina's destructive forces and the potential for such a natural calamity in the future.

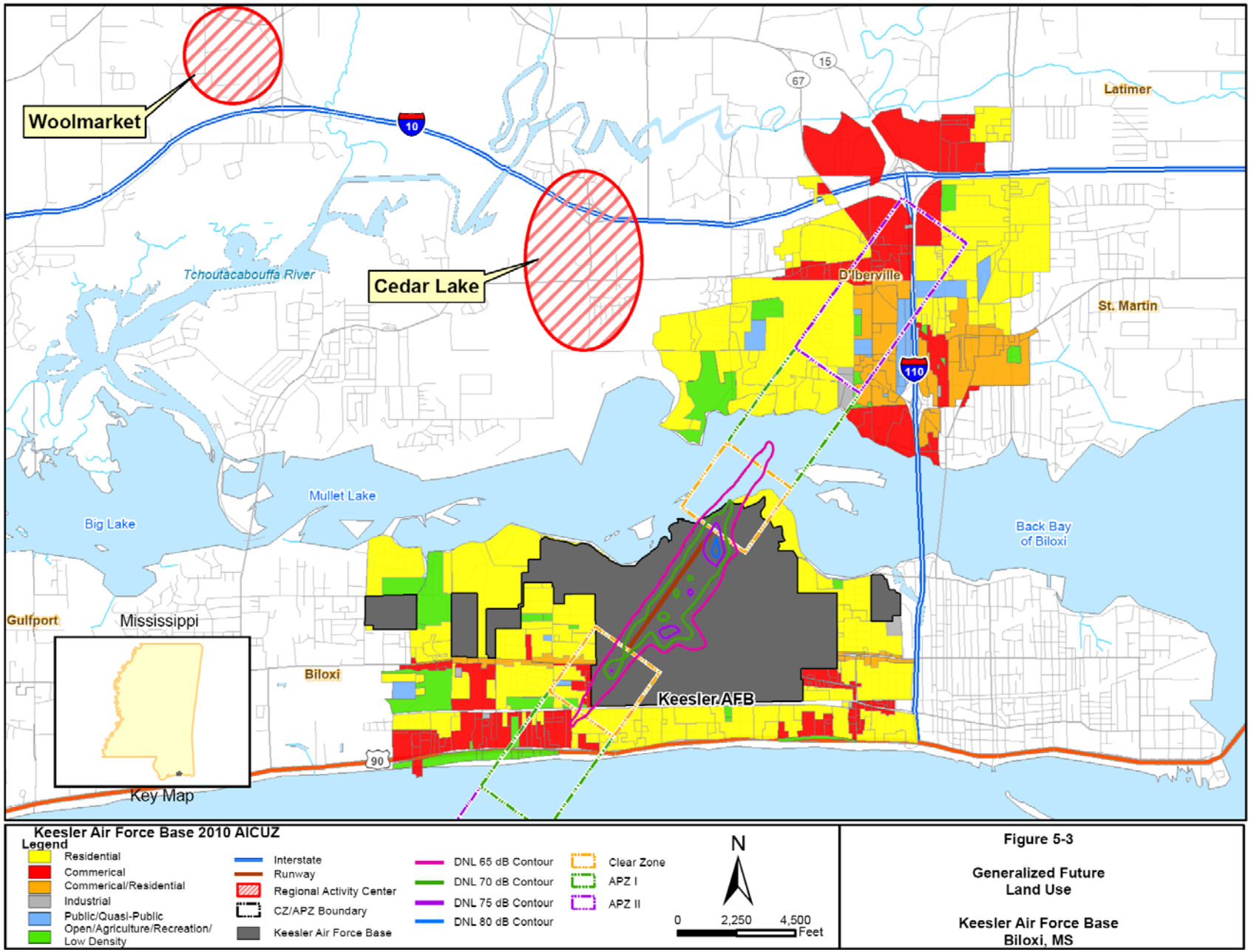


Figure 5-3

Generalized Future Land Use

Keesler Air Force Base
Biloxi, MS

The City of Biloxi's last comprehensive plan, *Vision 2020*, was adopted in 1996. The mid-1990s marked the beginning of a decade of population and economic growth in Biloxi. Considering the major changes that have occurred since 1996, most notably the impacts of Hurricane Katrina, the City of Biloxi needed a new course of action in the form of an updated comprehensive plan and other planning efforts. Major recovery has been accomplished in implementing the *Reviving the Renaissance Plan* (2006), the City's blueprint for recovery and rebuilding after Katrina. Other plans have also been prepared since 2005 to accomplish these two goals. The Future Land Use Plan (2009) for Biloxi addresses three major issues: storm vulnerability, rebuilding the peninsula, and managing growth north of the Bay of Biloxi.

The Future Land Use Plan for Biloxi generally reflects a continuation of the current land use pattern in the immediate vicinity of Keesler AFB. As indicated in Figure 5-3, the existing vacant lots in the Beach Blvd. area reflect in-fill development and redevelopment primarily as tourism and gaming oriented commercial uses, along with higher density residential uses in the form of condominiums. Residential land use to the east, south, and west of the Base reflect existing densities of medium to high density with four (4) dwelling units or more per acre.

Commercial land use designations in the Biloxi Future Land Use Plan include: (1) Neighborhood/Community Business, (2) Waterfront/Commercial Seafood District, and (3) Regional Business. Mixed Use designations include: (1) Regional Activity Center, (2) Neighborhood Center, and (3) Mixed-Use Corridor. Neighborhood/Community Business is designated for areas along Pass Road to the west of the Base, and for the existing commercial node at Judge Sekul/Howard Ave/Porter Ave. area to the east. Pass Road on the west, and Howard Ave./Porter Ave. and Division Street to the east of the Base are designated as Mixed-Use Corridors. The Mixed-Use Corridor designation applies as an overlay to major roadway corridors that support a mix of businesses, zoning designations, and land uses. Selected areas along Pass Road and Howard Avenue, in addition to Division Street to the east, are also designated as Neighborhood/Community Business Centers that provide local neighborhood level retail goods and services.

As noted in Figure 5-3, the majority of the area west of the Base between Irish Hill Road and Beach Blvd. is designated for commercial use. This area is designated as Regional Business and extends to the Biloxi/Gulfport boundary. Land uses within this category include hospitality based businesses, major commercial uses, and high-volume retail serving a local, regional, and visitor customer base. The Edgewater Shopping Mall and the Mississippi Coast Coliseum/Convention Center anchor this area.

North Biloxi is the current and future growth area of Biloxi. One of the long-range goals of the Future Land Use Plan is the planning and implementation of desired patterns of growth in this area experiencing development pressure. Availability of developable land, lower development costs, and less vulnerability to future hurricane and flooding damages are the major factors contributing to growth in this area. The City's Future Land Use Plan reflects a continuation of the current pattern of medium- and high- residential development south of I-10 and the Tchoutacabouffa River. Low-density residential development (less than four dwelling units per acre) is planned for the majority of the area north of I-10 and the Tchoutacabouffa River and focusing on the Woolmarket area. The intent of this residential density is to promote the orderly development of the Woolmarket area by maintaining low-density residential and

open space uses, focusing new development on mixed-use centers. The Woolmarket area, annexed into the City of Biloxi in 1999, is currently zoned for commercial uses, low density residential, and agriculture.

As reflected in Figure 5-3, major regional activity centers are proposed for Cedar Lake and Woolmarket in North Biloxi. The Cedar Lake Regional Activity Center, located at the interchange of I-10 and Cedar Lake Road, is currently developing with a mixture of uses, including commercial, institutional, and high-density residential. The Woolmarket Regional Activity Center is proposed at the I-10 and Highway 67 interchange, and is envisioned as a high-intensity area for commercial and residential development. Included in the plan is a potential business park and/or light industrial area to support Keesler AFB and related regional aerospace and shipbuilding industries.

The City of D'Iberville, also inflicted with extensive damages by Hurricane Katrina, has had several plans prepared since 2005 to address recovery and rebuilding efforts, and a vision for the future. In October 2005, the City was a participant in the governor's Commission on Recovery, Rebuilding, and Renewal planning charrette. Additionally, a *Citizens' Master Plan for D'Iberville* was adopted in 2006. This plan developed a vision for growth in two major regions in the City – the northern commercial area around the I-10/I-110 interchange, and the southern waterfront regional adjacent to the Back Bay.

The City of D'Iberville's Future Land Use Plan currently being prepared also focuses on the above two areas of the City. As indicated in Figure 5-3, the four quadrants at the I-10/I-110 interchange are designated as commercial/retail. The southeast and southwest quadrants currently remain undeveloped. These two quadrants are intended to provide for intensive retail and mixed-used developments. The City is currently pursuing the annexation of a 10.5 square mile area in Harrison County adjacent to the northern City Limits.

The southern waterfront area of the City contiguous to the Back Bay is designated as "Special District". This area includes the 'Old Town" section south of Racetrack Road east of I-110, and the area south of Brodie Road west of I-110. The Plan for the "Old Town" area envisions a working waterfront with a marina, casino/hotel, and mixed-use developments. The area west of I-110 is also planned for a casino/hotel and mixed-use developments. The City is currently working with potential developers of these two areas who are pursuing financing for the projects. Both of these potential projects have site approval from the Mississippi Gaming Commission.

Harrison County has updated its 1999 County Comprehensive Plan for the unincorporated areas of the County. Because Harrison County changed significantly following Hurricane Katrina, it was necessary to update the plan to reflect current conditions and community values. The majority of the land in unincorporated Harrison County in the vicinity of Biloxi and D'Iberville is planned for low-density residential development, agriculture, and open space uses. These planned uses generally reflect the existing land use pattern in this area.

5.5 INCOMPATIBLE LAND USES

Table 5-5 shows land use compatibility as it applies to generalized zoning within the APZs and noise contours DNL 65dB and greater for Keesler AFB. For a land use area to be considered compatible, it must meet both noise and accident potential criteria shown in Table 4-3. The compatibility guidelines shown in Table 4-3 were combined with the existing land use plan shown in Figure 5-1 to determine land use incompatibility associated with aircraft operations at Keesler AFB. Results of this analysis are depicted numerically in Table 5-5 and illustrated in Figure 5-4.

Table 5-5 Incompatible Land Use for Keesler AFB

Category	Acreage Within CZs and APZs			Acreage Within Noise Zones, (Not Included in CZs and APZs)				
	CZ	APZ I	APZ II	65-69	70-74	75-80	80+	Total
Residential	60	307	247	0	0	0	0	**614**
Commercial	9	7	1	0	0	0	0	**17**
Industrial	0	0	0	0	0	0	0	**0**
Public/Quasi-public	11	4	20	0	0	0	0	**35**
Recreation/Open/ Agricultural/Low Density	0	0	0	0	0	0	0	**0**
Total	**80**	**318**	**268**	**0**	**0**	**0**	**0**	**666**

**Represents compatible land use*

5.5.1 Runway 03 Clear Zones and Accident Potential Zones

5.5.1.1 Runway 03 Clear Zone and Accident Potential Zones I and II

Figure 5-4 shows incompatible land uses within the CZ and APZs of Runway 03 and Runway 21. The majority of the Runway 03 CZ is located on Keesler AFB property. However, the outer portion of the CZ extends south and west of the Base encompassing areas north and south of Pass Road, and south of Irish Hill Drive. There are a number of incompatible uses within the CZ. A portion of the Jeff Davis Elementary School on Rodeo Drive north of Pass Road is in the CZ, as are commercial land uses along Pass Road and D'Iberville Drive. Other incompatible uses include single-family residential areas north and south of Pass Road and south of Irish Hill Drive. These residential areas are developed at a density ranging from four-six units/acre. The Irish Hill Drive right-of-way, Pass Road right-of-way, other street rights-of-way in addition to the railroad right-of-way are also considered incompatible uses in a CZ. The open areas within the CZ are considered compatible uses.

5.5.1.2 Runway 03 Accident Potential Zone I

Residential development is the most extensive incompatible use in APZ1 as reflected in Figure 5-4 and Table 5-5. Residential land use consists of high density multi-family developments east and west of Rodenberg Avenue south of Irish Hill Drive, and medium-high density single-family developments primarily south of Irish Hill Drive. There are also two churches on Rodenberg Drive that represent an incompatible use in the APZ1. Other incompatible uses include the commercial development along Beach Blvd. The open areas and industrial uses are considered compatible uses within the APZ1. A number of areas currently consisting of open areas were occupied with structures prior to Hurricane Katrina.

5.5.1.3 Runway 03 Accident Potential Zone II

The APZ II extends over the Gulf of Mexico and does not encompass any land area.

5.5.2 Runway 21 Clear Zones and Accident Potential Zones

5.5.2.1 Runway 21 Clear Zone and Accident Potential Zones I and II

As reflected in Figure 5-4, the majority of the CZ is located on Keesler AFB property and over the Back Bay of Biloxi. A portion of the Kensington Park single-family subdivision adjacent to the north end of the Base is located within the CZ. There are no other incompatible uses within the CZ.

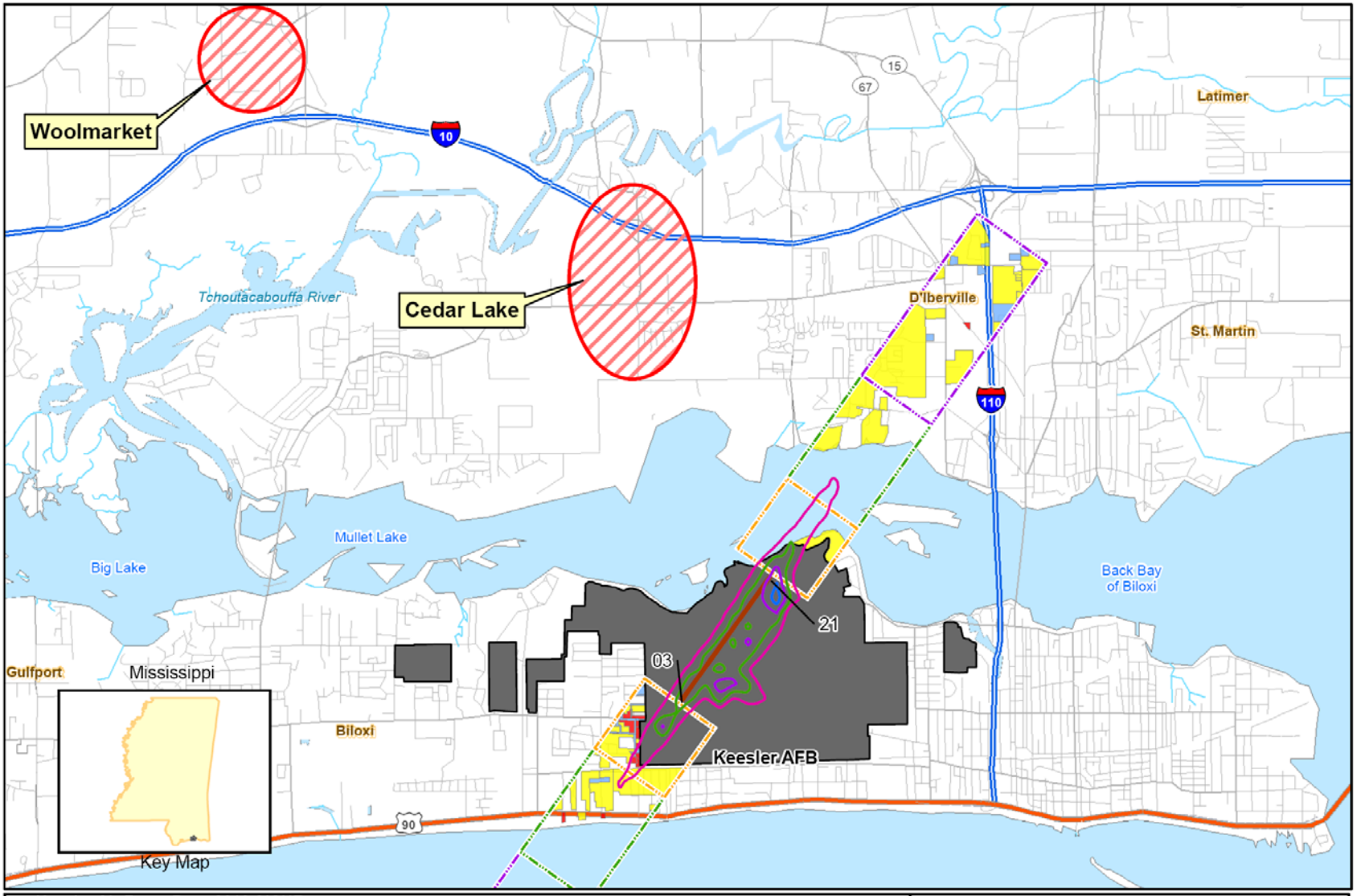
5.5.2.2 Runway 21 Accident Potential Zone I

The southern portion of the APZ is over the Back Bay of Biloxi, with the northern portion located over D'Iberville. Incompatible uses within the APZ1 include medium to medium-high density residential development south and north of Brodie Road. The residential area south of Brodie Road is of lower density than that north of Brodie Road. There are extensive areas of open, undeveloped land that is compatible use within the APZ.

5.5.2.3 Runway 21 Accident Potential Zone II

The entire APZ lies over the City of D'Iberville, primarily west of I-110. Incompatible uses within the APZ are represented primarily by residential development. Medium to medium-high density residential subdivisions west of Auto Mall Parkway are the primary incompatible uses within this zone. The Arbor View apartment complex across from city hall is a high-density incompatible use. There are two churches within the APZ, located on Suzanne Drive and Big Ridge Road respectively, that are considered incompatible. The majority of the heavily developed commercial areas on Auto Mall Parkway and D'Iberville Blvd. are considered compatible uses, with the exception of several eating establishments near the intersection of these two commercial corridors. The public use area containing the D'Iberville City Hall, post office and library are considered compatible uses because they represent generally lower-intensity uses.

Incompatible land uses within the APZ east of I-110 include D'Iberville High School on Lamey Bridge Road, a high-density multi-family development adjacent to the north of the high school, and some medium density single-family dwellings south of the high school. A church on Lamey Bridge Road also represents an incompatible use within the APZ. All industrial areas and open/undeveloped areas represent compatible uses within this zone.



Keesler Air Force Base 2010 AICUZ

Legend

- Residential
- Commerical
- Public/Quasi-Public
- Regional Activity Center
- Keesler Air Force Base
- Interstate
- Runway
- Clear Zone
- APZ I
- APZ II
- DNL 65 dB Contour
- DNL 70 dB Contour
- DNL 75 dB Contour
- DNL 80 dB Contour

N

0 2,250 4,500 Feet

Figure 5-4

Incompatible Land Use

Keesler Air Force Base Biloxi, MS

5.6 NOISE ZONES

At noise levels between DNL 65-69 dB, the only incompatible land use type is residential without noise level reduction (NLR) materials. Residential uses within the DNL 65-69 dB noise zone would be conditionally compatible upon incorporation of the appropriate amount of NLR. Based on the land use compatibility guidelines detailed in Table 4-3, residential use within the DNL 65-74 dB zone is discouraged unless there is a demonstrated community need and no viable alternate locations. Only a small off-Base area is located within the DNL 65-74 dB noise zone. This noise zone occurs near the southwest corner of the base, and includes a few single-family dwelling units south of Irish Hill Drive and a few commercial establishments on Iberville Drive. The majority of the residential areas south of Keesler AFB appear to have been built prior to the implementation of sound attenuation and energy insulation requirements. (Note: Although the residences are addressed as being exposed to DNL 65-74, they are not identified as incompatible for noise in Table 5-5. Instead, the residences are listed as incompatible because they are in the CZ and APZs. The intent of this study is to not double count incompatibility.)

5.7 PLANNING CONSIDERATIONS

AICUZ noise contours describe the noise characteristics of a specific operational environment, and as such, will change if a significant operational change is made. An AICUZ Study should be evaluated for an update if the noise exposure map changes by DNL 2 dB or more in noise sensitive areas from the noise contour map in the last publicly released AICUZ Study. Accordingly, this AICUZ Study updates the 1994 AICUZ Study and provides flight track, accident potential, clear zone, and noise zone information in this report which reflects the most accurate picture of the aircraft activities at Keesler AFB as of November 2009.

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SECTION 6
IMPLEMENTATION

6.1 INTRODUCTION

Implementation of the AICUZ Program must be a joint effort between the Base and the adjacent communities. Through this AICUZ Study, Keesler AFB seeks to assist local and state officials and the adjacent communities in protecting and promoting the public health, safety, and welfare by promoting compatible development within the studied areas and to protect its aircraft operations now and in the future from incompatible land use. Further, communities and governing officials are able to utilize the AICUZ Study to review, write, or address its comprehensive planning processes and zoning laws and regulations to promote prudent decisions and orderly development by considering the Base's military operations as an integral part of the physical and economic structure of the state and the adjacent communities.

6.2 AIR FORCE RESPONSIBILITIES

In general, the Air Force perceives its AICUZ responsibilities as encompassing the areas of flying safety, noise abatement, and participation in the land use planning process.

Well-maintained aircraft and well-trained aircrews do a great deal to assure the avoidance of aircraft accidents. Despite exceptionally trained aircrews and aircraft maintenance personnel, history shows that accidents do occur. To reduce risk to the underlying community, Keesler AFB routes flights over sparsely populated areas as regularly as possible.

To enforce noise dicipline from aircraft on surrounding areas, Air Force policy states that all AICUZ plans must be approved and periodically reviewed by commanders. These plans must include an analysis on the existing traffic patterns, instrument approaches, weather weather minimums (*e.g*., minimum descent altitudes for instrument approaches), operating practices, and any other flying related activities as they relate and affect the surrounding areas.

Preparation and production of the Keesler AICUZ Study is only one phase of the Base's attempt at being proactive in assisting the surrounding communities with the necessary information necessary to update their land use plans.

The AICUZ Program is recognized as an ongoing information gathering and sharing process, continuously being revised and updated with new information. To keep interested parties continuously informed, Keesler AFB has a specific staff in place to provide information, criteria, and guidelines to all government juristictions, as well as various other organizations, as needed. Also, Keesler AFB will ensure that regional planning departments, as well as zoning administrators, have updated copies of the AICUZ Study on hand whenever changes are implemented.

The most effective forum for land use planning when an Air Force Base is involved is through a straight forward round table discussion with all parties involved. All participants will be provided with copies of the AICUZ Study, including maps, before the meeting to

better prepare for futher discussion. It is through this process that inital issues can be addressed and resolved.

6.3 LOCAL COMMUNITY RESPONSIBILITIES

Area residents and the personnel at Keesler AFB have a long history of working together for mutual benefit. We feel adoption of the following recommendations will strengthen this relationship, increase the health and safety of the public, and help protect the integrity of the Base's flying mission:

- Continue to incorporate policies and guidelines of the AICUZ Program into the comprehensive plans of Harrison County and the Cities of Biloxi and D'Iberville. Use overlay maps of the AICUZ noise contours and Air Force Land Use Compatibility Guidelines to evaluate existing and future land use proposals.
- Modify existing zoning ordinances and subdivision regulations to support the compatible land uses outlined in this AICUZ Study and require real estate disclosure of noise impact to all prospective buyers of properties exposed to noise affecting the property.
- Modify building codes to ensure new construction within the AICUZ area has the recommended noise level reductions incorporated into its design and construction.
- Implement height and obstruction ordinances that reflect current Air Force and FAR Part 77 and UFC 3-260-01 requirements. Ensure proponents for wind generating facilities/turbines file FAA Form 7460-1, Notice of Proposed Construction, for FAA and Air Force review, as there are potential operational impacts that include reduced radar effectiveness, height obstructions, and increasing the minimum aircraft descent altitude.
- Continue supporting working groups, consisting of city, county, and Base planners, that meet, as needed, to discuss development proposals that could potentially affect airfield operations.
- Inform Keesler AFB of planning and zoning actions that have the potential to affect Base operations. Also, provide early notification to Keesler AFB of any wind generating facilities/turbine farm proposals in the vicinity of the Base as they potentially could impact Keesler AFB flying and navigational aids.

Appendix A

THE AICUZ CONCEPT, PROGRAM, METHODOLOGY, AND POLICIES

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THE AICUZ CONCEPT, PROGRAM, METHODOLOGY, AND POLICIES

A.1 Concept

Federal legislation, national sentiment, and other external forces, which directly affect the Air Force mission, serve greatly to increase the role of the Air Force in environmental and planning issues. Problems of airfield encroachment from incompatible land uses surrounding installations, as well as air and water pollution and socioeconomic impact, require continued and intensified Air Force involvement. The nature of these problems dictates direct Air Force participation in comprehensive community and land use planning. Effective, coordinated planning that bridges the gap between the federal government and the community requires establishment of good working relationships with local citizens, local planning officials, and state and federal officials. This depends on creating an atmosphere of mutual trust and helpfulness. The AICUZ concept has been developed in an effort to:

- protect local citizens from noise exposure and accident potential associated with flying activities; and
- prevent degradation of the capability of the Air Force to achieve its mission by promoting compatible land use planning.

The land use guidelines developed herein are a composite of a number of other land use compatibility studies that have been refined to fit the Keesler AFB aviation environment.

A.2 Program

Installation commanders establish and maintain active programs to promote the maximum feasible land use compatibility between air installations and neighboring communities. The program requires that all appropriate government bodies and citizens be fully informed whenever AICUZ or other planning matters affecting the installation are under consideration. This includes positive and continuous programs designed to:

- provide information, criteria, and guidelines to federal, state, regional, and local planning bodies, civic associations, and similar groups;
- inform such groups of the requirements of the flying activity, noise exposure, aircraft accident potential, and AICUZ plans;
- describe the noise reduction measures that are being used; and
- ensure that all reasonable, economical, and practical measures are taken to reduce or control the impact of noise-producing activities. These measures include such considerations as proper location of engine test facilities, provision of sound suppressors where necessary, and adjustment of flight patterns and/or techniques to minimize the noise impact on populated areas. This must be done without jeopardizing safety or operational effectiveness.

A.3 Methodology

The AICUZ consists of land areas upon which certain land uses may obstruct the airspace or otherwise be hazardous to aircraft operations, and land areas that are exposed to the health, safety, or welfare hazards of aircraft operations. The AICUZ includes:

- Accident Potential Zones (APZ) and Clear Zones (CZ) based on past Air Force aircraft accidents and installation operational data (see Appendix B);
- Noise zones (NZ) produced by the computerized DNL modeling of the noise created by aircraft flight and maintenance operations (see Appendix C); and
- The area designated by the FAA and the Air Force for purposes of height limitations in the approach and departure zones of the Base (see Section 4 of the Study).

The APZ, CZ, and NZ are the basic building blocks for land use planning with AICUZ data. Compatible land uses are specified for these zones (see Table 4-3), and recommendations on building materials and standards to reduce interior noise levels inside structures are provided in Appendix C.4.

As part of the AICUZ Program, the only real property acquisition for which the Air Force has requested and received Congressional authorization, and for which the installation and major commands request appropriation, are the areas designated as the CZ. Keesler AFB does not own all property in the CZs located at the ends of Runway 03/21. Compatible land use controls for the remaining airfield area of influence should be accomplished through the community land use planning processes.

A.4 AICUZ Land Use Development Policies

The basis for any effective land use control system is the development of, and subsequent adherence to, policies, which serve as the standard by which all land use planning and control actions are evaluated. Keesler AFB recommends the following policies be considered for incorporation into the comprehensive plans of agencies in the vicinity of the Base's area of influence:

A.4.1 Policy 1

To promote the public health, safety, peace, comfort, convenience, and general welfare of the inhabitants in the airfield area of influence, it is necessary to:

- guide, control, and regulate future growth and development;
- promote orderly and appropriate use of land;
- protect the character and stability of existing land uses;
- prevent destruction or impairment of the airfield and the public investment therein;
- enhance the quality of living in the areas affected; and
- protect the general economic welfare by restricting incompatible land use.

A.4.2 Policy 2

In furtherance of Policy 1, it is appropriate to:

- establish guidelines of land use compatibility;
- restrict or prohibit incompatible land use;
- prevent establishment of any land use which would unreasonably endanger aircraft operations and the continued use of the airfield;
- incorporate the AICUZ concept into community land use plans, modifying them when necessary; and
- adopt appropriate ordinances to implement airfield area of influence land use plans.

A.4.3 Policy 3

Within the boundaries of the CZ, certain land uses are inherently incompatible. The following land uses are not in the public interest and must be restricted or prohibited:

- uses that release into the air any substance, such as steam, dust, or smoke which would impair visibility or otherwise interfere with the operation of aircraft;
- uses that produce light emissions, either direct or indirect (reflective), which would interfere with pilot vision;
- uses that produce electrical emissions which would interfere with aircraft communication systems or navigation equipment;
- uses that attract birds or waterfowl, such as operation of sanitary landfills, maintenance or feeding stations, or growth of certain vegetation; and
- uses that provide for structures within 10 feet of aircraft approach-departure and/or transitional surfaces.

A.4.4 Policy 4

Certain noise levels of varying duration and frequency create hazards to both physical and mental health. A limited, though definite, danger to life exists in certain areas adjacent to airfields. Where these conditions are sufficiently severe, it is not consistent with public health, safety, and welfare to allow the following land uses:

- residential;
- retail business;
- office buildings;
- public buildings (schools, churches, etc.); and
- recreation buildings and structures.

A.4.5 Policy 5

Land areas below takeoff and final approach flight paths are exposed to significant danger of aircraft accidents. The density of development and intensity of use must be limited in such areas.

A.4.6 Policy 6

Different land uses have different sensitivities to noise. Standards of land use acceptability should be adopted, based on these noise sensitivities. In addition, a system of Noise Level Reduction guidelines (Appendix C) for new construction should be implemented to permit certain uses where they would otherwise be prohibited.

A.4.7 Policy 7

Land use planning and zoning in the airfield area of influence cannot be based solely on aircraft-generated effects. Allocation of land used within the AICUZ should be further refined by consideration of:

- physiographic factors;
- climate and hydrology;
- vegetation;
- surface geology;
- soil characteristics;
- intrinsic land use capabilities and constraints;
- existing land use;
- land ownership patterns and values;
- economic and social demands;
- cost and availability of public utilities, transportation, and community facilities; and
- other noise sources.

A.5 Basic Land Use Compatibility

Research on aircraft accident potential, noise, and land use compatibility is ongoing at a number of federal and other agencies. These and all other compatibility guidelines must not be considered inflexible standards. They are the framework within which land use compatibility questions can be addressed and resolved. In each case, full consideration must be given to local conditions such as:

- previous community experience with aircraft accidents and noise;
- local building construction and development practices;
- existing noise environment due to other urban or transportation noise sources;
- time periods of aircraft operations and land use activities;
- specific site analysis; and
- noise buffers, including topography.

These basic guidelines cannot resolve all land use compatibility questions, but they do offer a reasonable framework within which to work.

A.6 Accident Potential

Each end of Runway 03/21 at Keesler AFB has a 3,000 foot by 3,000 foot CZ and two APZs (see Section 5). Accident potential on or adjacent to the runway or within the CZ is so high that the necessary land use restrictions would prohibit reasonable economic use of land. As stated previously, it is Air Force policy to request Congress to authorize and appropriate funds for the necessary real property interests in this area to prevent incompatible land uses.

Accident Potential Zone I is less critical than the CZ, but still possesses a significant risk factor. This 3,000 foot by 5,000 foot area has land use compatibility guidelines, which are sufficiently flexible to allow reasonable economic use of the land, such as industrial/manufacturing, transportation, communication/utilities, wholesale trade, open space, recreation, and agriculture. However, uses that concentrate people are not acceptable.

Accident Potential Zone II is less critical than APZ I, but still possesses potential for accidents. Accident potential zone II, also 3,000 feet wide, is 7,000 feet long extending to 15,000 feet from the runway threshold. Acceptable uses include those of APZ I, as well as low density single family residential and those personal and business services and commercial/retail trade uses of low intensity or scale of operation. High density functions such as multistory buildings, places of assembly (theaters, churches, schools, restaurants, *etc*.), and high density office uses are not considered appropriate.

High-density populations should be limited to the maximum extent possible. The optimum density recommended for residential usage (where it does not conflict with noise criteria) in APZ II is one to two dwelling units per acre, possibly increased under a Planned Unit Development (PUD) where maximum lot coverage is less than 20 percent (see Table 4-3, Land Use Compatibility Guidelines), buildings should be limited to one story, and the lot coverage should not exceed 20 percent.

Land use guidelines (see Subsection 4.6.3.2) for Air Force Class B runway CZs and APZs are based on a hazard index system that compares the relationship of accident occurrence for five areas:

- on or adjacent to the runway;
- within the CZ;
- in APZ I;
- in APZ II; and
- in all other areas within a 10 nautical mile radius of the runway.

Accident potential on or adjacent to the runway or within the CZ is so high that few uses are acceptable. The risk outside APZ I and APZ II, but within the 10 nautical mile radius area, is significant, but is acceptable if sound engineering and planning practices are followed.

Land use guidelines for APZs I and II have been developed. The main objective has been to restrict all people-intensive uses because there is greater risk in these areas. The basic guidelines aim at prevention of uses that:

- have high residential density characteristics;
- have high labor intensity;
- involve above-ground explosives, fire, toxic, corrosive, or other hazardous characteristics;
- promote population concentrations;
- involve utilities and services required for area-wide population, where disruption would have an adverse impact (telephone, gas, etc.);
- concentrate people who are unable to respond to emergency situations, such as children, elderly, handicapped, etc.; and
- pose hazards to aircraft operations.

There is no question that these guidelines are relative. Ideally, there should be no people-intensive uses in any APZ. The free market and private property systems prevent this where there is a demand for land development. To go beyond these guidelines, however, substantially increases risk by placing more people in areas where there may ultimately be an aircraft accident.

A.7 Noise

Nearly all studies analyzing aircraft noise and residential compatibility recommend no residential uses in noise zones above DNL 75 dB. Usually, no restrictions are recommended below noise zone DNL 65 dB. There is currently no consensus between DNL 65-74 dB. These areas may not qualify for federal mortgage insurance in residential categories according to United States Department of Housing and Urban Development (HUD) Regulation 24 CFR 51B. In many cases, HUD approval requires noise attenuation measures, the Regional Administrator's concurrence, and an Environmental Impact Statement. The United States Department of Veterans Affairs also has airfield noise and accident restrictions, which apply to its home loan guarantee program. Whenever possible, residential land use should be located below DNL 65 dB according to Air Force land use recommendations. Residential buildings within the DNL 65-70 dB noise contours should contain noise level reduction in accordance with the Air Force land use compatibility guidelines in the AICUZ Study, Table 4-3.

Most industrial/manufacturing uses are compatible in the airfield area of influence. Exceptions are uses such as research or scientific activities that require lower noise levels. Noise attenuation measures are recommended for portions of buildings devoted to office use, receiving the public, or where the normal background noise level is low.

The transportation, communications, and utilities categories have a high noise level compatibility because they generally are not people-intensive. When people use land for these purposes, the use is generally very short in duration. Where buildings are required for these uses, additional evaluation is warranted.

The commercial/retail trade and personal and business services categories are compatible without restriction up to DNL 70 dB; however, they are generally incompatible above DNL

80 dB. Between DNLs 70-79 dB, noise level reduction measures should be included in the design and construction of buildings.

The nature of most uses in the public and quasi-public services category requires a quieter environment, and attempts should be made to locate these uses below DNL 65 dB (an Air Force land use recommendation), or else provide adequate noise level reduction.

Although recreational use has often been recommended as compatible with high noise levels, recent research has resulted in a more conservative view. Above DNL 75 dB, noise becomes a factor that limits the ability to enjoy such uses. Where the requirement to hear is a function of the use (*e.g.*, music shell, etc.), compatibility is limited. Buildings associated with golf courses and similar uses should be noise attenuated.

With the exception of forestry activities and livestock farming, uses in the resources production, extraction, and open space category are compatible almost without restrictions.

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Appendix B

CLEAR ZONES AND ACCIDENT POTENTIAL ZONES

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CLEAR ZONES AND ACCIDENT POTENTIAL ZONES

B.1 Guidelines For Accident Potential

Areas around airports are exposed to the possibility of aircraft accidents even with well-maintained aircraft and highly trained aircrews. Despite stringent maintenance requirements and countless hours of training, history makes it clear that accidents do happen.

When the AICUZ Program began, there were no current comprehensive studies on accident potential. To support the program, the Air Force completed a study of Air Force aircraft accidents that occurred between 1968 and 1972 within 10 nautical miles of airfields. The study of 369 accidents revealed that 75 percent of aircraft accidents occurred on or adjacent to the runway (1,000 feet to each side of the runway centerline) and in a corridor 3,000 feet (1,500 feet either side of the runway centerline) wide, extending from the runway threshold along the extended runway centerline for a distance of 15,000 feet. The Air Force updated these studies and this information is presented later in this section.

The runway CZ, APZ I, and APZ II were established based on crash patterns. The CZ starts at the end of the runway and extends outward 3,000 feet. It has the highest accident potential of the three zones. The Air Force adopted a policy of acquiring property rights to areas designated as CZs because of the high accident potential. APZ I extends from the CZ an additional 5,000 feet. It includes an area of reduced accident potential. APZ II extends from APZ I an additional 7,000 feet in an area of further reduced accident potential.

Research in accident potential conducted by the Air Force was the first significant effort in this subject area since 1952 when the President's Airport Commission published "The Airport and Its Neighbors," better known as the "Doolittle Report." The recommendations of this earlier report were influential in the formulation of the APZ concept.

The risk to people on the ground being killed or injured by aircraft accidents is small. However, an aircraft accident is a high consequence event, and when a crash does occur, the result is often catastrophic. Because of this, the Air Force does not attempt to base its safety standards on accident probabilities. Instead, the Air Force approaches this safety issue from a land use planning perspective.

B.2 Guidelines For Accident Potential

Military aircraft accidents differ from commercial air carrier and general aviation accidents because of the variety of aircraft used, the type of missions, and the number of training flights. In 1973, the Air Force performed a service-wide aircraft accident hazard study to identify land near airfields with significant accident potential. Accidents studied occurred within 10 nautical miles of airfields.

The study reviewed 369 major Air Force accidents during 1968-1972, and found that 61 percent of those accidents were related to landing operations, and 39 percent were takeoff related. It also found that 70 percent occurred in daylight, and that fighter and training aircraft accounted for 80 percent of the accidents.

Because the purpose of the study was to identify accident hazards, the study plotted each of the 369 accidents in relation to the airfield. This plotting found that the accidents clustered

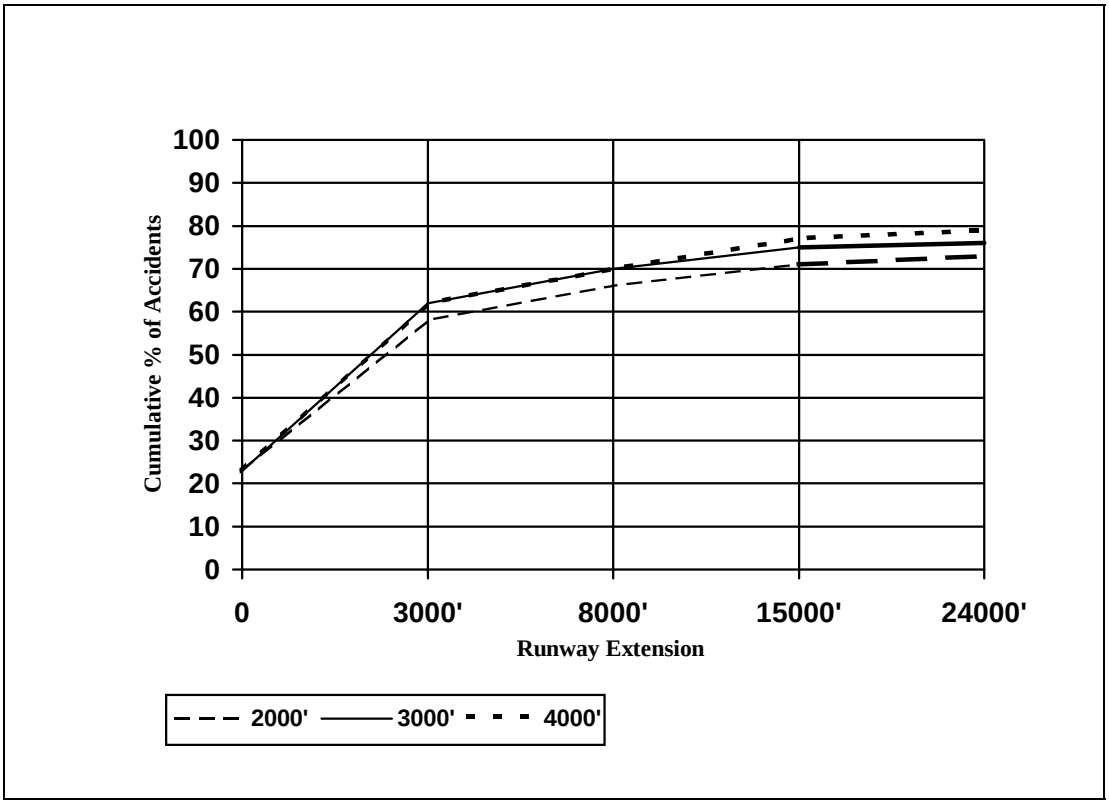
along the runway and its extended centerline. To further refine this clustering, a tabulation was prepared that described the cumulative frequency of accidents as a function of distance from the runway centerline along the extended centerline. This analysis was done for widths of 2,000, 3,000, and 4,000 total feet. Table B-1 reflects the location analysis.

Table B-1 Location Analysis

	Width of Runway Extension (feet)		
Length From Both Ends of Runway (feet)	**2000**	**3000**	**4000**
Percent of Accidents			
On or Adjacent to Runway (1,000 feet to each side of runway centerline)	23	23	23
0 to 3,000	35	39	39
3,000 to 8,000	8	8	8
8,000 to 15,000	5	5	7
Cumulative Percent of Accidents			
On or Adjacent to Runway (1,000 feet to each side of runway centerline)	23	23	23
0 to 3,000	58	62	62
3,000 to 8,000	66	70	70
8,000 to 15,000	71	75	77

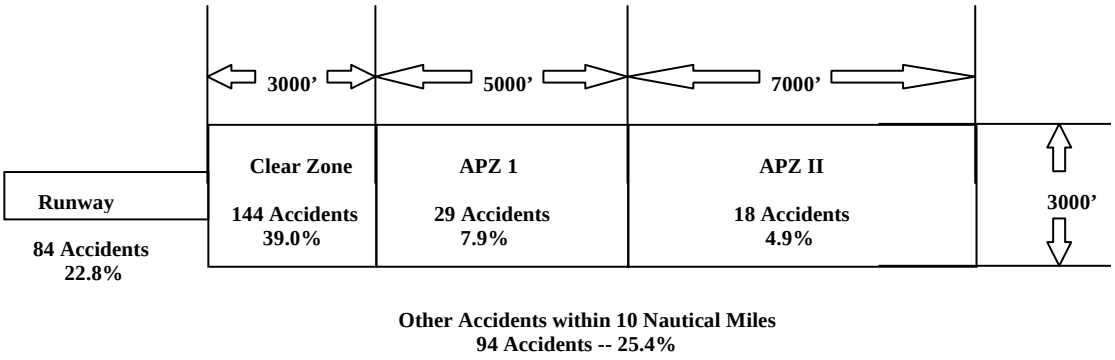
Figure B-1 indicates that the cumulative number of accidents rises rapidly from the end of the runway to 3,000 feet, rises more gradually to 8,000 feet, then continues at about the same rate of increase to 15,000 feet, where it levels off rapidly. The location analysis also indicates 3,000 feet as the optimum runway extension width and the width that includes the maximum percentage of accidents in the smallest area.

Figure B-1 Distribution of Air Force Aircraft Accidents (369 Accidents - 1968 - 1972)



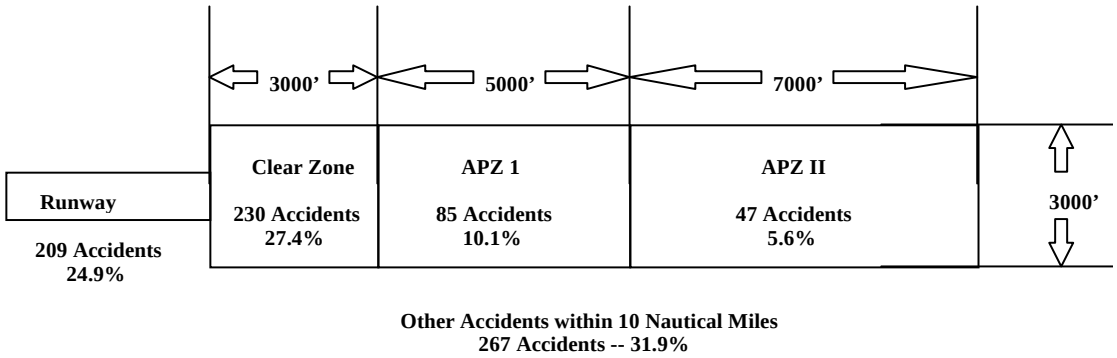
Using the optimum runway extension width, 3,000 feet, and the cumulative distribution of accidents from the end of the runway, zones were established that minimized the land area included and maximized the percentage of accidents included. The zone dimensions and accident statistics for the 1968-1972 study are shown in Figure B-2.

Figure B-2 Air Force Aircraft Accident Data (369 Accidents - 1968 - 1972)



The original study was updated to include accidents through September 1995. This updated study includes 838 accidents during the 1968-1995 period. Using the optimum runway extension width of 3,000 feet, the accident statistics of the updated study are shown in Figure B-3.

Figure B-3 Air Force Aircraft Accident Data (838 Accidents - 1968 - 1995)



Using the designated zones and accident data, it is possible to calculate a ratio of percentage of accidents to percentage of area size. These ratios indicate the CZ, with the smallest area size and the highest number of accidents, has the highest ratio, followed by the runway and adjacent area, APZ I, and then APZ II. Table B-2 reflects this data.

Table B-2 Accident to Area Ratio

Ratio of Percentage of Accidents to Percentage of Area (Air Force Accident Data 1968 - 1995)						
	Area[1] (Acres)	Number[2] Accident	Accident Per Acre	Percent of Total Area	Percent of Total Accidents	Ratio:[3] % Accidents to % Area
Runway Area	487	209	1 Per 2.3 acres	0.183	24.9	136
Clear Zone	413	230	1 Per 1.8 acres	0.155	27.4	177
APZ I	689	85	1 Per 8.1 acres	0.258	10.1	39
APZ II	964	47	1 Per 20.5 acres	0.362	5.6	16
Other Area	264,053	267	1 Per 989 acres	99.042	31.9	0.3

1 *Area includes land within 10 nautical miles of runway.*

2 *Total number of accidents is 838 (through 1995).*

3 *Percent total accidents divided by percent total area.*

Additional accident data for 1986 through July 1995 has been analyzed. Specific location data for some of the 1986-1995 accidents was not available and these were not included in the analysis. Table B-3 compares the 1968-1985 data with the data through July 1995:

Table B-3 Additional Accident Data

	1968-1985		1968-1995	
ZONE	Accidents	% of Total	Accidents	% of Total
On-Runway	197	27.1	209	24.9
Clear Zone	210	28.8	230	27.4
APZ I	57	7.8	85	10.1
APZ II	36	5.0	47	5.7
Other (Within 10 nautical miles)	228	31.3	267	31.9
Total	728	100.0	838	100.0

Analysis has shown that the cumulative changes evident in accident location through July 1995 reconfirm the dimensions of the CZs and APZs.

B.3 Definable Debris Impact Areas

The Air Force also determined which accidents had definable debris impact areas, and in what phase of flight the accident occurred. Overall, 75 percent of the accidents had definable debris impact areas, although they varied in size by type of accident. The Air Force used weighted averages of impact areas, for accidents occurring only in the approach and departure phase, to determine the following average impact areas:

Average Impact Areas for Approach and Departure Accidents

Overall Average Impact Area	5.06 acres
Fighter, Trainer, and Misc. Aircraft	2.73 acres
Heavy Bomber and Tanker Aircraft	8.73 acres

B.4 Findings

Designation of safety zones around the airfield and restriction of incompatible land uses can reduce the public's exposure to safety hazards.

Air Force accident studies have found that aircraft accidents near Air Force installations occurred in the following patterns:

- 61% were related to landing operations.
- 39% were related to takeoff operations.
- 70% occurred in daylight.
- 80% were related to fighter and training aircraft operations.

- 25% occurred on the runway or within an area extending 1,000 feet out from each side of the runway.
- 27% occurred in an area extending from the end of the runway to 3,000 feet along the extended centerline and 3,000 feet wide, centered on the extended centerline.
- 15% occurred in an area between 3,000 and 15,000 feet along the extended runway centerline and 3,000 feet wide, centered on the extended centerline.

Air Force aircraft accident statistics found 75% of aircraft accidents resulted in definable impact areas. The size of the impact areas were:

- 5.06 acres overall average.
- 2.73 acres for fighters and trainers.
- 8.73 acres for heavy bombers and tankers.

Appendix C

NOISE AND NOISE LEVEL REDUCTION GUIDELINES

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NOISE AND NOISE LEVEL REDUCTION GUIDELINES

C.1 General

Noise, often defined as unwanted sound, is one of the most common environmental issues associated with aircraft operations. Of course, aircraft are not the only sources of noise in an urban or suburban surrounding, where noise from interstate and local roadway traffic, rail, industrial, and neighborhood sources also intrude on the everyday quality of life. Nevertheless, aircraft are readily identifiable to those affected by their noise and are typically singled out for special attention and criticism. Consequently, aircraft noise problems often dominate analyses of environmental impacts.

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium such as air, and are sensed by the human ear. Whether that sound is interpreted as pleasant (*e.g.*, music) or unpleasant (*e.g.*, aircraft noise) depends largely on the listener's current activity, past experience, and attitude toward the source of that sound. It is often true that one person's music is another person's noise.

The measurement and human perception of sound involves two basic physical characteristics - intensity and frequency. Intensity is a measure of the acoustic energy of the sound vibrations and is expressed in terms of sound pressure. The higher the sound pressure, the more energy carried by the sound and the louder the perception of that sound. The second important physical characteristic is sound frequency, that is, the number of times per second the air vibrates or oscillates. Low-frequency sounds are characterized as rumbles or roars, while high-frequency sounds are typified by sirens or screeches.

The loudest sounds, which can be detected comfortably by the human ear, have intensities that are a trillion times larger than those of sounds that can be detected at the lower end of the spectrum. Because of this vast range, any attempt to represent the intensity of sound using a linear scale becomes very unwieldy. As a result, a logarithmic unit known as the decibel (dB) is used to represent the intensity of a sound. Such a representation is called a sound level.

A sound level of 0 dB is approximately the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level of approximately 60 dB. Sound levels above 120 dB begin to be felt inside the human ear as discomfort and eventually pain at still higher levels.

Because of the logarithmic nature of the decibel unit, sound levels cannot be added or subtracted directly and are somewhat cumbersome to handle mathematically. However, some simple rules are useful in dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. Thus, for example:

$$60 \text{ dB} + 60 \text{ dB} = 63 \text{ dB, and}$$

$$80 \text{ dB} + 80 \text{ dB} = 83 \text{ dB.}$$

The total sound level produced by two sounds of different levels is usually only slightly more than the higher of the two. For example:

60.0 dB + 70.0 dB = 70.4 dB.

Because the addition of sound levels behaves differently than that of ordinary numbers, such an addition is often referred to as "decibel addition" or "energy addition." The latter term arises from the fact that what is really happening when decibel values are added is each decibel value is first converted to its corresponding acoustic energy, then the energies are added using the normal rules of addition, and finally the total energy is converted to its decibel equivalent.

An important facet of decibel addition arises later when the concept of time-average sound levels is introduced to explain Day-Night Average A-Weighted Sound Level (DNL). Because of the logarithmic units, the louder levels that occur during the averaging period dominate the time-average sound levels. As a simple example, consider a sound level that is 100 dB and lasts for 30 seconds, followed by a sound level of 50 dB which also lasts for 30 seconds. The time-average sound level over the total 60-second period is 97 dB, not 75 dB.

Sound frequency is measured in terms of cycles per second (cps), or hertz (Hz), which is the preferred scientific unit for cps. The normal human ear can detect sounds that range in frequency from about 20 Hz to about 15,000 Hz. All sounds in this wide range of frequencies, however, are not heard equally well by the human ear, which is most sensitive to frequencies in the 1000 to 4000 Hz range. In measuring community noise, this frequency dependence is taken into account by adjusting the sound levels of the very high and low frequencies to approximate the human ear's lower sensitivity to those frequencies. This is called "A-weighting" and is commonly used in measurements of community environmental noise.

Sound levels measured using A-weighting are most properly called A-weighted sound levels while sound levels measured without any frequency weighting are most properly called sound levels. However, since most environmental impact analysis documents deal only with A-weighted sound levels, the adjective "A-weighted" is often omitted, and A-weighted sound levels are referred to simply as sound levels. In some instances it will be indicated that the sound levels have been A-weighted by using the abbreviation dBA or dB(A), rather than the abbreviation dB, for decibel. As long as the use of A-weighting is understood to be used, there is no difference implied by the terms "sound level" and "A-weighted sound level" or by the units dB, dBA, and dB(A).

In this document and most AICUZ documents, all sound levels are A-weighted sound levels and the adjective "A-weighted" has been omitted and dB is used for the decibel units.

Sound levels do not represent instantaneous measurements but rather averages over short periods of time. Two measurement time periods are most commonly used - one second and one-eighth of a second. Most environmental noise studies use slow response measurements, and the adjective "slow response" is usually omitted. It is easy to understand why the proper descriptor "slow response A-weighted sound level" is usually shortened to "sound level" in environmental impact analysis documents.

C.2 Noise Metrics

A "metric" is defined as something "of, involving, or used in measurement." In environmental noise analyses, a metric refers to the unit or quantity that quantitatively measures the effect of noise on the environment. Noise studies have typically involved a confusing proliferation of noise metrics as individual researchers have attempted to understand and represent the effects of noise. As a result, past literature describing environmental noise abatement has included many different metrics.

Various federal agencies involved in environmental noise mitigation agree on common metrics for environmental impact analysis documents, and both the Department of Defense (DoD) and the FAA specified those that should be used for federal aviation noise assessments. These metrics are as follows.

C.2.1 Maximum Sound Level

The highest A-weighted sound level measured during a single event in which the sound level changes value as time goes on (*e.g.*, an aircraft overflight) is called the maximum A-weighted sound level or maximum sound level, for short. It is usually abbreviated by ALM, $L_{max,}$ or L_{Amax}.

C.2.2 Sound Exposure Level

Individual time-varying noise events have two main characteristics - a sound level which changes throughout the event and a period of time during which the event is heard. Although the maximum sound level, described above, provides some measure of the intrusiveness of the event, it alone does not completely describe the total event. The period of time during which the sound is heard is also significant. The Sound Exposure Level (abbreviated SEL or L_{AE}) combines both of these characteristics into a single metric.

Sound Exposure Level is a logarithmic measure of the total acoustic energy transmitted to the listener during the event. Mathematically, it represents the sound level of the constant sound that would, in one second, generate the same acoustic energy as did the actual time-varying noise event. Since aircraft overflights usually last longer than 1 second, the SEL of an overflight is usually greater than the ALM of the overflight.

Note that sound exposure level is a composite metric that represents both the intensity of a sound level of the constant sound and its duration. It does not directly represent the sound level heard at any given time, but rather provides a measure of the net impact of the entire acoustic event. It has been well established in the scientific community that SEL measures this impact much more reliably than just the ALM.

Because the SEL and the ALM are both A-weighted sound levels expressed in decibels, there is sometimes confusion between the two, so the specific metric used should be clearly stated.

C.2.3 Day-Night Average Sound Level

Time-average sound levels are measurements of sound levels that are averaged over a specified length of time. These levels provide a measure of the average sound energy during the measurement period.

For the evaluation of community noise effects, and particularly aircraft noise effects, the DNL (mathematically represented as L_{dn}) is used. DNL averages aircraft sound levels at a location over a complete 24-hour period, with a 10-dB adjustment added to those noise events which take place between 10:00 p.m. and 7 a.m. (local time). This 10-dB "penalty" represents the added intrusiveness of sounds that occur during normal sleeping hours, both because of the increased sensitivity to noise during those hours and because ambient sound levels during nighttime are typically about 10 dB lower than during daytime hours.

Ignoring the 10-dB nighttime adjustment for the moment, DNL may be thought of as the continuous DNL occurring over a 24-hour period smoothed out to contain the same total sound energy.

DNL provides a single measure of overall noise impact, but does not provide specific information on the number of noise events or the individual sound levels that occur during the day. For example, a DNL of 65 dB could result from a very few noisy events, or a large number of quieter events.

As noted earlier for SEL, DNL does not represent the sound level heard at any particular time. Scientific studies and social surveys that have been conducted to evaluate community annoyance to all types of environmental noise have found the DNL to be the best measure to predict annoyance. Its use is endorsed by the scientific community (See References C.1 through C.5 at the end of this section).

There is, in fact, a remarkable consistency in the results of attitudinal surveys about aircraft noise conducted in different countries to find the percentages of groups of people who express various degrees of annoyance when exposed to different levels of DNL.

Reference C.6 was published in 1978. A more recent study has reaffirmed this relationship (Reference C.7). In general, correlation coefficients of 0.85 to 0.95 are found between the percentages of groups of people highly annoyed and the level of average noise exposure. The correlation coefficients for the annoyance of individuals are relatively low, however, on the order of 0.5 or less. This is not surprising, considering the varying personal factors that influence the manner in which individuals react to noise. Nevertheless, findings substantiate that community annoyance to aircraft noise can be predicted quite reliably using DNL.

This relation between community annoyance and DNL has been confirmed, even for infrequent aircraft noise events. Reference C.8 reported the reactions of individuals in a community to daily helicopter overflights correlated quite well with the daily time-average sound levels over this range of numbers of daily noise events.

The use of DNL has been criticized as not accurately representing community annoyance and land use compatibility with aircraft noise. Much of that criticism stems from a lack of understanding of the basis for the measurement or calculation of L_{dn}. One frequent criticism is based on the principle that people inherently react more to single noise events and not as much to "meaningless" time-average sound levels.

In fact, a time-average noise metric, such as DNL, takes into account both the noise levels of all individual events which occur during a 24-hour period and the number of times those events occur. As described briefly above, the logarithmic nature of the decibel unit causes the noise levels of the loudest events to control the 24-hour average.

As a simple example of this characteristic, consider a case in which only one aircraft overflight occurs in daytime during a 24-hour period, creating a sound level of 100 dB for 30 seconds. During the remaining 23 hours, 59 minutes, and 30 seconds of the day, the ambient sound level is 50 dB. The DNL for this 24-hour period is 65.5 dB. Assume, as a second example, that ten such 30-second overflights occur in daytime hours during the next 24-hour period, with the same ambient sound level of 50 dB during the remaining 23 hours and 55 minutes of the day. The DNL for this 24-hour period is 75.4 dB. Clearly, the averaging of noise over a 24-hour period does not ignore the louder single events and tends to emphasize both the sound levels and number of those events. This is the basic concept of a time-average sound metric, and specifically the DNL.

C.3 Noise Effects

C.3.1 Hearing Loss

Noise-induced hearing loss is probably the best-defined of the potential effects of human exposure to excessive noise. Federal workplace standards for protection from hearing loss allow a time-average level of 90 dB over an 8-hour work period, or 85 dB averaged over a 16-hour period. An outdoor DNL of 75 dBA is considered the threshold above which the risk of hearing loss should be evaluated. Following guidelines recommended by the Committee on Hearing, Bioacoustics, and Biomechanics of the National Research Council, the average change in the threshold of hearing for people exposed to DNL equal to or greater than 75 dBA was evaluated. Results indicated that an average of 1 dBA hearing loss could be expected for people exposed to DNL equal to or greater than 75 dBA. For the most sensitive 10 percent of the exposed population, the maximum anticipated hearing loss would be 4 dBA. These hearing loss projections must be considered conservative as the calculations are based on an average daily outdoor exposure of 16 hours (7:00 a.m. to 10:00 p.m.) over a 40-year period. Since it is unlikely that airport neighbors will remain outside their homes 16 hours per day for extended periods of time, there is little possibility of hearing loss below a DNL of 75 dB, and this level is extremely conservative.

C.3.2 Nonauditory Health Effects

Nonauditory health effects of long-term noise exposure, where noise may act as a risk factor, have never been found to occur at levels below those protective against noise-induced hearing loss, described above. Most studies attempting to clarify such health effects have found that noise exposure levels established for hearing protection will also protect against any potential nonauditory health effects, at least in workplace conditions. The best scientific summary of these findings is contained in the lead paper at the National Institute of Health Conference on Noise and Hearing Loss, held on 22-24 January 1990 in Washington, D.C.

> "The nonauditory effects of chronic noise exposure, when noise is suspected to act as one of the risk factors in the development of hypertension, cardiovascular disease, and other nervous disorders, have never been proven to occur as chronic manifestations at levels below these criteria (an average of 75 dBA for complete protection against hearing loss for an eight-hour day). At the recent (1988) International Congress on Noise as a Public Health Problem, most studies attempting to clarify such health effects did not find them at levels below the criteria protective of noise-induced hearing loss, and even above these

> criteria, results regarding such health effects were ambiguous. Consequently, one comes to the conclusion that establishing and enforcing exposure levels protecting against noise-induced hearing loss would not only solve the noise-induced hearing loss problem but also any potential nonauditory health effects in the work place." (Reference C.9; parenthetical wording added for clarification.)

Although these findings were directed specifically at noise effects in the work place, they are equally applicable to aircraft noise effects in the community environment. Research studies regarding the nonauditory health effects of aircraft noise are ambiguous, at best, and often contradictory. Yet, even those studies which purport to find such health effects use time-average noise levels of 75 dB and higher for their research.

For example, in an often-quoted paper, two University of Mississippi at Los Angeles (UCLA) researchers apparently found a relationship between aircraft noise levels under the approach path to Los Angeles International Airport and increased mortality rates among the exposed residents by using an average noise exposure level greater than 75 dB for the "noise-exposed" population (Reference C.10). Nevertheless, three other UCLA professors analyzed those same data and found no relationship between noise exposure and mortality rates (Reference C.11).

In summary, there is no scientific basis for a claim that potential health effects exist for aircraft DNL below 75 dB.

C.3.3 Annoyance

The primary effect of aircraft noise on exposed communities is one of annoyance. Noise annoyance is defined by the U.S. Environmental Protection Agency as any negative subjective reaction on the part of an individual or group (Reference C.3). As noted in the discussion of DNL above, community annoyance is best predicted by that metric.

It is often suggested that a lower DNL, such as 60 or 55 dB, be adopted as the threshold of community noise annoyance for airport environmental analysis documents. While there is no technical reason why a lower level cannot be measured or calculated for comparison purposes, a DNL of 65 dB:

- provides a valid basis for comparing and assessing community noise effects;
- represents a noise exposure level which is normally dominated by aircraft noise and not other community or nearby highway noise sources; and
- reflects the FAA's threshold for grant-in-aid funding of airport noise mitigation projects.
- United States Department of Housing and Urban Development also establishes a DNL standard of 65 dB for eligibility for federally guaranteed home loans.

C.3.4 Speech Interference

Speech interference associated with aircraft noise is a primary cause of annoyance to individuals on the ground. The disruption of routine activities such as radio or television

listening, telephone use, or family conversation gives rise to frustration and irritation. The quality of speech communication is also important in classrooms, offices, and industrial settings and can cause fatigue and vocal strain in those who attempt to communicate over the noise. Research has shown that "whenever intrusive noise exceeds approximately 60 dB indoors, there will be interference with speech communication" (Reference C.5). A steady A-weighted background sound level of 60 dB will produce 93 percent intelligibility; that of 70 dB will produce 66 percent intelligibility; and that of 75 dB will produce 2 percent intelligibility (Figure D-1 in Reference C.3).

C.3.5 Sleep Interference

Sleep interference may be measured in either of two ways. "Arousal" represents actual awakening from sleep, while a change in "sleep stage" represents a shift from one of four sleep stages to another stage of lighter sleep without actual awakening. In general, arousal requires a somewhat louder noise level than does a change in sleep stage.

A recent analysis sponsored by the Air Force summarized 21 published studies concerning the effects of noise on sleep (Reference C.14). The analysis concluded that a lack of reliable studies in homes, combined with large differences among the results from the various laboratory studies and the limited in-home studies, did not permit development of an acceptable accurate assessment procedure. The noise events used in the laboratory studies and in contrived in-home studies were presented at much higher rates of occurrence than would normally be experienced in the home. None of the laboratory studies was of sufficiently long duration to determine any effects of habituation, such as those that would occur under normal community conditions.

Nevertheless, some guidance is available in judging sleep interference. The U.S. Environmental Protection Agency (USEPA) identified an indoor DNL of 45 dB as necessary to protect against sleep interference (Reference C.3). Assuming a very conservative structural noise insulation of 20 dB for typical dwelling units, this corresponds to an outdoor DNL of 65 dB as minimizing sleep interference.

The Federal Interagency Committee on Noise (Reference C.5) reviewed the sleep disturbance issue and presented an Air Force-developed sleep disturbance dose-response prediction curve, which is based on data from Reference C.14, as an interim tool for analysis of potential sleep disturbance. This interim curve shows that for an indoor SEL of 65 dB, approximately 15 percent or less of those exposed should be awakened.

C.3.6 Noise Effects on Domestic Animals and Wildlife

Animal species differ greatly in their responses to noise. Each species has adapted, physically and behaviorally, to fill its ecological role in nature, and its hearing ability usually reflects that role. Animals rely on their hearing to avoid predators, obtain food, and communicate with and attract other members of their species. Aircraft noise may mask or interfere with these functions. Secondary effects may include nonauditory effects similar to those exhibited by humans - stress, hypertension, and other nervous disorders. Tertiary effects may include interference with mating and resultant population declines.

Many scientific studies are available regarding the effects of noise on wildlife and some anecdotal reports of wildlife "flight due to noise." Few of these studies or reports include any reliable measures of the actual noise levels involved.

In the absence of definitive data on the effect of noise on animals, the Committee on Hearing, Bioacoustics, and Biomechanics proposed that protective noise criteria for animals be taken to be the same as for humans (Reference C.16).

C.3.7 Effects of Noise-Induced Vibration on Structures and Humans

The sound from an aircraft overflight travels from the exterior to the interior of the house in one of two ways: through the solid structural elements and directly through the air. The sound transmission starts with noise impinging on the wall exterior. Some of this sound energy will be reflected away and some will make the wall vibrate. The vibrating wall radiates sound into the airspace, which in turn sets the interior finish surface vibrating, with some of the energy lost in the airspace. This surface then radiates sound into the dwelling interior. Vibrational energy also bypasses the air cavity by traveling through the studs and edge connections.

Normally, the most sensitive components of a structure to airborne noise are the windows and, infrequently, the plastered walls and ceilings. An evaluation of the peak sound pressure impinging on the structure is normally sufficient to determine the possibility of damage. In general, at sound levels above 130 dB, there is the possibility of structural damage. While certain frequencies (such as 30 Hz for window breakage) may be of more concern than other frequencies, conservatively, only sounds lasting more than 1 second above a sound level of 130 dB are potentially damaging to structural components (Reference C.17).

In terms of average acceleration of wall or ceiling vibration, the thresholds for structural damage (C.18) are:

- 0.5 meters/sec/sec—threshold of risk of damage to sensitive structures (e.g., ancient monuments); and
- 1.0 meter/sec/sec—threshold of risk of damage to normal dwellings (e.g., houses with plaster ceilings and walls).

Noise-induced structural vibration may also cause annoyance to dwelling occupants because of induced secondary vibrations, or "rattle," of objects within the dwelling - hanging pictures, dishes, plaques, and bric-a-brac. Loose window panes may also vibrate noticeably when exposed to high levels of aircraft noise, causing homeowners to fear breakage. In general, such noise-induced vibrations occur at sound levels above those considered normally compatible with residential land use. Thus, assessments of noise exposure levels for compatible land use should also be protective of noise-induced secondary vibrations.

In the assessment of vibrations on humans, the following factors determine if a person will perceive and possibly react to building vibrations:

- Type of excitation: steady state, intermittent, or impulsive vibration;
- Frequency of the excitation. ISO 2631-2 (Reference C.18) recommends a frequency range of 1 to 80 Hz for the assessment of vibration on humans;

- Orientation of the body with respect to the vibration;
- The use of the occupied space; and
- Time of day.

C.3.8 Noise Effects on Terrain

It has been suggested that noise levels associated with low-flying aircraft may affect the terrain under the flight path by disturbing fragile soil or snow structures, especially in mountainous areas, causing landslides or avalanches. There are no known instances of such effects, and it is considered improbable that such effects will result from routine, subsonic aircraft operations.

C.3.9 Noise Effects on Historical and Archaeological Sites

Because of the potential for increased fragility of structural components of historical buildings and other historical sites, aircraft noise may affect such sites more severely than newer, modern structures. Again, there are few scientific studies of such effects to provide guidance for their assessment.

One study involved the measurements of sound levels and structural vibration levels in a superbly restored plantation house, originally built in 1795, and now situated approximately 1,500 feet from the centerline at the departure end of Runway 19L at Washington Dulles International Airport. These measurements were made in connection with the proposed scheduled operation of the supersonic Concorde airplane at Dulles (Reference C.19). There was a special concern for the building's windows, since roughly half of the 324 panes were original. No instances of structural damage were found. Interestingly, despite the high levels of noise during Concorde takeoffs, the induced structural vibration levels were actually less than those induced by touring groups and vacuum cleaning.

As noted above for the noise effects of noise-induced vibrations of normal structures, assessments of noise exposure levels for normally compatible land uses should also be protective of historic and archaeological sites.

C.4 Noise Level Reduction Guidelines

In April 2005, Wyle Labs published a study for the Naval Facilities Engineering Command, entitled "*Guidelines for Sound Insulation of Residences Exposed to Aircraft Operations*." (C.20) The study provides in-depth, state-of-the-art noise level reduction guidelines. Copies of this study are available on-line at:
http://www.afcee.af.mil/shared/media/document/AFD-070914-039.pdf .

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