Air Installations Compatible Use Zones Study for NAS Kingsville and NALF Orange Grove

FINAL – FEBRUARY 2013

Prepared by

UNITED STATES DEPARTMENT OF THE NAVY
Naval Facilities Engineering Command Southeast
Jacksonville, Florida

AIR INSTALLATIONS COMPATIBLE USE ZONES STUDY

FOR

NAS KINGSVILLE AND NALF ORANGE GROVE

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Executive Summary

This Air Installations Compatible Use Zones (AICUZ) Study has been prepared for Naval Air Station (NAS) Kingsville and Navy Auxiliary Landing Field (NALF) Orange Grove, Texas, in accordance with federal regulations and guidelines and United States Department of the Navy (Navy) instructions. The study has been prepared in consideration of expected changes in mission, aircraft, and projected operational levels that will occur within the next 10- to 15-year planning period. The 2013 AICUZ noise contours and accident potential zones (APZs) presented in this study are based on projected flight operations for NAS Kingsville (referred to herein as the Installation) and NALF Orange Grove.

ES.1 Purpose of an AICUZ Study

The United States Department of Defense (DOD) initiated the AICUZ Program to assist governmental entities and communities in identifying and planning for compatible land use and development near military installations. In the early 1970s, the DOD established the AICUZ Program in response to growing incompatible urban development around military airfields and community concerns over aircraft noise and accident potential. Today, the AICUZ Program is worldwide and is considered a vital tool used by all branches of the military to communicate with neighboring communities, government entities, and individuals regarding compatible land use and development concerns.

This AICUZ Study provides background information on NAS Kingsville and NALF Orange Grove, presents the 2013 AICUZ noise contours associated with aircraft operations, establishes 2013 AICUZ APZs for aircraft, identifies areas of incompatible land uses and proposed development within these zones, and recommends actions to encourage compatible land use.

ES.2 NAS Kingsville

NAS Kingsville and NALF Orange Grove are located in South Texas. NAS Kingsville, the main base, is located approximately 1 mile east of the City of Kingsville in Kleberg County, Texas.

NAS Kingsville is one of Chief of Naval Air Training's (CNATRA's) two jet strike pilot training bases. NAS Kingsville's primary mission is to train tactical jet pilots for the Navy and Marine Corps. Training Air Wing (TRAWING) TWO, the primary unit at NAS Kingsville, is responsible for Navy and Marine Corps aviator training. With approximately 250 Student Naval Aviators (SNAs) and 75 instructor pilots (CNATRA 2011), TRAWING TWO is comprised of two advanced Strike Training Squadrons: Training Squadron TWENTY-ONE (VT-21) "Redhawks," and Training Squadron TWENTY-TWO (VT-22) "Golden Eagles."

NAS Kingsville hosts several other tenant organizations that support the Installation and TRAWING TWO or perform specialized functions. Other tenant organizations include the U.S. Army Medical Evacuation (MEDEVAC), U.S. Army Reserve, and the U.S. Border Patrol.

ES.3 Aircraft Operations

The T-45A/C is a single-engine, fixed-wing, carrier-capable jet aircraft that is used for intermediate and advanced jet training of Navy and Marine Corps SNAs. This aircraft accounts for the majority of flight operations at NAS Kingsville and NALF Orange Grove. T-45 operations occurring at NAS Kingsville include departures, straight-in arrivals, overhead break arrivals, touch-and-go patterns, Field Carrier Landing Practice (FCLP), and Ground Controlled Approach (GCA) operations. NALF Orange Grove supports training operations for NAS Kingsville, and the majority of flight operations occurring at NALF Orange Grove are touch-and-go patterns and FCLP operations. NAS Kingsville SNAs also train in designated offshore and onshore special use airspace (SUA). Flight operations at NAS Kingsville and NALF Orange Grove follow the curriculum set forth by CNATRA for TRAWING TWO student aviators.

Each airfield has designated flight tracks associated with the various aircraft operations being conducted. Flight tracks are specific routes an aircraft must follow while conducting an operation at the airfield, between airfields, or within a Military Operating Area (MOA). Flight tracks are graphically represented as single lines. However, flights vary due to aircraft performance, pilot technique, weather conditions, and Air Traffic Control (ATC) variables. The actual flight track is most accurately represented as a band, often 0.5 mile to several miles wide. The flight tracks shown in this AICUZ Study are idealized representations based on pilot and ATC input.

As a planning document, the AICUZ Study forecasts flight activity levels as far out as possible (often 5, 10, or 15 years into the future) to assess an air station's potential impact on the local community. Projected aircraft operations help ensure that the future operational capability of the air installation is sustainable.

ES.4 Aircraft Noise

The main sources of noise at an airfield are preflight and/or maintenance run-ups and flight operations. In support of this AICUZ Study, a noise analysis is conducted to assess the noise impacts of aircraft operations and to define noise contours at NAS Kingsville and NALF Orange Grove.

The noise exposure from aircraft is measured using the day-night average sound level (DNL) metric. The DNL is depicted visually as a noise contour that connects points of equal value. NOISEMAP, a DOD-approved noise modeling program, calculates DNL noise contours resulting from aircraft operations using such variables as power settings, aircraft model and type, maximum sound levels, and duration and flight profiles. The contours generally follow the flight paths of aircraft. The noise contours generated from the modeling program graphically illustrate where aircraft noise occurs in and around an airfield and at what sound level. The noise contours in this AICUZ Study are depicted in increments of 5 A-weighted decibels (dBA) (60, 65, 70, 75, 80, and 85 DNL).

Noise contours provide the Installation, local community planning organizations, and the general public with maps of the modeled noise-related impacts of aircraft operations. Noise contours, when overlaid with local land uses, can help identify areas of incompatible land uses and plan for future development around an air station. Noise contours provided in this AICUZ Study are identified as the 2013 AICUZ noise contours, representing the year of the study's release. Projections of aircraft operations were based on data provided by NAS Kingsville.

ES.5 Airfield Safety

While the likelihood of an aircraft mishap occurring is remote, accidents can occur. The Navy has designated areas of accident potential based on historical data for aircraft mishaps near military airfields to assist in land use planning. APZs identify areas where an aircraft accident is most likely to occur if an accident were to take place. The APZs are not a prediction of accidents or accident frequency. APZs are designed to minimize potential harm to the public, pilots, and property if a mishap does occur by limiting incompatible uses in the designated APZ areas.

APZs follow departure, arrival, and pattern flight tracks. There are three different types of APZs: the Clear Zone, APZ I, and APZ II. AICUZ guidelines recommend that certain land uses that concentrate large numbers of people, such as apartments, churches, and schools, be avoided within the APZs. This AICUZ Study presents the 2013 APZs for NAS Kingsville and NALF Orange Grove.

ES.6 Land Use Compatibility Analysis

The AICUZ footprint of an airfield—the combination of noise contours and APZs—defines the minimum acceptable area in which land use control measures are recommended to protect the public's health, safety, and welfare while sustaining the Navy's flying mission. The Navy has developed guidelines for compatible development and land use within an airfield's AICUZ footprint. These guidelines are provided in the Navy's (2008) AICUZ Program Instructions (Office of the Chief of Naval Operations Instruction [OPNAVINST] 11010.36C).

The land use compatibility analysis is based on the assessment of existing land uses and proposed development near NAS Kingsville and NALF Orange Grove. Existing land use is assessed to determine current land use activity, while future land plans are evaluated to project development and potential growth areas. Population growth projections, city and county land use data, zoning regulations, and comprehensive plans also were evaluated to determine how local and regional development patterns could impact future operations at each airfield.

ES.7 Land Use Tools and Recommendations

Federal, state, and local governments, businesses, real estate professionals, and citizens, along with the Navy, all play an important role in implementing this AICUZ Study. NAS Kingsville should maintain routine communication with local, state, and regional governments to be aware of land use plans and zoning regulations and to ensure the Navy's input is offered in the early stages of any long-range planning initiatives. NAS Kingsville should provide community decision makers with the information and educational materials necessary to make informed decisions regarding the impact of their actions on mission readiness. To guide compatible development near NAS Kingsville and NALF Orange Grove, local municipalities should incorporate the projected 2013 AICUZ noise zones and APZs into zoning ordinances, land use guidelines, and planning initiatives.

ES.8 Appendices

Appendix A: Discussion of Noise and its Effect on the Environment

Appendix A provides a detailed discussion of the basics of sound, sound measurements, and noise effects on humans and wildlife.

Appendix B: Land Use Compatibility Recommendations

Appendix B presents the comprehensive Navy Land Use Recommendations tables within noise zones and APZs, as provided in OPNAVINST11010.36C, "Air Installations Compatible Use Zones Program."

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Acronyms and Abbreviations

– A –

AFB	Air Force Base
AGL	above ground level
AICUZ	Air Installations Compatible Use Zones
Air Ops	Air Operations
APZ	accident potential zone
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
ATU	Advanced Training Unit

– B –

BASH	Bird/Animal Aircraft Strike Hazard

– C –

CBCOG	Coastal Bend Council of Governments
CIP	capital improvements program
CNATRA	Chief of Naval Air Training
CNEL	Community Noise Equivalent Level
CNIC	Commander, Navy Installations Command
CO	Commanding Officer
CPLO	Community Plans and Liaison Officer
CY	Calendar Year

– D –

dB	decibel(s)
dBA	A-weighted decibel(s)
DNL	day-night average sound level
DOD	(United States) Department of Defense

– E –

EA	Environmental Assessment
EIS	Environmental Impact Statement
EMI	electromagnetic interference
EPA	(United States) Environmental Protection Agency
ETJ	extra-territorial jurisdiction

– F –

FAA	Federal Aviation Administration
FCLP	Field Carrier Landing Practice
FICUN	Federal Interagency Committee on Urban Noise
FY	fiscal year

– G –

GCA	Ground Controlled Approach
GIS	Geographic Information System

– H –

HUD	Housing and Urban Development

– I –

ICO	Installation Commanding Officer
IFR	instrument flight rules
ILS	Instrument Landing System

– J –

JAZB	Joint Airport Zoning Board
JLUS	Joint Land Use Study

– M –

MARSA	Military Assumes the Responsibility for Separation of Aircraft
MEDEVAC	Medical Evacuation
MOA	Military Operating Area
MSL	mean sea level

– N –

NAAS	Naval Auxiliary Air Station
NALF	Naval Auxiliary Landing Field
NAS	Naval Air Station
NATRACOM	Naval Air Training Command
Navy	United States Department of the Navy
NEPA	National Environmental Policy Act
NOTAM	Notice to Airmen

– O –

OEA	Office of Economic Adjustment
OLS	Optical Landing System
OPNAVINST	Office of the Chief of Naval Operations Instruction

– P –

PAO	Public Affairs Officer
PAR	precision approach radar
PDR	purchase of development rights
PLS	Palletized Load System

– R –

R	restricted area
RAICUZ	Range Air Installations Compatible Use Zones

– S –

SNA	Student Naval Aviator
SUA	special use airspace

– T –

T45TS	T-45 Training System
TACAN	Tactical Air Navigation
TCC	Texas Commanders Council
TDR	transfer of development rights
TMPC	Texas Military Preparedness Commission
TRAWING	Training Air Wing

– U –

U.S.C.	United States Code

– V –

VFR	visual flight rules
VT-	Training Squadron

– W –

W	warning area

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1 Introduction

Military airfields experience population growth and increased development in proximity to their "fence line." New homes are constructed close to an installation to allow both military and civilian personnel who work at a base to live closer to their employer. Similarly, businesses are established around these residential areas and the military installation to take advantage of increased opportunities. Some of this development may be incompatible with aircraft operations and, over time, can result in nearby residents or businesses being adversely impacted and potentially can degrade the mission of the Installation. Although the size of the military is being reduced, the United States Department of Defense (DOD) must sustain critical pieces of infrastructure to develop and train with weapon systems that are frequently faster, have longer range, and, in some cases, are more destructive than earlier conventional systems.

The DOD initiated the Air Installations Compatible Use Zones (AICUZ) Program to assist governmental entities and communities in identifying and planning for compatible land use and development near military installations. The goal of this program is to protect the health, safety, and welfare of the public while also protecting military operational capabilities.

The AICUZ Program recommends that noise contours, accident potential zones (APZs), height and obstruction requirements, and associated land use recommendations be incorporated into local community planning to minimize impacts to the mission and the residents in the surrounding community. Mutual cooperation between installations and neighboring communities serves to increase public awareness of the importance of air installations and the need to address mission requirements and associated noise and risk factors. As the communities that surround airfields grow and develop, the United States Department of the Navy (Navy) has the responsibility to communicate and collaborate with local governments regarding land use planning, zoning, and mission impacts.

This AICUZ Study has been prepared for Naval Air Station (NAS) Kingsville (referred to herein as the Installation) and Naval Auxiliary Landing Field (NALF) Orange Grove. The 2013 AICUZ Study updates information on aircraft operations since the release of the 1998 AICUZ Study and provides noise contours and APZs. The 2013 AICUZ noise contours and APZs presented in this study are based on projected flight operations for NAS Kingsville and NALF Orange Grove. The study has been prepared in consideration of expected changes in mission, aircraft, and projected operational levels that will occur within the next 10- to 15-year planning period. This 2013 AICUZ Study is comprised of the following chapters:

- **Chapter 1:** Provides background information on the AICUZ Program, historical data from previous AICUZ studies and other related documents, and changes that require an AICUZ Update.
- **Chapter 2:** Describes the location and history of the Installation, tenants, and operational areas.
- **Chapter 3:** Provides information on aircraft types, flight operations, and flight tracks for both NAS Kingsville and NALF Orange Grove.
- **Chapter 4:** Contains the updated aircraft noise contours for both NAS Kingsville and NALF Orange Grove, outlines the methodology for determining noise contours, and discusses changes in noise contours and what measures the Navy has implemented to mitigate any community noise concerns.
- **Chapter 5:** Discusses aircraft safety issues and the development of APZs for both NAS Kingsville and NALF Orange Grove.
- **Chapter 6:** Evaluates the compatibility of both current and proposed surrounding land uses with aircraft operations.
- **Chapter 7:** Provides recommendations for promoting land use compatibility consistent with the goals of the AICUZ Program.

- **Chapter 8:** Presents a list of references used in this study.
- **Appendix A:** Summarizes the effects of noise on the environment.
- **Appendix B:** Contains a matrix of compatible land use recommendations for development within AICUZ noise zones and APZs adapted from the Navy's (2008) AICUZ Program Instructions (Office of the Chief of Naval Operations Instruction [OPNAVINST] 11010.36C).

The goal of the AICUZ Program is to protect the health, safety, and welfare of the public while also protecting military operational capabilities.

This goal is accomplished by achieving compatible land use patterns and activities in the vicinity of a military installation.

OPNAVINST 11010.36C is the current Navy guidance document that governs the AICUZ Program.

1.1 AICUZ Program

In 1973, the DOD established the AICUZ Program in response to growing incompatible urban development around military airfields and community concerns over aircraft noise and accident potential. The Navy's AICUZ Program Instruction (OPNAVINST 11010.36C) currently governs the AICUZ Program. The objectives of the AICUZ Program, according to OPNAVINST 11010.36C, are as follows:

- To protect the health, safety, and welfare of civilians and military personnel by encouraging land use that is compatible with aircraft operations;
- To protect Navy and Marine Corps installation investments by safeguarding the installations' operational capabilities;
- To reduce noise impacts caused by aircraft operations while meeting operational, training, and flight safety requirements, both on and in the vicinity of air installations; and
- To inform the public about the AICUZ Program and seek cooperative efforts to minimize noise and aircraft accident potential impacts by promoting compatible development in the vicinity of military air installations.

The Federal Aviation Administration (FAA) and the DOD have developed guidance to encourage local communities to restrict development or land uses that could endanger aircraft, including lighting (direct or reflected) that would impair pilot vision; towers, tall structures, and vegetation that penetrate navigable airspace or are constructed near the airfield; uses that generate smoke, steam, or dust; uses that attract birds, especially waterfowl; and electromagnetic interference (EMI) sources that may adversely affect aircraft communication, navigation, or other electrical systems. Hazards to pilot safety and flight operations are discussed in greater detail in Section 5.1 *Flight Safety and Aircraft Mishaps*.

1.2 Purpose, Scope, and Authority

The purpose of the AICUZ Program is to achieve compatibility between air installations and neighboring communities. To satisfy this purpose, the Navy works with the local community to promote compatible development in the vicinity of military airports. As development increases near an airfield, more people may be exposed to noise and accident potential associated with aircraft operations. AICUZ studies analyze community development trends, land use tools, and mission requirements at the airfield to develop a recommended strategy to promote compatible land development adjacent to an installation. AICUZ recommendations are based on the impacts of noise and accident potential. Implementation of the AICUZ Program requires cooperation between the Installation Commanding Officer (ICO) and the local government.

The scope of this AICUZ Study includes analysis of historic, current, and future aircraft operations; aircraft noise zones and APZs for future-year forecasts; noise abatement measures; an analysis of existing and projected land use conditions within the aircraft noise zones and APZs; and possible solutions to existing and potential incompatible land use problems.

The authority for the establishment and implementation of the AICUZ Program, as well as guidance on facility requirements, are derived from:

- DOD Instruction 4165.57, “Air Installations Compatible Use Zones,” dated May 2, 2011 (DOD 2011);

- OPNAVINST 11010.36C, "Air Installations Compatible Use Zones Program," dated October 9, 2008 (Navy 2008);
- Unified Facilities Criteria 3-260-01, "Airfield and Heliport Planning and Design," dated November 17, 2008 (Air Force Civil Engineer Support Agency 2008);
- Naval Facilities Engineering Command P-80.3, "Facility Planning Factor Criteria for Navy and USMC Shore Installations: Airfield Safety Clearances," dated January 1982 (NAVFAC 1982); and
- United States Department of Transportation, FAA Regulations, Code of Federal Regulations, Title 14, Part 77, "Objects Affecting Navigable Airspace" (U.S. Department of Transportation 2006).

1.3 Responsibility of Compatible Land Use

Ensuring land use compatibility within the AICUZ footprint is a cooperative effort of many organizations, including the DOD and the Navy, the local naval air installation command, local planning and zoning agencies, real estate agencies, residents, developers, and builders. Military installations can provide recommendations or advise community decision makers, but ultimately, local municipalities have the planning and zoning authority to preserve land use compatibility near the military installation. Cooperative action by all parties is essential to prevent land use incompatibility.

The Navy has established a collaborative working relationship with the local municipalities and communities surrounding the airfields at NAS Kingsville and NALF Orange Grove. These organizations meet regularly to discuss mutual concerns and goals. A more detailed discussion of the Navy's compatible land use management measures is provided in Chapter 7 *Land Use Tools and Recommendations*.

Table 1-1 identifies some responsibilities for various community stakeholders.

Table 1-1:
Roles in Compatible Land Use Development

Stakeholders	Responsibility
Navy	▪ Examine air mission for operation changes that could reduce impacts. ▪ Conduct noise and accident potential zone (APZ) studies. ▪ Develop Air Installations Compatible Use Zones (AICUZ) maps. ▪ Examine local land uses and growth trends. ▪ Make land use recommendations. ▪ Release an AICUZ Study. ▪ Work with local governments and private citizens. ▪ Monitor operations and noise complaints. ▪ Update AICUZ studies, as required.
Local Government	▪ Incorporate AICUZ guidelines into a comprehensive development plan and zoning ordinance. ▪ Regulate height and obstruction concerns through an airport ordinance. ▪ Regulate acoustical treatment in new construction. ▪ Require fair disclosure in real estate for all buyers, renters, lessees, and developers.
Private Citizens	▪ Educate oneself on the importance of the Installation's AICUZ Program. ▪ Identify AICUZ considerations in all property transactions. ▪ Understand AICUZ effects before buying, renting, leasing, or developing property.
Real Estate Professionals	▪ Ensure potential buyers and lessees receive and understand AICUZ information on affected properties. ▪ When working with builder/developers, ensure an understanding and evaluation of the AICUZ Program.
Builders/Developers	▪ Develop properties in a manner that appropriately protects the health, safety, and welfare of the civilian population by constructing facilities that are compatible with aircraft operations (e.g., sound attenuation features, densities, and occupations).

1.4 Previous AICUZ Efforts and Related Studies

PREVIOUS AICUZ EFFORTS

- **1976** Original AICUZ Study
- **1981** Installation Master Plan
- **1987** Installation Master Plan
- **1992** Environmental Assessment for NAS Kingsville Realignment
- **1998** AICUZ Requirements Study, Installation Master Plan
- **2008** Joint Land Use Study

Since the development of the first AICUZ Study for NAS Kingsville in 1976, operational parameters, aircraft mix, and the Navy AICUZ instruction have changed. These changes were reflected in subsequent 1981 and 1987 Installation Master Plans and the 1998 NAS Kingsville AICUZ Study. The 1998 NAS Kingsville AICUZ Study currently serves as the official AICUZ Study, pending adoption of this study. The AICUZ Study updates have accounted for changes in aircraft, changes in operational parameters, such as revised flight tracks, and changes derived from revisions to the Navy AICUZ Instructions.

With the introduction of the T-45 “Goshawk” aircraft, an Environmental Assessment (EA) report was prepared in 1992 to reflect operational projections and noise impacts with the transition of strike training at NAS Kingsville. Noise contours from this EA were the basis for the City of Kingsville’s AICUZ Zoning Regulations.

The City of Kingsville partnered with the DOD Office of Economic Adjustment to develop a Joint Land Use Study (JLUS). The study was initiated as part of the nationwide DOD JLUS Program. The JLUS provides recommendations regarding land development policy and, specifically, addresses the Navy’s air mission in the region related to NAS Kingsville. The study identifies impacts from noise exposure and APZs resulting from aircraft operations, land uses that adversely impact air operations, limitations on tall structures interfering with flight operations, and local government approaches to reduce the impacts associated with air operations. The JLUS and the recommended implementation actions were adopted by the City Commission on April 24, 2008.

1.5 Changes that Require an AICUZ Update

AICUZ studies should be updated when an air installation has a significant change in aircraft operations (i.e., the number of takeoffs and landings), a change in the type of aircraft stationed and operating at the installation, or changes in flight paths or procedures.

AICUZ studies should be updated when an installation has:

- **Significant changes in aircraft operations.**
- **Changes in the type of aircraft stationed and operating at the installation.**
- **Changes in flight paths or procedures.**

In accordance with OPNAVINST 11010.36C, this AICUZ Study has been prepared to reflect flight tracks, APZs, and projected annual operations for Calendar Year 2013. Since publication of the 1998 AICUZ Study, changes have occurred for runway usage, flight characteristics and procedures, and published flight tracks. Runway utilization at NAS Kingsville has shifted slightly from Runway 13 to Runway 35, and flight tracks have been modified to avoid flying over the on-base childcare center and populated areas. Runway utilization at NALF Orange Grove has increased on Runway 13 and decreased on Runway 19. These changes affect the APZs and noise contours. Navy AICUZ Instruction, OPNAVINST 11010.36C, has been updated since the 1998 AICUZ Study and provides guidance and instruction that was not considered in that study. In addition, land use changes and increased development have occurred around the installation.

1.5.1 Update Land Use within the Noise Zones and APZs

An up-to-date record of land uses within AICUZ noise zones and APZs is essential to understanding land use compatibility with the Navy's mission at an installation and identifying potential areas of incompatible development. New development has occurred within the City of Kingsville since the previous AICUZ Study. Additionally, the Navy and the City of Kingsville have implemented new land use management initiatives since the 2008 JLUS. This AICUZ Study reflects changes to land use data and new initiatives.

1.5.2 Update on Population Data from 2010 Census

Similar to land use within the AICUZ noise zones and APZs, the populations around NAS Kingsville and NALF Orange Grove have changed since the release of the 1978 AICUZ Study. Data from the 2010 decennial U.S.

Census provide up-to-date population statistics, which are incorporated into this study. Updated population data are provided in Section 2.6 *Regional Population*.

1.5.3 Update on Accomplishments and Recommended Strategies

The Navy AICUZ Instruction has a variety of recommendations and strategies for working with the local municipalities to address incompatible development and establishing partnerships. Following the 2008 Kingsville JLUS, the Navy and the City of Kingsville have successfully implemented several strategies to address incompatible or potentially incompatible development around NAS Kingsville. These strategies and the results of their implementation are discussed in Chapter 7 *Land Use Tools and Recommendations*.

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2

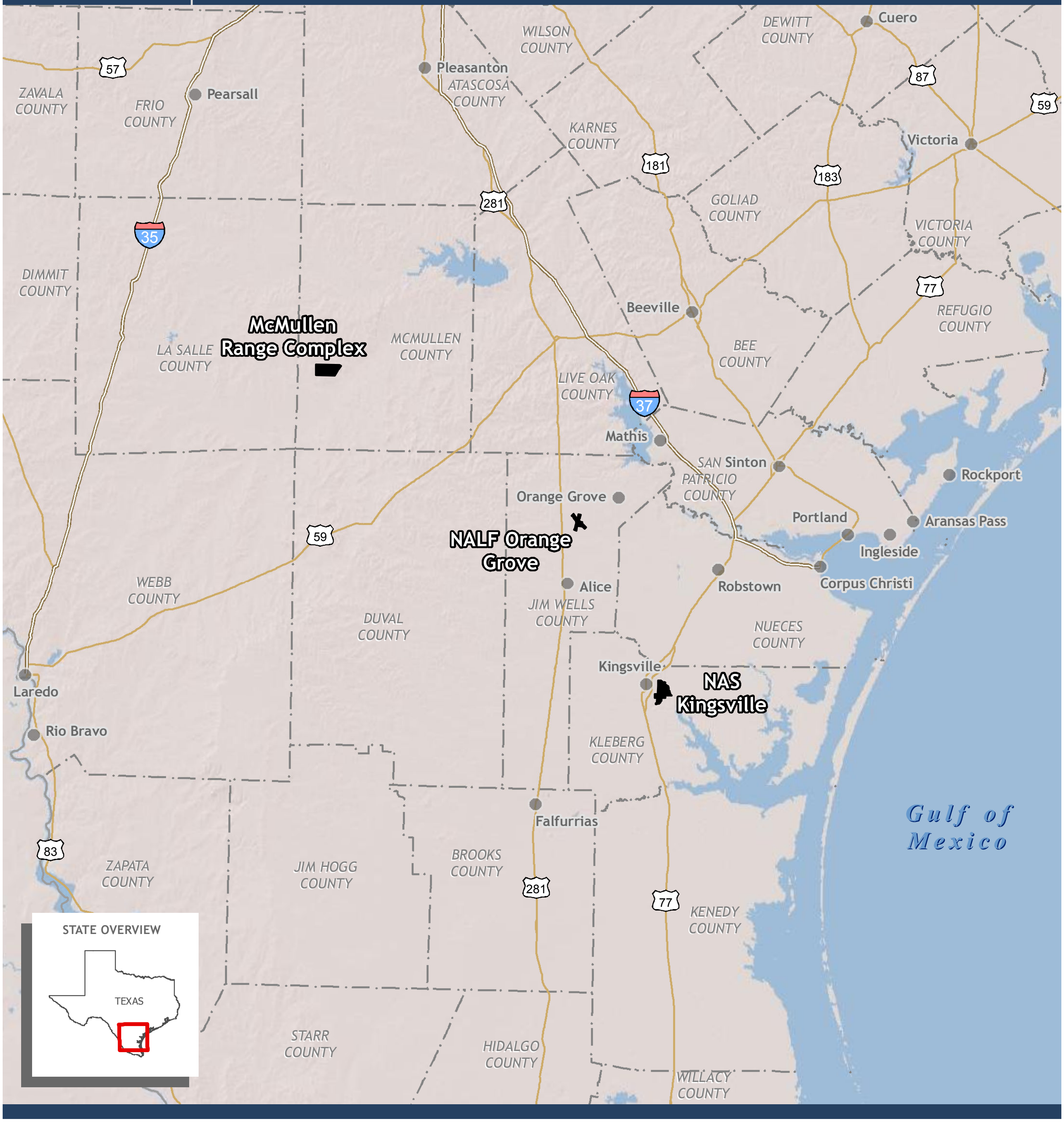
NAS Kingsville

2.1 Location

NAS Kingsville and NALF Orange Grove are located in South Texas. NAS Kingsville, the main base, is located approximately 1 mile east of the City of Kingsville, in Kleberg County, Texas (Figure 2-1). The Installation is 35 miles inland from the Gulf of Mexico and 43 miles southwest of the City of Corpus Christi. NALF Orange Grove is located in Jim Wells County, approximately 35 miles northwest of NAS Kingsville and 40 miles west of the City of Corpus Christi, between the cities of Alice and Orange Grove, Texas.

Installation tenants also conduct training at the McMullen Range Complex, located approximately 80 miles northwest of NAS Kingsville, in McMullen County, Texas. This AICUZ Study addresses NAS Kingsville and NALF Orange Grove. Further information on the McMullen Range Complex is provided in the Range Air Installations Compatible Use Zones (RAICUZ) Study.

FIGURE 2-1 REGIONAL LOCATION MAP OF NAS KINGSVILE AND NALF ORANGE GROVE, TEXAS



Source: ESRI 2011, Navy 2011

0 5 10 15 20
Miles

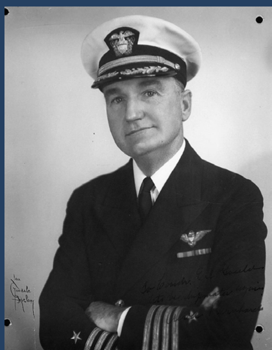
Military Installation
Waterbody
City/Town
Interstate
US Highway
County Boundary

2.2 History

NAS Kingsville, historically known as "P-4 Kingsville Field" or "Naval Auxiliary Air Station (NAAS) Kingsville Field," was established as one of the six auxiliary air stations for Naval Air Technical Training Command headquartered at NAS Corpus Christi. NAAS Kingsville was commissioned on July 4, 1942 as an extension of NAS Corpus Christi to train Navy and Marine Corps pilots for combat during World War II.

Naval Auxiliary Air Station (NAAS) Kingsville, late 1940s

After World War II, training was reduced, and the Navy leased NAAS Kingsville to the City of Kingsville and Texas A&I University under caretaking status to accommodate housing for the large influx of students at the university. Over the next few years, the university continued to use the facility for housing as well as teaching. At the start of the Korean War in 1951, the Chief of Naval Operations re-commissioned NAAS Kingsville as an auxiliary airfield for NAS Corpus Christi and a permanent component of the Naval Aeronautical shore establishment. The first jet training class began on July 15, 1951. The airfield underwent reconstruction and reconditioning over the following years, including construction of permanent buildings and new hangars and extension of all existing runways.



Vice Admiral
Alva Bernhard
(Retired)

On August 9, 1968, the air station was designated NAS Kingsville, an independent airfield. In 1986, the airfield was named in honor of Vice Admiral Alva Bernhard who was the Commanding Officer of NAS Corpus Christi when Kingsville was first commissioned.

NALF Orange Grove was built to serve as an outlying airfield for NAS Kingsville and NAS Corpus Christi. The airfield opened in 1957 with one runway, and a second runway was constructed between 1964 and 1969 (Freeman 2012). In June 1985, the airfield temporarily closed for a refurbishment project to improve airfield runways and facilities. Today, NALF Orange Grove continues to support the Training Air Wing (TRAWING) TWO mission.

2.3 Mission

NAS Kingsville Mission

"To provide NAS Kingsville personnel, including all tenant activities, with the best reliable and sustainable shore infrastructure and services to enable and support the Fleet, fighter, and family."

NAS Kingsville's primary mission is to train tactical jet pilots for the Navy and the Marine Corps. In support of that mission, the aviation training facility enables and supports Fleet, fighter, and family readiness through reliable and sustainable shore infrastructure and services, as well as provides for the safety and security of NAS Kingsville personnel.

NAS Kingsville is responsible for providing basic facility services, business and support functions, housing and accommodations, and quality of life services, all in support of the Installation's mission. The Installation and its support departments, which are under the purview of the Commander, Navy Installations Command (CNIC), support the training and deployment of TRAWING TWO and the missions of other base tenant commands. NAS Kingsville's ICO is responsible for all Installation activities. In addition to the ICO, TRAWING TWO is led by a Commodore whose primary responsibility is pilot training activities.

NATRACOM Mission

"To train the world's finest combat quality aviation professionals, delivering them at the right time, in the right numbers, and at the right cost to the Joint Forces for tasking in the Global War on Terrorism" (NATRACOM 2010).

Today, NAS Kingsville is one of Chief of Naval Air Training's (CNATRA's) two jet strike pilot training bases (the second jet strike training base is located at NAS Meridian, Mississippi). CNATRA, which is headquartered at NAS Corpus Christi, is responsible for the coordination of pilot training operations and the administration of the Naval Air Training Command (NATRACOM). NATRACOM is composed of five Training Air Wings located on naval air stations in Florida, Mississippi, and Texas. NATRACOM is responsible for training combat-quality aviation professionals, and delivering these aviators to fleet training squadrons precisely as needed and when needed.

Naval Aviator Training

Once flight students complete Aviation Preflight Indoctrination at the Naval Aviation Schools Command, they begin to advance through their individual pilot training pipelines. All Student Naval Aviators (SNAs) complete their primary flight training in either the T-34 or the T-6B aircraft at NAS Whiting Field, NAS Corpus Christi, or Vance Air Force Base (AFB). Upon completion of primary flight training, SNAs are selected for a specific aviation pipeline which determines the types of aircraft they will fly.

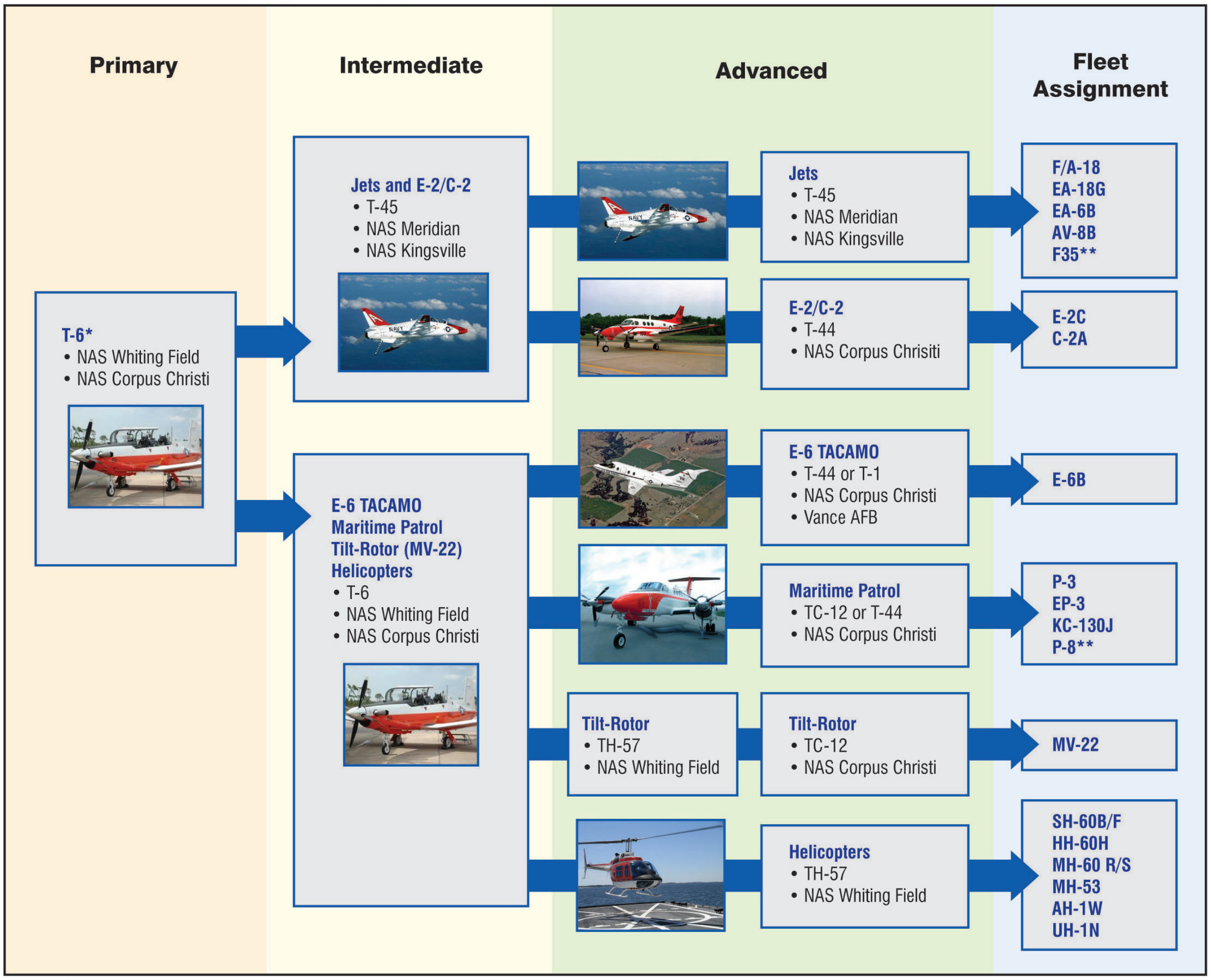
The location of an SNA's intermediate and advanced phases of flight training depends upon the type of aircraft the student has been selected to fly. CNATRA offers six different training pipelines for SNAs (Figure 2-2). SNAs are selected for maritime (multi-engine prop), E-2/C-2, rotary (helicopters), strike (jets), and the E-6 "Mercury" aircraft. Intermediate training is completed at NAS Meridian, NAS Corpus Christi, NAS Kingsville, and NAS Whiting Field.

Student pilots entering the strike pilot pipeline complete their training at either at NAS Kingsville in the T-45A/C or at NAS Meridian in the T-45C. During strike training, pilots learn strike tactics, weapons delivery, air combat maneuvering, and receive their carrier landing qualification.

TRAWING TWO will be upgrading all T-45A aircraft to the T-45C, which has comparable avionics to tactical fleet aircraft.

Figure 2-2: Pilot Training Pipeline

02:002958.0003-02TTO\NAS Kingsville_Pilot Training Figure.ai-GRA-2/7/13



* The T-34 is currently being phased out of the inventory and replaced by the T-6
** New aircraft coming into inventory

The strike flight curriculum comprises 16 different flight training stages. The first stages are geared to familiarize SNAs to jet aircraft and include instrument training, jet familiarization flights, formation flights, night familiarization flights, and land-based carrier qualifications. During the latter training stages, SNAs are introduced to offensive weapons and tactics and operational navigation at low-level flight routes. SNAs practice air-to-ground bombing, gunnery, and air combat maneuvers with other aircraft. Finally, students perform Field Carrier Landing Practice (FCLP) in preparation for their carrier qualifications aboard a carrier at sea. After students complete four touch-and-go landings and ten carrier-arrested landings at sea, they graduate from naval flight training and earn their *Wings of Gold*. Student pilots continue to the advanced strike pipeline or advanced E-2/C-2 pipelines. SNAs selected for the advanced strike pipeline report to an F/A-18 or EA-6B/EA-18G Fleet Replacement Squadron, and then eventually to a Fleet squadron (CNATRA n.d.).

2.4 Installation Activities

2.4.1 Training Air Wing TWO

TRAWING TWO, the primary unit at NAS Kingsville, is responsible for Navy and Marine Corps aviator training. With approximately 250 SNAs and 75 instructor pilots (CNATRA 2011), TRAWING TWO is comprised of two advanced Strike Training Squadrons: Training Squadron TWENTY-ONE (VT-21) “Redhawks,” and Training Squadron TWENTY-TWO (VT-22) “Golden Eagles.”

The T-45 “Goshawk” is the training aircraft used for intermediate and advanced Navy/Marine Corps pilot training programs, including jet carrier aviation and tactical strike missions. TRAWING TWO employs the Goshawk T-45 Training System (T45TS) which combines academic, flight, and instrument simulation training into an integrated computerized training approach to improve efficiency and reduce training hours. The T45TS is the first complete integrated jet aircraft training system developed for and used by the Navy.

Training Squadron TWENTY-ONE (VT-21)

The primary mission of VT-21 is to conduct advanced pilot training for the carrier jet aviators of the future. VT-21 was originally commissioned at NAS Kingsville as Advanced Training Unit 202 (ATU-202) in 1951, and then re-designated as Flight Training Squadron VT-21 in 1960. VT-21 has been consistently recognized and awarded for distinguished performance in aviation safety. VT-21 was the first Navy squadron to transition to the T-45 Training System (CNIC 2011).

Training Squadron TWENTY-TWO (VT-22)

The primary mission of VT-22 is to conduct strike jet training for SNAs. Known as the premier strike training squadron, flight operations include air combat maneuvering, air-to-ground employment, and carrier qualification.

VT-22 was originally formed at NAS Corpus Christi in 1949 as ATU-6 and underwent multi re-designations and relocations before being commissioned as VT-22 at NAS Kingsville in 1960 (CNIC 2011).

2.4.2 Other Tenant Commands and Organizations

NAS Kingsville hosts several other tenant organizations that support the Installation and TRAWING TWO or perform specialized functions.

U.S. Army Medical Evacuation (MEDEVAC)

U.S. Army Medical Evacuation (MEDEVAC) F-Company, 7-158th Aviation Regiment is stationed at NAS Kingsville. Their mission is to provide emergency movement of medical personnel, equipment, or supplies, including helicopter air medical evacuation for division-level units. Training activities occur primarily off station, but 40 MEDEVAC support personnel are on base on a daily basis.

U.S. Army Reserve Unit

U.S. Army Reserve 370th Transportation Company Detachment 1 is stationed at NAS Kingsville. This unit has four Palletized Load System (PLS)-capable trucks that are currently assigned to the base (Navy 2011). The U.S. Army Reserve unit at NAS Kingsville includes approximately 50 soldiers, with three full-time active Army Reserve staff members. The headquarters office is located in Brownsville, Texas.

U.S. Border Patrol

The U.S. Border Patrol's mission is to detect and prevent illegal entry of terrorists and terrorist weapons into the United States. The U.S. Border Patrol works with other Immigration and Customs Enforcement officers to facilitate the importing of legal immigration and goods while preventing the illegal trafficking of people and contraband. The Kingsville Station patrol area includes Kleberg and Kenedy counties, and the patrol is responsible for operating the Sarita Checkpoint on Highway 77. Additional duties include highway interdiction operations, brush crew details, train checks, and all-terrain vehicle operations (U.S. Border Patrol 2012).

2.4.3 Installation Operations and Management

Command and Staff Services

A variety of support activities are required to operate an installation. Command and Staff Services is the overarching name given to activities such as the Legal Office, Administration, Command Evaluation Office, and Public Affairs that provide support to TRAWING TWO and the tenant commands. The Legal Office provides powers of attorney and notaries, in addition to other legal services, to active-duty service members, retirees, and their dependents. The Administration Office is the liaison between individual departments and the NAS Kingsville Executive Branch. They process correspondence, manage directives, maintain personnel data, and provide assistance with manpower issues. The Command Evaluation Office manages external audits and inspectors, and serves as the Installation's Security Manager of sensitive Information System resources. The Public Affairs Office produces a weekly base newspaper, *The Flying K*, coordinates the tours program and VIP visits, supports command participation in numerous community programs and special events, maintains liaison with local media representatives, administers the Fleet Hometown News Program, and manages community and media relations in the case of all accidents, incidents, and unusual occurrences involving personnel attached to NAS Kingsville and TRAWING TWO. Other support services at NAS Kingsville include Emergency Management, Fire Services, Safety, Security, Facilities, and Environmental.

Air Operations

Air Ops is an integral component to operations at NAS Kingsville and this AICUZ Study because historic knowledge, current operations and statistics, and future projections all fall under the responsibility of this department.

The Air Operations (Air Ops) Department provides air traffic controllers, ground electronics personnel, weapons personnel, and fire department personnel for NAS Kingsville and NALF Orange Grove. Air Ops is responsible for the daily coordination and safety of all aircraft and operations onboard NAS Kingsville and NALF Orange Grove in support of TRAWING TWO. Air Ops is the overarching term to describe aircraft operations, the coordination of flights, the availability of airspace and airfields, the maintenance of airport facilities and services, and the safety of aviators and the public.

Aircraft Maintenance

TRAWING TWO's Boeing T-45 "Goshawk" training aircraft are maintained by contractor maintenance personnel. NAS Kingsville has an onsite facility to maintain aircraft and ground and simulator instruction. Contractor maintenance personnel support includes flight-line operations and maintenance, component and depot maintenance, general aircraft maintenance, and inventory management and supply.

2.5 Operational Areas

2.5.1 Airfields

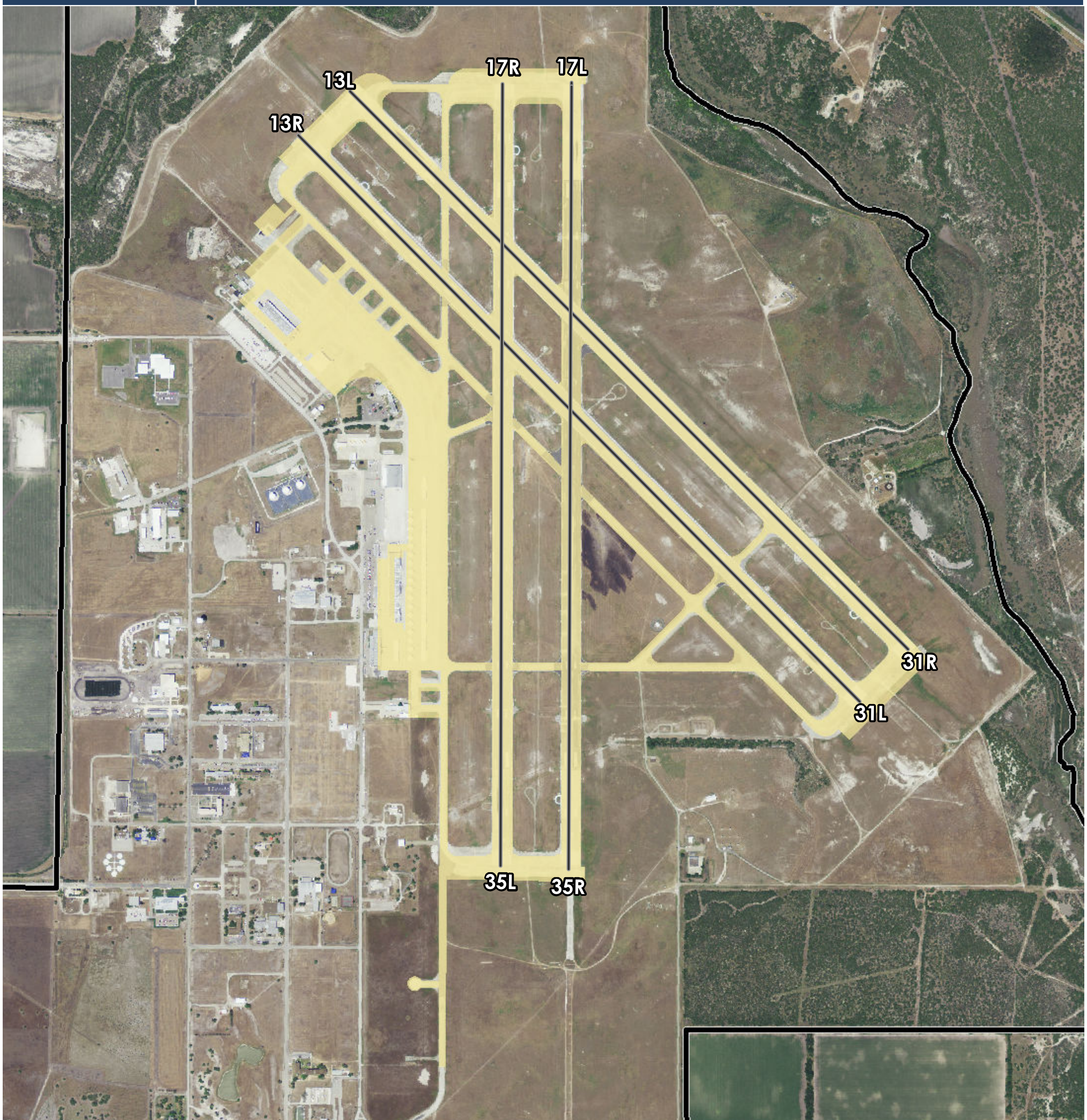
All runways at NAS Kingsville and NALF Orange Grove are Class B runways.

The Office of the Secretary of Defense and the Department of the Navy provide guidance for aircraft runway classifications for defining APZs for the AICUZ Program. DOD fixed-wing runways are separated into two classes: Class A and Class B. Runways are classified according to the type of aircraft that operate from the runway. Airfield runways at NAS Kingsville and NALF Orange Grove are categorized as Class B runways. Class B runways are primarily used by large, heavy, and high-performance aircraft.

NAS Kingsville, Bernhard Field

NAS Kingsville is home to Bernhard Field, which occupies approximately 578 acres on the northeast portion of the Installation. (The entire Installation occupies 3,346 acres.) The airfield is equipped with four Class B runways, each measuring 200 feet wide by 8,000 feet long. The two sets of parallel runways run southeast/northwest (13L/31R and 13R/31L) and north/south (17L/35R and 17R/35L) (Figure 2-3). The airfield elevation is 50 feet above mean sea level (MSL).

FIGURE 2-3 BERNHARD FIELD, NAS KINGSVILLE



Source: ESRI 2011, Navy 2011, NAIP 2012

0 2,000
Feet

NAS Kingsville
Runway
Airfield Surface Area

The airfield operates daily from 7:30 a.m. to 11:30 p.m. Monday through Thursday and from 7:30 a.m. to 5:30 p.m. on Friday. The airfield is closed on Saturdays. Current hours of operation and the schedule for Sunday hours or holidays are published in Notices to Airmen (NOTAMs). Extenuating circumstances can result in extended operating hours or temporarily suspended operations. The Air Ops Officer may temporarily close the airfield in consideration of landing area conditions, crash crew equipment availability, status of navigational aids, and severe weather conditions.

Instrument Landing System (ILS) and Tactical Air Navigation (TACAN) are navigation systems to guide aircraft approaching an airfield using radio signals and transmitters.

All runways are equipped with two sets of hydraulic arresting gear (E-28) and high-intensity runway edge lighting. Instrument Landing System (ILS) approaches are available for Runway 13R, and Tactical Air Navigation (TACAN) approaches are available for Runways 13R and 35R/L, with circling approaches using Runways 17 R/L and 31 R/L. Precision Approach Radar (PAR) and Airport Surveillance Radar (ASR) approaches are also available.

Pilots use Optical Landing Systems (OLS) to determine the proper aircraft glideslope for approaches to the runways in order to train for carrier-based landings.

Portable Fresnel Lens Optical Landing Systems (OLS) are also available on each runway. Pilots use the OLS to determine the proper aircraft glideslope for approaches to the runways in order to train for carrier-based landings. The OLS mobile lens unit is positioned on the left side of the runway and reflects light cells to form the image of a single visible light or “meatball.” The angle of the lens from the pilot's line of vision determines the color and position of the visible light. Pilots track the “meatball” against a row of green datum lights to gauge if their approach is too steep or shallow. To simulate landings on carriers through FCLP training, Runways 13L, 17L, and 35L have simulated carrier flight deck lighting to provide the same landing cues as a ship. Aircraft run-up pads and designated high-power turn up areas for aircraft maintenance are also located on the airfield and are discussed in detail in Section 3.3 *Runway and Flight Track Utilization*.

NALF Orange Grove

NALFs are typically used for training, practice, or other routine operations. Aircraft are not stationed, parked overnight, or maintained at NALFs.

NALF Orange Grove is a 1,379-acre outlying training airfield for approaches and arrested landings in support of the training mission of NAS Kingsville. The airfield is located approximately 35 miles northwest of NAS Kingsville between the cities of Alice and Orange Grove, Texas. The airfield elevation is 257 feet MSL. The airfield operates Monday through Friday from 8:00 a.m. to 4:00 p.m. and is closed on weekends and federal holidays. Operation hours may be extended or suspended in accordance with training obligations.

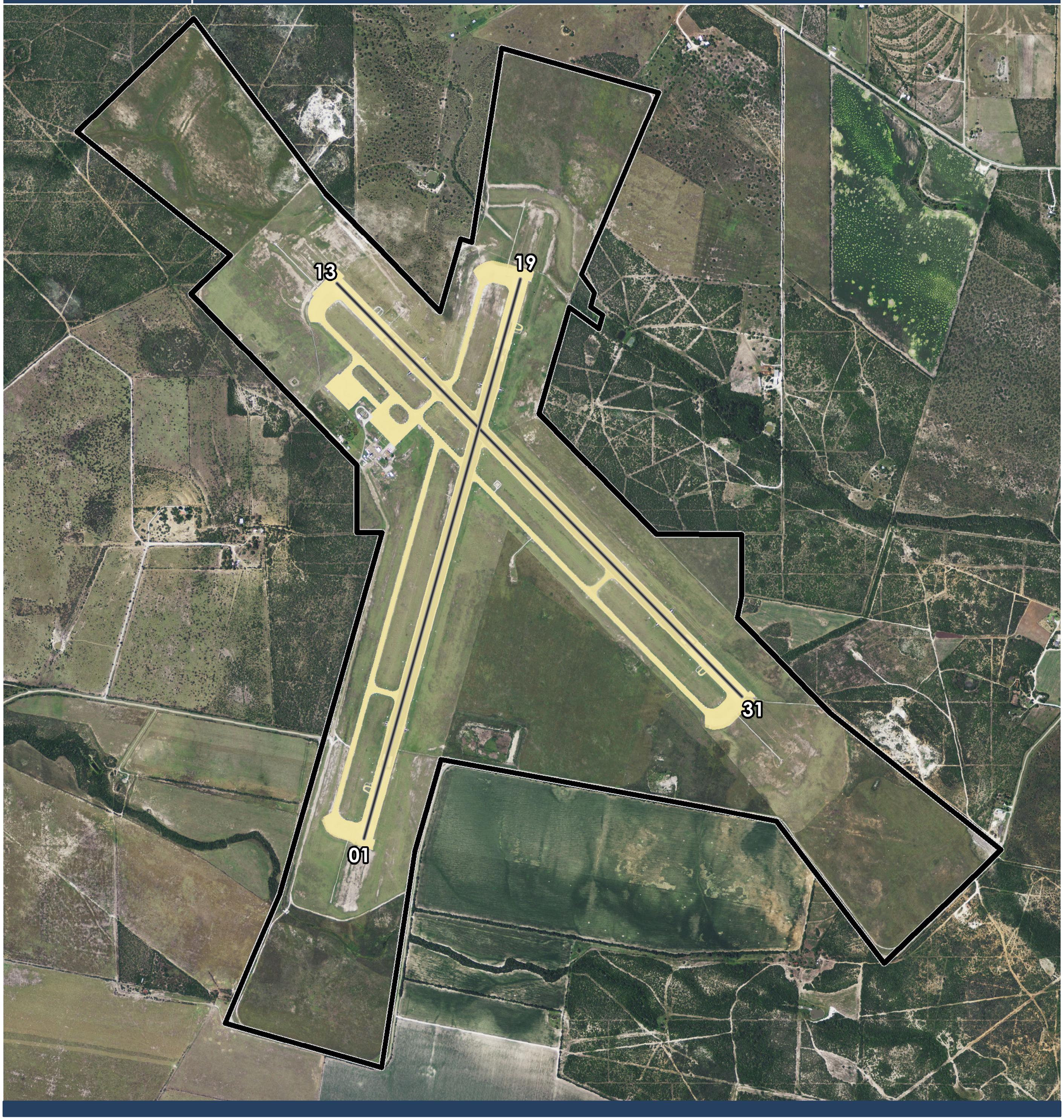
NALF Orange Grove has two Class B runways consisting of one north/south Runway (1/19) and one southeast/northwest Runway (13/31) (Figure 2-4). Each runway measures 200 feet wide by 8,000 feet long. ILS approaches are available for Runway 13, and other non-precision approaches are available for Runway 13/31. The runways are equipped with two sets of hydraulic arresting gear (E-28), high-intensity runway edge lighting, and a portable Fresnel Lens OLS. Hangar space is not available at the airfield.

2.5.2 Airspace

The use of airspace over NAS Kingsville and NALF Orange Grove is approved by the FAA, which manages the National Airspace System. The National Airspace System seeks to ensure the safe, orderly, and efficient flow of commercial, private, and military aircraft.

There are two categories of airspace: regulatory and non-regulatory. Within these two categories, there are four types of airspace: controlled, uncontrolled, special use, and other airspace. Controlled airspace—designated Class A through Class E—includes the airspace within which Air Traffic Control (ATC) clearance is required. Uncontrolled airspace is the portion of the airspace not designated as Class A through Class E within which ATC has no authority or responsibility to control air traffic (FAA 2008) (Figure 2-5).

FIGURE 2-4 NALF ORANGE GROVE

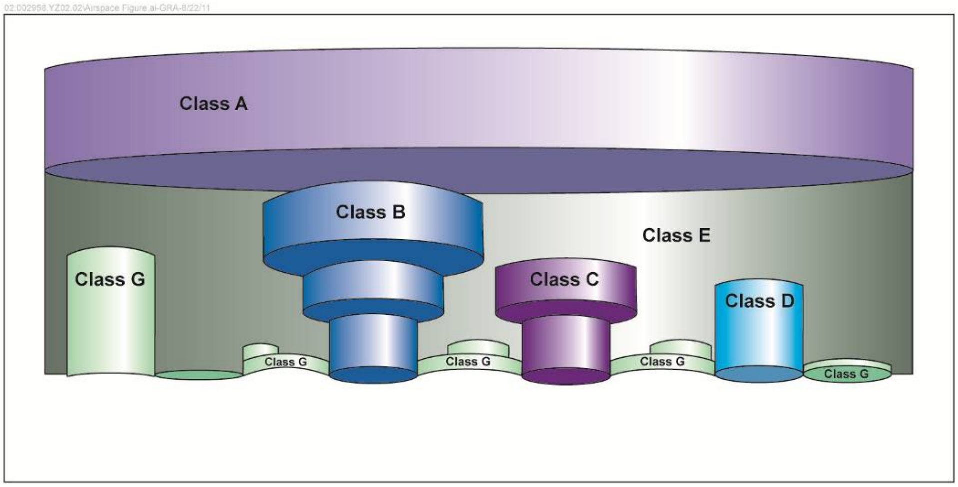


Source: ESRI 2011, Navy 2011, NAIP 2012

0 2,000
Feet

NALF Orange Grove
Runway
Airfield Surface Area

Figure 2-5: General Airspace Classification



> **NAS Kingsville and NALF Orange Grove airspaces are classified as Class D airspace.**

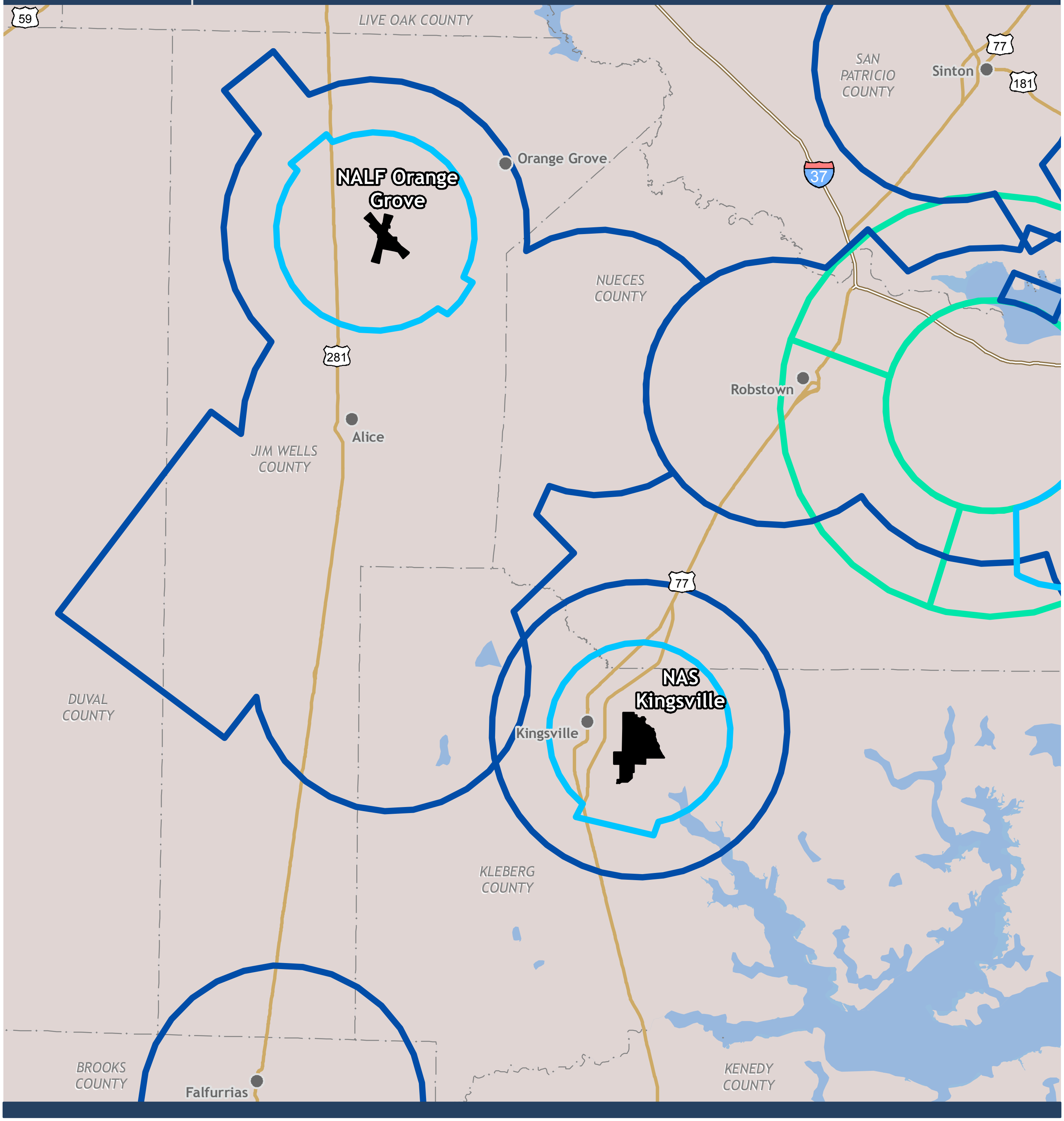
NAS Kingsville and NALF Orange Grove airspaces are classified as Class D airspace (Figure 2-6). Class D airspace generally extends from the surface to 2,500 feet above ground level (AGL) surrounding those airports that have an operational control tower, are serviced by a radar approach control, and have a certain number of instrument flight rules (IFR) operations or passenger enplanements. Each aircraft must establish two-way radio communication with the air traffic controller prior to entering the airspace and maintain communication while flying within the airspace. Visual flight rules (VFR) arrivals must contact Kingsville Approach prior to entering the Class D airspace for radar services and sequencing over the appropriate VFR entry points.

2.5.3 Special Use Airspace

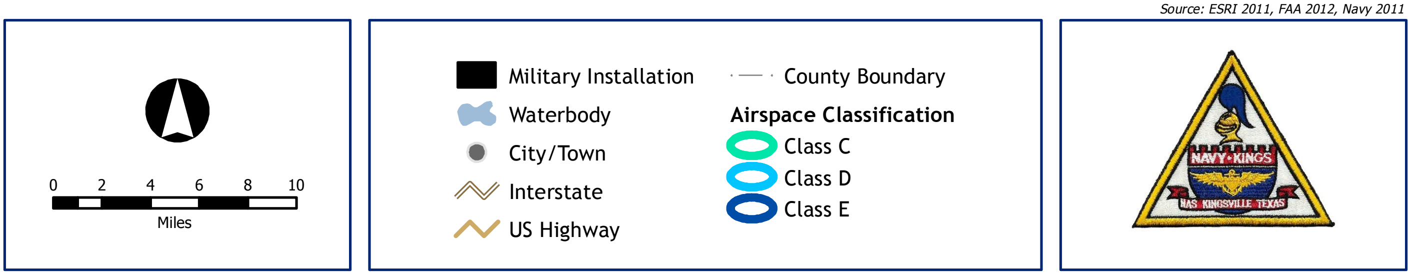
Special use airspace (SUA) is the designation of airspace in which certain activities must be confined or where limitations may be imposed on aircraft operations that are not part of those activities. The SUA dimensions are defined so that military activities can operate and have boundaries that limit access by non-participating aircraft. NAS Kingsville has offshore and onshore SUA to fulfill its training mission (Figure 2-7). Relevant local SUA used by aircraft operating at NAS Kingsville and NALF Orange Grove are described below.

FIGURE 2-6

AIRSPACE CLASSIFICATION, NAS KINGSVILLE AND NALF ORANGE GROVE

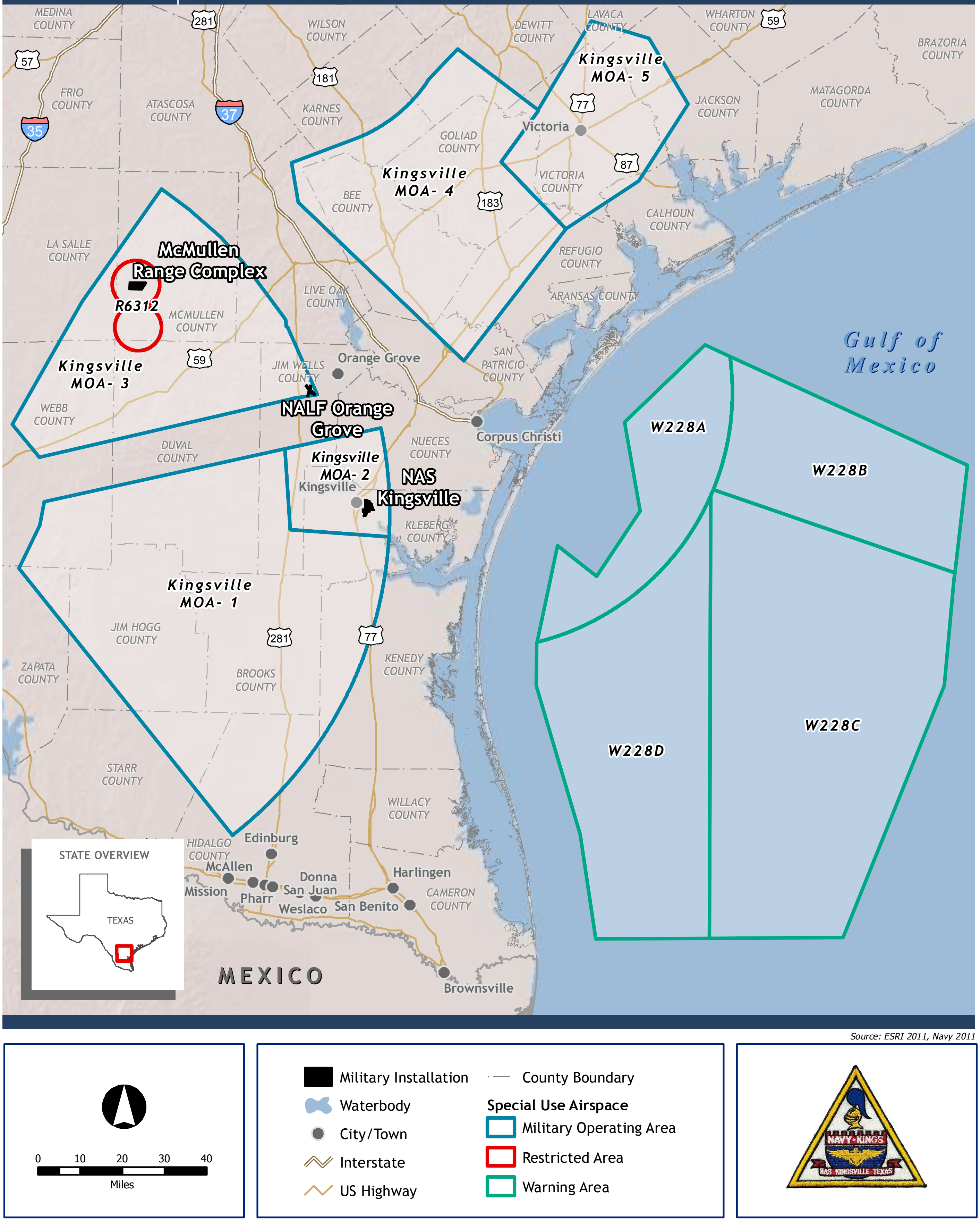


Source: ESRI 2011, FAA 2012, Navy 2011



Draft Work Product – FOR OFFICIAL USE ONLY

FIGURE 2-7 NAS KINGSVILLE SPECIAL USE AIRSPACE



Source: ESRI 2011, Navy 2011

Draft Work Product – FOR OFFICIAL USE ONLY

Warning Areas: Airspace of defined dimensions, extending from 3 nautical miles outward from the coast of the United States, containing activity that may be hazardous to non-participating aircraft. These areas may contain a variety of aircraft and on-aircraft activities, such as aerial gunnery, bombing, aircraft carrier operations, surface and subsurface operations, naval gunfire, and missile shoots.

- Warning Area 228 (W228) is controlled by NAS Corpus Christi and located southeast of NAS Kingsville. This SUA encompasses approximately 12,574 square miles of airspace over the Gulf of Mexico. The airspace is divided into four sub-areas: W228A/B/C/D. TRAWING TWO is the primary user of W228D and uses the area for air-to-air gunnery training.

Military Operating Areas (MOAs): Airspace with defined vertical and lateral limits to segregate certain non-hazardous military activities from IFR traffic and to identify VFR traffic where military activities are conducted.

NAS Kingsville has five MOAs for student pilot training, undergraduate intermediate jet training, and undergraduate advanced training exercises.

- Kingsville MOA-1, MOA-2, and MOA-4: NAS Kingsville is the primary user, and TRAWING TWO is responsible for scheduling the use of these MOAs;
- Kingsville MOA-3: NAS Kingsville and the Texas Air National Guard are primary users, and TRAWING TWO schedules use of Kingsville MOA-3; and
- Kingsville MOA-5: The U.S. Air Force (Randolph AFB) is the primary user. TRAWING TWO grants Randolph AFB scheduling privileges for Kingsville MOA-5.

For training student pilots, TRAWING TWO uses both restricted areas and MOA airspace.

Restricted Areas: Airspace where flight of aircraft is subject to restrictions. Restricted areas are established to separate operations that are hazardous to non-participating aircraft.

- R6312 is the restricted airspace above the McMullen Range Complex and is located within Kingsville MOA-3. R6312 consists of two 5-nautical-mile circles from the center of both Dixie and Yankee target ranges, extending from surface to 23,000 feet altitude. For simultaneous training at Dixie Target Range and Yankee Target Range, designated Air Force and Navy units can share use of R6312 under a Letter of Agreement establishing Military Assumes the Responsibility for Separation of Aircraft (MARSA) procedures. Although Navy and Air Force units are accepted through the Letter of Agreement, R6312 is exclusive-use airspace.

2.6 Local Economic Impacts

The military provides direct, indirect, and induced economic benefits to the regional and local communities through jobs and wages. Benefits include employment opportunities and increases in local business revenue, property sales, and tax revenue. In fiscal year (FY) 2010, the DOD's expenditures in Texas totaled $54.25 billion (U.S. Census Bureau 2011).

Historic Downtown Kingsville

The economic impact of a military installation is based on annual payroll (jobs and salaries), local procurement, and contracts (expenditures). The military also contributes to the economic development of the communities through increased demand for local goods and services and increased household spending by military and civilian employees.

Downtown Kingsville, Present Day

NAS Kingsville has a positive economic impact on the local communities and surrounding region. The Installation employs a combined workforce of 1,821 military and civilian personnel, and construction activities in 2010 created an additional 293 jobs (Impact DataSource 2009). NAS Kingsville's direct annual economic impact totaled $23.5 million. In 2010, NAS Kingsville spending generated $22.3 million in local business sales and supported 2,601 jobs throughout the Kingsville region. In total, the Installation contributed a $458 million economic impact and supported a total of 4,715 jobs in the local community. The total number of personnel and the values of annual payroll, local procurement, and contracts for NAS Kingsville are shown in Table 2-1.

Table 2-1:
FY 2010 Personnel, Expenditures, and Contracts at NAS Kingsville

Personnel (Direct)	
Military Jobs	597
Civilian Jobs	1,224
Contract	293
Total	**2,114**
Salary (Direct)	
Military	$38,827,394
Civilian	$57,973,585
Contract	$13,200,000
Total	**$110,000,979**
Annual Local Economic Impact	
Local Expenditures	$105,225,809
Construction Expenditures	$33,000,000
Salaries	$96,800,979
Total Direct Output	**$235,026,788**
Total Indirect Output	**$223,275,448**
Total Economic Impact	**$458,302,236**

Source: Impact DataSource 2009.

NAS Kingsville, including spending by the facility and by facility personnel and employees, generates approximately $19 million per year in revenue for the local tax districts. Property tax from military personnel or employers directly or indirectly supported by the military facility accounts for $11 million in annual revenue and is the largest contributor of the total revenue for taxing districts (Impact DataSource 2009).

2.7 Regional Population

2.7.1 Kingsville, Kleberg County

Kingsville is the county seat and is the most populated city in Kleberg County. The city has a total land area of approximately 14 square miles within the northwestern portion of the county (U.S. Census Bureau 2010a). The City of

Kingsville has a population of 26,213 persons, including 8,964 households and 10,354 housing units. The city has a population density of approximately 1,895 persons per square mile and an 87.8 percent occupancy rate (U.S. Census Bureau 2010b). The city's population has grown approximately 2.5 percent over the last 10 years and is projected to grow at a continuous rate for the next 20 years. Population estimates and projections for Kleberg County and the City of Kingsville are provided in Table 2-2.

Table 2-2:
Regional Population Estimates and Projections

Population Area	1990[1]	2000[1]	2010[1]	2020[2]	2030[2]	% Growth 2000-2010	% Growth 2020-2030
City of Kingsville	25,276	25,575	26,213	27,756	28,347	2.5%	2.1%
Kleberg County	30,274	31,549	32,061	40,849	43,370	1.6%	6.2%
City of Orange Grove	1,175	1,288	1,318	1,484	1,544	2.3%	4.0%
Jim Wells County	37,679	39,326	40,838	45,303	47,149	3.8%	4.1%

Sources: (1) U.S. Census Bureau Population Estimates 1990, 2000, and 2010.
(2) Texas Water Development Board 2011.

2.7.2 Orange Grove, Jim Wells County

Jim Wells County is located directly west of Kleberg County. The county's total area is approximately 868 square miles, and almost half of the total land area is prime farmland (Garza 2011). The county has an estimated population of 39,326 persons and 13,961 households (U.S. Census Bureau 2010c). Orange Grove is a rural farming community located in northeastern Jim Wells County. The city has an estimated population of 1,318 persons, including 498 households and 561 housing units (U.S. Census Bureau 2010d).

Table 2-2 identifies the decennial population estimates and additional 10-year projected populations for the City of Kingsville, Kleberg County, Jim Wells County, and Orange Grove through 2030. The Texas State Data Center and U.S. Census Bureau do not provide long-term population projections for cities/places, so population projections for the City of Kingsville and Orange

Grove were provided by the Texas Water Development Board. For consistency, the Board's county projections also were used.

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3 Aircraft Operations

NAS Kingsville serves as a pilot training installation, and most air operations are conducted by advanced jet aircraft from active-duty squadrons. This chapter discusses aircraft stationed at NAS Kingsville, the types and quantities of operations conducted at the airfields, including projected (2013) operations, and the runways and flight tracks used to conduct the operations.

3.1 Aircraft Types

There are two basic types of aircraft: fixed-wing (propellers or jet-fighters) and rotary-wing (helicopters). The T-45A/C fixed-wing aircraft is stationed at NAS Kingsville and accounts for the majority of flight operations at NAS Kingsville and NALF Orange Grove. Small numbers of other aircraft occasionally use NAS Kingsville and NALF Orange Grove. No aircraft are stationed at NALF Orange Grove.

3.1.1 Fixed-Wing Aircraft

T-45A/C "Goshawk"

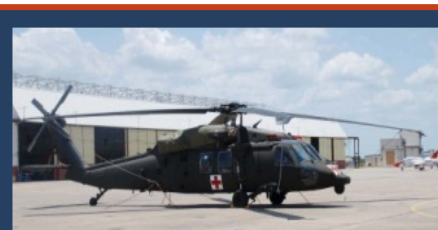
T-45A/C "Goshawk"

The T-45A/C is a single-engine, two-seat, advanced aircraft that is used for intermediate and advanced portions of the Navy pilot and navigator training program for jet carrier aviation and tactical strike missions. The T-45A/C replaced the T-2 Buckeye trainer and the TA-4 trainer with an integrated training system. The "Goshawk" T-45 Training System (T45TS) combines academic, flight, and instrument simulation training into an integrated computerized training approach to improve training efficiency and reduce training hours. The T45TS is the first complete integrated jet aircraft training system developed for and used by the Navy.

The T-45A/C “Goshawk” was introduced to NAS Kingsville in 1992. The “Goshawk,” with a wingspan of 30 feet and a length of 39 feet, can reach a maximum speed of 560 knots with an operational range of 700 nautical miles. The T-45A/C weighs 10,403 pounds and has a service ceiling of 42,500 feet. NAS Kingsville is transitioning from the T-45A to the T-45C model, with improvements such as a glass cockpit and inertial navigation.

3.1.2 Rotary-Wing Aircraft

HH-60M “Blackhawk”



HH-60M “Black Hawk”

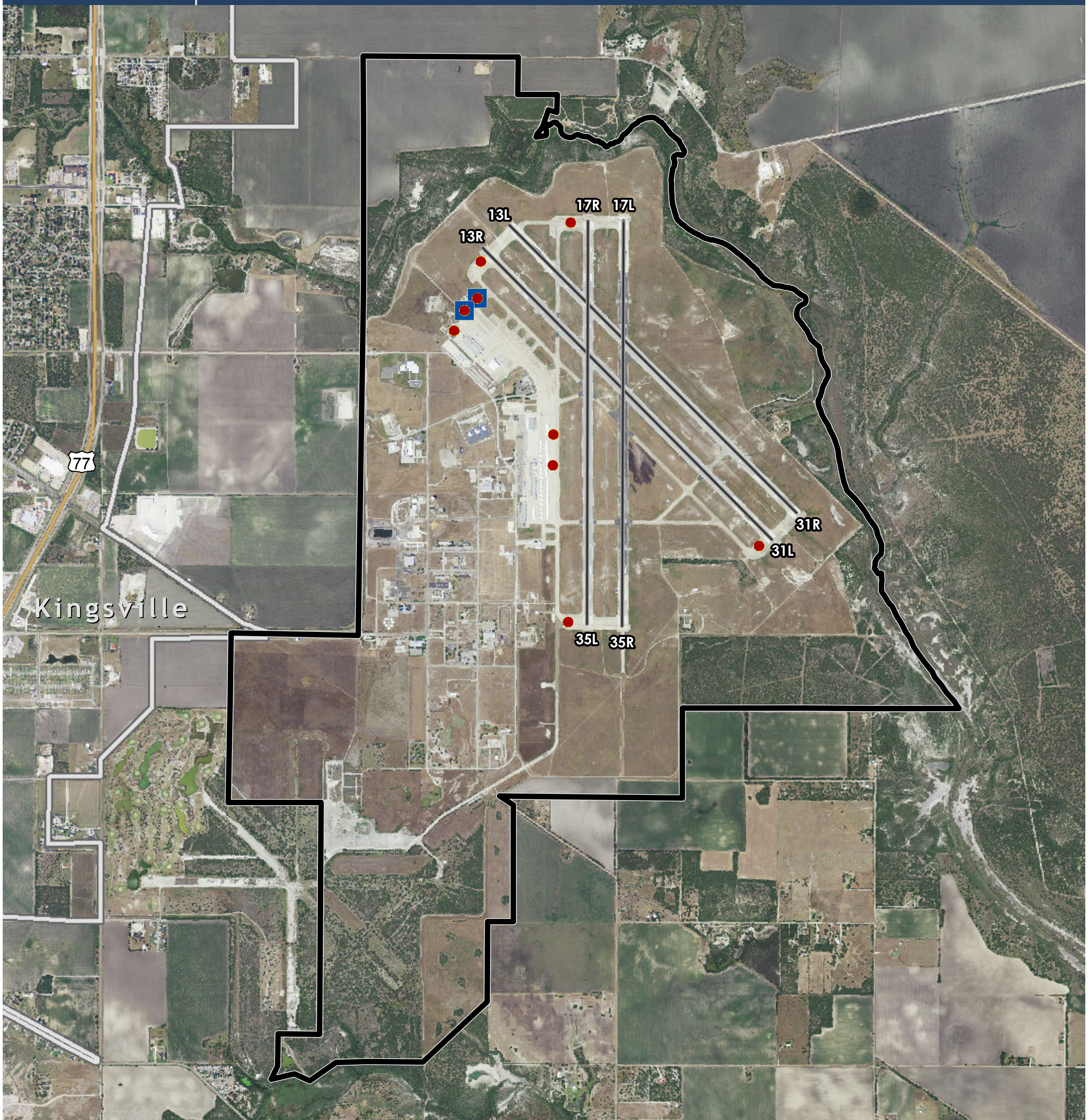
The HH-60M “Blackhawk” is designed for MEDEVAC missions and is equipped to provide en-route medical care for patients being transported from an injury site to a hospital facility. This rotary-wing aircraft includes an environmental control system, oxygen-generating system, patient monitors, and an external electrical rescue hoist.

3.2 Aircraft Operations

3.2.1 Maintenance Run-Up Operations

Ground engine maintenance “run-up” operations are associated with preflight and maintenance checks. Aircraft engine maintenance run-up operations at NAS Kingsville are conducted west of the flight line (Figure 3-1). These activities include engine rinses and washes, maintenance turns, and high-power turns. Seven maintenance run-up locations, including two flight line pads, four preflight pads, and one high-power pad, are located at NAS Kingsville.

FIGURE 3-1 AIRCRAFT MAINTENANCE RUN-UP LOCATIONS, NAS KINGSVILLE



Source: ESRI 2011, Navy 2011, NAIP 2012

0 0.5
Miles

- NAS Kingsville
- Engine Run-Up Locations
- Test Cell Locations
- Runway
- US Highway
- Urban Area

A test cell is a building specially designed to verify aircraft engine performance.

In addition to the run-up locations, aircraft engine "test cells" provide a muffled environment at the Installation for un-mounted engine testing and in-frame engine testing, respectively. Two test cell areas are located south of the approach end of Runway 13R at NAS Kingsville (Figure 3-1).

3.2.2 Flight Operations

As part of the typical training syllabus for flight crews, flight operations at NAS Kingsville include departures, arrivals, touch-and-go's, and practice radar approaches. Flight operations at NAS Kingsville and NALF Orange Grove follow the curriculum set forth by CNATRA for TRAWING TWO student aviators. Since no fleet squadrons are stationed at NAS Kingsville, all flight operations are for training purposes. All basic flight maneuvers, as well as intermediate and advanced operations, are flown at NAS Kingsville and NALF Orange Grove. Basic flight operations conducted at NAS Kingsville and NALF Orange Grove include:

Departure: An aircraft takes off to a training area or as part of a training maneuver (i.e., touch-and-go).

Arrival: An aircraft returns from a local or non-local training area or from a training maneuver (e.g., touch-and-go) and lands.

- **Straight-In/Full-Stop Arrival:** An aircraft lines up on the runway centerline, descends gradually, lands, comes to a full stop, and then taxis off the runway.
- **Overhead Break Arrival:** An expeditious arrival using VFR. An aircraft approaches the runway 500 feet above the altitude of the landing pattern. Approximately halfway down the runway, the aircraft performs a 180-degree turn to enter the landing pattern. Once established in the pattern, the aircraft lowers landing gear and flaps and performs a 180-degree descending turn to land on the runway. NAS Kingsville uses the carrier break, and aircraft enter the break at 800 feet AGL then descend to a pattern altitude of 600 feet AGL.

- **Radar Approach:** A radar instrument approach provided with active assistance from ATC with the use of a radio transmitter and receiver. The ATC vectors the aircraft to align it with the runway centerline. The controller continues the vectors to keep the aircraft on course until the pilot can complete the approach and landing by visual reference to the surface. A radar approach may be given to any aircraft upon request and may be offered to pilots of aircraft in distress or to expedite traffic.

Aircraft Patterns: Pattern work refers to traffic pattern training where the pilot performs takeoffs and landings in quick succession by taking off, flying the pattern, and then making a touch-and-go landing.

- **Touch-and-Go:** An aircraft lands and takes off on a runway without coming to a full stop. After touching down, the pilot immediately goes to full power and takes off again. The touch-and-go is counted as two operations—the landing is counted as one operation, and the takeoff is counted as another.

Touch-and-Go Flight Operation

- **Ground Controlled Approach (GCA):** A radar or "talk down" approach directed from the ground by ATC personnel. ATC personnel provide pilots with verbal course and glideslope information, allowing them to make an instrument approach during inclement weather. The GCA Box is counted as two operations—the landing is counted as one operation, and the takeoff is counted as another.
- **Field Carrier Landing Practice (FCLP):** An aircraft training procedure that simulates landing on the flight deck of an at-sea carrier. Ships and aircraft carriers have different flight deck configurations and optical landing systems (lighting). This operation

is conducted to prepare for flight operations when deployed aboard ships at sea. The FCLP is counted as two operations—the landing is counted as one operation and the takeoff is counted as another. At NAS Kingsville, the carrier break altitude is 800 feet AGL, and the FCLP downwind leg is at 600 feet AGL.

- **Precautionary Approach:** A procedure taught to student pilots to ensure that a safe landing can be made if indications of an impending engine failure should occur. Precautionary approaches are used when the engine reliability is questionable or there are indications of impending engine failure.
- **Low Approach:** A low approach to a runway during which the pilot does not make contact with the runway but, rather, increases altitude and departs the airfield's airspace.

Primary operations occurring at NAS Kingsville include departures, straight-in arrivals, overhead break arrivals, touch-and-go patterns, and GCA and FCLP operations. NALF Orange Grove supports training operations for NAS Kingsville, and the majority of flight operations occurring at NALF Orange Grove are touch-and-go patterns and FCLP operations.

Table 3-1 provides historic data of annual flight operations conducted at NAS Kingsville and NALF Orange Grove, respectively, between 2002 and 2010. The data were compiled from Air Traffic Activity Reports (NAS Kingsville 2010) provided by ATC personnel. Operational levels at NAS Kingsville and NALF Orange Grove remain fairly constant, with a slight decrease in 2009 and 2010. The decrease in operations may be due to fewer SNAs. Additionally, NALF Orange Grove Runway 13 was under repair in 2009, attributing to the decrease in annual operations for that year.

Table 3-1:
Total Annual Operations at NAS Kingsville and NALF Orange Grove
(2002 through 2010)

Year	Annual Operations				Total
	Military		Civil		
	Navy/Marine	Other	Air Carrier	General Aviation	
NAS Kingsville					
2002	200,214	462	18	230	200,924
2003	167,793	145	2	152	168,092
2004	202,445	277	64	374	203,160
2005	183,046	117	17	115	183,295
2006	158,476	78	4	140	158,698
2007	174,229	41	4	112	174,386
2008	178,452	81	0	6	178,539
2009	157,758	36	0	4	157,798
2010	145,569	45	0	166	145,780
NALF Orange Grove					
2002	45,040	1452	0	80	46,572
2003	45,013	285	0	6	45,304
2004	42,080	2422	0	34	44,536
2005	50,270	72	0	42	50,384
2006	42,766	419	0	7	43,192
2007	32,358	66	0	8	32,432
2008	32,355	32	0	2	32,389
2009	35,544	14	0	8	35,566
2010	33,660	13	0	4	33,677

Source: NAS Kingsville 2010.

3.2.3 Projected Flight Operations

NAS Kingsville

A total of 203,682 annual flight operations are projected at NAS Kingsville for the 2013 AICUZ Study. Projected operations are based on the highest total of annual military operations between 2002 and 2010, which

occurred in 2004, in addition to 960 projected flight operations for occasional surges in weapons detachment training at the McMullen Range Complex.

Table 3-2 presents the 2013 projected flight operations for the T-45A/C by operation type at NAS Kingsville. Approximately 99 percent of projected operations will be conducted during daytime hours (7:00 a.m. to 10:00 p.m.).

Table 3-2:
Projected Annual T-45 Operations at NAS Kingsville

Operation Type	Average Annual Operations Day 0700-2200	Night 2200-0700	Total Annual Operations
Departure	34,024	344	34,368
Arrival	34,024	344	34,368
Pattern	133,704	1,242	134,946
Total	**201,752**	**1,930**	**203,682**

Source: BRRC 2012.

NALF Orange Grove

A total of 52,262 annual flight operations are projected at NALF Orange Grove for the 2013 AICUZ Study. Projected operations are based on the highest total of annual operations between 2000 and 2010, which occurred in 2005, in addition to 1,920 projected flight operations for occasional surges in weapons detachment training at the McMullen Range Complex.

Table 3-3 presents the 2013 projected flight operations by operation type at NALF Orange Grove. Few operations occur during nighttime hours.

Table 3-3:
Projected Annual Operations at NALF Orange Grove

	Annual Average Operations		
Operation Type	Day 0700-2200	Night 2200-0700	Total Annual Operations
Departure	4,987	0	4,987
Arrival	4,987	0	4,987
Pattern	42,288	0	42,288
Total	**52,262**	**0**	**52,262**

Source: BRRC 2012.

3.3 Runway and Flight Track Utilization

Each airfield has designated flight tracks associated with the various aircraft operations being conducted. A flight track is a specific route an aircraft follows while conducting operations at the airfield. Flight tracks typically depict departure and arrival patterns to demonstrate how the aircraft flies in relation to the airfield. Flight tracks are graphically represented as single lines, but flights vary due to aircraft performance, pilot technique, weather conditions, and ATC variables. The actual flight track is most accurately represented as a band that is often 0.5 mile to several miles wide. Rotary-wing aircraft are not limited to fixed-wing flight tracks. The flight tracks shown in this AICUZ Study are idealized representations based on pilot and ATC input.

Each flight track is identified and numbered according to runway, flight operation, and numerical sequence for multiple flight tracks. Flight operations are abbreviated as: Departure (D), Straight-In Arrival (A), Overhead Break Arrival (O), Touch-and-Go Pattern (T), Ground Control Approach (GCA), and FCLP (F). For example, flight track 13LD1 at NAS Kingsville is interpreted as:

- Utilized Runway: 13L (Left)
- Type of Flight Operation: Departure
- Flight Track Departure Sequence: First

3.3.1 NAS Kingsville Runway Utilization and Flight Tracks

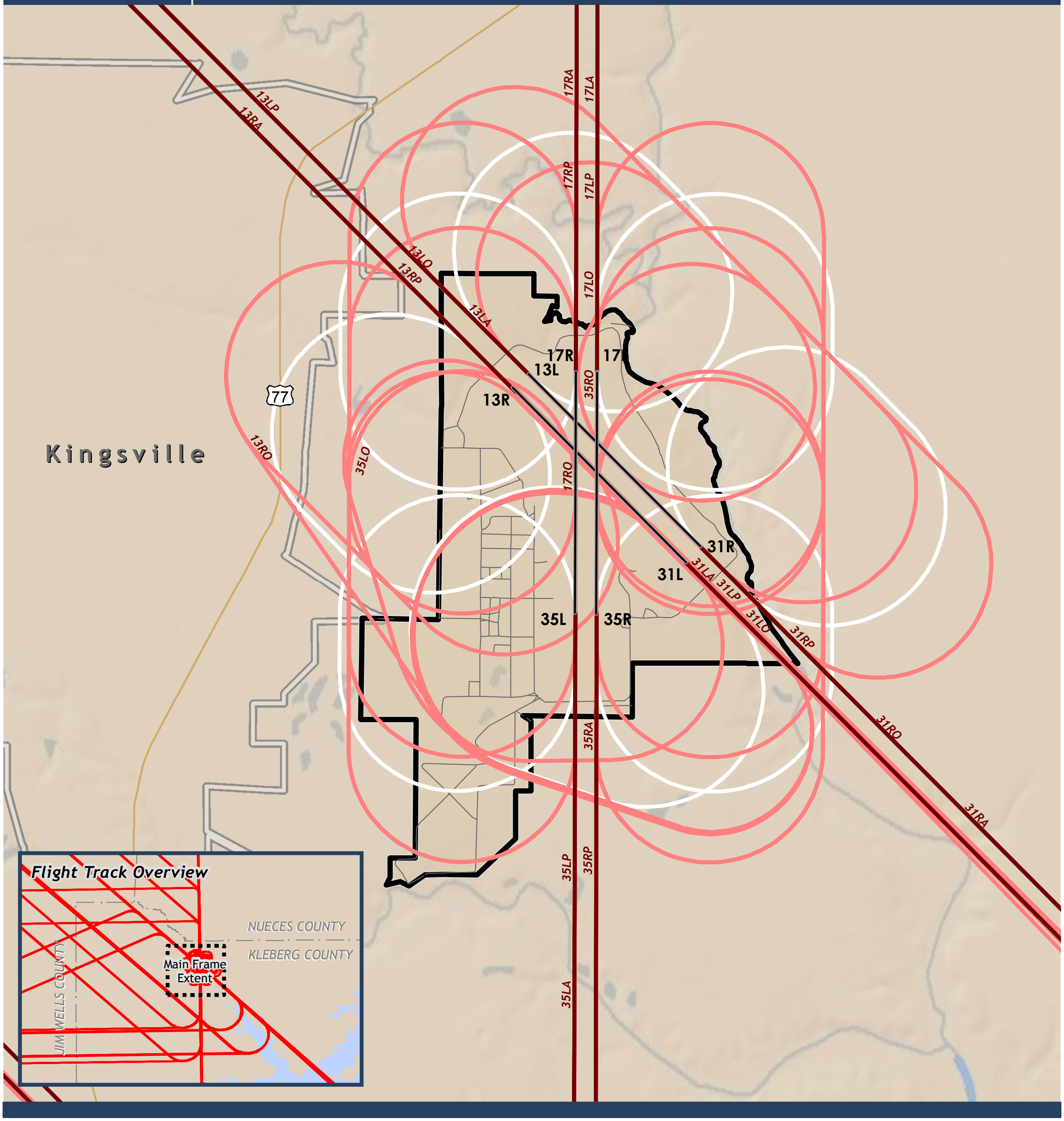
Predominant runway usage at NAS Kingsville occurs on Runway 13 R/L (59 percent) and Runway 35 R/L (22 percent); the remaining runway use is divided between Runway 17 R/L (17 percent) and Runway 31 R/L (2 percent). Current runway utilization has changed only slightly since the 1998 AICUZ, with a minimal shift of operations from Runway 13 R/L to Runway 35 R/L (approximately 10 percent).

Some flight tracks are modified to avoid direct flight over the on-base childcare center. The modified flight tracks include overhead arrivals on Runways 13R and 31L, precautionary approaches for Runway 31L, touch-and-go patterns for Runways 13R and 31L, and FCLPs on Runway 31. Figures 3-2 through 3-4 illustrate the arrival, departure, and pattern flight tracks for NAS Kingsville, respectively.

3.3.2 NALF Orange Grove Runway Utilization and Flight Tracks

Predominant runway usage at NALF Orange Grove occurs on Runway 13 (60 percent) and Runway 01 (19 percent); the remaining runway use is divided between Runway 19 (11 percent) and Runway 31 (10 percent). Figures 3-5 through 3-7 illustrate the arrival, departure, and pattern flight tracks for NALF Orange Grove, respectively.

FIGURE 3-2 ARRIVAL FLIGHT TRACKS, NAS KINGSVILLE



Source: ESRI 2011, BRRC 2011, Navy 2011

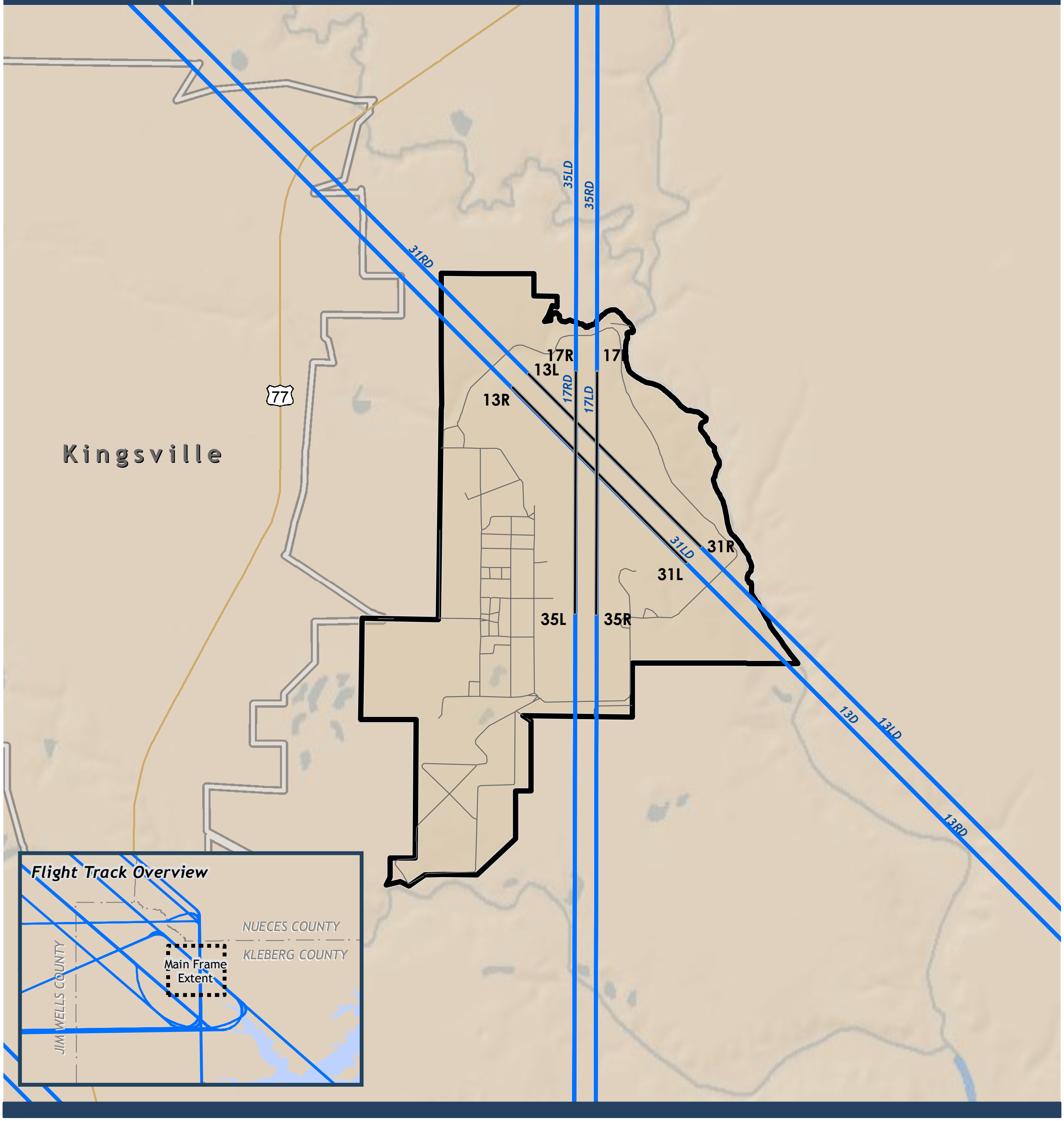
0 1
Miles

NAS Kingsville
Urban Area
Local Road
US Highway
Runway

Arrival Flight Operations

Overhead Break Arrival
Precautionary Approach
Straight-In Arrival
All Arrival Tracks (Inset)

FIGURE 3-3 DEPARTURE FLIGHT TRACKS, NAS KINGSVILLE



Source: ESRI 2011, BRRC 2011, Navy 2011

0 1
Miles

NAS Kingsville
Urban Area
Local Road
US Highway
Runway

Departure Flight Operations
Departure

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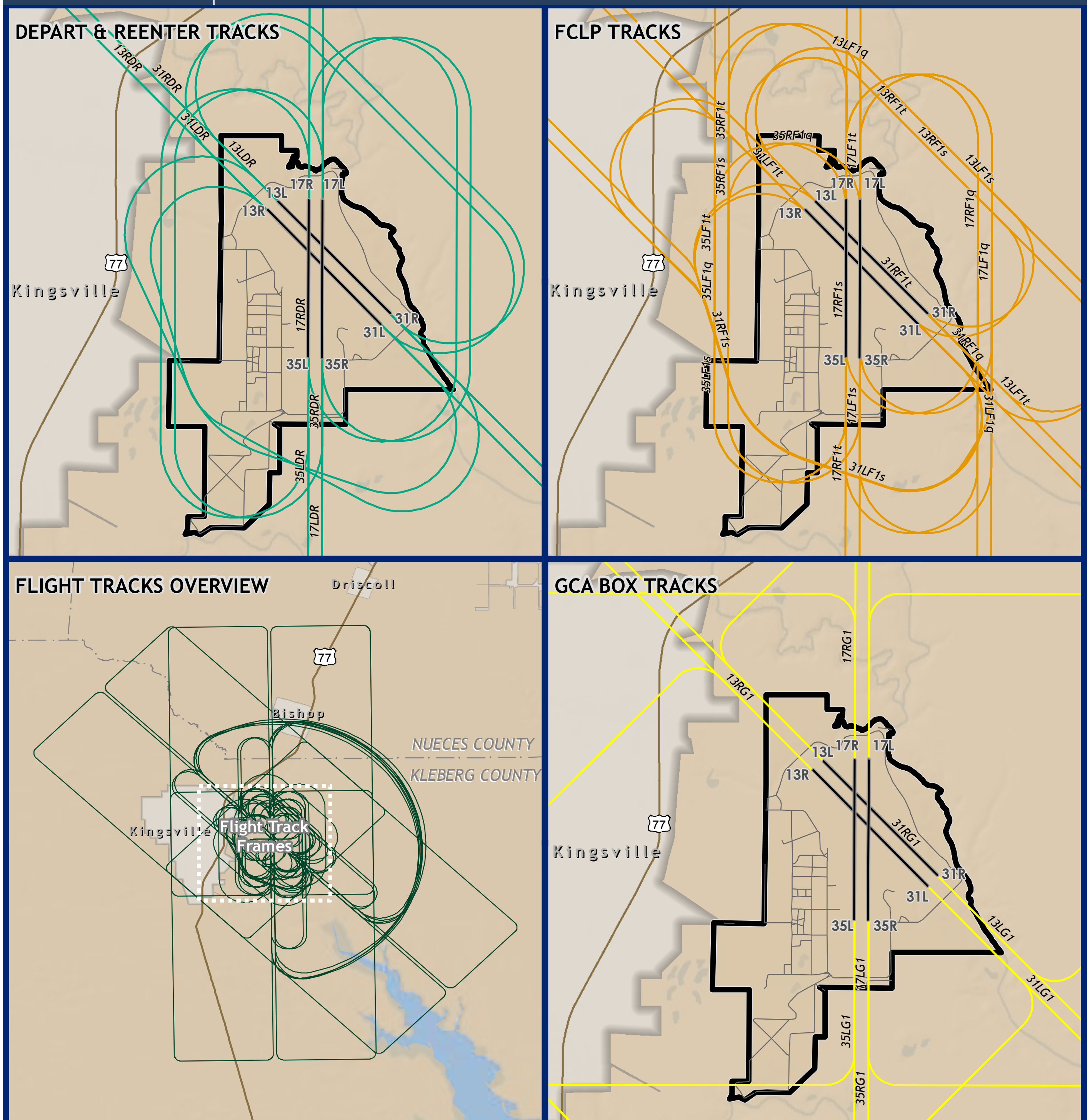
FIGURE 3-4A PATTERN FLIGHT TRACKS, NAS KINGSVILLE



Source: ESRI 2011, BRRC 2011, Navy 2011

0 8
Overview Frame (Miles)

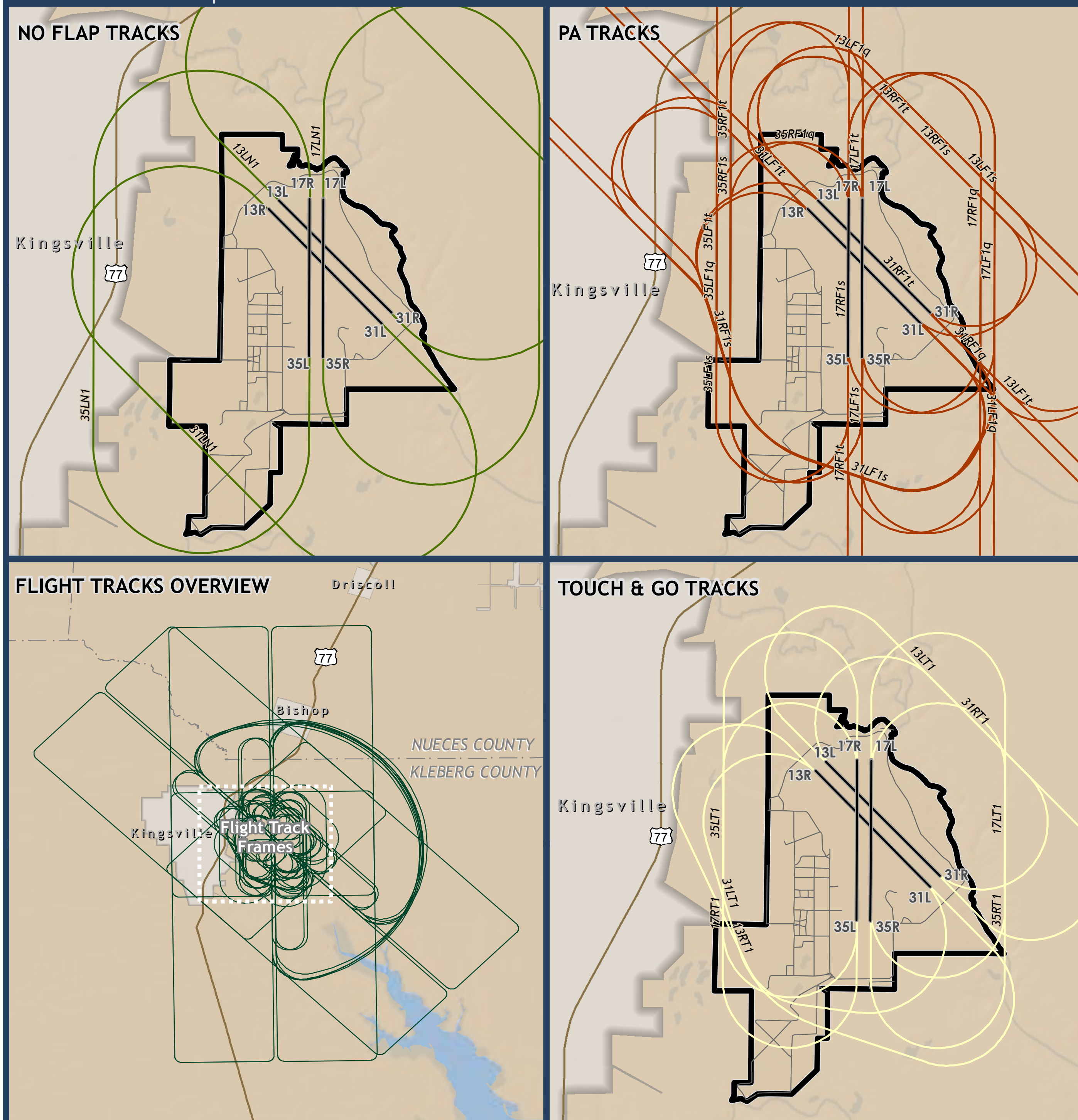
0 2
Flight Track Frames (Miles)

- NAS Kingsville
- Urban Area
- Local Road
- US Highway
- Runway

Pattern Flight Operations

- Depart & Reenter
- Flight Carrier Landing Pattern
- Ground Control Approach Box
- All Pattern Tracks (Inset)

FIGURE 3-4B PATTERN FLIGHT TRACKS, NAS KINGSVILLE



Source: ESRI 2011, BRRC 2011, Navy 2011

0 8
Overview Frame (Miles)

0 2
Flight Track Frames (Miles)

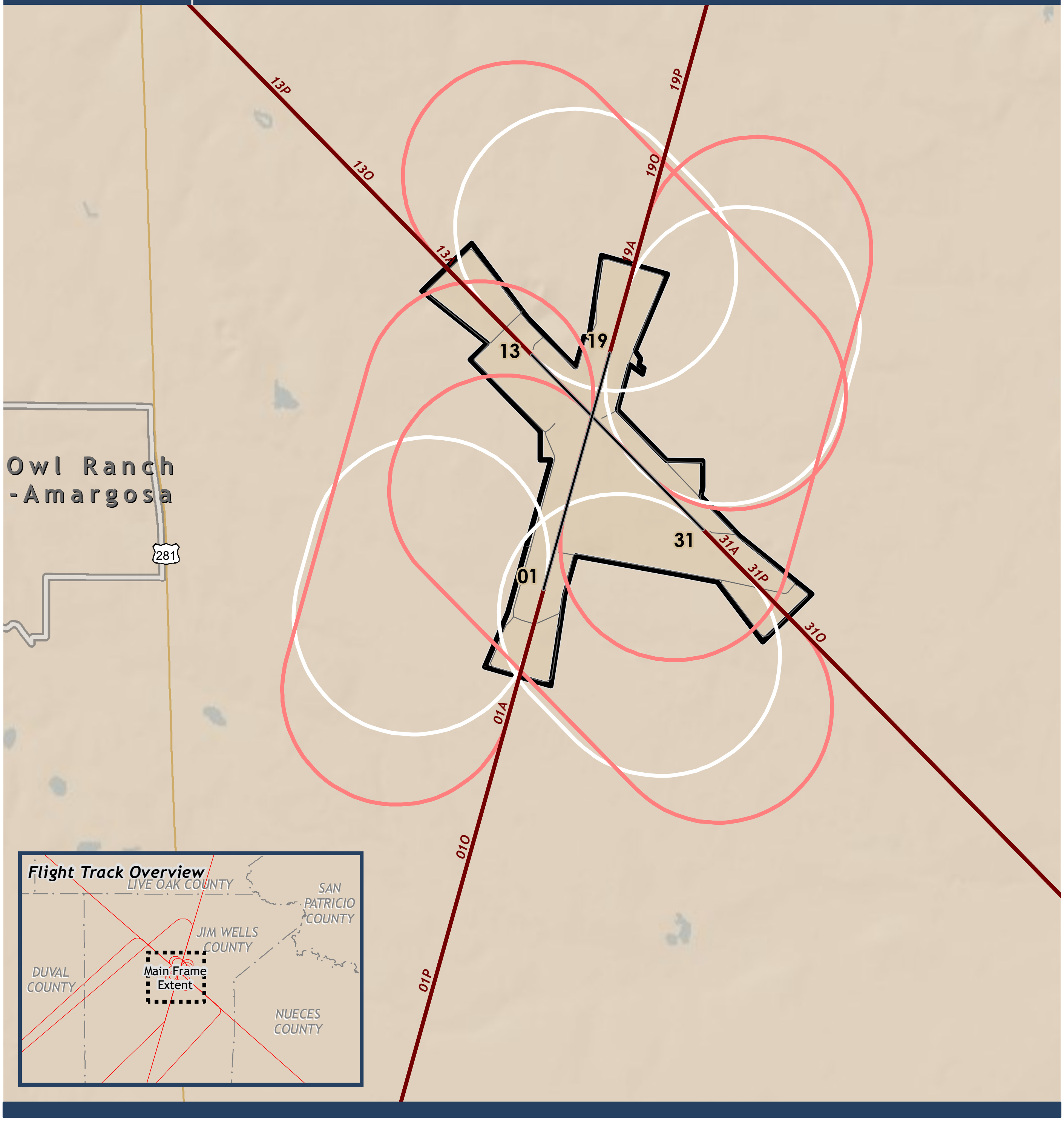
- NAS Kingsville
- Urban Area
- Local Road
- US Highway
- Runway

Pattern Flight Operations

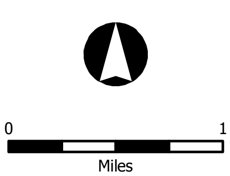
- No Flap
- Precision Approach
- Touch & Go
- All Pattern Tracks (Inset)

FIGURE 3-5

ARRIVAL FLIGHT TRACKS, NALF ORANGE GROVE



Source: ESRI 2011, BRRC 2011, Navy 2011



NALF Orange Grove
Urban Area
Local Road
US Highway
Runway

Arrival Flight Operations
Overhead Break Arrival
Precautionary Approach
Straight-In Arrival
All Arrival Tracks (Inset)

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FIGURE 3-6 DEPARTURE FLIGHT TRACKS, NALF ORANGE GROVE

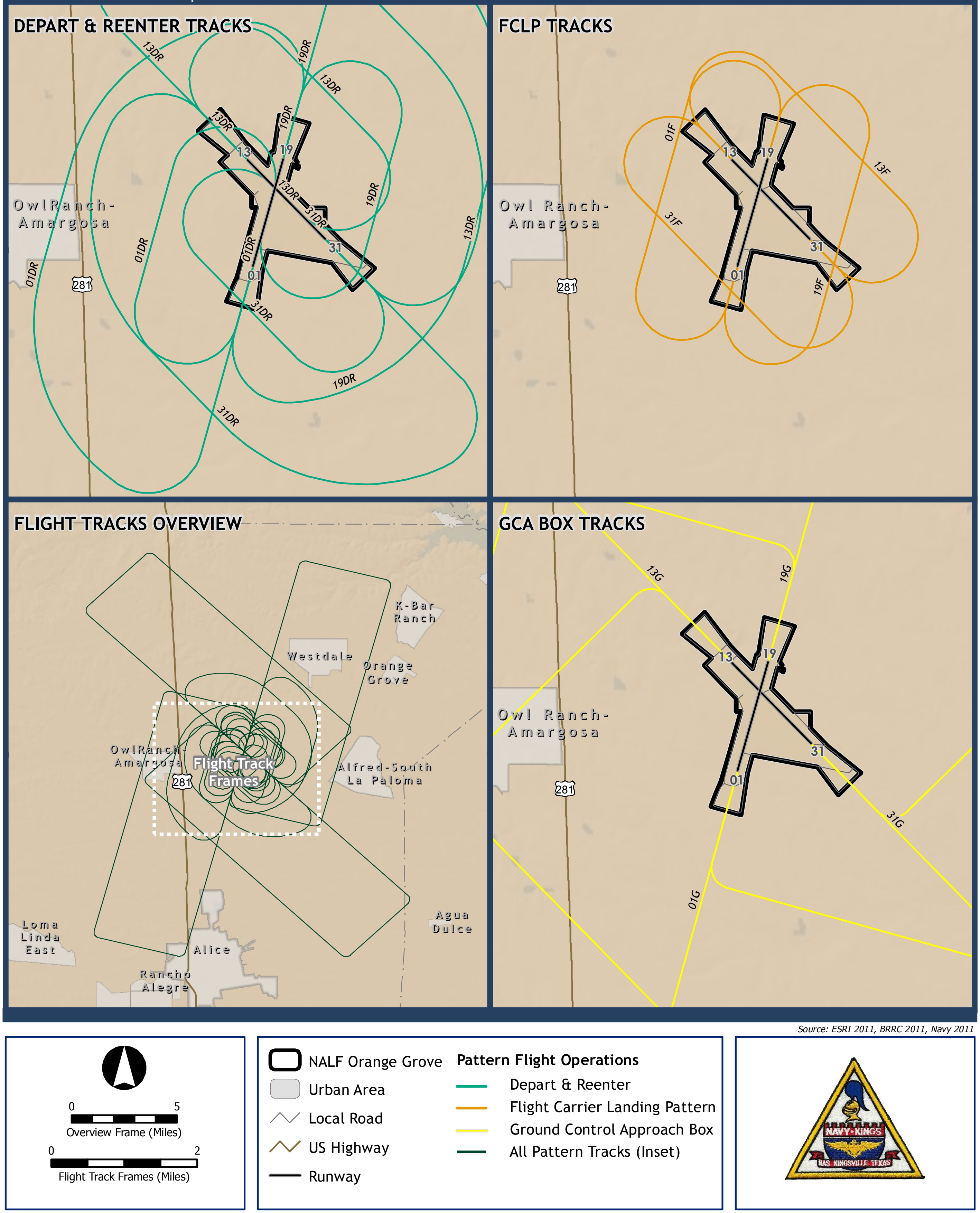
Source: ESRI 2011, BRRC 2011, Navy 2011

0 1
Miles

NALF Orange Grove
Urban Area
Local Road
US Highway
Runway

Departure Flight Operations
Departure

FIGURE 3-7A PATTERN FLIGHT TRACKS, NALF ORANGE GROVE



Source: ESRI 2011, BRRC 2011, Navy 2011

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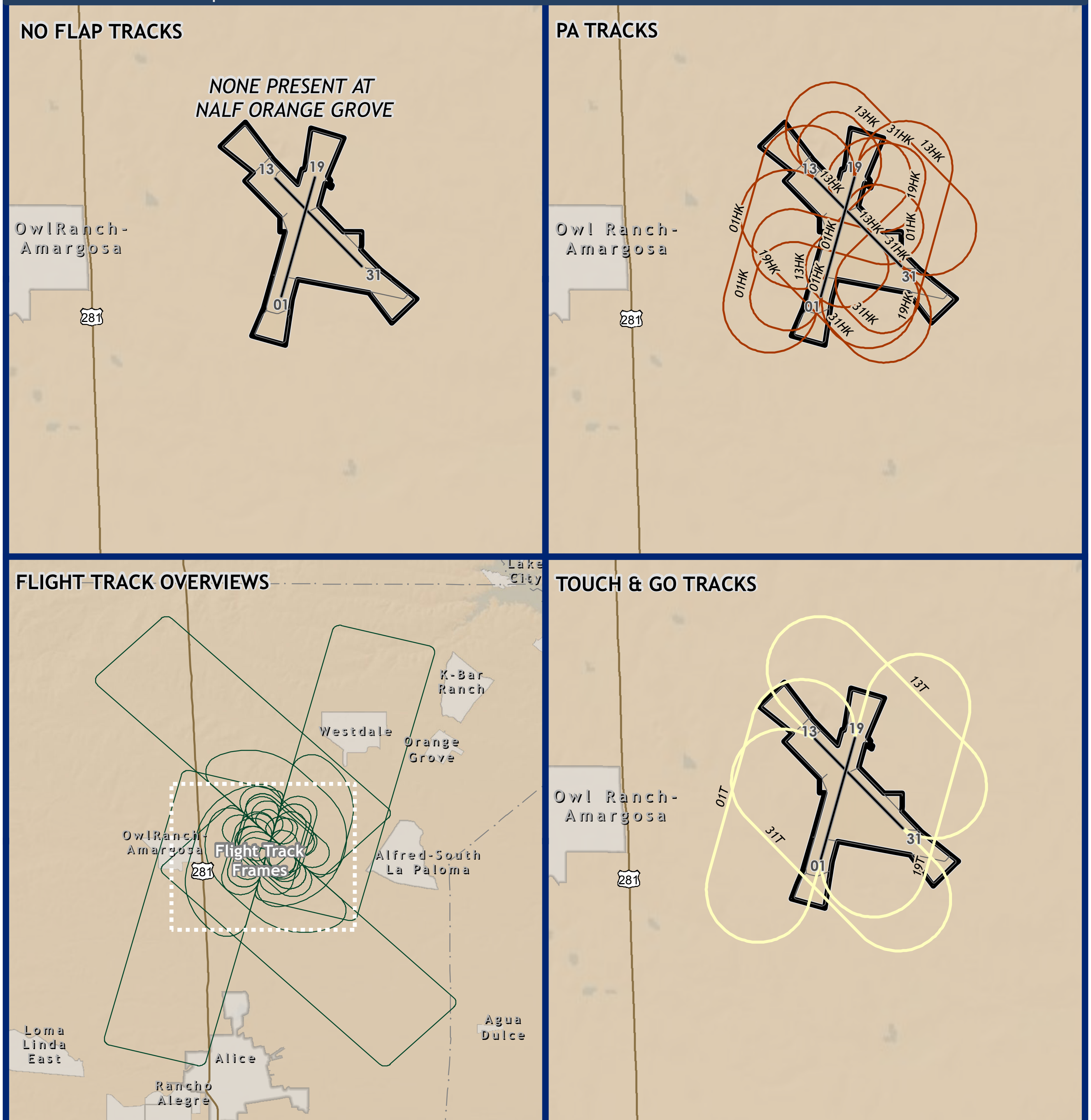
FIGURE 3-7B | PATTERN FLIGHT TRACKS, NALF ORANGE GROVE



Source: ESRI 2011, BRRC 2011, Navy 2011

0 5
Overview Frame (Miles)

0 2
Flight Track Frames (Miles)

- NALF Orange Grove
- Urban Area
- Local Road
- US Highway
- Runway

Pattern Flight Operations

- No Flap
- Precision Approach
- Touch & Go
- All Pattern Tracks (Inset)

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NAS KINGSVILLE TEXAS

4

Aircraft Noise

The impact of aircraft noise is a critical factor in the planning of future land use near air facilities, and how an installation manages aircraft noise can play a significant role in shaping the installation's relationship with the community. The Navy has defined noise zones for the surrounding areas of each airfield using the guidance provided in AICUZ Instructions. These noise zones provide the community with a tool to plan for compatible development near airfields.

4.1 What is Sound/Noise?

Sound is vibrations in the air, which can be generated by a multitude of sources. When sound is deemed as unwanted or invasive to a listener, it becomes noise. Some sources of noise include roadway traffic, recreational activities, railway activities, and aircraft operations. Further discussion of noise and its effects on people and the environment is provided in Appendix A.

On an A-weighted scale, barely audible sound is set at 0 decibels (dB), and normal speech has a sound level of approximately 60 to 65 dB. Generally, a sound level above 120 dB will begin to discomfort a listener, and the threshold of pain is 140 dB (Berglund and Lindvall 1995).

In this AICUZ Study, all sound or noise levels are measured in A-weighted decibels (dBA), which represents sound pressure adjusted to the range of human hearing. When the use of A-weighting is understood, the adjective "A-weighted" is often omitted and the measurements are expressed as dB. In this AICUZ Study, dB units refer to A-weighted sound levels.

The noise exposure from aircraft is measured using the day-night average sound level (DNL) metric. The DNL metric, established in 1980 by the Federal Interagency Committee on Urban Noise (FICUN), presents a reliable measure of

TYPICAL A-WEIGHTED SOUND LEVELS AND COMMON SOUNDS

0 db Threshold of Hearing

20 dB Ticking Watch

45 dB Bird Calls (distant)

60 dB Normal Conversation

70 dB Vacuum Cleaner (3 feet)

80 dB Alarm Clock (2 feet)

90 dB Motorcycle (25 feet)

100 dB Ambulance Siren (100 feet)

110 dB Chain Saw

120 dB Rock Concert

130 dB Jackhammer

140 dB Threshold of Pain

Refer to Appendix A for additional examples and details on sound levels.

community sensitivity to aircraft noise and has become the standard metric used in the United States (except California, which uses a similar metric, Community Noise Equivalent Level [CNEL]). DNL averages the sound energy from aircraft operations at a location over a 24-hour period. DNL also adds an additional 10 dB to events occurring between 10:00 p.m. and 7:00 a.m. This 10-dB "night-time penalty" represents the added intrusiveness of sounds due to the increased sensitivity to noise when ambient sound levels are low.

By combining factors most noticeable about noise annoyance—maximum noise levels, duration, the number of events over a 24-hour period, and the nighttime penalty—DNL provides a single measure of overall noise impact. Scientific studies and social surveys conducted to evaluate community annoyance to all types of environmental noise have found DNL to be the best correlation to community annoyance (FICUN 1980; U.S. Environmental Protection Agency [EPA] 1982; American National Standards Institute 1990; Federal Interagency Committee on Noise 1992). Although DNL provides a single measure of overall noise impact, it does not provide specific information on the number of noise events or the individual sound levels that occur during the day. For example, a day-night average sound level of 65 dBA could result from a few noisy events or a large number of quieter events.

The DNL is depicted visually as a noise contour that connects points of equal value. The noise contours in this document are depicted in 5-dBA increments (60, 65, 70, 75, 80, and 85 DNL). The area between two noise contours is known as a noise zone. The AICUZ Program generally divides noise exposure areas into three noise zones for land use planning purposes:

- **Noise Zone 1:** Less than 65 DNL, area of low or no noise impact;
- **Noise Zone 2:** 65 to 75 DNL, area of moderate impact, where some land use control measures are recommended; and
- **Noise Zone 3:** Greater than 75 DNL, most severely impacted area where the greatest degree of land use control is recommended.

Calculated noise contours do not represent exact measurements. Noise levels inside a contour may be similar to those outside a contour line. When the contour lines are close, the change in noise level is greater. When the contour lines are far apart, the change in noise level is gradual.

4.2 Airfield Noise Sources and Noise Modeling

The Navy conducts noise studies, as needed, to assess the noise impacts of aircraft operations. In support of this AICUZ Study, a noise analysis was conducted to define noise contours at NAS Kingsville and NALF Orange Grove. This analysis uses NOISEMAP, a widely accepted computer-based modeling program that projects noise impacts around military airfields to determine noise exposure.

The main sources of noise at an airfield are preflight and/or maintenance run-ups and flight operations. As part of this AICUZ Study, data were collected from NAS Kingsville and NALF Orange Grove and incorporated into the noise model to generate noise contours. The input data incorporated into the NOISEMAP computer model include:

- Type of operation (i.e., arrival, departure, and pattern);
- Number of operations per day;
- Time of operation;
- Flight track;
- Aircraft power settings, speeds, and altitudes;
- Numbers and duration of preflight and maintenance run-ups;
- Terrain (surface type); and
- Environmental data (temperature and humidity).

The noise contours generated from the modeling program graphically illustrate where aircraft noise occurs in and around an airfield and at what sound level. The noise modeling results were verified, approved, and provided to the Navy under a separate submittal as the NAS Kingsville 2013 Noise Study.

4.3 2013 AICUZ Noise Contours

Noise contours provide a military installation, local planning organizations, and the public with a graphical representation of potential noise-related impacts associated with aircraft operations.

These contours can assist in locating, identifying, and addressing any incompatible land uses and assist in plans for future development.

Noise contours provide an installation, local community planning organizations, and the general public with maps of the modeled noise-related impacts of aircraft operations. Noise contours, when overlaid with local land uses, can help identify areas of incompatible land uses and plan for future development around an air station.

Noise contours provided in this AICUZ Study are identified as the 2013 AICUZ noise contours, representing the year of the study's release. Projections of aircraft operations were based on data provided by NAS Kingsville. As a planning document, an AICUZ Study forecasts flight activity levels as far out as possible (often 5, 10, or 15 years into the future) to assess an air station's potential impact on the local community. Projected aircraft operations also help ensure that the future operational capability of the air installation is sustainable.

Figures associated with the discussions provided in this section are presented at the conclusion of the respective subsections and include:

- 2013 AICUZ noise contours for NAS Kingsville (Figure 4-1) and NALF Orange Grove (Figure 4-4);
- 2013 AICUZ noise gradients for NAS Kingsville (Figure 4-2) and NALF Orange Grove (Figure 4-5); and
- Comparison overlays for the 1998 and 2013 AICUZ noise contours for NAS Kingsville (Figure 4-3) and NALF Orange Grove (Figure 4-6).

4.3.1 NAS Kingsville 2013 AICUZ Noise Contours

The 2013 AICUZ noise contours align with the runways and follow the dominate flight tracks for arrivals, departures, and patterns at each airfield; noise propagates outward from those paths. As expected, the highest noise levels are concentrated over the airfield and along the runways.

Touch-and-go patterns and departures have the greatest effect on the shape of the noise contours. Touch-and-go patterns are the most common flight operation at NAS Kingsville, and most touch-and-go operations occur on Runway 13L. Departures and the descending portion of pattern operations require a greater power setting which generates greater noise and influences the shape of the contours.

The AICUZ noise contours extend off station, primarily to the north, east, and south of the base boundary. The 65-DNL noise contour extends approximately 2.8 miles off station to the north (Runway 17), 2.4 miles to the south (Runway 35), and 4 miles to the east (Runway 31). The concentration of touch-and-go patterns from Runway 13L causes the extension of the 65-DNL noise contour to the east. The 75-DNL noise contour extends slightly off station from the ends of Runways 31 and 35. The 80- to 85-DNL noise contours are almost exclusively on station, with minimal areas extending off station. Departures on Runways 35, 13, and 17 result in an extension of the noise contours to the north, southeast, and south (Figure 4-1). Especially high numbers of departures from Runway 13L cause the longer extension of the noise contours to the southeast.

Figure 4-2 is a DNL color-gradient map that provides a simulated view of the noise propagating from the Installation outside the confines of the noise contours. Noise contours show the extent of a certain DNL, while the color gradient shows the fluidity of noise which does not stop at the contour lines depicted on maps and figures. The highest noise levels are concentrated within the Installation boundaries and decrease to much lower levels into the surrounding community. The figure also depicts the noise outside the 65-DNL noise contour to 45 DNL, which is considered an ambient or background noise level.

Comparison of NAS Kingsville 1998 and 2013 AICUZ Noise Contours

The geographic extent and distribution of the 2013 AICUZ noise contours have changed in comparison to the 1998 AICUZ noise contours. The 2013 AICUZ noise contours have slightly decreased in overall size from the 1998 AICUZ noise contours (Figure 4-3). Generally, flight patterns have not changed significantly at NAS Kingsville. The difference in the geographic extent of the noise contours is attributed to a decrease in annual operations of approximately

35 percent from the 1998 projected annual operations, changes in runway utilization, and modified flight tracks. Additionally, the 2013 AICUZ noise contours were modeled using NOISEMAP 7.2 modeling software. In comparison to modeling software available in 1989, the NOISEMAP program has expanded to account for atmospheric sound propagation effects over varying terrain.

The 65-DNL noise contours in the 1998 AICUZ Study extended further west and southwest, crossing over Highway 77. NAS Kingsville pilots have modified their flight course for pattern and arrival operations on Runway 31L to avoid flying over populated areas of the City of Kingsville, consequently reducing the extent of the 65-DNL noise contour to the west.

Under recent AICUZ guidelines (OPNAVINST 11010.36C), noise contours are modeled to 60 DNL, which was not required in the previous 1998 AICUZ Study. Therefore, the land area for the 60- to 65-DNL range is included in the total land area of the 2013 AICUZ noise zones, but not in the total land area for the 1998 AICUZ noise zones. Table 4-1 compares the total land area within NAS Kingsville's 2013 AICUZ noise zones and 1998 AICUZ noise zones. Although the 2013 AICUZ noise contours have decreased in size, the total land area of the 2013 AICUZ noise contours is greater than the total area of the 1998 AICUZ noise contours.

Table 4-1:
Land Area within Noise Zones, NAS Kingsville

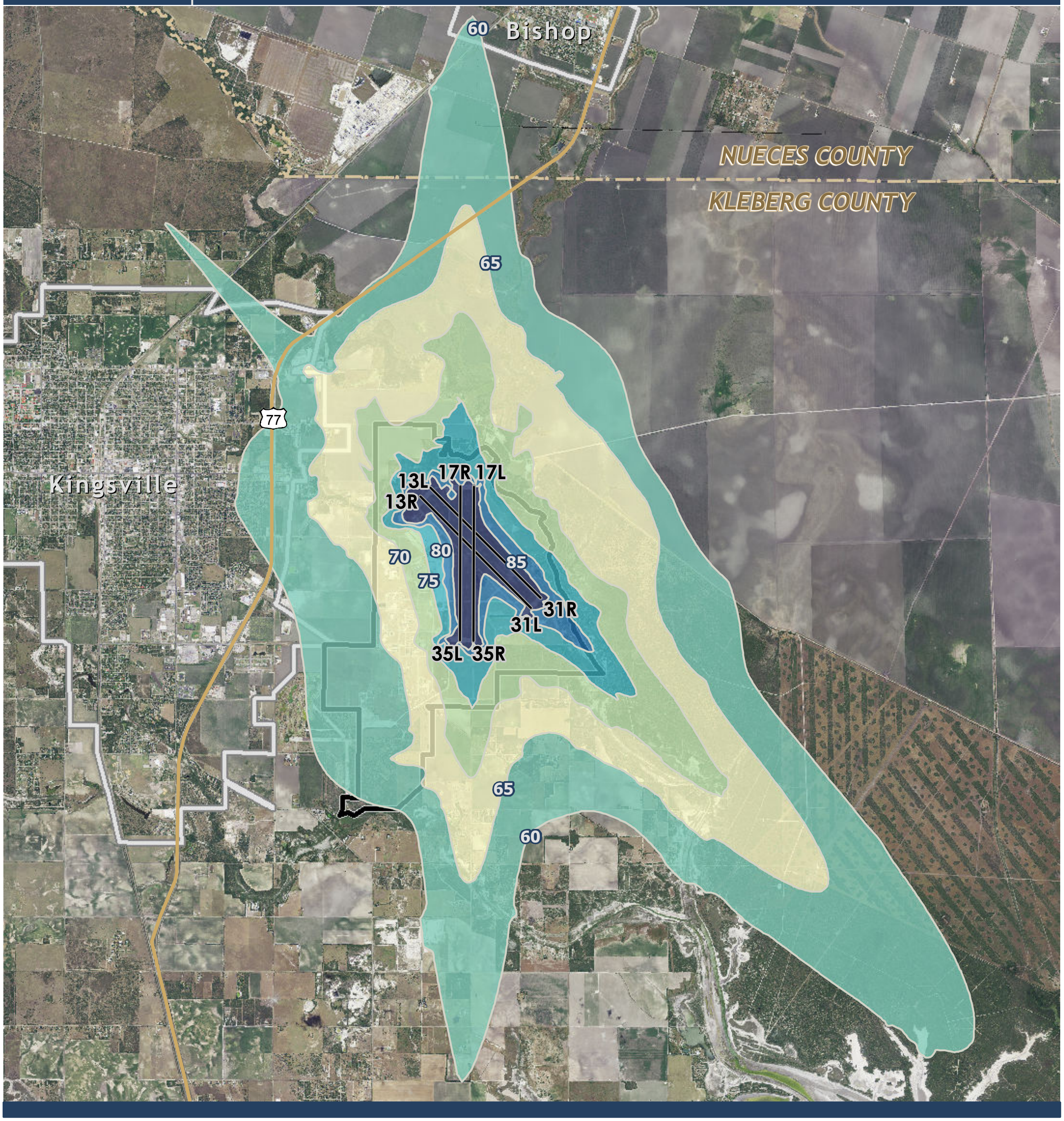
Noise Zone	Total Land Area 1998 AICUZ Noise Zones (acres)	2013 AICUZ Noise Zones (acres)
60-65 DNL	N/A	9,170
65-70 DNL	4,778	5,126
70-75 DNL	3,606	2,281
75-80 DNL	1,560	946
80+ DNL	1,357	925
Total Area	**11,301**[1]	**18,448**

Source: NAS Kingsville 1998; BRRC 2012.

Note:

(1) The total acreage does not include land area within the 60- to 65-DNL range.

FIGURE 4-1 2013 AICUZ NOISE CONTOURS, NAS KINGSVILLE



Source: ESRI 2011, E&E 2012, NAIP 2012, BRRC 2012

0 2 Miles

NAS Kingsville
Runway
US Highway
Urban Area
County Boundary

2013 AICUZ Noise Contour (dB DNL)
60 dB
65 dB
70 dB
75 dB
80 dB
85 dB

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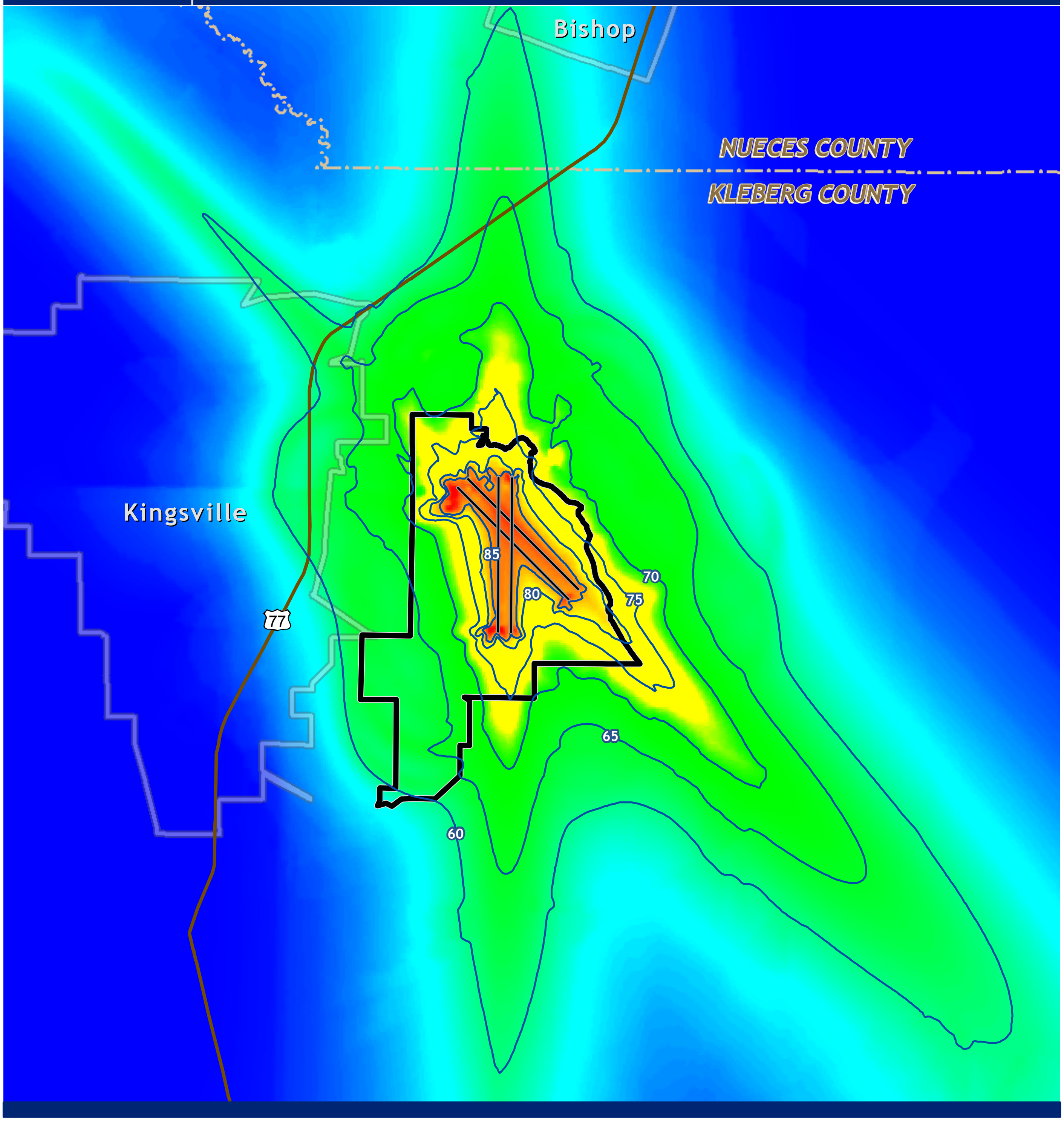
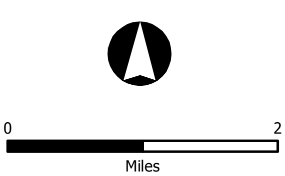
FIGURE 4-2 **2013 AICUZ NOISE GRADIENT, NAS KINGSVILLE**

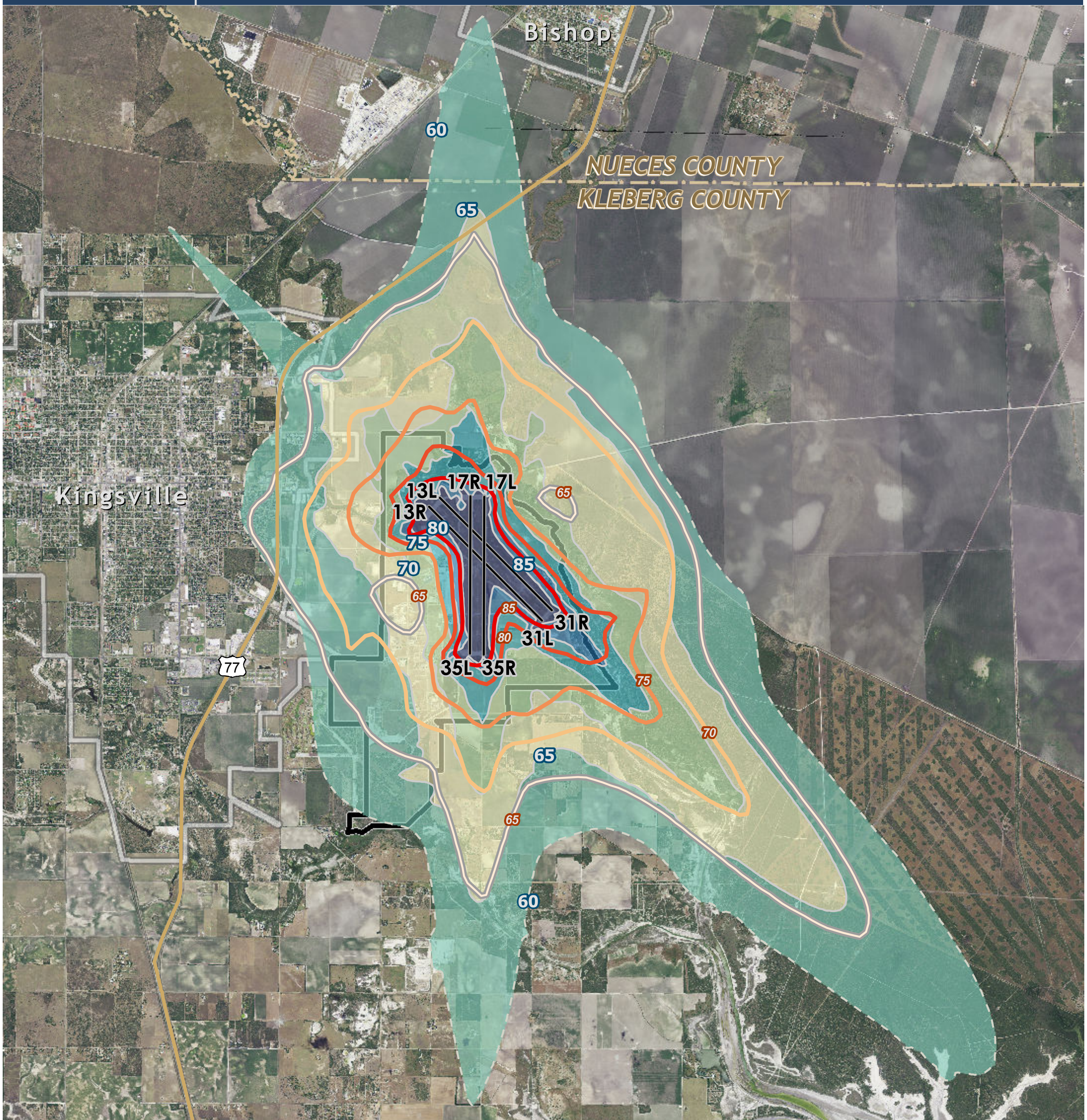


Source: ESRI 2011, NAIP 2012, BRRC 2012, Navy 2011



NAS Kingsville
Runway
US Highway
Urban Area
County Boundary
2013 AICUZ Noise Contour (DB DNL)
Noise Gradient (dBA DNL)
35 55 70 80 100

FIGURE 4-3 COMPARISON OF 1998 AND 2013 AICUZ NOISE CONTOURS, NAS KINGSVILLE



Source: ESRI 2011, Navy 1998 & 2011, NAIP 2012, BRRC 2012

0 2
Miles

NAS Kingsville
Runway
US Highway
Urban Area
County Boundary

1998 AICUZ Noise Contour (dB DNL)
65 dB 70 dB 75 dB 80 dB 85 dB

2013 AICUZ Noise Contour (dB DNL)
60 dB 65 dB 70 dB 75 dB 80 dB 85 dB

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4.3.2 NALF Orange Grove 2013 AICUZ Noise Contours

The 65-DNL noise contour extends approximately 1.4 miles off station to the northwest (Runway 13), 1.2 miles to the northeast (Runway 19), and 1.6 miles to the southeast (Runway 31). The 70-DNL and 75-DNL noise contours extend slightly off station, and the 80-DNL and the 85-DNL noise contours are exclusively on station. The extent of the noise contours at NALF Orange Grove is smaller in comparison to the noise contours at NAS Kingsville because fewer operations are conducted at this airfield.

Pattern operations and departures on Runway 13 control the shape of the 2013 AICUZ noise contours at NALF Orange Grove. The majority of the airfield's departures (60 percent) occur at Runways 13, which causes the longer extension of the noise contours to the southeast (Figure 4-4). Departure flights on Runway 19, in combination with pattern flight operations from Runways 01 and 19, shape the noise contours to the southwest.

The 'horn' shape of the 65-DNL noise contours north of the airfield is generated from departures and overhead break and straight-in arrivals. The curved 65-DNL noise contour to the northeast is generated from departures on Runway 01 (returning to NAS Kingsville), and the curved 65-DNL noise contour to the northwest is caused by arrivals to NALF Orange Grove on Runway 13 (from NAS Kingsville). Pattern operations on Runway 13, in combination with Runway 01 departures, cause the asymmetric shape of the 65- to 70-DNL and the 75- to 80-DNL noise contours in the northeast.

Figure 4-5 provides a DNL color gradient of the noise propagating from NALF Orange Grove. The highest noise levels are concentrated within the airfield and decrease into Jim Wells County. Noise extending past the 65-DNL noise contour is primarily from pattern operations. This figure shows that noise outside the 65-DNL noise contour is considered an ambient or background noise level, which is deemed minimal by the AICUZ Program.

Comparison of NALF Orange Grove 1998 and 2013 AICUZ Noise Contours

The 2013 AICUZ noise contours have changed considerably in size and form from the 1998 AICUZ noise contours (Figure 4-6). The 65-DNL noise contours in the 1998 AICUZ Study extend significantly off base to the north, west, and southeast in wider-shaped bands. This change is attributed to changes in runway utilization. Pattern operations have shifted from Runway 19 to Runway 01. The 2013 AICUZ noise contours are elongated on Runway 13 due to the increase in arrivals and formation flights.

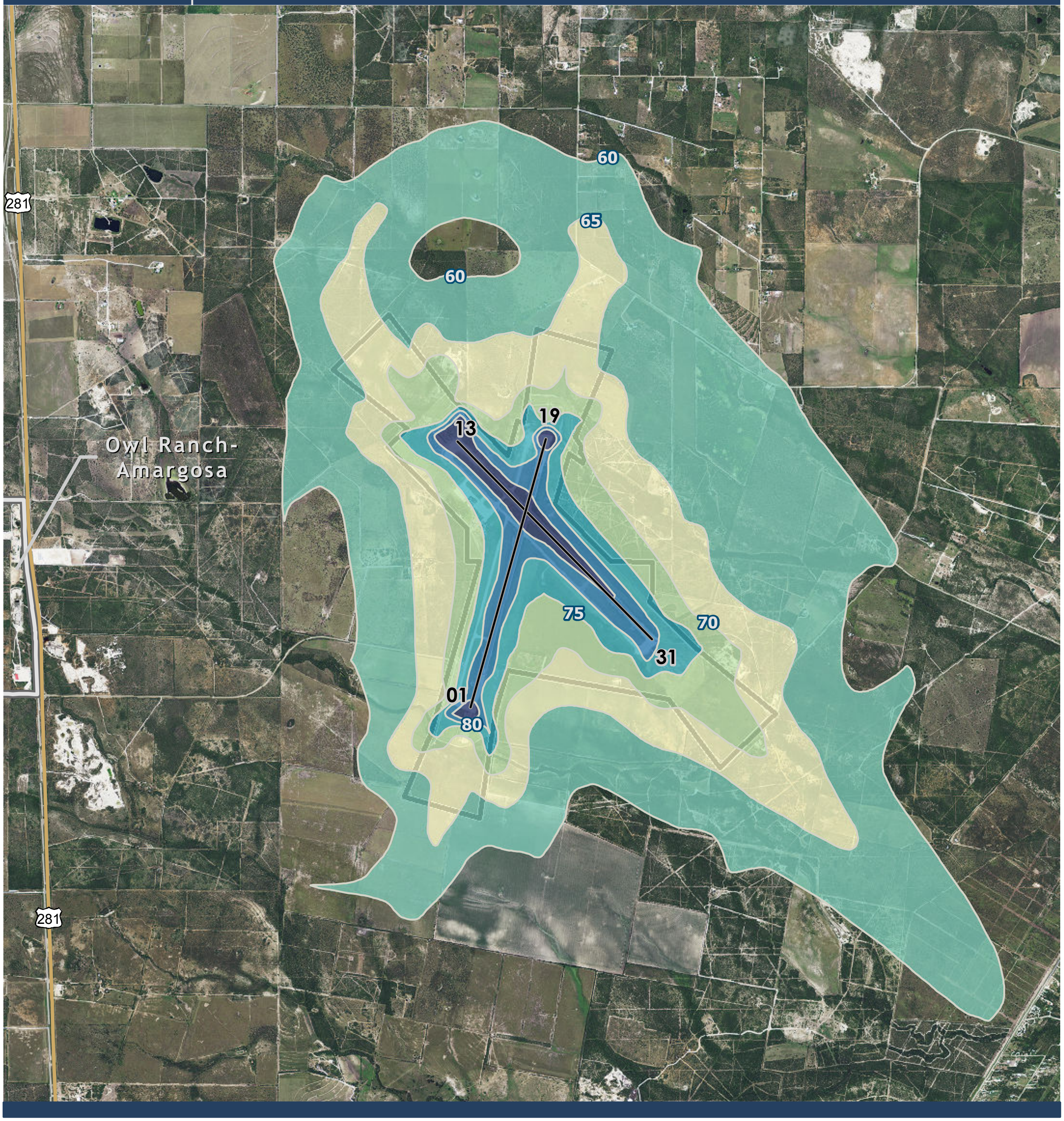
Table 4-2 compares the area of noise zones within NALF Orange Grove's 2013 AICUZ noise contours and 1998 AICUZ noise contours. The total area of the 2013 AICUZ noise contours is 1,342 acres greater than the total area of the 1998 AICUZ noise contours; however, the geographic extent and distribution of the contours have changed. Under recent AICUZ guidelines (OPNAVINST 11010.36C), noise contours are modeled to 60 DNL, which was not required in the previous 1998 AICUZ Study. Therefore, the land area for the 60- to 65-DNL range is included in the total land area of the 2013 AICUZ noise zones, but not in the total land area for the 1998 AICUZ noise zones.

Table 4-2:
Land Area within Noise Zones, NALF Orange Grove

Noise Zone	Total Land Area	
	1998 AICUZ Noise Zones (acres)	2013 AICUZ Noise Zones (acres)
60-65 DNL	N/A	3,823
65-70 DNL	3,194	1,475
70-75 DNL	1,173	683
75-80 DNL	467	364
80+ DNL	513	344
TOTAL AREA	**5,347**[1]	**6,689**

Source: NAS Kingsville 1998; BRRC 2012.
Note:
(1) The total acreage does not include land area within the 60- to 65-DNL range.

FIGURE 4-4 2013 AICUZ NOISE CONTOURS, NALF ORANGE GROVE



Source: ESRI 2011, E&E 2012, NAIP 2012, BRRC 2012

0 1 Miles

NALF Orange Grove
Runway
US Highway
Urban Area

2013 AICUZ Noise Contour (dB DNL)
- 60 dB
- 65 dB
- 70 dB
- 75 dB
- 80 dB
- 85 dB

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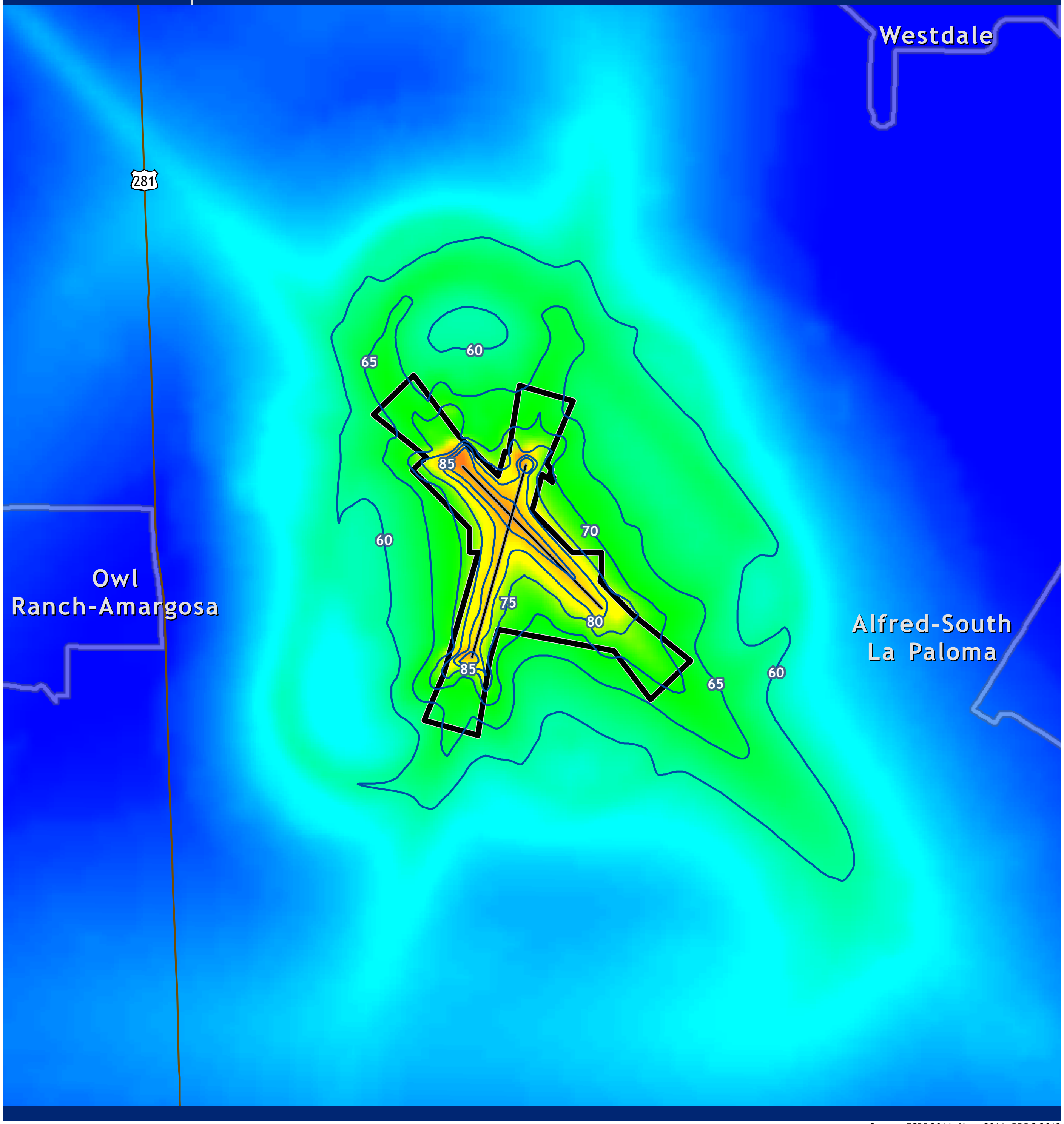
FIGURE 4-5 2013 AICUZ NOISE GRADIENT, NALF ORANGE GROVE



Source: ESRI 2011, Navy 2011, BRRC 2012

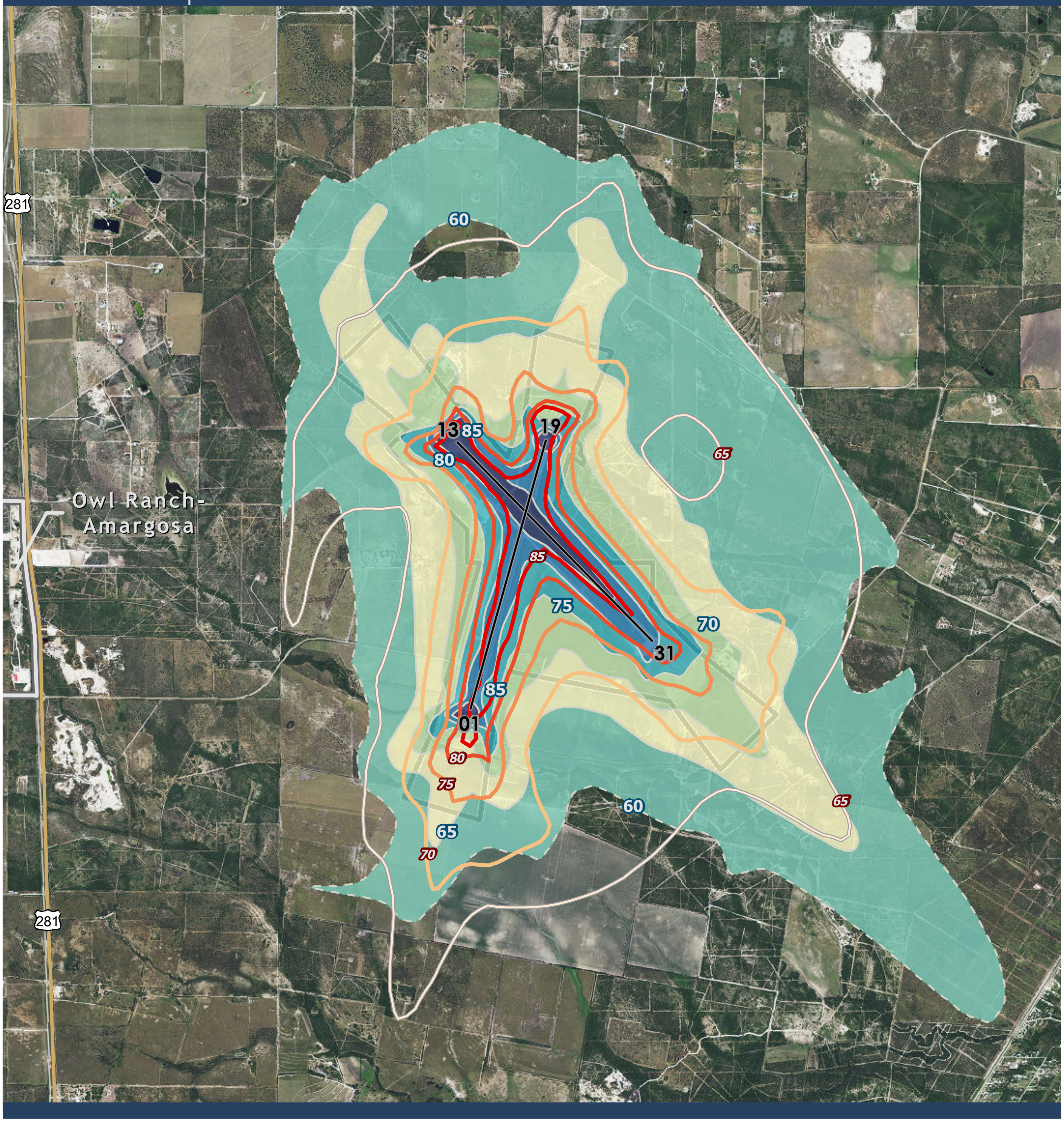
0 1
Miles

- NALF Orange Grove
- Runway
- US Highway
- Urban Area
- 2013 AICUZ Noise Contour (DB DNL)

Noise Gradient (dBA DNL)

35 55 70 80 100

FIGURE 4-6 COMPARISON OF 1998 AND 2013 AICUZ NOISE CONTOURS, NALF ORANGE GROVE



Source: ESRI 2011, Navy 1998 & 2011, NAIP 2012, BRRC 2012

0 1
Miles

NALF Orange Grove
Runway
US Highway
Urban Area
County Boundary

1998 AICUZ Noise Contour (dB DNL)
65 dB, 70 dB, 75 dB, 80 dB, 85 dB

2013 AICUZ Noise Contour (dB DNL)
60 dB, 65 dB, 70 dB, 75 dB, 80 dB, 85 dB

4.4 Noise Abatement and Complaints

Impacts from noise associated within NAS Kingsville and NALF Orange Grove occur in areas off station, with areas in proximity to aircraft operations experiencing greater impacts. NAS Kingsville is aware of land uses surrounding its airfields and makes every effort to reduce noise impacts to sensitive areas; however, given the training requirements and high level of activity at the airfields, noise complaints are occasionally filed with the Installation. NAS Kingsville has instituted noise abatement procedures to minimize noise in recognition of community response to aircraft noise at NAS Kingsville and NALF Orange Grove. NAS Kingsville personnel are active members in the communities surrounding the airfield and are continuously reaching out to stakeholders to establish open communication and resolution of noise issues.

Training on Aircraft Carrier

4.4.1 Noise Abatement

NAS Kingsville actively pursues operational measures to minimize aircraft noise. Noise abatement procedures apply to flight operations, as well as engine run-up and maintenance operations conducted on station. Noise abatement procedures at NAS Kingsville and NALF Orange Grove are implemented under the NAS Kingsville Air Ops Manual. All pilots are required to comply with noise abatement procedures. The Air Ops Officer is responsible for addressing aircraft noise complaints and communicating complaints to the ICO.

The Navy cannot alter critical portions of flight patterns to accommodate noise complaints without increasing safety risks; however, other measures are currently implemented to reduce off-station noise impacts. Noise abatement procedures at NAS Kingsville and NALF Orange Grove include the following:

- Flight crews (pilots and ground maintenance) are briefed on noise abatement procedures and noise-sensitive areas detailed in Inflight Guides.

- Flight crews are briefed before each flight on the existing patterns designed to minimize disruption to the communities, and the need to maintain the patterns.
- All high-power turns are conducted, to the extent possible, between the hours of 6:00 a.m. and 11:00 p.m., Monday through Saturday, and from 12:00 p.m. to 10:00 p.m. on Sundays. High-power turns outside these times must be scheduled through the CNATRA Detachment.
- Runways 13/31 are designated as the noise abatement runways and are used to the maximum extent possible. If a right downwind is required for Runway 13R, all aircraft will fly to the east and south of the Highway 77 bypass.
- Aircraft arrivals are advised to stay clear of the City of Kingsville, King Ranch headquarters, Hoesht Celanese Chemical Plant, the City of Bishop, and populated areas on the Installation.
- All turbojet/turbofan aircraft avoid overflying the mobile home park located 2.5 miles south/southeast of the airport during approaches to Runway 35L/R; the mobile home park located 1.5 miles northwest of the airport when turning right downwind to Runway 13R or turning left downwind for Runway 31L); and houses within 0.5 mile west of the Installation.

4.4.2 Noise Complaints

The origin and nature of noise complaints within the geographic region is often a tangible barometer of the success or failure of noise abatement procedures. Complaints can arise outside the areas depicted by noise contours. This is frequently due to a single event that is unusual, such as aircraft flying over an area not commonly overflown or new aircraft operating in the region. In general, individual response to noise levels varies and is influenced by factors including:

- Activity the individual is engaged in at the time of the noise event;
- General sensitivity to noise;

- Time of day or night;
- Length of time an individual is exposed to a noise;
- Predictability of noise; and
- Weather conditions.

Noise contours and land use recommendations are based on average annoyance responses of a population, but some people have greater noise sensitivity than others. A small increase in noise level generally will not be notable, but as the change in noise level increases, individual perception is greater, as shown in Table 4-3.

Table 4-3:
Subjective Response to Noise

Change	Change in Perceived Loudness
1 decibel	Requires close attention to notice
3 decibels	Barely noticeable
5 decibels	Quite noticeable
10 decibels	Dramatic – twice or half as loud
20 decibels	Striking – fourfold change

NOISE COMPLAINTS

NAS Kingsville
361-516-6108

Noise complaints are coordinated by the Command Duty Officer and ATC, in coordination with Air Ops. The Public Affairs Officer (PAO) will provide a public notice for events or training activities that are expected to generate noise. Citizens are encouraged to contact the NAS Kingsville noise complaints phone line to officially log their complaints about aircraft noise near NAS Kingsville or NALF Orange Grove. Information regarding the noise complaint phone line is provided on the NAS Kingsville website.

5 Airfield Safety

Safety is paramount to the Navy, and airfield safety is a shared responsibility between the Navy and the surrounding communities, each playing a vital role in its success. As such, the Navy has established a flight safety program and has designated areas of accident potential around NAS Kingsville and NALF Orange Grove. Cooperation between the Navy and the community results in strategic and effective land use planning and development around naval airfields.

Identifying safety issues and areas of accident potential can assist the community in land use compatibility planning for airfield operations. Safety issues include hazards around the airfield that obstruct or interfere with aircraft arrivals and departures, pilot vision, communications, or aircraft electronics, and areas of accident potential. While the likelihood of an aircraft mishap occurring is remote, accidents can occur. The Navy establishes APZs based on historical data for aircraft mishaps near military airfields. This AICUZ Study presents the 2013 APZs for NAS Kingsville and NALF Orange Grove.

5.1 Flight Safety and Accident Potential

Flight safety includes measures implemented to ensure both pilot safety during aircraft operations and the safety of those in the community who live and work in the vicinity of an air station. The FAA and the military define flight safety zones (imaginary surfaces) below aircraft arrival and departure flight tracks around the airfield. Heights of structures and trees are restricted in these imaginary surfaces. The flight safety zones are designed to reduce the hazards that can cause an aircraft mishap.

5.1.1 Imaginary Surfaces

The Navy, the FAA, and federal aviation regulations identify a complex series of imaginary planes and transition surfaces that define the airspace that needs to remain free of obstructions to ensure safe flight approaches, departures, and pattern operations. Obstructions include natural terrain and manmade features, such as buildings, towers, poles, wind turbines, railroads, and other vertical obstructions to airspace navigation.

Fixed-wing runways and rotary-wing runways/helipads have different imaginary surfaces. In general, aboveground structures are not permitted in the primary surface of Clear Zones, and height restrictions apply to transitional surfaces and approach and departure surfaces. These height restrictions are more stringent when approaching the runway.

Imaginary surfaces for fixed-wing Class B runways are illustrated on Figure 5-1 and brief discussions are provided in Table 5-1.

Figure 5-1: Imaginary Surfaces and Transition Planes for Class B Fixed-Wing Runways

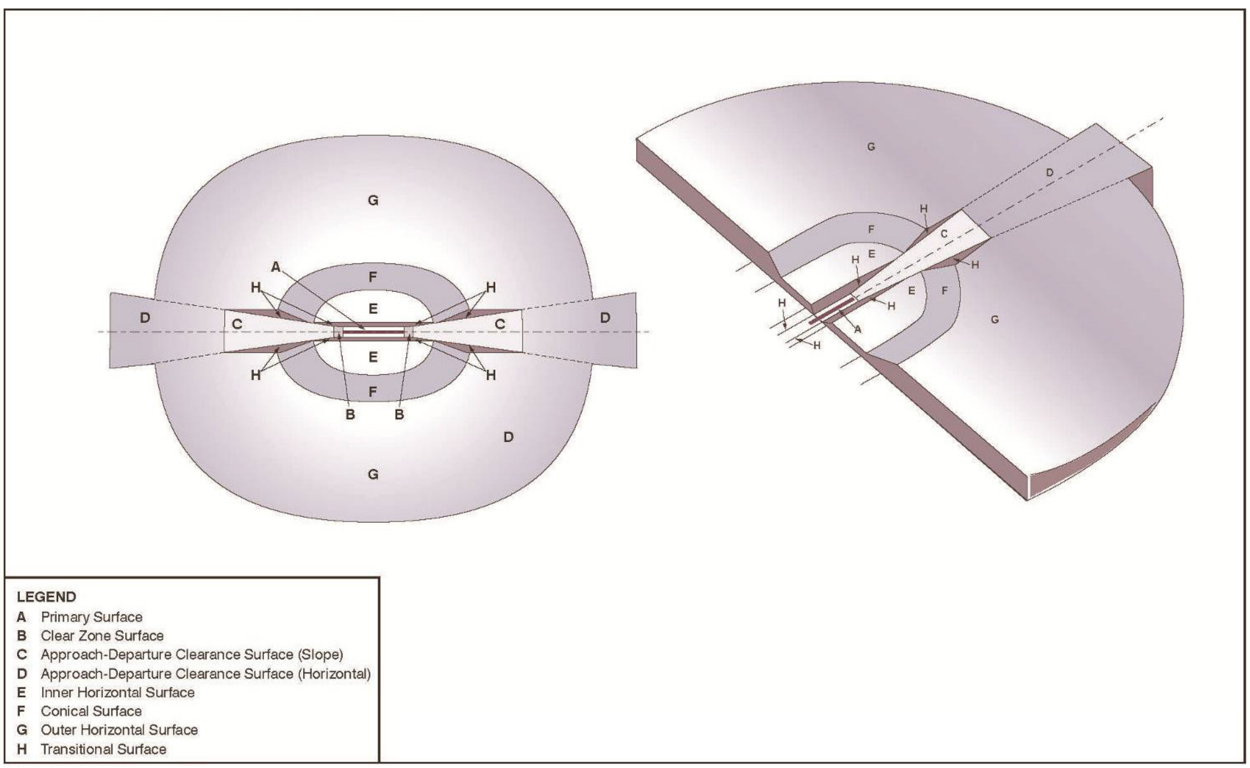


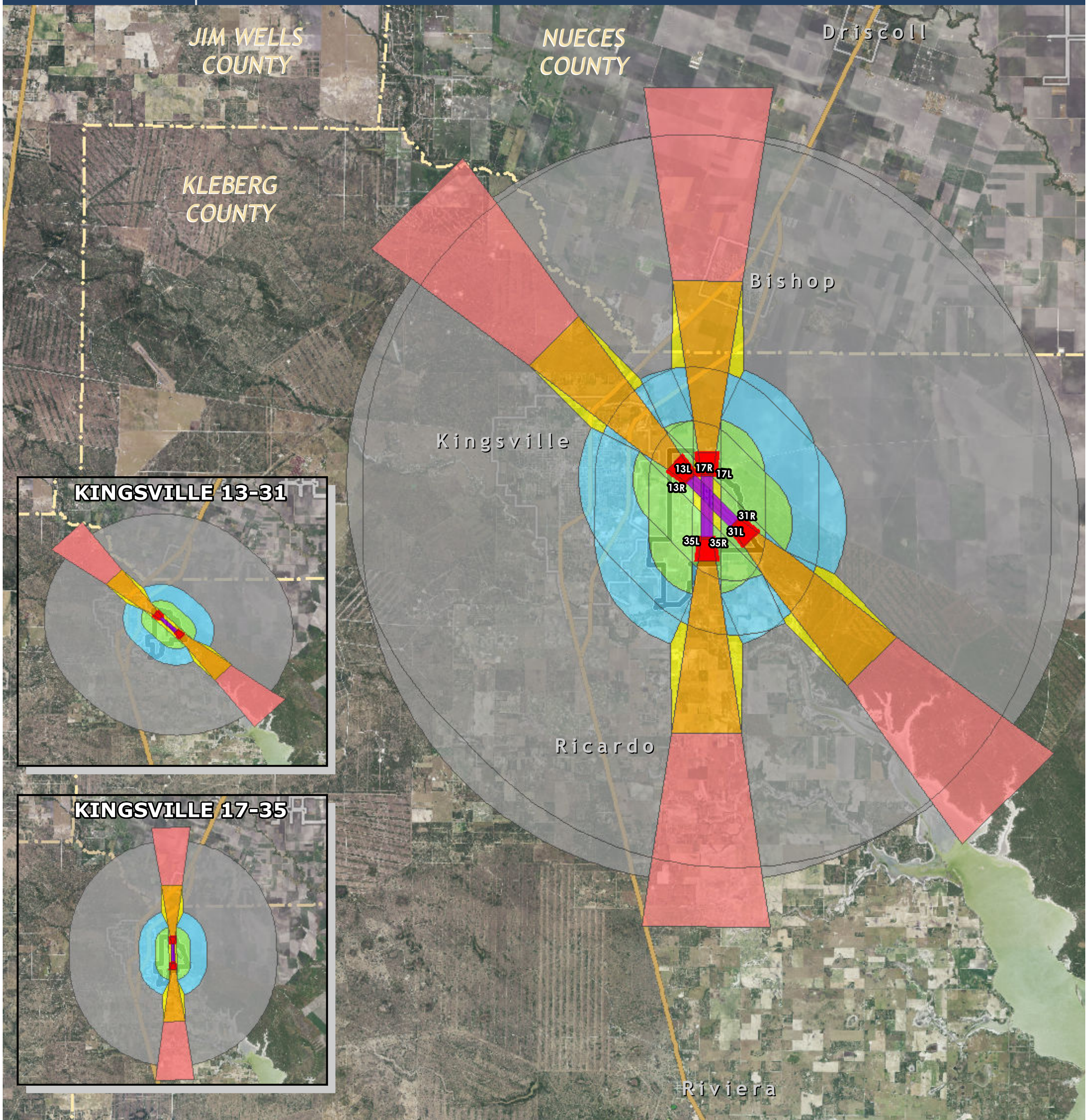
Table 5-1:
Descriptions of Imaginary Surfaces - Class B Runways

Planes and Surfaces	Geographical Dimensions
Primary Surface	Aligned (longitudinally) with each runway and extending 200 feet from each runway end. The width is 1,500 feet.
Clear Zone	Located immediately adjacent to the end of the runway and extending 3,000 feet beyond the end of the runway; 1,500 feet wide and flaring out to 2,284 feet wide.
Approach-Departure Clearance Surface	An inclined or combination inclined and horizontal plane, symmetrical about the runway centerline. The slope of the surface is 50:1 until an elevation of 500 feet and continues horizontally 50,000 feet from the beginning. The outer width is 16,000 feet.
Inner Horizontal Surface	An oval-shaped plane 150 feet above the established airfield elevation. Constructed by scribing an arc with a radius of 7,500 feet around the centerline of the runway.
Outer Horizontal Surface	A horizontal plane located 500 feet above the established airfield elevation, extending outward from the conical surface for 30,000 feet.
Conical Surface	An inclined plane extending from the inner horizontal surface outward and upward at a 20:1 slope and extending for 7,000 feet and to a height of 500 feet above the established airfield elevation.
Transitional Surface	An inclined plane that connects the primary surface and the approach-departure clearance surface to the inner horizontal surface, conical surface, and outer horizontal surface. These surfaces extend outward and upward at right angles to the runway centerline and the runway centerline extended at a slope of 7:1 from the sides of the primary surface and from the sides of the approach surfaces.

Source: Navy 1982.

Imaginary surfaces are applied to each runway; thus, imaginary surfaces are applied to each of the four runways at NAS Kingsville. NALF Orange Grove has two runways and, therefore, has two sets of imaginary surfaces. Imaginary surfaces at NAS Kingsville and NALF Orange Grove are depicted on Figures 5-2 and 5-3, respectively. Figures 5-2 and 5-3 show the imaginary surfaces for each airfield's individual runways, as well as each airfield's composite of imaginary surfaces and transition planes.

FIGURE 5-2 IMAGINARY SURFACES AND TRANSITION PLANES, NAS KINGSVILLE



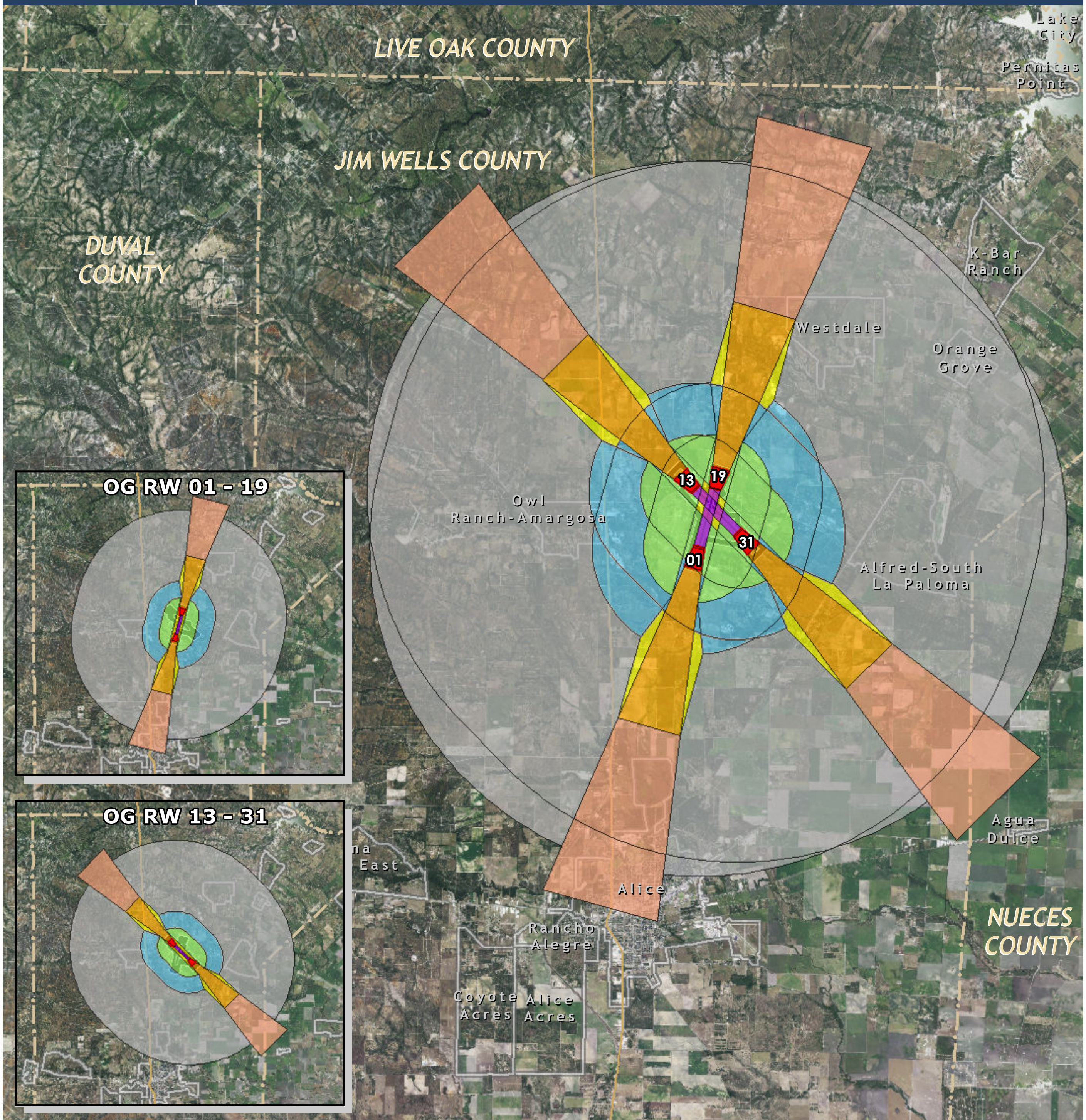
Source: ESRI 2011, Navy 2011, NAIP 2012

0 10
Inset Frames (Miles)
0 5
Main Frame (Miles)

- NAS Kingsville
- Runway
- US Highway
- Urban Area
- County Boundary

- A: Primary Surface
- B: Clear Zone Surface
- C: Approach-Departure Clearance Surface
- D: Approach-Departure Clearance Surface
- E: Inner Horizontal Surface
- F: Conical Surface
- G: Outer Horizontal Surface
- H: Transitional Surface

FIGURE 5-3 IMAGINARY SURFACES AND TRANSITION PLANES, NALF ORANGE GROVE



Source: ESRI 2011, Navy 2011, NAIP 2012

0 10
Inset Frames (Miles)

0 5
Main Frame (Miles)

- NALF Orange Grove
- Runway
- US Highway
- Urban Area
- County Boundary

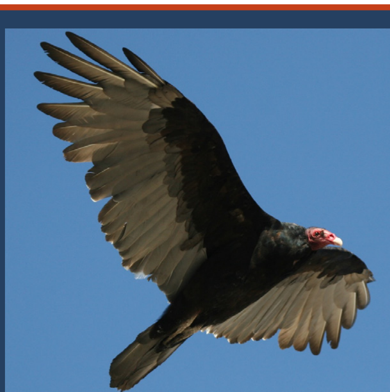
- A: Primary Surface
- B: Clear Zone Surface
- C: Approach-Departure Clearance Surface
- D: Approach-Departure Clearance Surface
- E: Inner Horizontal Surface
- F: Conical Surface
- G: Outer Horizontal Surface
- H: Transitional Surface

5.1.2 Flight Hazards

Bird/Animal Aircraft Strike Hazard (BASH)

Wildlife represents a significant hazard to flight operations. Birds, in particular, are drawn to different habitat types found in the airfield environment including hedges, grass, brush, forest, water, and even the warm pavement of the runways.

Although most bird and animal strikes do not result in crashes, they cause structural and mechanical damage to aircraft as well as loss of flight time. Most collisions occur when the aircraft is at an elevation of less than 1,000 feet. Due to the speed of the aircraft, collisions with wildlife can happen with considerable force. To reduce the potential of a bird/animal aircraft strike hazard (BASH), the FAA and the military recommend that land uses that attract birds be located at least 5 miles from the airfield's active movement areas. These land uses include transfer stations, landfills, golf courses, wetlands, stormwater ponds, and dredge disposal sites. The city landfill is located south of NAS Kingsville and directly in line with existing flight courses. Birds and raptors in search of food or rodents will flock to the landfill, increasing the probably of BASH occurrences. Additionally, a 4.8-acre retention pond, which is a bird attractant and BASH concern, is located on farming property directly west of the Installation. On base, the two retention ponds located west of Runway 35 and the ponds on the golf course located on the southwest corner of the Installation are also potential BASH sources.



Turkey vultures are typically found around the airfield and present a BASH hazard to NAS Kingsville pilots. BASH management at the base is an ongoing process.

NAS Kingsville has a full-time BASH coordinator who develops management guidelines to reduce bird densities at the airfields. The current BASH management strategies focus on modifying or reducing favorable bird habitat surrounding airfields and initiating 'bird avoidance behavior' from specified areas. NAS Kingsville also has a BASH Plan outlining specific procedures to minimize bird strikes, including reporting and disseminating hazardous bird activity. Flight operations are scheduled to avoid known bird migration patterns.

Three NAS Kingsville aircraft have been destroyed over the past 10 years from large bird strikes. Small bird collisions also cause costly repair damage, accounting for approximately 55 percent of reworked engines (Earwood [Installation BASH Coordinator] 2010).

Electromagnetic Interference (EMI)

New generations of military aircraft are highly dependent on complex electronic systems for navigation and critical flight and mission-related functions. Consequently, care should be taken in siting any activities that create EMI. EMI is defined by the American National Standards Institute as any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics/electrical equipment. EMI may be caused by atmospheric phenomena, such as lightning and precipitation static, and by non-telecommunications equipment, such as vehicles and industry machinery. EMI also affects consumer devices, such as cell phones, FM radios, television reception, and garage door openers.

Lighting

Bright lights, either direct or reflected, in the airfield vicinity can impair a pilot's vision, especially at night. A sudden flash from a bright light causes a spot or "halo" to remain at the center of the visual field for a few seconds or more, rendering a person virtually blind to all other visual input. This is particularly dangerous at night when the flash can diminish the eye's adaptation to darkness. Partial recovery of this adaptation is usually achieved in minutes, but full adaptation typically requires 40 to 45 minutes.

Smoke, Dust, and Steam

Industrial or agricultural sources of smoke, dust, and steam in the airfield vicinity can obstruct the pilot's vision during takeoff, landing, or other periods of low-altitude flight. NAS Kingsville and NALF Orange Grove are located near agriculture and ranch lands.

Wind Farms

Wind turbines may restrict training operations, reduce the quality of training, and compromise pilot safety if not properly sited near military installations and in the direct course of low-level training routes. Wind turbines may significantly impact the effectiveness of military air defense radar systems, navigation systems, weather radar systems, and ATC radar systems, while compromising security, aviation safety, and military readiness. Factors contributing to radar inference include the radar cross-section of a wind turbine, the number of turbines and their configuration, and Doppler shift. Favorable wind conditions off the coast of South Texas offer onshore and offshore wind energy development opportunities. According to the American Wind Energy Association (2012), Texas is ranked first in the United States for wind resources and leads the nation in wind energy development with 10,337 megawatts installed. Wind farms are growing throughout South Texas, and several wind farms have been proposed near NAS Kingsville.

5.1.3 Aircraft Mishaps

The Navy categorizes aircraft mishaps into one of three classes based on the severity of the injury to individuals involved and the total property damage: Class A (most severe mishap classification); Class B; or Class C (least severe mishap classification). Table 5-2 summarizes the Navy classifications.

Table 5-2:
Naval Aircraft Mishap Classification

Mishap Class	Total Property Damage	Fatality/Injury
A	$2,000,000 or more and/or aircraft destroyed	Fatality or permanent total disability
B	$500,000 or more, but less than $2M	Permanent partial disability or three or more persons hospitalized as inpatients
C	$50,000 or more, but less than $500K	Nonfatal injury resulting in loss of time from work beyond day/shift when injury occurred

Source: Naval Safety Center 2011.

From 2005 to 2012, NAS Kingsville reported eight Class A mishaps, all of which involved the T-45 aircraft (Navy Safety Center 2011). These mishaps did not cause injuries to any citizens or damage to public or private property. Table 5-3 summarizes NAS Kingsville Class A mishaps from 2005 to 2012.

Table 5-3:
NAS Kingsville Mishaps 2005 to 2012

Date	Mishap Class	Description
May 11, 2005	A	T-45A aircraft struck ground on final approach; the pilot ejected and aircraft was destroyed.
October 31, 2005	A	T-45 aircraft struck a bird during a VFR landing pattern and the engine lost thrust; the two pilots ejected and aircraft was destroyed.
September 27, 2007	A	T-45 crashed on return flight to base; aircrew ejected safely.
October 1, 2007	A	T-45 crashed after striking a bird while landing and engine lost thrust; the air crew ejected safely and aircraft was destroyed.
November 1, 2007	A	T-45 aircraft had engine failure immediately after takeoff and struck the ground; the two pilots ejected and no fatalities were reported.
June 10, 2010	A	T-45 aircraft failed to stop on rollout and departed the runway; the pilot ejected safely.
June 15, 2011	A	A student aviator crashed a T-45 during a routine training flight near George West, Texas; the pilot ejected safely with no injuries.
November 2011	A	T-45 crashed during section takeoff; the aircrew ejected and no fatalities were reported.

Source: Naval Safety Center 2012; NAS Kingsville 2012.

5.2 Accident Potential Zones

While the Navy cannot predict a mishap, if one did occur, it would most likely occur within APZs on arrival or departure.

In the 1970s and 1980s, the military conducted studies of historic accident and operations data throughout the military. The studies showed that most aircraft mishaps occur on or near the runway, diminishing in likelihood with distance from the runway. Based on these studies, the DOD has identified APZs as areas where an aircraft accident is most likely to occur if an accident were to take place. The APZs are not a prediction of accidents or accident frequency.

APZs follow departure, arrival, and pattern flight tracks. They are based on the analysis of historical data and are designed to minimize potential harm to the public, pilots, and property if a mishap does occur by limiting incompatible uses in the designated APZ areas. APZs are used by the military and local planning agencies to ensure compatible development within the APZs. Although the likelihood of an accident is remote, AICUZ guidelines recommend that certain land uses that concentrate large numbers of people (e.g., apartments, churches, and schools) be avoided within the APZs.

There are three different types of APZs: the Clear Zone, APZ I, and APZ II. APZs are, in part, based on the number of operations conducted at the airfield—more specifically, the number of operations conducted on specific flight tracks.

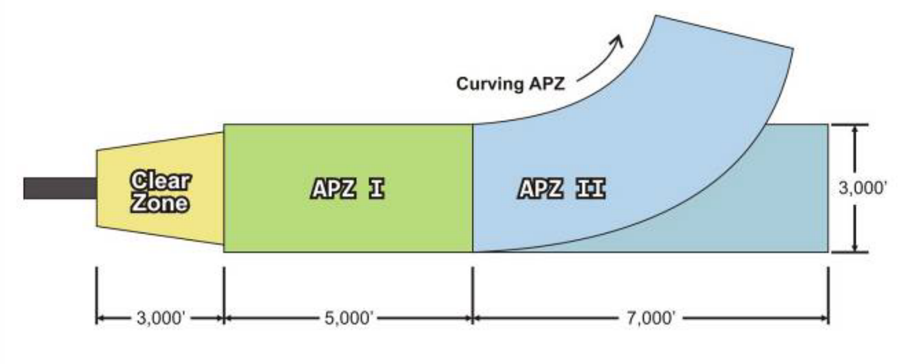
The Navy recommends that land uses with a high concentration of people (apartments, churches, schools) be located outside of APZs.

All runways at NAS Kingsville and NALF Orange Grove are classified as Class B runways. The components of standard APZs for Class B runways are defined in the AICUZ Instruction as follows and are identified on Figure 5-4:

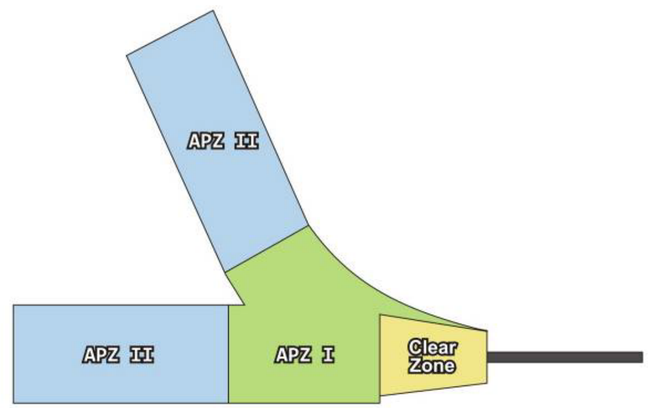
- **Clear Zone.** The Clear Zone is a trapezoidal area lying immediately beyond the end of the runway and outward along the extended runway centerline for a distance of 3,000 feet. The Clear Zone measures 1,500 feet in width at the runway threshold and 2,284 feet in width at the outer edge. A Clear Zone is required for all active runways and should remain undeveloped.
- **APZ I.** APZ I is the rectangular area beyond the Clear Zone. APZ I is provided under flight tracks that experience 5,000 or more annual operations (departures or approaches). APZ I is typically 3,000 feet in width and 5,000 feet in length and may be rectangular or curved to conform to the shape of the predominant flight track.
- **APZ II.** APZ II is the rectangular area beyond APZ I. APZ II is typically 3,000 feet in width by 7,000 feet in length and, as with APZ I, may be curved to correspond with the predominant flight track. When FCLP is an active aspect of aircraft operations at an installation, APZ II extends the entire FCLP track beyond APZ I.

Parallel runways will have overlapping Clear Zones; therefore, the combined area of the overlapping Clear Zone is merged into one larger Clear Zone. Figure 5-5 illustrates a “merged” Clear Zone for parallel runways at NAS Kingsville.

Figure 5-4: Accident Potential Zones

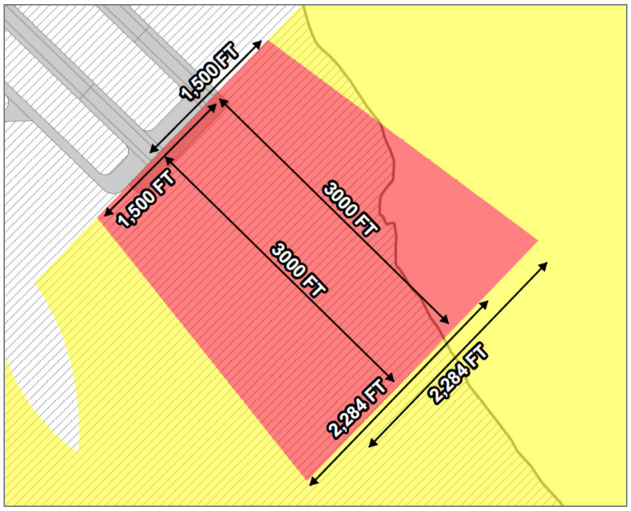


a) Standard Accident Potential Zones



b) Accident Potential Zones With More Than One Predominant Flight Track

Figure 5-5: Clear Zone for Airfields with Parallel Runways



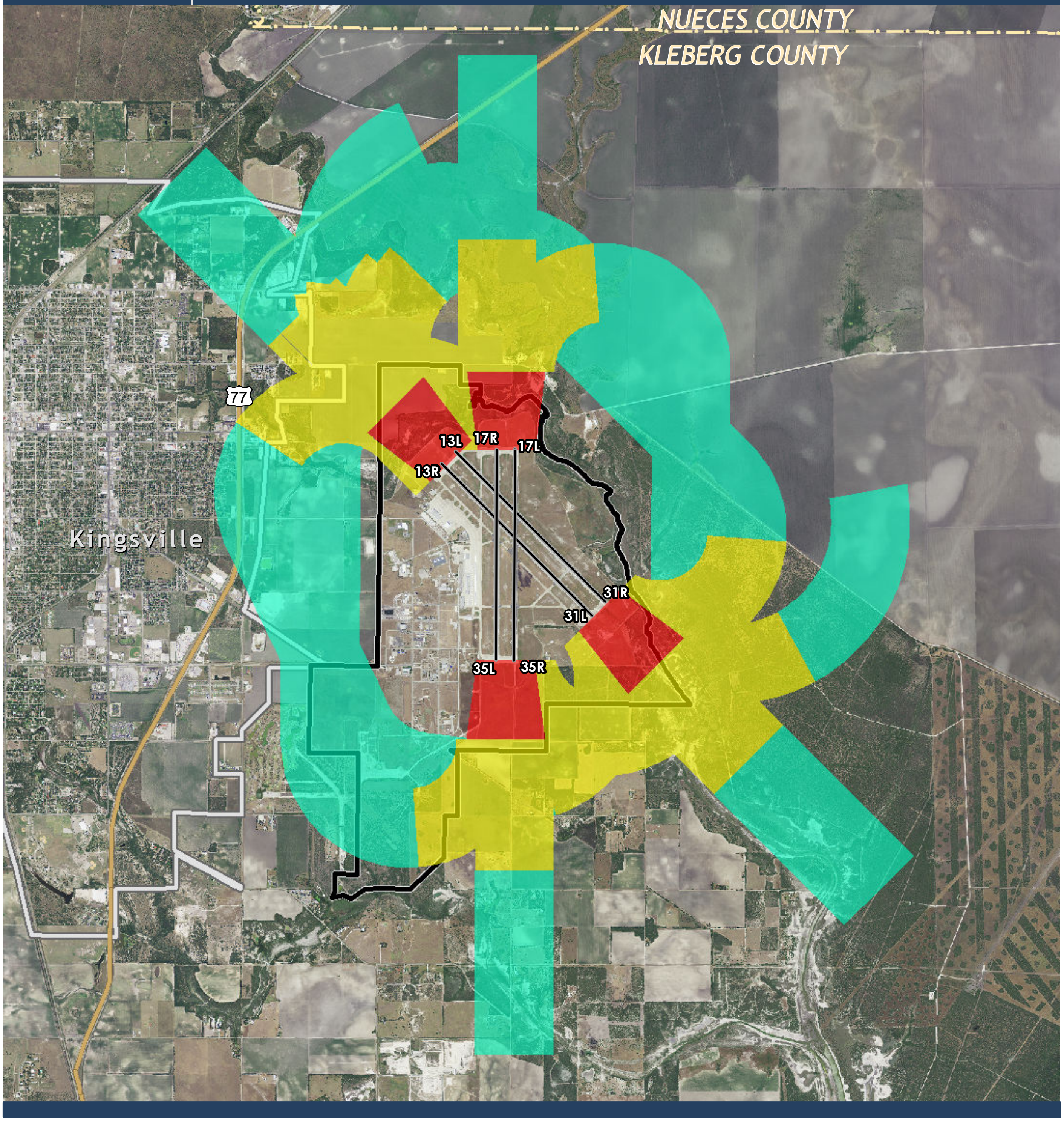
APZs extend from the end of the runway, but apply to the predominant arrival and departure flight tracks used by the aircraft. Therefore, if an airfield has more than one predominant flight track to or from the runway, APZs can extend in the direction of each flight track, as shown on Figure 5-4.

Within the Clear Zone, most uses are incompatible with military aircraft operations. For this reason, the Navy's policy, where possible, is to acquire real property interests in land within the Clear Zone to ensure incompatible development does not occur. Within APZ I and APZ II, a variety of land uses are compatible; however, people-intensive uses (e.g., schools, apartments, churches, etc.) should be restricted because of the greater safety risk in these areas. Land use and recommendations for addressing incompatibility issues within APZs for each airfield are provided and discussed in Chapter 6 *Land Use Compatibility Analysis.*

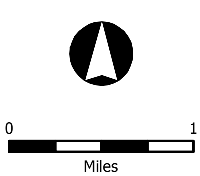
5.2.1 NAS Kingsville 2013 AICUZ APZs

The APZs represent a reasonable reflection of each airfield's mission as well as dominate flight tracks currently flown (refer to Figures 3-2 through Figure 3-7). Figure 5-6 illustrates the 2013 AICUZ APZs generated for NAS Kingsville. Due to the SNA training environment at NAS Kingsville, flight tracks with annual operations within 10 percent of the APZ operational threshold (5,000 annual operations) were reviewed by the Navy for consideration as part of the 2013 APZs. The 2013 APZs were enlarged to better reflect the Installation's mission (training) and the local mishap history. For example, the annual operations for precautionary approaches and no-flap operations on Runway 13L were slightly below the threshold, but were included as part of the 2013 AICUZ APZs. Operations following the same predominant flight track were also combined. The total of annual overhead arrivals and touch-and-go operations on Runways 35L, 17L, and 13R follow the same flight track and were combined with the arrival portion of touch-and-go operations to generate APZs I and II. Annual operations for FCLPs and touch-and-go operations on Runways 13L, 17L, and 35L were also combined.

FIGURE 5-6 2013 AICUZ APZS, NAS KINGSVILLE



Source: ESRI 2011, E&E 2012, NAIP 2012, Navy 2011



NAS Kingsville
Runway
US Highway
Urban Area
County Boundary

2013 AICUZ APZs
Clear Zone
APZ I
APZ II

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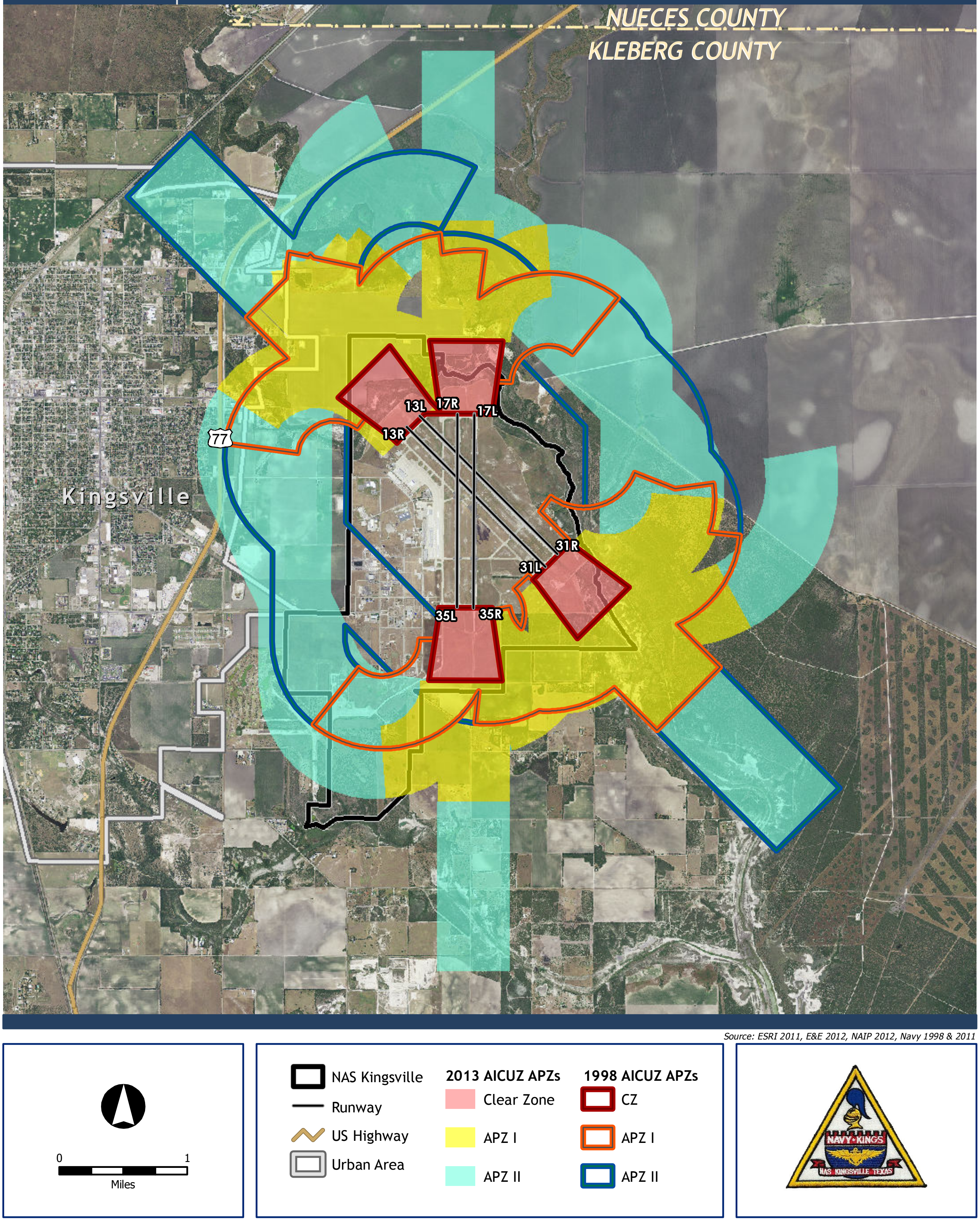
The 2013 AICUZ APZs for NAS Kingsville were developed to reflect the changes in runway use and flight tracks since the 1998 AICUZ Study. New APZs are warranted for departures on Runways 17L and 35L, no-flap patterns on Runway 13L (curved APZs), precautionary approaches on Runway 13L (curved APZs), and FCLPs (closed-loop APZs) on Runways 13L, 17L, and 35L. Figure 5-7 compares the 1998 AICUZ APZs with the 2013 AICUZ APZs. Although the projected straight-in arrivals and departures on Runway 13R were below the operational threshold, the 2013 AICUZ APZ I and APZ II on Runway 13R were extended to match the boundary of the 1998 APZs for the corresponding operations. The difference in the 1998 and 2013 AICUZ APZs is attributed to shifts in runway utilization.

As shown in Table 5-4, the land area within the 2013 APZ II has increased in comparison to the 1998 AICUZ Study. This change is due to the increase in departure on Runways 17 and 35, wider FCLP patterns, and wider patterns for no-flap approaches.

Table 5-4:
Land Area within Accident Potential Zones, NAS Kingsville

APZs	Total Land Area 1998 AICUZ APZs (acres)	2013 AICUZ APZs (acres)
Clear Zone	712	717
APZ I	3,371	3,373
APZ II	3,844	6,268
Total Area	**7,927**	**10,358**

FIGURE 5-7 COMPARISON OF 1998 AND 2013 AICUZ APZS, NAS KINGSVILLE



Source: ESRI 2011, E&E 2012, NAIP 2012, Navy 1998 & 2011

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5.2.2 NALF Orange Grove 2013 AICUZ APZs

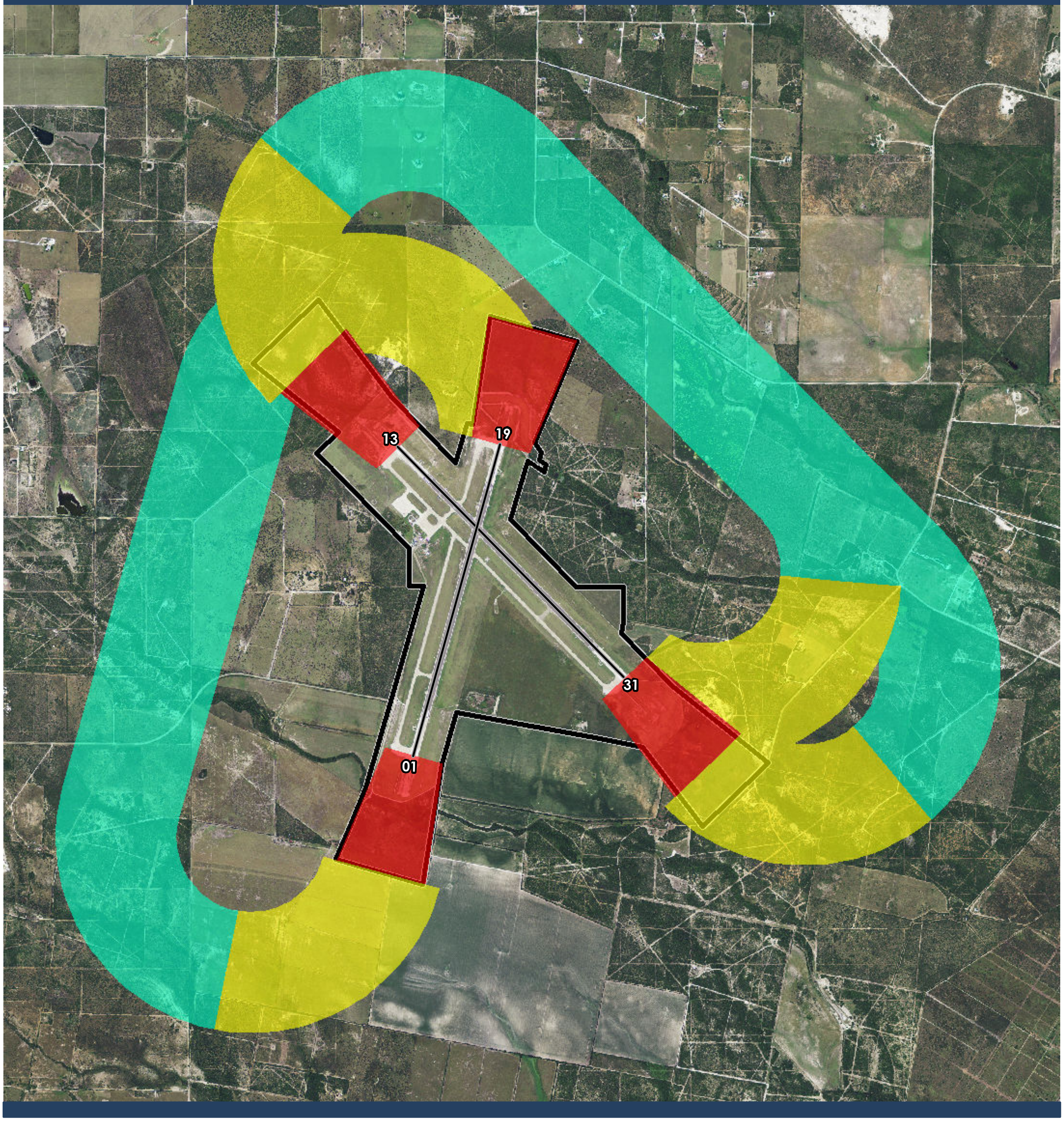
The NALF Orange Grove 2013 AICUZ APZs also were developed based on annual aircraft operations and the Installation's training mission (Figure 5-8). The annual operations for FCLPs were combined with annual touch-and-go operations; therefore, closed-looped APZs are warranted on Runways 13 and 01. New APZs are also warranted for additional FCLP flight tracks on Runway 13 that exceed the APZ operational threshold. In comparison to the 1998 AICUZ Study, no APZs are warranted on Runway 19 due to reduced runway utilization. The comparison of the 1998 AICUZ APZs and 2013 AICUZ APZs is illustrated on Figure 5-9.

As shown in Table 5-5, the land area within the 2013 APZ II increased significantly in comparison to the 1998 AICUZ Study. This change is due to the increased number of FCLP annual operations with elongated patterns.

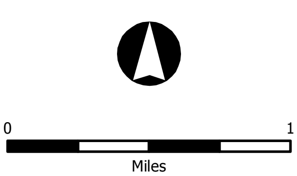
Table 5-5:
Land Area within Accident Potential Zones, NALF Orange Grove

APZs	Total Land Area 1998 AICUZ APZs (acres)	 2013 AICUZ APZs (acres)
Clear Zone	522	521
APZ I	1,664	1,666
APZ II	910	2,858
Total Area	**3,096**	**5,045**

FIGURE 5-8 2013 AICUZ APZS, NALF ORANGE GROVE



Source: ESRI 2011, E&E 2012, NAIP 2012, Navy 2011



NALF Orange Grove

Runway

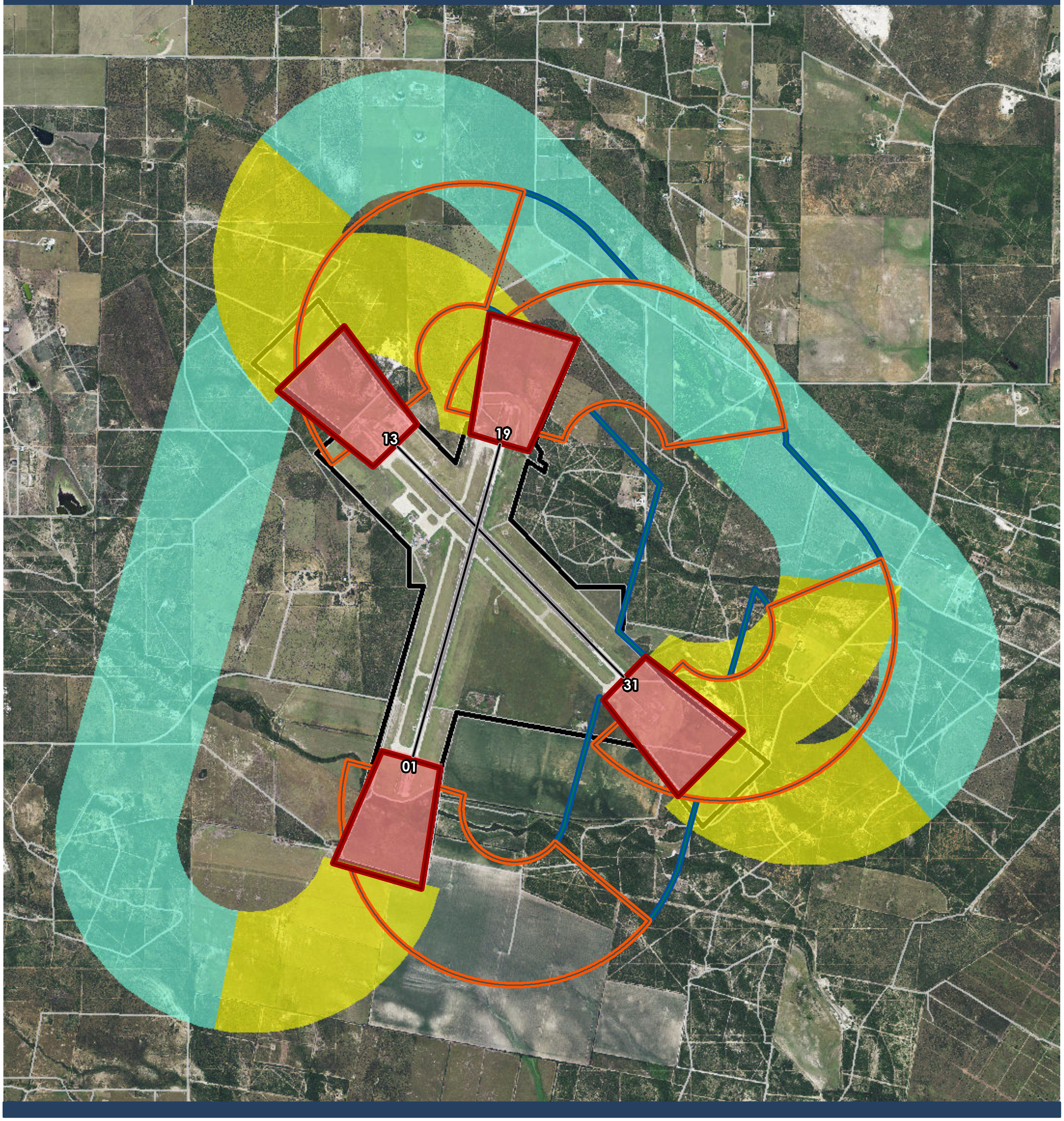
2013 AICUZ APZs

Clear Zone

APZ I

APZ II

FIGURE 5-9 COMPARISON OF 1998 AND 2013 AICUZ APZS, NALF ORANGE GROVE



Source: ESRI 2011, E&E 2012, NAIP 2012, Navy 1998 & 2011

0 1
Miles

NALF Orange Grove
Runway
Local road

2013 AICUZ APZs
Clear Zone
APZ I
APZ II

1998 AICUZ APZs
CZ
APZ I
APZ II

NAVY • KINGS
NAS KINGSVILLE TEXAS

6 Land Use Compatibility Analysis

The AICUZ footprint of an airfield—the combination of noise contours and APZs—defines the minimum acceptable area in which land use control measures are recommended to protect the public's health, safety, and welfare while sustaining the Navy's flying mission. To guide compatible development near NAS Kingsville and NALF Orange Grove, local municipalities should incorporate the projected 2013 AICUZ noise zones and APZs into zoning ordinances, land use guidelines, and planning initiatives. The AICUZ Study is a planning document for the Navy to use when working with government entities to adopt programs, policies, and regulations that support the Navy mission and encourage compatible development within the vicinity of military facilities.

The land use compatibility analysis is based on the assessment of existing land uses and proposed development near NAS Kingsville and NALF Orange Grove. Population growth projections, land use regulations, and planning practices were evaluated to determine how local and regional development patterns could impact future operations at each airfield.

6.1 Land Use Compatibility Guidelines and Classifications

The Navy has developed guidelines for compatible development and land use within an airfield's AICUZ APZs and noise zones. These guidelines are provided in the Navy's AICUZ Program Instructions OPNAVINST 11010.36C (Navy 2008). Table 6-1 provides a list of common land use classifications and their compatibility recommendations within AICUZ noise zones and APZs. Land use classifications in this table are generalized and do not represent the local communities' land use designations. A complete index of the Navy's land use compatibility recommendations is presented in Appendix B. Because most land uses are deemed compatible within Noise Zone 1, the Navy does not typically provide land use recommendations for this noise zone; therefore, Noise Zone 1 (less than 65 DNL) is not included in Appendix B.

Table 6-1:
Land Use Classification and Compatibility Guidelines

Land Use	Compatibility with AICUZ Noise Zone (DNL)						Compatibility with AICUZ APZs		
	Noise Zone 1		Noise Zone 2		Noise Zone 3		CZ	APZ I	APZ II
	<55	55-65	65-70	70-75	75-80	>85			
Single-Family Residential	Compatible	Compatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible	Compatible (1)
Multi-Family Residential and Hotels	Compatible	Compatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible
Public Assembly Areas and Auditoriums	Compatible	Compatible	Compatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible
Schools and Hospitals	Compatible	Compatible	Compatible (2)	Compatible (2)	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible
Manufacturing/Industrial	Compatible	Compatible	Compatible	Compatible	Incompatible	Incompatible	Incompatible	Incompatible	Compatible
Outdoor Parks and Recreation Areas	Compatible	Compatible	Compatible	Compatible	Incompatible	Incompatible	Incompatible	Compatible (4)	Compatible (4)
Business Services	Compatible	Compatible	Compatible	Compatible (2)	Compatible (2)	Incompatible	Incompatible	Compatible (3)	Compatible (3)
Agriculture, Forestry, and Mining	Compatible	Compatible	Compatible	Compatible	Compatible	Compatible	Compatible	Compatible	Compatible

Source: Adapted from OPNAVINST 11010.36C.

Notes: This generalized land use table provides an overview of recommended land use. Specific land use compatibility guidelines are provided in Appendix B.
(1) Maximum density of 1 to 2 dwellings per acre.
(2) Land use and related structures generally compatible; however, measures to achieve recommended noise level reduction should be incorporated into design and construction of the structures.
(3) Maximum floor area ratio that limits people density may apply.
(4) Facilities must be low intensity.

Key:

AICUZ = Air Installations Compatible Use Zones.
APZ = Accident Potential Zone.
CZ = Clear Zone.
DNL = day-night average sound level.
[green] = Compatible
[red] = Incompatible

6.2 Planning Authorities

Local governments manage land use and future growth through zoning regulations, land use plans, subdivision regulations, and building codes. These planning tools define standards to restrict or permit land uses, density, and development. Elected city or county legislators enact zoning laws and appoint agencies/boards to review proposed development and administer zoning regulation provisions. Although land use activities directly outside an installation's fence line can impact Navy operations, the use and development of the surrounding properties is under the jurisdiction of local governments.

Under Chapter 212 of Texas Local Government Code, the City of Kingsville is authorized to extend regulations related to the subdivision of land within their extra-territorial jurisdiction (ETJ).

The regulatory authority of local governments is granted by the state and limited to the extent of their geographic jurisdictional boundaries. In Texas, municipal zoning is limited to the extent of the city limits. County governments do not have zoning authority to control land use and development in the unincorporated areas except as provided for by the Texas Local Government Code 241, "Municipal and County Zoning Authority around Airports" (see Sections 6.2.2 and 6.2.3 for more information). Cities can enforce subdivision regulations through platting approval within their extra-territorial jurisdiction (ETJ), which is the unincorporated area that is contiguous to the corporate boundaries of the municipality area of land. The extent of a city's ETJ varies from 0.5 mile to 5 miles, based on the number of inhabitants of the municipality, and cannot overlap the ETJ of another city. A city's platting authority is extended to their ETJ under the Texas Local Government Code Chapter 212. NAS Kingsville is located partially within the City of Kingsville's ETJ and unincorporated limits of Kleberg County. NALF Orange Grove is located within the unincorporated limits of Jim Wells County.

6.2.1 City of Kingsville

Land Use Master Plan

The City of Kingsville's Master Plan provides guidelines and policies for future development, redevelopment, and community enhancement within the city limits and the city's 2-mile ETJ. The guidelines and policies are implemented through zoning ordinances, subdivision regulations, and building codes. The

Master Plan's land use polices support growth strategies and intergovernmental coordination to encourage compatible development near NAS Kingsville. The city's Master Plan was updated and adopted by the City Commission in 2010.

Zoning Authorities

> **"It shall be the duty of the Planning and Zoning Commission to make and recommend for adoption a master plan, as a whole or in parts, or the future development and redevelopment of the municipality and its environs and shall have the power and duty to prepare a comprehensive plan and zoning regulations for the City of Kingsville."**
>
> **City of Kingsville 2012**

All properties within the city are classified into zoning districts that permit or prohibit property use and development density. Zoning laws are adopted and amended by the Kingsville City Commission. The Planning and Zoning Commission is an advisory board to the Kingsville City Commission responsible for preparing zoning regulations, reviewing development proposals, and enforcing zoning ordinance provisions to ensure consistency with the City Master Plan. Zoning appeals and variance requests are heard and granted by the Zoning Board of Adjustment. The City of Kingsville has a Mandatory Referral Agreement to notify NAS Kingsville of all proposed developments, property rezoning requests, and variance permit applications that may affect land use surrounding the Installation.

The City of Kingsville adopted the Air Installation Zoning Regulations into the city's zoning ordinance (§15.6.35 through §15.6.41) to minimize airport hazards and incompatible development. The City's Director of Development Services administers the provisions of the Air Installation Zoning Regulations. The regulations specify allowable land uses and construction mitigation measures within the "Controlled Compatible Land Use Area" with regards to height limitations, noise sensitivity, and accident potential. The Controlled Compatible Land Use Area extends 5 miles beyond each end of the runway and 1.5 miles on each side of the extended runway centerline. The zoning regulations also require buyers to execute a disclosure statement when purchasing property within a Controlled Compatible Land Use Area. The City's building codes also require new construction or modifications to existing structures within the AICUZ noise zones to include sound attenuation measures. Developers or landowners must inform prospective buyers that the Air Installation Zoning Regulations may limit the development and use of the property. The AICUZ footprint is within the Controlled Compatible Land Use Area and is referred to as the AICUZ Overlay Zone. When the Installation updates the AICUZ Study, the ordinance and the

AICUZ Overlay Zone will be revised to reflect the new AICUZ noise contours, safety zones, and height limitation areas.

Joint Land Use Study

> To balance future growth and the Installation's operational mission requirements, the City of Kingsville and Kleberg County conducted a Joint Land Use Study (JLUS) in 2008.

Through the Office of Economic Adjustment (OEA), the DOD developed the JLUS program to enhance coordination between military installations and their surrounding communities and to address existing and future compatibility issues. To balance future growth and the Installation's operational mission requirements, the City of Kingsville and Kleberg County conducted a JLUS Study in 2008. The JLUS was a collaborative land use planning effort among the City of Kingsville, Kleberg County, NAS Kingsville, and local interest groups and organizations. The study identifies compatibility concerns and provides recommended compatible land use management strategies and implementation actions. The JLUS and the recommended implementation actions were adopted by the City Commission on April 24, 2008. Recommendations from the JLUS and the City Master Plan both include establishing a Joint Airport Zoning Board (JAZB) to regulate land use within the unincorporated areas surrounding NAS Kingsville. Additional information on the JAZB is provided in Section 6.2.3 *Joint Airport Zoning Board*.

6.2.2 Kleberg and Jim Wells Counties

The Commissioners Court is the governing body of the county. The Commissioners Court consists of four elected commissioners and the County Judge, who is the presiding officer. The Commissioners Court establishes the commissioners' precinct boundaries. Kleberg County and Jim Wells County are both divided into four precinct districts, each with an elected precinct commissioner appointed to oversee the district.

The County Commissioners Court is responsible for constructing and maintaining county roads, adopting an annual budget, establishing the annual property tax rate, providing utility service infrastructure, and carrying out other responsibilities as set forth by Texas State statutes. The Commissioners Court also acquires property for rights-of-way or public uses, adopts and enforces subdivision regulations, and provides emergency ambulance and fire protection services to rural areas of the county.

Kleberg County

Kleberg County and Jim Wells County do not have zoning authority or a comprehensive planning process to regulate land use and development in the counties' unincorporated areas.

Kleberg County does not have general zoning authority or a comprehensive planning process to regulate land use and development in the county's unincorporated areas. Chapter 241 of the Texas Local Government Code, "Municipal and County Zoning Authority around Airports," authorizes counties to adopt zoning regulations to prevent the creation of an airport hazard. In 2012, Kleberg County adopted the Compatible Land Use and Hazard Zoning Regulations through the JAZB, a joint endeavor between Kleberg County and the City of Kingsville. Since the county does not have designated planning and zoning staff, the city administers the regulations on behalf of the county.

Jim Wells County

NALF Orange Grove is located within the unincorporated area of Jim Wells County. Jim Wells County does not have zoning authority or a comprehensive planning process to guide development surrounding the airfield. Outside city limits, the Jim Wells County Judge and the Commissioners Court administer permits for development.

Jim Wells County, with the support of the DOD's OEA, is preparing a JLUS to develop compatible land use planning practices with military operations at NALF Orange Grove. Through the JLUS process, the county can generate short- and long-term recommendations to guide future development practices and incorporate compatible land use control measures in the vicinity of NALF Orange Grove.

6.2.3 Joint Airport Zoning Board

Under Texas Local Government Code §241.014 (Texas Legislature 2011), municipalities and counties are authorized to form airport zoning boards to regulate land uses within a designated airport/airfield hazard area.

In 2010, the City of Kingsville and Kleberg County established a JAZB to coordinate future planning efforts and protect the operational sustainability of NAS Kingsville. The five-member Board is comprised of two county-appointed officials, two city-appointed officials, and one chairperson to be appointed by the other four Board members.

Under Texas Local Government Code §241.014, the Kingsville-Kleberg JAZB is authorized to adopt, administer, and enforce land use in the vicinity of NAS Kingsville to ensure public safety and compatibility. In conjunction with the city's Air Installation Zoning Regulations, the Kingsville-Kleberg JAZB adopted the Compatible Land Use and Hazard Zoning Regulations to regulate zoning within the unincorporated area of the county located within the Controlled Compatible Land Use Area. Within the Controlled Compatible Land Use Area, the JAZB designates land use zones and airport overlay zones and establishes land use restrictions specific to each zone[1]. Zoning regulations address compatibility concerns regarding safety zones, aircraft noise, and vertical obstructions. The JAZB will update the AICUZ Overlay Zone to reflect updates to the AICUZ noise contours, safety zones, and height limitation areas. The Kingsville-Kleberg JAZB also approved lighting regulations restricting the Installation, types and use of outdoor lighting in the vicinity of NAS Kingsville.

6.3 Land Use and Proposed Development

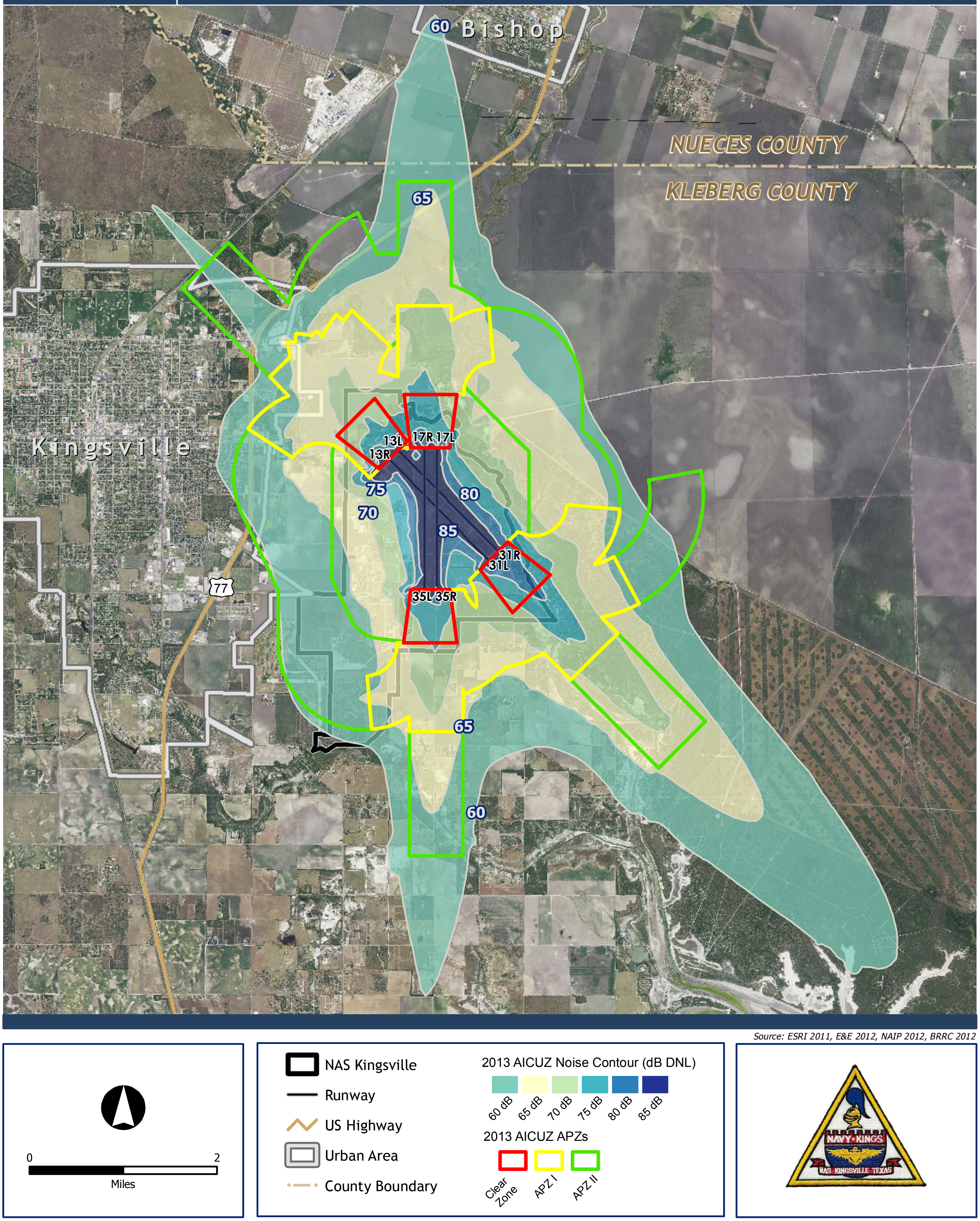
The AICUZ land use compatibility analysis identifies existing and future land uses near NAS Kingsville and NALF Orange Grove to determine compatibility conditions. Existing land use is assessed to determine current land use activity, while future land plans are used to project development and potential growth areas. The composite AICUZ maps ("AICUZ footprints") for NAS Kingsville and NALF Orange Grove, which are comprised of the 2013 AICUZ noise contours and APZs, are used as the basis for the land use compatibility analysis (Figures 6-1 and 6-2). Recommended strategies for AICUZ implementation are based on the findings from the land use analysis.

Kingsville Aerial

[1] The JAZB AICUZ Overlay does not reflect the 1998 AICUZ footprint for NAS Kingsville.

FIGURE 6-1

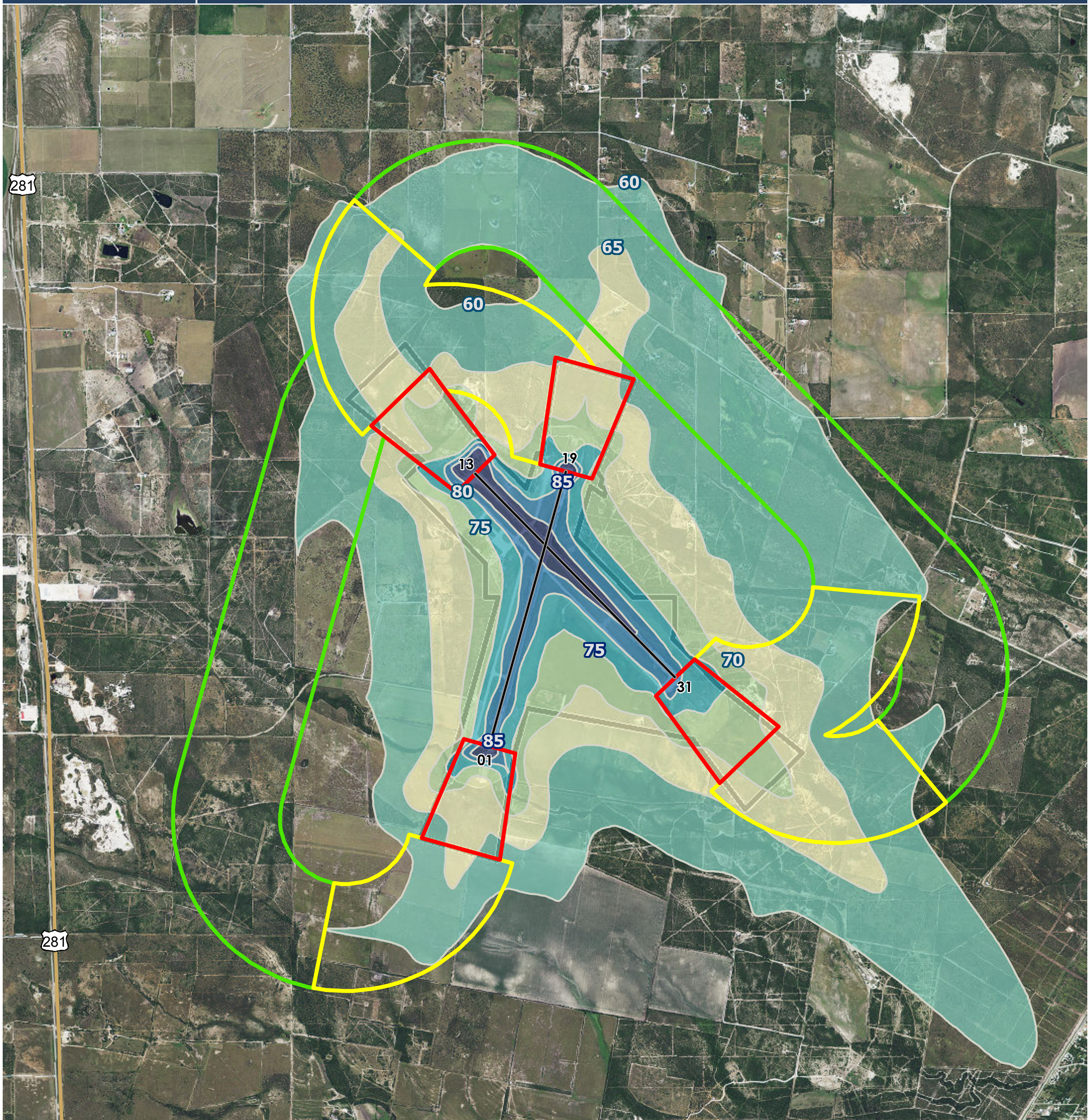
2013 COMPOSITE AICUZ MAP, NAS KINGSVILLE



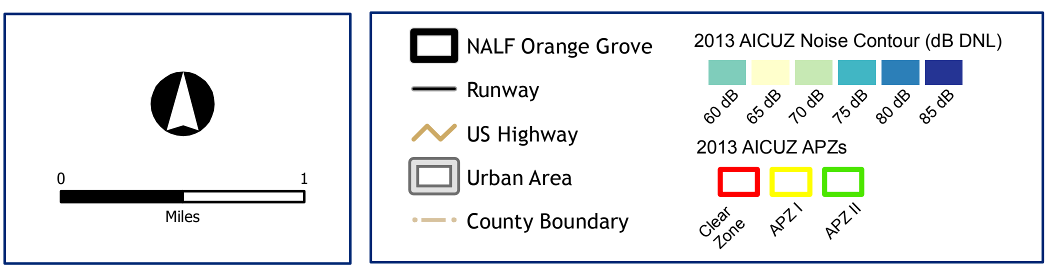
Source: ESRI 2011, E&E 2012, NAIP 2012, BRRC 2012

FIGURE 6-2

2013 COMPOSITE AICUZ MAP, NALF ORANGE GROVE



Source: ESRI 2011, E&E 2012, NAIP 2012, BRRC 2012



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6.3.1 Existing Land Uses

Existing land use and parcel data were evaluated to ensure an actual account of land use activity regardless of conformity to zoning classification or designated planning or permitted use. Zoning districts do not always indicate the actual land use. Typical land use categories include residential, commercial, public use, agricultural, parks/open space, and industrial. Additionally, local management plans, policies, ordinances, and zoning regulations were evaluated to determine the type and extent of land use allowed in specific areas.

For properties in the vicinity of NAS Kingsville, land use data were derived from the Kleberg County Tax Assessor Office's Geographic Information System (GIS) parcel data and were verified with aerial photographs and land use maps in the City of Kingsville's Master Plan. Land use data for the surrounding area of NALF Orange Grove were derived from the Jim Wells County Appraisal District's parcel data and verified with aerial photographs.

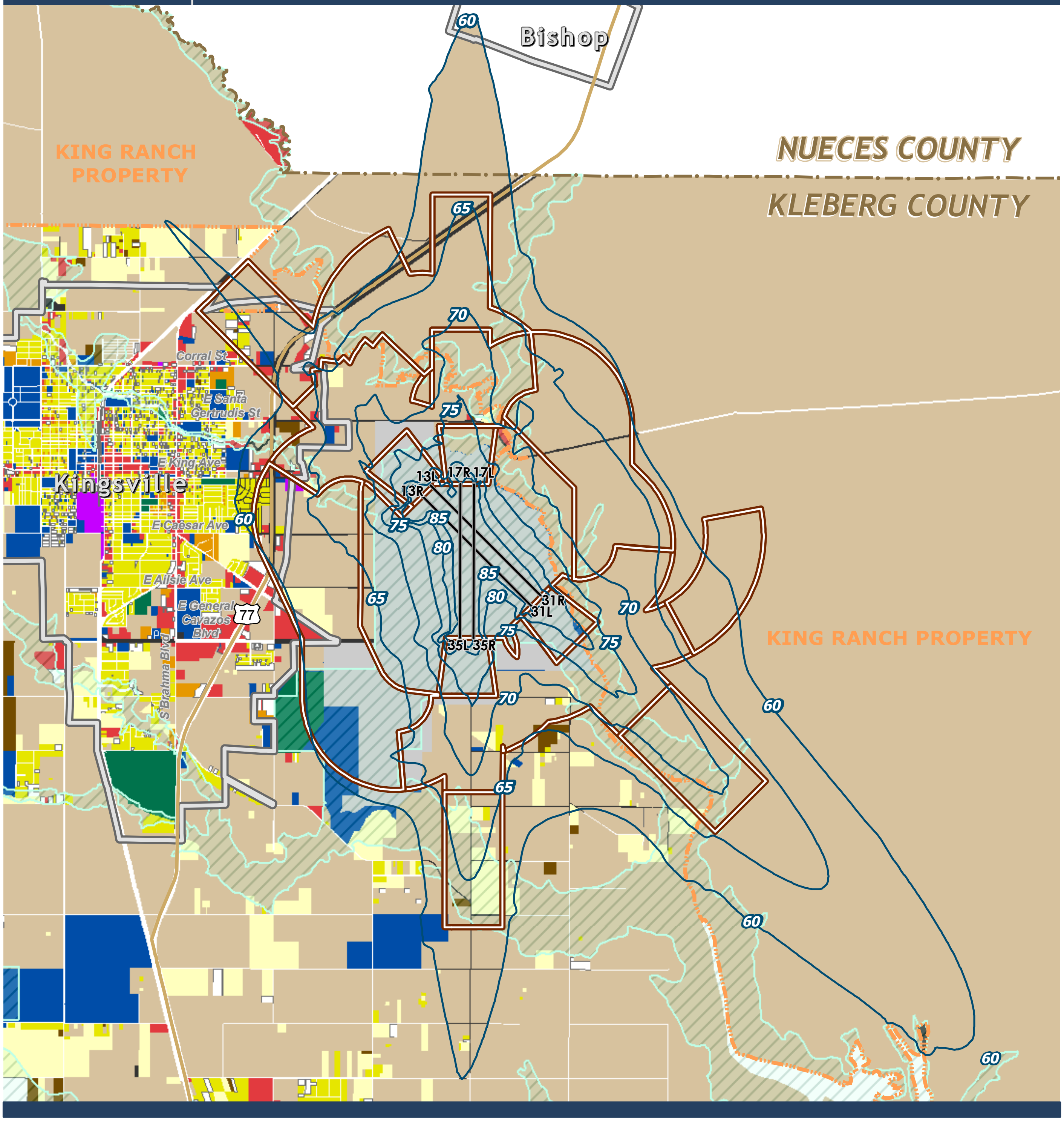
NAS Kingsville

Predominant land uses surrounding NAS Kingsville include:

- Farm/Agricultural
- Commercial Businesses
- Single-Family Residential
- Public Use Facilities

NAS Kingsville is situated wholly within Kleberg County, to the east of the City of Kingsville and U.S. Highway 77, outside the city limits. The area surrounding NAS Kingsville is predominantly rural and agricultural/ranch land. A mix of urban development is located west of the Installation within the City of Kingsville, including commercial business, residential developments, and public use facilities. The city limits extend just east of U.S. Highway 77, but the city's density is concentrated to the west of U.S. Highway 77. The King Ranch, categorized as agricultural land use, borders the entire eastern property boundary of the Installation. Figures 6-3 and 6-4 illustrate the existing land use surrounding NAS Kingsville and points of interest surrounding the airfield, respectively.

FIGURE 6-3 2013 COMPOSITE AICUZ MAP WITH EXISTING LAND USE, NAS KINGSVILLE



Source: ESRI 2011, E&E 2012, NAIP 2010, BRRC 2012, Kleberg County 2011, FEMA 2010, Navy 2011

0 — 1 Miles

- Runway
- US Highway
- Urban Area
- County Boundary
- King Ranch Property Line
- 2013 AICUZ Noise Contours (dB DNL)
- 2013 AICUZ APZs
- Flood Zone

Land Use (2011)

- Rural Single-Family Residential
- Single-Family Residential
- Multi-Family Residential
- Mobile Homes
- Commercial
- Public Use/Institutional
- Industrial
- Parks and Open Space
- Agricultural/Rural
- Vacant
- Military Property
- Other (ROW and Utilities)

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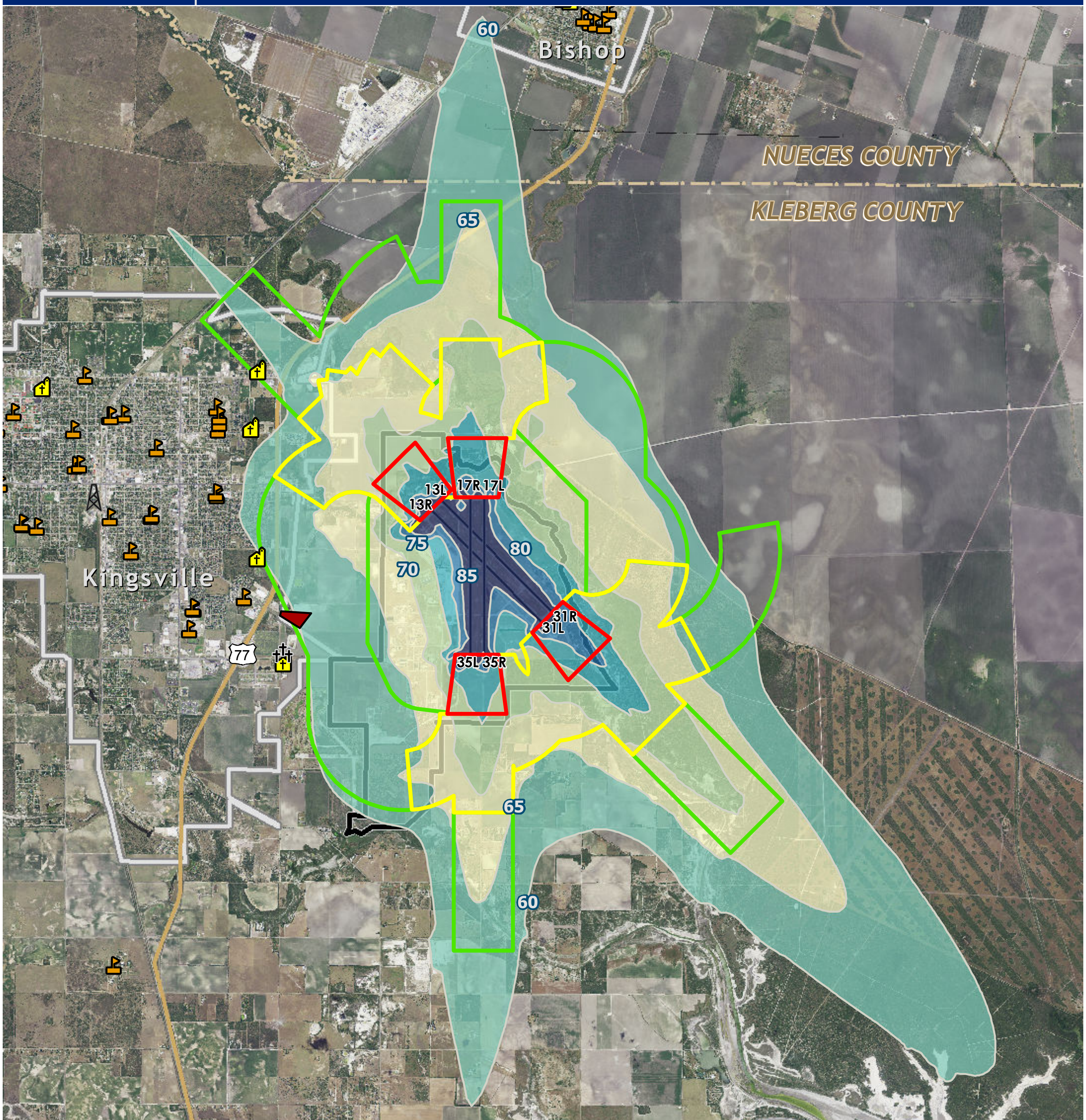
FIGURE 6-4 POINTS OF INTREST NEAR NAS KINGSVILLE



Source: ESRI 2011, E&E 2012, NAIP 2012, BRRC 2012, Kleberg County 2011, FCC 2012

0 2
Miles

NAS Kingsville
Runway
US Highway
Urban Area
Funeral Home
Church
Cellular Tower
Customs Border Patrol Compound
School

2013 AICUZ Noise Contour (dB DNL)
60 dB 65 dB 70 dB 75 dB 80 dB 85 dB

2013 AICUZ APZs
Clear Zone APZ I APZ II

Residential Development. Residential land use is located west and southwest of NAS Kingsville and west of Highway 77. Land to the south and east of NAS Kingsville is rural and less developed, with large tracts of land for farming and ranching; however, pockets of residential dwellings are scattered throughout this area. Residential land use near the Installation is predominantly single-family housing. Limited areas of medium- and high-density residential housing, including apartments and duplexes, are located west of the Installation. Approximately 50 single-family residences are located directly within the NAS Kingsville AICUZ footprint. Within the past five years, the City of Kingsville has approved construction of several residential areas located west and southwest of the Installation (outside of the 2013 AICUZ footprint). The city projects residential development to continue to grow in the southern portion of the city.

Commercial Development. Commercial development in vicinity of NAS Kingsville is concentrated along Highway 77 and continues to expand south of the City of Kingsville.

Churches and Schools. Churches, schools, and public assembly facilities are considered “people-intensive” land uses, which are compatibility concerns when located in the vicinity of air installations. Churches/worship facilities and schools surrounding NAS Kingsville are depicted on Figure 6-4. A total of two churches and no schools are located directly within the AICUZ footprint.

The predominant land use within the NAS Kingsville 2013 AICUZ APZs and noise contours is rural/agricultural land. Table 6-2 summarizes the total acreage of land uses within NAS Kingsville 2013 AICUZ APZs and noise zones. Overall, the area around NAS Kingsville consists of low-density development, with significant areas of undeveloped property to the south and east of the Installation. Areas west and south of the Installation are projected to grow and increase in densities, especially along Highway 77. Areas of specific land use compatibility concerns within the AICUZ APZs and noise contours are further evaluated in Section 6.4.1. *NAS Kingsville Land Use Compatibility Concerns*.

Table 6-2:
Existing Land Use Within the NAS Kingsville AICUZ Footprint

Land Use	AICUZ Noise Zone (acres)							AICUZ APZs (acres)		
	Noise Zone 1		Noise Zone 2		Noise Zone 3			CZ	APZ I	APZ II
	<55	55-65	65-70	70-75	75-80	80-85	>85			
Single-Family Residential	N/A	86	21	0	0	0	0	0	15	62
Rural Single-Family Residential	N/A	372	150	18	0	0	0	0	76	278
Multi-Family Residential	N/A	1	0	0	0	0	0	0	0	0
Mobile Homes	N/A	50	15	1	0	0	0	0	11	9
Commercial	N/A	94	12	9	1	0	0	0	29	81
Public Use/Institutional	N/A	255	16	11	7	8	0	9	24	178
Industrial	N/A	14	0	0	0	0	0	0	2	12
Agricultural/Rural	N/A	7,234	4,442	1,529	274	6	0	104	2,720	4,718
Vacant	N/A	40	8	3	0	0	0	0	14	58
Military Property	N/A	610	379	668	658	376	535	603	440	511
Other (ROW and Utilities)	N/A	355	83	42	6	0	0	1	42	290
Park/Exempted Areas	N/A	59	0	0	0	0	0	0	0	71

Key:
AICUZ = Air Installations Compatible Use Zones.
APZ = Accident Potential Zone.
CZ = Clear Zone.
ROW = right of way.

NALF Orange Grove

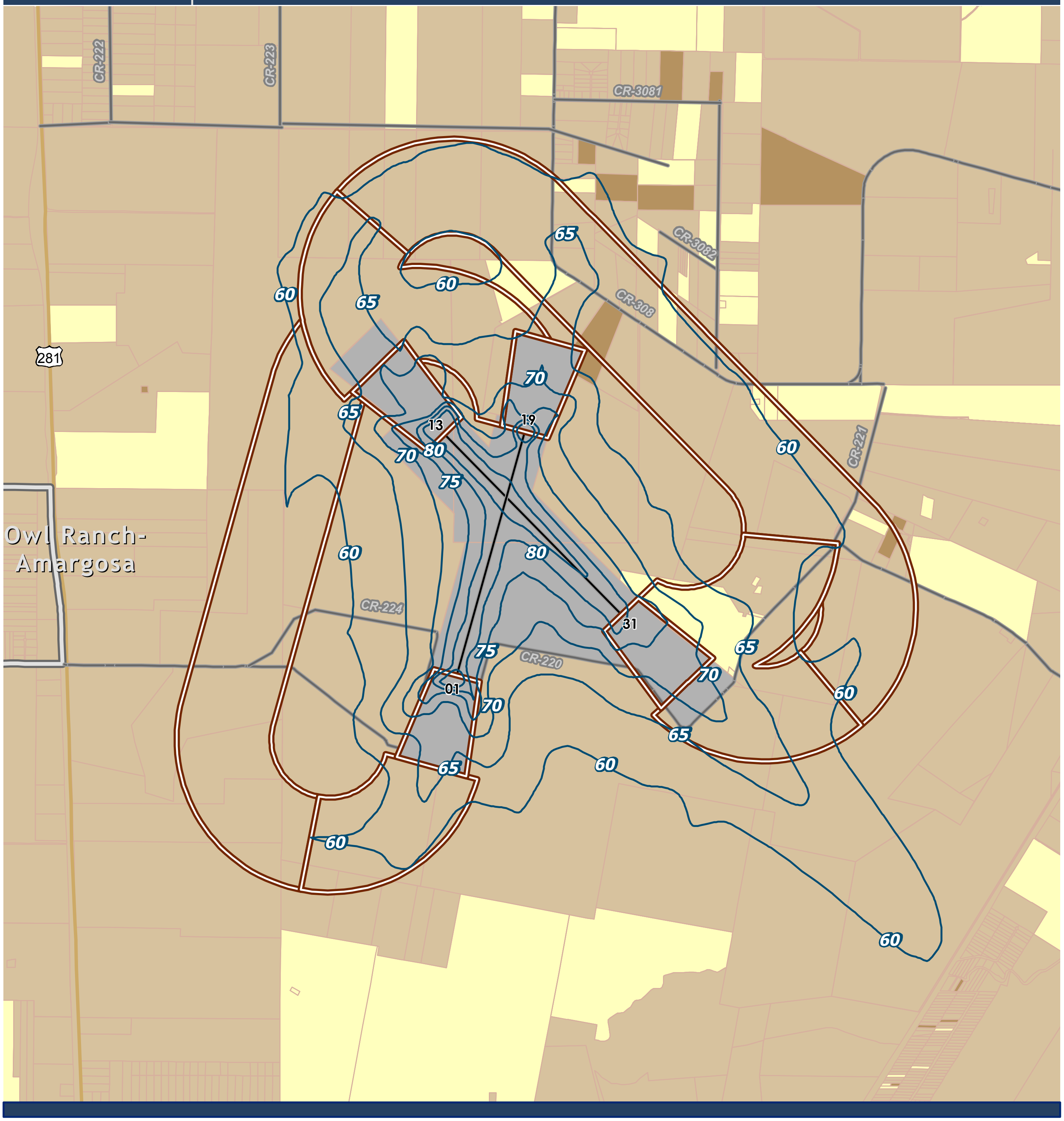
NALF Orange Grove is located in a rural setting, primarily surrounded by farming and ranch lands with sparse residential use within the airfield vicinity. A few rural single-family residences are located northeast of the airfield (north of Runway 19), along County Road 308 and southeast of Runway 31 along County Road 220. Owl Ranch Amargosa is a residential area located approximately 3 miles west of the airfield. In total, approximately 149 residences are located within a 4-mile radius of NALF Orange Grove, including five houses within the 2013 AICUZ noise zones and 16 houses within the AICUZ APZs. No commercial or industrial land uses are located near NALF Orange Grove. No churches or schools are located near the airfield. Figure 6-5 illustrates the existing land use surrounding NALF Orange Grove.

Predominant land uses surrounding NALF Orange Grove are rural with sparse residential use, and include:

- **Agricultural Lands**
- **Ranch Lands**

The total acreage of existing land uses within the noise zones and APZs are summarized in Table 6-3. No zoning regulations or future land use control tools are currently in place to prevent development surrounding NALF Orange Grove.

FIGURE 6-5 2013 COMPOSITE AICUZ MAP WITH EXISTING LAND USE, NALF ORANGE GROVE



Source: ESRI 2011, E&E 2012, BRRC 2012, Jim Wells County 2012, Navy 2011

0 — 1 Miles

- Runway
- Local Road
- Highways
- Parcel
- Urban Area
- 2013 Noise Contour (dB DNL)
- 2013 AICUZ APZs

Land Use (2012)

- Rural Single-Family Residential
- Mobile Homes (Farm and Ranch)
- Agricultural/Rural
- Military Property

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Table 6-3:
Existing Land Use Within the NALF Orange Grove AICUZ Footprint

Land Use	AICUZ Noise Zone (acres)							AICUZ APZs (acres)		
	Noise Zone 1		Noise Zone 2		Noise Zone 3			CZ	APZ I	APZ II
	<55	55-65	65-70	70-75	75-80	80-85	>85			
Single-Family Residential	N/A	0	0	0	0	0	0	0	0	0
Rural Single-Family Residential	N/A	106	106	45	6	0	0	6	143	90
Multi-Family Residential	N/A	0	0	0	0	0	0	0	0	0
Mobile Homes	N/A	51	3	0	0	0	0	0	0	41
Commercial	N/A	0	0	0	0	0	0	0	0	0
Public Use/Institutional	N/A	0	0	0	0	0	0	0	0	0
Industrial	N/A	0	0	0	0	0	0	0	0	0
Agricultural/Rural	N/A	3,606	1,070	243	41	0	0	14	1,403	2,702
Vacant	N/A	0	0	0	0	0	0	0	0	0
Military Property	N/A	36	276	385	315	243	101	497	102	0
Other (ROW and Utilities)	N/A	24	20	10	2	0	0	4	18	25

Key:
AICUZ = Air Installations Compatible Use Zones.
APZ = Accident Potential Zone.
CZ = Clear Zone.
ROW = right-of-way.

6.3.2 Future Land Use

NAS Kingsville

Future development in the City of Kingsville is guided by the city's Master Plan. The Master Plan provides principles to manage growth and encourage efficient development patterns, as well as identifies targeted areas for future growth. Planning principles promote compact development patterns and infill development to cost-effectively provide utility services and infrastructure to new businesses and homes. The Master Plan also promotes redevelopment and adaptive reuse of existing structures.

Based on area development trends surrounding the Installation, the area with the greatest potential for growth will be land in the southeast and southwest portions of the City of Kingsville along Highway 77.

Vacant properties in the southeast and southwest portions of the City of Kingsville and along Highway 77 are targeted growth areas for future development within Kingsville's city limits. Growth to the east is constrained by King Ranch and NAS Kingsville. Commercial development is shifting from the city's central core area to the Highway 77 frontage corridors, and residential development is increasing to the south. Based on the city's projected population and current land use, an additional 222 to 768 acres of land will be required to accommodate future single-family development (Kendig Keast 2008). In response to the City of Kingsville's projected population growth and the limited housing stock, the Kingsville Economic Development Council initiated the Residential Development Incentive Agreement to encourage the construction of quality master-planned housing communities in the city. Under this Agreement, the City Commission has approved the development of several new subdivisions.

The majority of NAS Kingsville is located within the city's 2-mile ETJ. In addition to contiguous development for vacant properties within the city limits, the city supports staged annexation for vacant areas within the ETJ. Properties within the ETJ are zoned as agricultural use as soon as they are annexed into the city limits. Future development surrounding the Installation that is outside of the city limits will be guided by the JAZB zoning ordinances.

NALF Orange Grove

No large-scale commercial or residential development plans are proposed in Jim Wells County near NALF Orange Grove (Saenz [Jim Wells County Judge] 2010). The county does not have a strategic land use plan to dedicate future growth, but does not expect an increase in industrial or business development that would impact growth. NALF Orange Grove is located within a rural area of the county and is not included within any neighboring community's future land use plans. Development is more likely to occur close to city limits and not in the county's rural areas. Transportation and commerce plans for the South Texas region could increase commercial and residential development near the airfield. The county is proposing to complete a JLUS for NALF Orange Grove with the intention of sustaining the airfield's surrounding property as agriculture land use.

6.4 Compatibility Concerns

Land use compatibility conditions determined in the analysis are derived from the Navy's land use recommendation for both AICUZ noise zones and APZs (Appendix B). To assess whether existing land use is compatible with aircraft operations at NAS Kingsville and NALF Orange Grove, the 2013 AICUZ noise contours and the 2013 AICUZ APZs were overlaid on property parcel data, land use data, and/or aerial photographs.

The land use compatibility analysis of these areas includes an assessment of developed properties, as well as the identification of properties that are currently vacant or have development potential. Vacant property, in its present state, is compatible with the Navy's land use compatibility guidance; however, if vacant properties are developed to their fullest potential, they may not remain compatible with the Navy's land use recommendations.

6.4.1 NAS Kingsville Land Use Compatibility Concerns

Figure 6-6 illustrates the areas of compatibility concern for NAS Kingsville. The areas that are inset on the figure are discussed in detail below.

FIGURE 6-6 AREAS OF COMPATIBILITY CONCERNS, NAS KINGSVILLE

1A-West of Highway 77, one church is located within the APZ II of Runway 13 and one church is located partially within the 60- to 65-DNL AICUZ noise contours.

1B-The Oasis Mobile Home Park is located within the 60- to 65-DNL noise contours and partially within APZ I of Runway 13.

1C-Residential development is located within APZ II and the 60- to 65-DNL AICUZ noise contour area (low-impact noise zone).

1D-Development interest to the west of the Installation is a future compatibility concern. Undeveloped property between NAS Kingsville and Highway 77, which is predominantly within the APZ II and partially within the 60- to 65- and 65- to 70- DNL noise zones, may be used for a high-density land use to meet development pressures.

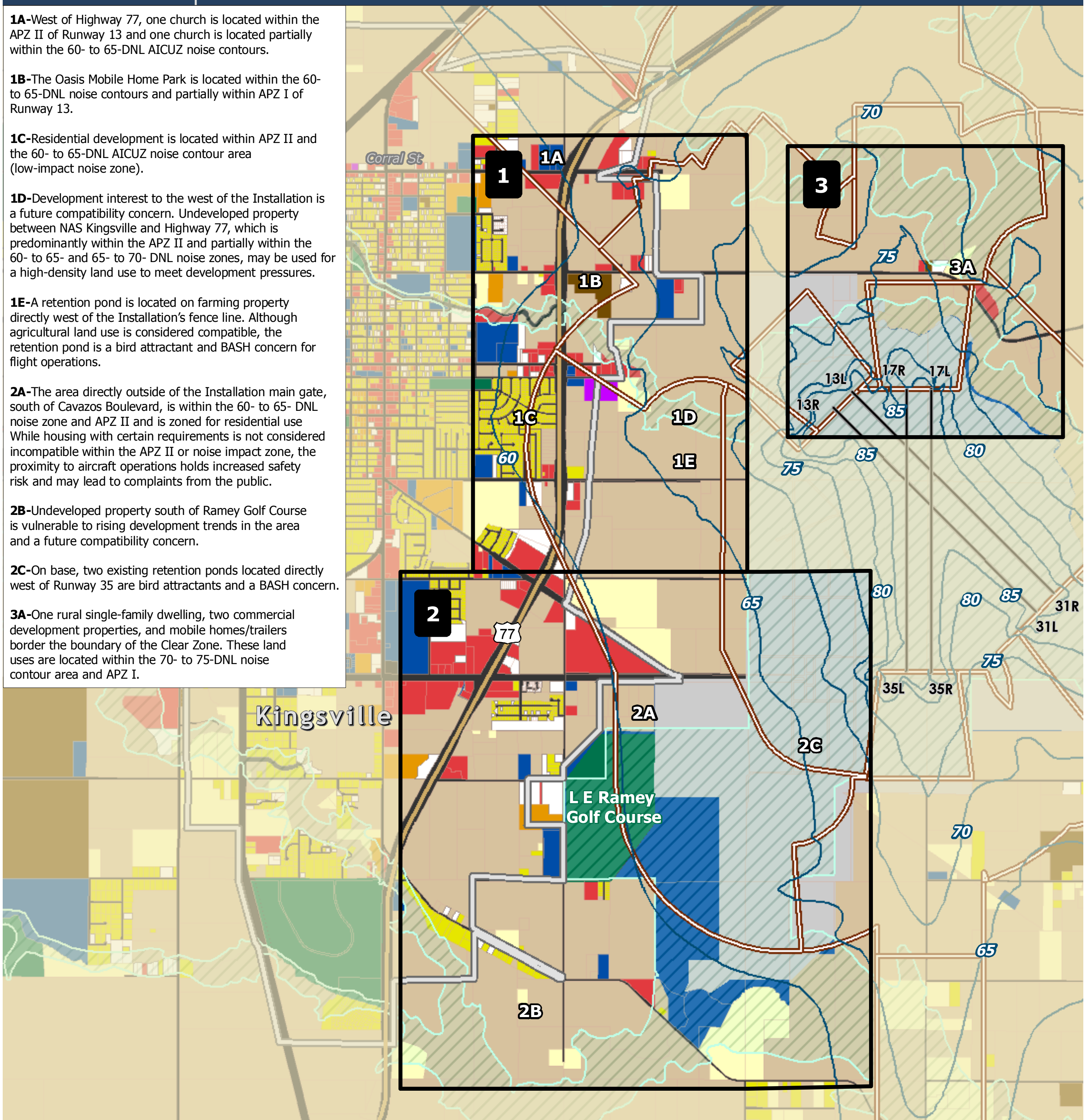
1E-A retention pond is located on farming property directly west of the Installation's fence line. Although agricultural land use is considered compatible, the retention pond is a bird attractant and BASH concern for flight operations.

2A-The area directly outside of the Installation main gate, south of Cavazos Boulevard, is within the 60- to 65- DNL noise zone and APZ II and is zoned for residential use While housing with certain requirements is not considered incompatible within the APZ II or noise impact zone, the proximity to aircraft operations holds increased safety risk and may lead to complaints from the public.

2B-Undeveloped property south of Ramey Golf Course is vulnerable to rising development trends in the area and a future compatibility concern.

2C-On base, two existing retention ponds located directly west of Runway 35 are bird attractants and a BASH concern.

3A-One rural single-family dwelling, two commercial development properties, and mobile homes/trailers border the boundary of the Clear Zone. These land uses are located within the 70- to 75-DNL noise contour area and APZ I.



Source: ESRI 2011, E&E 2012, NAIP 2010, BRRC 2012, Kleberg County 2011, FEMA 2010, Navy 2011

0 1
Miles

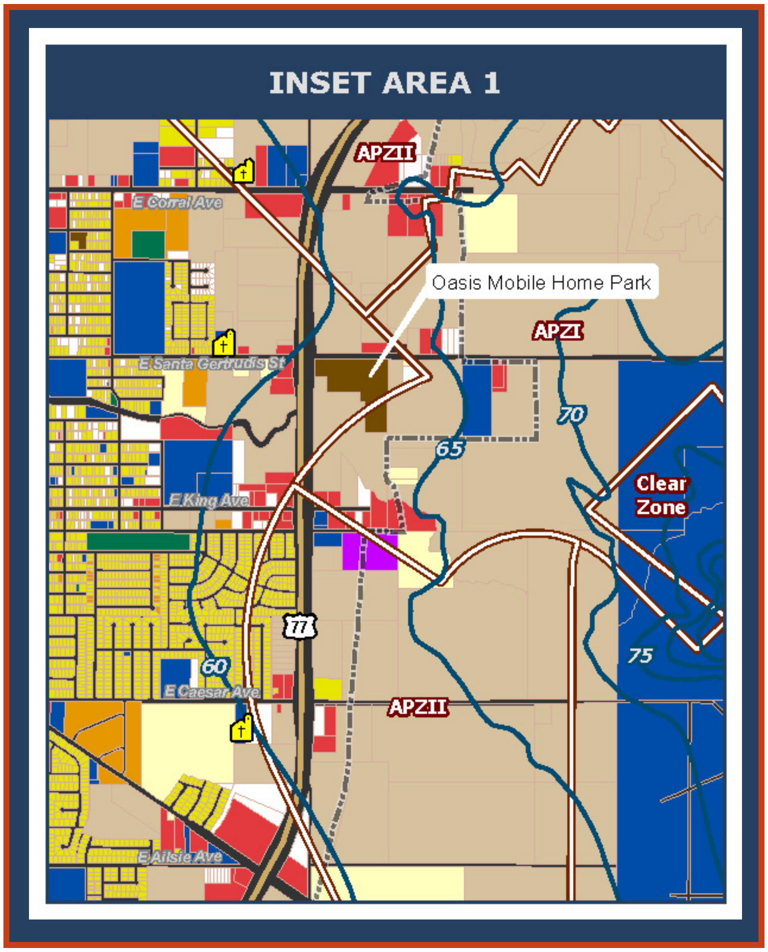
Runway
US Highway
Parcel
Urban Area
County Boundary
2013 AICUZ Noise Contours (db DNL)
2013 AICUZ APZs
Flood Zone

Land Use (2011)

Rural-Single Family Residential
Single-Family Residential
Multi-Family Residential
Mobile Homes
Commercial
Public Use/Institutional
Industrial
Parks and Open Space
Agricultural/Rural
Vacant
Military Property
Other (ROW and Utilities)

Draft Work Product – FOR OFFICIAL USE ONLY

Area 1: Development along Highway 77, West of Installation. Existing and future growth along Highway 77 is a potential land use compatibility concern. Residential areas and supporting commercial business are located within APZ II and the 60- to 65-DNL noise contour area (low-impact noise zone). Residential development is generally considered compatible, with restrictions, within APZ II based on dwellings per acres. While housing is not considered incompatible within this AICUZ noise zone, the proximity to aircraft operations may lead to noise complaints from the public. The Oasis Mobile Home Park, located west of the airfield, is an incompatible land use in both the airfield APZs and noise zones. The mobile home park is situated within the 60- to 65-DNL noise contours and partially within APZ I of Runway 13.

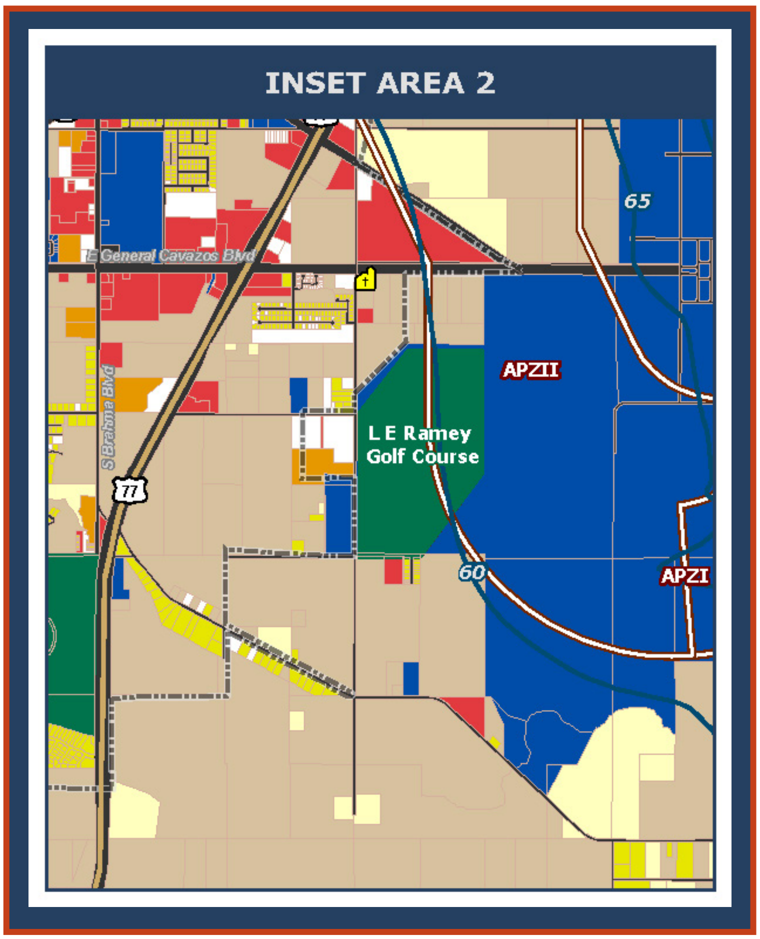


West of Highway 77, one church is located within the APZ II of Runway 13 and one church is located partially within the 60- to 65-DNL noise contours. This facility is considered generally compatible by the AICUZ Instruction land use guidelines if noise level reduction measures are incorporated into building design and construction.

As the City of Kingsville grows, the undeveloped properties between NAS Kingsville and Highway 77 may be used for a high-density land use to meet development pressures. Specifically, development interest and properties for sale to the east of the Installation are future compatibility concerns. The area between NAS Kingsville and Highway 77 is predominantly within APZ II and partially within the 60- to 65- and 65- to 70-DNL noise zones. Proposed developments such as churches, schools, and public assembly facilities would be incompatible within APZ II, and single- and multi-family housing would be incompatible within the 65- to 70-DNL noise zones.

According to the City of Kingsville's Future Land Use Plan, the area east of Highway 77 is projected for rural/agricultural and commercial land use. However, the city's current zoning allows for industrial and commercial land use directly east of Highway 77. Industrial and commercial land uses are generally incompatible within APZ I. According the JAZB zoning, property further east of Highway 77, and beyond the city limits, is zoned mostly as agricultural use. Currently, a retention pond is located on farming property directly west of the Installation's fence line. Although agricultural land use is considered compatible, the retention pond is a bird attractant and BASH concern for flight operations.

Area 2: South and Southwest of Airfield. Currently, the area southwest of the Installation is primarily rural or agricultural land; however, these undeveloped properties are vulnerable to rising development trends in the area. The City projects residential development to continue to grow in the southern portion of the city. According to the City of Kingsville's Future Land Use Plan, the area south of the city and southwest of the Installation is projected for residential development (single-family residential and suburban residential). The area directly outside of the Installation main gate, south of Cavazos Boulevard, is within the 60- to 65-DNL noise zone and APZ II and is zoned for residential use. While housing with certain requirements is not considered incompatible within APZ II or the noise impact zone, the proximity to aircraft operations holds increased safety risk and may lead to complaints from the public. Undeveloped property south of L.E. Ramey Golf Course is also a future compatible concern. On base, two existing retention ponds located directly west of Runway 35 are bird attractants and a BASH concern.



Several rural, single-family residences (including rural, single-family dwellings and farming properties with mobile homes) are located south of the airfield within APZ I and APZ II of Runway 35 and within the 65- to 70- and 70- to 75-DNL noise contour areas (moderate-impact noise zone). Residential land use is not recommended within APZ I, and the maximum density for single-family housing in APZ II is one to two dwelling units per acre. Single-family residential land use is discouraged within the 65- to 70-DNL noise contour and strongly discouraged within the 70- to 75-DNL noise contour (moderate-impact noise zone). Mobile homes are incompatible in both the airfield APZs and noise zones.

Area 3: Runway 17 Clear Zone. Areas of land use compatibility concern are identified directly north/northeast of the Clear Zone of Runway 17. One rural single-family dwelling, two commercial development properties, and mobile homes border the boundary of the Clear Zone. These land uses are located within the 70- to 75-DNL noise contour area and APZ I. Residential land use is incompatible within APZ I and strongly discouraged within the 70- to 75-DNL noise zone. Mobile homes are incompatible in both the airfield APZs and noise zones.

The northern portion of the Clear Zone of Runway 17 is not entirely within the Installation fence line, but the area is protected from incompatible development through existing airport zoning and avigation easements.

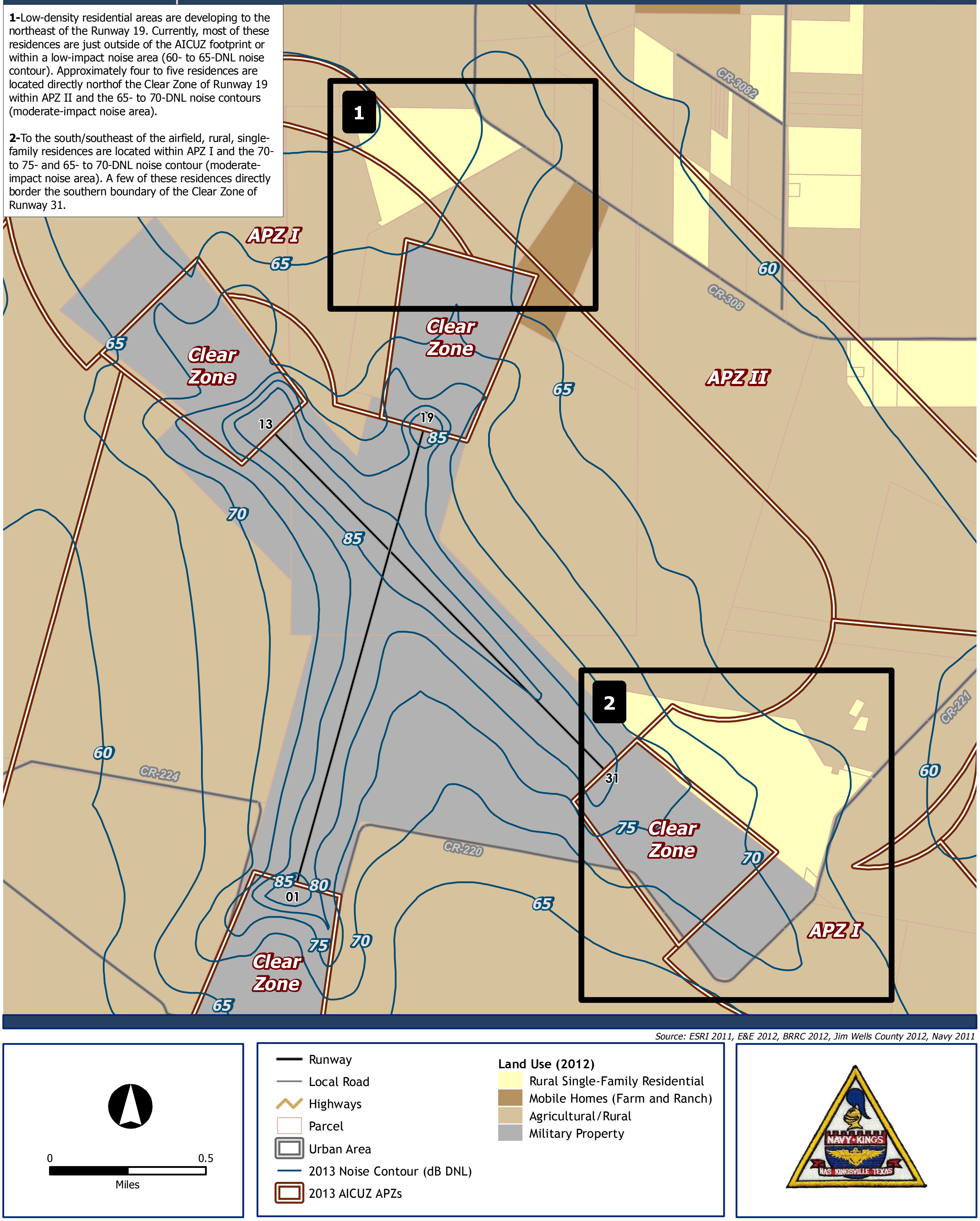
6.4.2 NALF Orange Grove Land Use Compatibility Concerns

NALF Orange Grove is located in a rural/agricultural area, and Navy operations are not likely to impact land use in the surrounding area. However, the county does not have a strategic land use plan to guide future development. Figure 6-7 illustrates the areas of compatibility concerns for NALF Orange Grove. Areas that pose the greatest land use compatibility concern are illustrated on the figure by insets and are detailed on the following pages.

FIGURE 6-7 AREAS OF COMPATIBILITY CONCERNS, NALF ORANGE GROVE

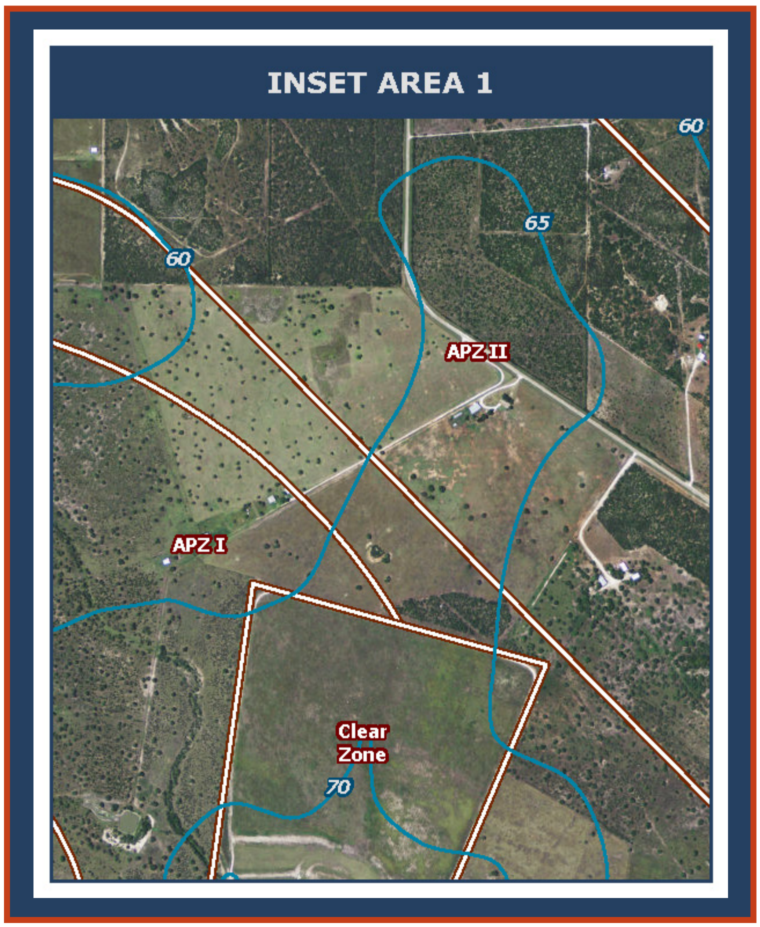
1-Low-density residential areas are developing to the northeast of the Runway 19. Currently, most of these residences are just outside of the AICUZ footprint or within a low-impact noise area (60- to 65-DNL noise contour). Approximately four to five residences are located directly northof the Clear Zone of Runway 19 within APZ II and the 65- to 70-DNL noise contours (moderate-impact noise area).

2-To the south/southeast of the airfield, rural, single-family residences are located within APZ I and the 70- to 75- and 65- to 70-DNL noise contour (moderate-impact noise area). A few of these residences directly border the southern boundary of the Clear Zone of Runway 31.



Source: ESRI 2011, E&E 2012, BRRC 2012, Jim Wells County 2012, Navy 2011

Area 1: Northeast Area. Low-density residential areas are developing northeast of Runway 19. Currently, most of these residences are just outside of the AICUZ footprint or within a low-impact noise area (60- to 65-DNL noise contour). Approximately four to five residences (including rural single-family dwellings and farming properties with mobile homes) are located directly north of the Clear Zone for Runway 19 within APZ II and the 65- to 70-DNL noise contours (moderate-impact noise area). Single-family residential land use is discouraged within the 65- to 70-DNL noise contours. Mobile homes are incompatible in both the airfield APZs and noise zones. If this area continues to develop, the increased exposure to aircraft operations would likely generate complaints from residents.



Area 2: Southeast Area. To the south/southeast of the airfield, rural single-family residences are located within APZ I and the 70- to 75- and 65- to 70-DNL noise contour (moderate-impact noise area), and are generally considered incompatible by the AICUZ land use guidelines. A few of these residences directly border the southern boundary of the Clear Zone for Runway 31. The proximity of these homes to aircraft operations and associated noise exposure may lead to noise complaints.

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7

Land Use Tools and Recommendations

The goal of the AICUZ Program—to protect the health, safety, and welfare of those living near military airfields while preserving the defense flying mission—can most effectively be accomplished by active participation of all interested parties, including Navy, state, regional and local governments, private citizens, developers, real estate professionals, and others. This chapter provides tools, alternative techniques, and recommendations for NAS Kingsville, local governments and agencies, and private citizens for use in exploring, modifying, combining, and implementing policies, plans, and regulations necessary to help ensure the goal of the AICUZ Program is met.

7.1 Federal/Navy Tools and Recommendations

At the installation level, the ICO is responsible for ensuring a successful AICUZ Program. Pursuant to OPNAVINST 11010.36C (AICUZ Program), the ICO at NAS Kingsville is committed to and shall:

- Implement an AICUZ Program for the air installation and associated outlying landing fields;
- Work with state and local planning officials to implement the objectives of the AICUZ Study;
- If appropriate, designate a CPLO to assist in the execution of the AICUZ Study and to represent the ICO on AICUZ matters. NAS Kingsville has a designated CPLO on base;
- Promote attendance at AICUZ seminars by commanding officers, executive officers, Air Ops and ATC facility officers, the CPLO, and

other aviation-related staff to increase awareness of current trends and techniques for AICUZ Program development and implementation;

- Provide assistance in developing AICUZ information, including operational data needed to update the AICUZ Study;
- Work with local decision makers in the surrounding communities to evaluate and justify the retention of land or interest in land required for operational performance; and
- Notify the chain-of-command in the AICUZ Program office whenever local conditions merit update or review of the AICUZ Study.

Additionally, various federal agency programs can support the local governments' ongoing efforts to control land use and development near NAS Kingsville and NALF Orange Grove.

7.1.1 Federal/Navy Land Use Compatibility Tools

Environmental Review

Fundamentals of the AICUZ Study can be incorporated into the environmental review process for federal projects.

Federal agencies, including the Navy, are required to consider the environmental impacts of any federal project that could significantly impact the environment by conducting a comprehensive environmental review. The National Environmental Policy Act (NEPA) mandates full disclosure of the environmental effects resulting from proposed federal actions, approvals, or funding. Impacts of the action are generally documented in an Environmental Impact Statement (EIS) or an EA. The environmental review process is a viable means for incorporating the fundamentals of the AICUZ Study in the planning review process of a project.

Executive Order 12372, Intergovernmental Review of Federal Programs (July 1982)

Executive Order 12372 allows state governments, in consultation with local governments, to establish review periods and processes for federal projects.

Executive Order 12372 allows state governments, in consultation with local governments, to establish review periods and processes for federal projects. In accordance with the Intergovernmental Cooperation Act of 1968, the United States Office of Management and Budget requires federal agencies to coordinate and communicate with state, regional, and local officials in the early planning stages of any federal aid development projects. The Intergovernmental Review Program provides an early entry point into the process for the Navy to introduce AICUZ concepts and discuss AICUZ issues.

Housing and Urban Development Circular 1390.2: Noise Abatement and Control

In 1971, the United States Department of Housing and Urban Development (HUD) established noise standards and polices for approving HUD-assisted housing projects in high noise areas and noise attenuation measures under HUD Circular 1390.2: *Noise Abatement and Control*. HUD published new noise regulations in 1979 with the same standards set forth in Circular 1390.2, and included new noise measurement descriptions to account for improvements in noise modeling technology. The approval of all mortgage loans from the Federal Housing Administration or the Veterans Administration is subject to the standards and polices of the HUD noise regulations. The HUD regulations set forth a discretionary policy to withhold funds for housing projects when noise exposure is in excess of prescribed levels. The HUD regulations allow for new housing construction assisted or supported by HUD within a noise area of 65 DNL or less. Construction within a 65- to 75-DNL noise area is subject to appropriate sound attenuation measures, and construction within an area exceeding a 75-DNL noise level is not acceptable. Due to the discretionary framework of the HUD policy, variances may be permitted, depending on regional interpretation and local conditions. HUD regulations include policies that prohibit funding for HUD-assisted projects sited in Clear Zones and APZs unless the project is compatible with the AICUZ.

DOD Encroachment Partnering Program

Encroachment partnering is a cooperative, multi-party, real estate-based program use to mitigate the impacts of off-base land uses that are potentially incompatible with military operations. It implies that the DOD and its partner(s) are both willing and able to contribute to the cost and effort of acquiring land interests.

Title 10, United States Code (U.S.C.) § 2684a authorizes the Secretary of Defense or the Secretary of a military department to enter into agreements with an eligible entity or entities to address the use or development of real property in the vicinity of, or ecologically related to, a military installation or military airspace, to limit encroachment or use of the property that would be incompatible with the mission of the installation or place other constraints on military training, testing, and operations. Eligible entities include a state, a political subdivision of a state, and a private entity that has as its principal organizational purpose or goal the conservation, restoration, or preservation of land and natural resources, or a similar purpose or goal.

Encroachment partnering agreements provide for an eligible entity to acquire fee title, or a lesser interest, in land for the purpose of limiting encroachment on the mission of a military installation and/or to preserve habitat off the installation to relieve current or anticipated environmental restrictions that might interfere with military operations or training on the installation. The DOD can share the real estate acquisition costs for projects that support the purchase of fee simple or conservation or other restrictive easement for such property. The eligible entity negotiates and acquires the real estate interest for encroachment partnering projects with a voluntary seller. The eligible entity must transfer the agreed-upon restrictive easement interest to the United States of America upon the request of the Secretary.

Land Acquisition

If a threat to an installation's operational integrity from incompatible development is identified, and the local community cannot resolve the threat, the Navy can obtain the land through purchase, voluntary agreement, or condemnation.

When the operational integrity of an installation is threatened by incompatible land use and development, and when the local community is unwilling or unable to address the threat using their own authority, the Navy may seek to acquire interest in properties (acquisition) to protect their mission. The first priority for acquisition, whether in fee or by restrictive easement, is the Clear Zone. The second priority is the other APZs. Noise zones outside the Clear Zone and APZs may be considered for acquisition only when all avenues of achieving compatible use zoning or similar protection have been explored and the operational integrity of the installation is clearly threatened. Land can be purchased through negotiation and voluntary agreement or through condemnation procedures using the power of eminent domain.

Adjustment of Operational Procedures

Adjustments to operational procedures can be made only after careful consideration of all options and only if the changes do not compromise the installation's mission.

The Navy, in very limited situations, can adjust operational procedures to reduce aircraft noise exposure (noise abatement) and potential mishaps. The options available to military authorities vary among installations due to specific local conditions, local air operations, and local mission requirements. Only after careful consideration of all options should changes in operational procedures be made. No changes that compromise the mission of the installation should be instituted.

7.1.2 Federal/Navy Action Recommendations

Engage in the Local Planning Process

NAS Kingsville should maintain routine communication with the Planning Department at the City of Kingsville and with the Kleberg County and Jim Wells County governments to be aware of local land use plans and zoning regulations and to ensure the Navy's input is offered in the early stages of any long-range planning initiatives. The Installation CPLO should attend the City of Kingsville's Development Review Committee meetings to review proposed development applications including site plans, preliminary plats, master plats, planned unit developments, and conditional use permits, and to discuss development-related issues that may impact training activities.

The ICO and/or the CPLO should attend public hearings and provide comments on actions affecting AICUZ planning.

The NAS Kingsville ICO and/or the Installation CPLO should attend public hearings and provide comments on actions that affect AICUZ planning for NAS Kingsville and NALF Orange Grove, including JLUSs, regional and local comprehensive plan updates, capital improvement plans, zoning, building code amendments, and other land development regulation updates/amendments. As the local municipalities update or develop their community comprehensive plans and future land use plans, the CPLO should advise the cities and counties of future Navy operations and offer guidance on identifying areas of potential incompatibilities.

In addition to ongoing community involvement, the ICO and/or the Installation CPLO should attend the Commissioners Court meetings. Attendance and participation will keep the Installation engaged in the local planning process and provide a forum for comments as they affect AICUZ planning. During local planning meetings, NAS Kingsville can also address current and future aircraft-related activity at NAS Kingsville and NALF Orange Grove, noise complaints (both the process for filing and resolving complaints), and other relevant topics related to the interaction between the NAS Kingsville and its neighbors.

Community Outreach Activities

NAS Kingsville should provide community decision makers with the appropriate information necessary to make informed decisions regarding the impact of their actions on mission readiness.

Outreach and information-sharing assist in educating the community about the Navy's mission and help build alliances with the community and regional decision makers to ensure continuation of mission-essential operations. NAS Kingsville should provide community decision makers with the information necessary to make informed decisions regarding the impacts of their actions on mission readiness. The CPLO should be responsible for communicating NAS Kingsville program changes and offering supporting information and resources to the community decision makers. Through outreach efforts, the CPLO and the PAO can educate the public on the importance of the Installation's training operations, its economic impact on the community, and the ability of the Installation to support military activities to sustain a combat-ready Navy.

Current outreach initiatives include visits and tours of NAS Kingsville, school mentorship assistance, community self-help program assistance, and participation in several local meetings and events. The ICO and the CPLO attend local organizations' meetings, such as the Navy League, Rotary Club, Lions Club, Chambers of Commerce, and Economic Development Council of Kingsville, to further foster community partnership and the implementation of this AICUZ Study. The Installation CPLO should continue to participate in public outreach efforts and community events to raise awareness of the Navy's contribution to the community and the mutual benefit of compatible land use planning.

On station, the NAS Kingsville Encroachment Working Group, which consists of Air Ops, Public Affairs, Environmental, Security, Facilities, and the

CPLO, should conduct routine meetings to address encroachment-related concerns across all disciplines on station.

Presentation of the AICUZ Study and Educational Materials

NAS Kingsville personnel should make presentations to community decision makers regarding the AICUZ Program. For the public, a website and community outreach materials should be developed.

To encourage community interaction and to facilitate a better understanding of the Navy's scope of operations, NAS Kingsville should develop a package of AICUZ outreach materials, including community presentations and educational brochures, on training activities and its mission.

NAS Kingsville should create a brochure for a civilian audience with appropriate verbiage and maps to explain the basic elements of the AICUZ Program and how incompatible development within the AICUZ footprint can impact NAS Kingsville's operations and mission. The brochure should detail the significance of APZs and noise zones to protect both Navy pilots and civilian safety. Maps illustrating the APZs and noise zones should be included in the brochure, and these maps should be provided to real estate brokers for property disclosure.

NAS Kingsville should prepare a presentation outlining elements of the AICUZ Program for community decision makers, including the City Commission, Commissioners Court, Planning and Zoning Commission, JAZB, Zoning Board of Adjustments, Economic Development Council, Board of Realtors, and local civic organizations. The AICUZ Program presentation should also discuss how land uses and local policies (e.g., infrastructure siting, schools, rezoning) can influence Navy operations.

NAS Kingsville should develop an AICUZ website to post the 2013 AICUZ Study and related educational materials. Presentation and distribution materials, including AICUZ poster boards, maps of the airfields, and fact sheets, also should be posted to the website and used for community outreach activities.

Real Estate Disclosures

NAS Kingsville should meet with the Kingsville Board of Realtors to discuss the importance of real estate disclosure when buying or selling property within or near the AICUZ footprint.

NAS Kingsville should provide local real estate agencies with AICUZ-related materials and maps showing military training routes, MOAs, AICUZ boundaries, and high-impact areas. The CPLO should meet with the Kingsville Board of Realtors to discuss the importance of real estate disclosure when buying or selling property within or near the AICUZ footprint. Similarly, NAS Kingsville should approach the Texas Home Builders Association and provide guidelines regarding construction techniques and use of materials for noise attenuation to mitigate potential airborne noise.

Noise Complaint Monitoring and Response Program

NAS Kingsville should continue its noise monitoring program to emphasize its commitment to the public regarding the control of noise.

To mitigate noise complaints and provide citizens with a prompt response, NAS Kingsville created a direct noise complaint “hotline.” NAS Kingsville should continue to record and assess noise complaints. Assessing noise complaints identifies noise-sensitive areas, determines which operational activities are responsible for the noise complaints, and ultimately helps abate future noise complaints. The Installation’s response to noise complaints is further explained in Section 4.4.2 *Noise Complaints*.

Through the Installation’s noise abatement program, NAS Kingsville personnel evaluate alternative flight procedures to reduce noise impacts on the surrounding communities and validate noise modeling associated with AICUZ documentation. Additionally, the program emphasizes NAS Kingsville’s commitment to the public and demonstrates that noise abatement is an important issue to the Installation.

7.2 State/Regional Tools and Recommendations

Texas regulations and programs that impact land use controls and growth around the NAS Kingsville and NALF Orange Grove can be used to control development within the AICUZ footprint. In addition, regional planning agencies can help control incompatible growth by aiding and influencing local governments in the development of policies, plans, and regulations necessary for the physical and economic expansion of the region.

7.2.1 State/Regional Level Tools

Texas Military Preparedness Commission

The Texas Military Preparedness Commission (TMPC) protects missions as well as the defense communities within the State of Texas by advising state and local officials on defense-related issues.

The Texas Military Preparedness Commission (TMPC) is a 13-member commission established within the Office of the Governor in 2003. In 2009, the TMPC was incorporated into the Office of Economic Development and Tourism with a mission to preserve and expand Texas' military installations. The TMPC protects missions as well as the defense communities within the state of the Texas by advising state and local officials on defense-related issues and providing financial assistance through grants and loans. The TMPC produces an Annual Master Plan with recommendations regarding policies and plans to support the long-term military mission viability, including best methods for communities to enhance their relationship with military installations.

Texas Commanders Council

The Texas Commanders Council (TCC) is a coalition of major military installations that formulates resolutions for encroachment concerns to state legislators.

The Texas Commanders Council (TCC) is a coalition of major military installations in Texas that provides an information-sharing forum to formulate comprehensive resolutions for common encroachment concerns among the bases in Texas. The TCC provides the installations with an effective avenue to communicate and coordinate with state legislators. The objective of the TCC is to "provide a unified position by promulgating an environment of cooperation, collaboration and coordination among all Texas military installations to enhance sustainment of military training operations, ranges and airspace, provide for coordination of responses to environmental issues and requirements, and ensure the highest possible level of respective compatible development" (TCC 2011).

Coastal Bend Council of Governments

The Coastal Bend Council of Governments (CBCOG) is comprised of 12 counties and 32 cities and provides cost-effective planning within the region.

The Coastal Bend Council of Governments (CBCOG) is a voluntary association of local governments in southeast Texas established to provide cost-effective planning and coordination within the region; the CBCOG is comprised of 12 counties and 32 cities. The CBCOG was established by the authority of Texas in 1966 and is based out of Corpus Christi. It was incorporated as part of the Texas Association of Regional Councils in 1973 as part of an initiative to bring together 24 individual regional councils within the state. The committee works with state and local government, as well as the private sector, on a variety of issues such as environmental quality, economic growth, and land use planning and implementation.

7.2.2 State/Regional Level Recommendations

The Navy should work with the TMPC and the TCC to propose state-wide regulations that prohibit the development of structures that may interfere with the use of military training routes or compromise the Navy's mission and operations. NAS Kingsville should provide these organizations with information regarding Navy air operations and flight courses.

7.3 Local Government Tools and Recommendations

Local governments have the authority to implement regulations and programs to control development and direct growth to ensure land use activity is compatible within the AICUZ footprint. Local governments should recognize their responsibility in providing land use control in those areas encumbered by the AICUZ footprint by incorporating AICUZ information into their planning policies and regulations.

Local planning authorities surrounding NAS Kingsville and NALF Orange Grove include the City of Kingsville, Kleberg County, Jim Wells County, and the Kingsville JAZB. Future land use and development is guided by local comprehensive land use planning and regulated by these authorities.

7.3.1 Local Government Tools

Local Government Comprehensive Plans

Municipalities in Texas can adopt a comprehensive plan to guide future development and growth, establish long-range planning policies, and ultimately provide the framework for zoning and land use regulations. Comprehensive plans are decision-making tools to evaluate proposed development and/or land use activities in context with the community's long-range planning policies. While comprehensive plans provide guidance for future land uses and development, these plans do not constitute zoning regulations or establish zoning district boundaries. According to Texas Local Code §211.004, "Zoning regulations must be adopted in accordance with a municipality's comprehensive plan." Components of a comprehensive plan may include future land use, annexation, transportation, infrastructure, conservation, recreation and open space, intergovernmental coordination, and capital improvements. Comprehensive plans also can influence the capital budget and funding of capital improvement plans to purchase open land or development rights.

Comprehensive plans should include specific language and maps regarding the AICUZ Program for coordination with NAS Kingsville regarding land use decisions.

The City of Kingsville's Master Plan establishes the planning vision, goals, and strategies over the next 20 years for the city and the surrounding area. The Master Plan identifies targeted growth areas, mobility and transportation needs, parks and recreational resources, and strategies for strengthening economic development. The Master Plan also assesses the city's growth capacity and provides specific policies to accommodate and manage growth. Policies address annexation, redevelopment, and future development patterns. The city's future land use plans and policies support development compatible with the AICUZ footprint and encourage protective development measures to control land use activities that may compromise the Installation's mission.

Zoning

Zoning is the legal tool to implement a municipality's land use plan. Zoning regulates land use, density, and height of structures, and can prohibit the creation of other hazards.

While comprehensive planning allows municipalities to consider the impacts of current and future development, zoning is the legal tool to implement a municipality's land use plan. Zoning regulates land use, density, and height of structures, and can prohibit the creation of other hazards, including smoke, radio interference, and glare. In Texas, zoning authority is limited to incorporated cities. Through zoning regulations, cities are authorized to create zoning districts that permit or prohibit property use, construction standards, and development density.

Municipalities can establish overlay zones to protect resource areas and ensure land use compatibility for special uses or areas of unusual conditions related to noise and safety issues. Overlay zoning may apply greater restrictions for land uses and/or additional development standards and design guidelines for a designated area. Overlay zones may also allow for less restrictive standards.

The City of Kingsville has adopted Air Installations Zoning Regulations to minimize hazards and incompatible development near airports. Additionally, the Kingsville-Kleberg JAZB adopted Compatible Land Use and Hazard Zoning Regulations to regulate development and land use within the unincorporated areas surrounding NAS Kingsville. The JAZB zoning regulations restrict development and activities that may interfere (including electrical interferences, impairing visibility, or creating the potential of bird strike hazards) with aircraft intending to use NAS Kingsville and enforce height limitations within airport hazard abatement zones.

Capital Improvements Programs

Capital improvements programs (CIPs) can be used to direct future growth patterns and ensure that areas near the military installations are developed in accordance with the AICUZ Program's recommended land use guidelines.

Capital improvements program (CIP) projects, such as extension of potable water lines or transmission lines, road paving and/or improvements, right-of-way acquisition, and school construction/renovation, can encourage new development to under-served areas. CIPs can be used to direct future growth patterns and ensure that the areas near military installations are developed in accordance with the AICUZ Program's recommended land use guidelines. Local governments can coordinate CIP projects to avoid extending infrastructure into or near high noise zones or APZs.

Joint Land Use Studies

The goal of a Joint Land Use Study (JLUS) is to encourage local governments to coordinate with military installations to promote compatible community growth that supports military training and operational missions.

A JLUS is a cooperative planning initiative between an installation and the surrounding city(ies)/county(ies). Sponsored by the DOD's OEA, the goal of a JLUS is to encourage local governments to coordinate with military installations to promote compatible community growth that supports military training and operational missions. The study helps introduce AICUZ technical data into local planning and recommends cooperative implementation actions for the community and installation to address current and future land use compatibility. The City of Kingsville completed a JLUS in 2008. The City of Kingsville and Kleberg County have successfully implemented several recommendations from the JLUS in support of compatible land use practices.

Jim Wells County, with the support of the DOD OEA, is preparing a JLUS to develop compatible land use planning practices with NAS Kingsville operations at NALF Orange Grove. Through the JLUS process, the county can generate short- and long-term recommendations to guide future development practices and incorporate compatible land use control measures in the vicinity of NALF Orange Grove.

Transfer of Development Rights

By transferring development rights, property around an installation that is incompatible with noise contours and APZs can be transferred for property that is more favorable to that type of development.

Transfer of development rights (TDR) allows landowners in development-restricted areas to sell the rights to develop their property (sending property) and transfer those development rights to another landowner's property (receiving property) that can support greater density development. Transfers are typically administered through a local TDR program, which is typically established through local zoning ordinances. TDR programs are established to preserve environmentally sensitive areas, agricultural resources, historic properties, or valuable open space. A successful TDR program should identify the public purpose of the program, sending and receiving districts/areas, and the procedures to carry out the transaction.

Development rights from the sending property are purchased as TDR credits. After development rights are transferred, the sending property is secured from future development under a conservation easement or deed restrictions, and the TDR credit is applied to the receiving property as a density bonus. The value of TDR credits should be defined in the local TDR program.

Purchase of Development Rights

Local government can purchase development rights so that incompatible development around installations is avoided.

Local governments (or a land trust) can also establish purchase of development rights (PDR) programs to manage growth and preserve open space. A local government or agency provides landowners compensation for not developing their land—essentially buying the development rights—and then obtains a legal easement (conservation easement) that further restricts development on the property. The landowner maintains ownership of the property and can use the land under conditions specified in the terms of the easement (e.g., farming, timber production, or hunting). The local government may consider PDR for agricultural land within the AICUZ footprint.

Building codes can help reduce impacts from aircraft noise through the enforcement of sound insulation construction techniques and materials.

Building Codes

Building codes, which are enforced through local ordinances, are standards applied to the construction, modification, and/or use of buildings. Local building codes may be modified to ensure consistency with the noise attenuation recommendations of the AICUZ Program through construction permits. By using proper sound insulation construction techniques and materials, impacts from aircraft noise can be minimized and interference of regular indoor activities can be reduced. Although building codes will not prevent incompatible development, they can help reduce impacts.

Real Estate Disclosures

Real estate disclosures should provide information to prospective clients regarding aviation noise and APZs so they can make informed decisions, thereby reducing frustration and criticism of an installation's mission.

Real estate disclosures allow prospective buyers, lessees, or renters of property in the vicinity of military operations areas to make informed decisions regarding the purchase or lease of property. Disclosure of noise and safety zones is a crucial tool in protecting and notifying the community about expected impacts of aviation noise and locations of APZs, subsequently reducing frustration and anti-airport criticism by those who were not adequately informed prior to purchase of properties within impact areas.

Under the City of Kingsville's local zoning ordinances, property sellers and their agents are currently required to disclose that a property is near NAS Kingsville and subject to aircraft noise and flight operations. The real estate disclosure form identifies the noise zone and APZ that the parcel of property is located within, and the form must be signed at the closing by the buyer, seller, and witnesses.

Land Acquisition Programs

To eliminate land use incompatibilities with installations, land can be acquired through voluntary real estate transactions.

Local governments can establish land acquisition programs to support the AICUZ Program. Land acquisition programs are designed to eliminate land use incompatibilities through voluntary transactions in the real estate market and local development process. Land acquisition strategies can support goals of preventing urban growth near an airfield, while protecting the environment, maintaining agricultural lands, and conserving open spaces. Local governments can partner with an installation to identify areas of conservation interest and determining protection priorities around airfields.

7.3.2 Local Government Recommendations

Local governments should continue to actively inform and request input from NAS Kingsville regarding land use decisions that could impact the operational integrity of the Installation.

Communication

NAS Kingsville is responsible for informing and educating community decision makers about the AICUZ Program; however, local governments should continue to actively inform and request input from NAS Kingsville regarding land use decisions that could impact the operational integrity of the Installation. Local government websites should include information about the AICUZ Program for NAS Kingsville and provide a link to the NAS Kingsville website for information regarding aircraft operations.

Applicable land use regulations should be updated to reflect the 2013 AICUZ Study noise contours, APZs, and Clear Zones.

Land Use Plans and Regulations

The City of Kingsville Planning and Zoning Commission, Kleberg County representatives, and the JAZB of Kingsville and Kleberg County should update their comprehensive plans, zoning ordinances, subdivision regulations, building codes, and any other applicable land use regulations to reflect the 2013 AICUZ Study noise contours, APZs, and Clear Zones. Local governments should adhere to the land use recommendations in the AICUZ Instructions to mitigate noise impacts, accident potential, height obstructions, and incompatible development within the AICUZ footprint.

Capital improvement projects should be evaluated for impacts on the AICUZ Program.

Capital Improvement Projects

All capital improvement projects in proximity to the installation should be evaluated and reviewed for potential direct and indirect impacts that such improvements may have on the ability to implement a successful AICUZ Program.

Local governments should amend building codes to include noise attenuation techniques for all new construction within the AICUZ footprint.

Building Codes

Local governments should continue to monitor and/or amend their building codes to require noise attenuation techniques for new construction within the AICUZ footprint. Additional insulation and soundproofing should be included in the local building standards for all new single- and multi-family residential construction within the footprint.

Real Estate Disclosures

Any property affected by noise and/or APZs requires a disclosure statement to be acknowledged by both parties.

The City of Kingsville's local zoning ordinances require disclosure statements with an acknowledgement by both buyer and seller that the property is affected by noise and/or APZs in the vicinity of NAS Kingsville. The City of Kingsville and the JAZB should continue to ensure that real estate professionals, buyers, and sellers adhere to disclosure requirements.

Jim Wells County should provide disclosure notification for all real estate transactions for properties surrounding NALF Orange Grove. As part of the JLUS recommendations, the county should consider establishing a real estate disclosure area around NALF Orange Grove to enforce disclosure regulations.

7.4 Private Citizens/Real Estate Professionals/Businesses Tools and Recommendations

Local citizens and businesses should recognize their responsibility in adhering to and complying with land use controls in those areas encumbered by the 2013 AICUZ footprint. The following are actions, procedures, and recommendations that private groups can use or consider to help control development within the 2013 AICUZ footprint.

Lenders should review noise and accident potential to promote compatible development with the installations and protect investors.

Real estate professionals should advise prospective clients about high-noise zones and APZs, as the ethical practice of full disclosure is an important element of the AICUZ Program's success.

Citizens can choose not to invest in property located within a high-noise zone or APZ.

7.4.1 Private Sector Tools

Business Development and Construction Loans to Private Contractors

Lending institutions can limit financing for real estate purchases for construction incompatible with the AICUZ Program by restricting or prohibiting mortgages and/or other types of loans. The state and/or local government could designate restricted areas around the Installation.

Real Estate Professionals

Real estate professionals have the ability to ensure prospective buyers or lessees are fully aware of what it means to be within a high noise zone and/or APZ. Real estate professionals have the ability and should be required to show prospective buyers and lessees the property at a time when noise exposure is expected to be at its worst.

Private Citizens

Citizens have the responsibility to do their due diligence to avoid purchasing property and/or investing in construction projects on property within high noise zones and/or APZs.

7.4.2 Private Sector Recommendations

Business Development and Construction Loans to Private Contractors

Lenders should implement a "Due Diligence Review" of all loans for noise and APZ impacts, and limit financing for construction or real estate purchases incompatible with the AICUZ Program.

Lending institutions should consider whether to limit financing for real estate purchases or construction incompatible with the AICUZ Program. This strategy encourages evaluation of noise and accident potential as part of a lender's investigation of potential loans to private interests for real estate acquisition and development. Diligent lending practices will promote compatible development of the area surrounding NAS Kingsville and NALF Orange Grove and protect lenders and developers alike. Local banking and financial institutions should be encouraged to incorporate a "Due Diligence Review" of all loan applications to determine possible noise or APZ impacts on the mortgaged property. The Navy can help facilitate this strategy by providing AICUZ seminars to lenders throughout the region.

Real Estate Professionals Cooperation

Real estate agents should provide full disclosure of noise exposure and APZs to prospective clients and acknowledge the AICUZ Program on their websites.

Real estate professionals should also educate themselves on the locations of noise zones and APZs in relation to the properties they represent.

Real estate professionals should continue to ensure that prospective buyers or lessees have all the available information concerning the noise environment and accident potential zones surrounding an airfield prior to purchasing or leasing property near an air station. They should provide written disclosure to prospective purchasers, renters, or lessees when a property is located within an APZ or high noise zone. Real estate professionals should also show properties at a time when noise exposure is expected to be at its worst in order to provide full awareness of the potential magnitude of noise exposures.

Real estate agencies should provide information about the AICUZ Study on their websites and provide a link to NAS Kingsville's website for information on aircraft operations. Additionally, real estate agencies can distribute AICUZ maps and brochures (provided on NAS Kingsville's website) to prospective buyers and lessees.

Private Citizens

Citizens should educate themselves on the AICUZ Program and inquire about noise zones and APZs when considering an investment in property near the Installation. In addition, noise complaints should provide thorough and accurate information.

The citizens of the local communities surrounding NAS Kingsville and NALF Orange Grove should become informed about the AICUZ Program and learn about the program's goals and objectives, its value in protecting the health, safety, and welfare of the population, the limits of the program, and the positive community aspects of a successful AICUZ Program.

Citizens considering purchasing, renting, or leasing properties near NAS Kingsville and NALF Orange Grove should ask local real estate professionals, lending institutions, city planning personnel, county appraisal personnel, and/or a NAS Kingsville representative if the property is within an APZ and/or noise zone.

Citizens should also provide sufficient and accurate information when registering a noise compliant with the Installation. The Installation needs sufficient and accurate information to assess the potential causes resulting in the complaint and to assess any practical remedies for reducing future complaints.

8

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Appendix A

Discussion of Noise and Its Effects on the Environment

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Discussion of Noise and its Effects on the Environment

March 2012

Prepared for:
Ecology and Environment, Inc.

Authors:
Wyle Staff

Table of Contents

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1 Basics of Sound

Noise is unwanted sound. Sound is all around us; sound becomes noise when it interferes with normal activities, such as sleep or conversation.

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., jackhammers) depends largely on the listener's current activity, past experience, and attitude toward the source of that sound.

The measurement and human perception of sound involves three basic physical characteristics: intensity, frequency, and duration. First, intensity is a measure of the acoustic energy of the sound vibrations and is expressed in terms of sound pressure. The greater the sound pressure, the more energy carried by the sound and the louder the perception of that sound. The second important physical characteristic of sound is frequency, which 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 third important characteristic of sound is duration or the length of time the sound can be detected.

The loudest sounds that can be detected comfortably by the human ear have intensities that are a trillion times higher than those of sounds that can barely be detected. Because of this vast range, using a linear scale to represent the intensity of sound becomes very unwieldy. As a result, a logarithmic unit known as the decibel (abbreviated 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. Sound levels between 130 to 140 dB are felt as pain (Berglund and Lindvall 1995).

Because of the logarithmic nature of the decibel unit, sound levels cannot be arithmetically added or subtracted 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. For example:

60 dB + 60 dB = 63 dB, and

80 dB + 80 dB = 83 dB.

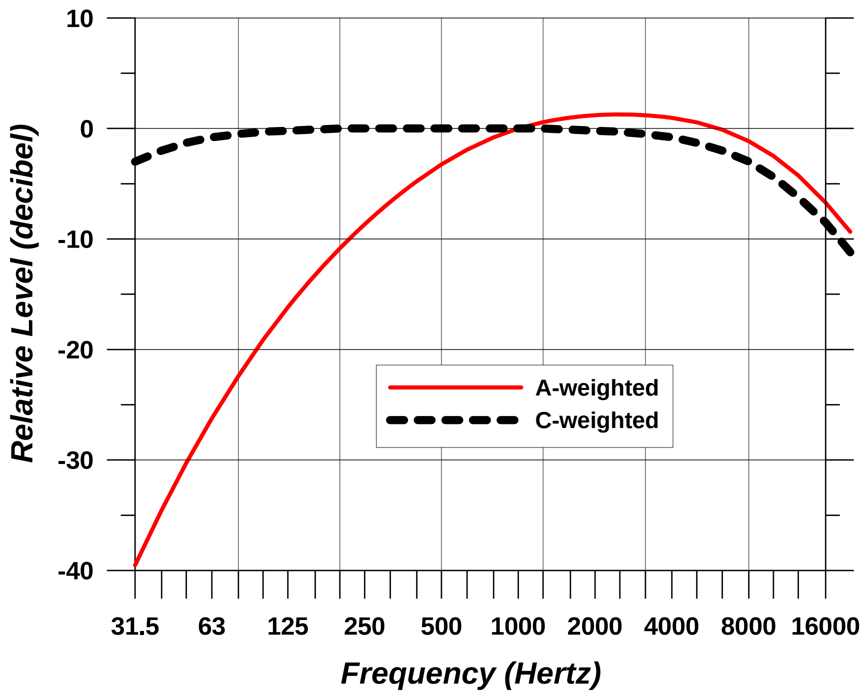
Second, the total sound level produced by two sounds of different levels is usually only slightly more than the higher of the two. For example:

60.0 dB + 70.0 dB = 70.4 dB.

Because the addition of sound levels is different than that of ordinary numbers, such addition is often referred to as "decibel addition" or "energy addition." The latter term arises from the fact that what we are really doing when we add decibel values is first converting each decibel value to its corresponding acoustic energy, then adding the energies using the normal rules of addition, and finally converting the total energy back to its decibel equivalent.

The minimum change in the sound level of individual events that an average human ear can detect is about 3 dB. On average, a person perceives a change in sound level of about 10 dB as a doubling (or halving) of the sound's loudness, and this relation holds true for loud and quiet sounds. A decrease in sound level of 10 dB actually represents a 90 percent decrease in sound intensity but only a 50 percent decrease in perceived loudness because of the nonlinear response of the human ear (similar to most human senses).

Sound frequency is measured in terms of cycles per second (cps), or hertz (Hz), which is the standard 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 by the human ear, which is most sensitive to frequencies in the 1,000 to 4,000 Hz range. Weighting curves have been developed to correspond to the sensitivity and perception of different types of sound. A-weighting and C-weighting are the two most common weightings. A-weighting accounts for frequency dependence by adjusting the very high and very low frequencies (below approximately 500 Hz and above approximately 10,000 Hz) to approximate the human ear's lower sensitivities to those frequencies. C-weighting is nearly flat throughout the range of audible frequencies, hardly de-emphasizing the low frequency sound while approximating the human ear's sensitivity to higher intensity sounds. The two curves shown in Figure A-1 are also the most adequate to quantify environmental noises.



Source: ANSI S1.4A -1985 "Specification of Sound Level Meters"

Figure A-1. Frequency Response Characteristics of A- and C-Weighting Networks

1.1 A-weighted Sound Level

Sound levels that are measured using A-weighting, called A-weighted sound levels, are often denoted by the unit dBA or dB(A) rather than dB. When the use of A-weighting is understood, the adjective “A-weighted” is often omitted and the measurements are expressed as dB. In this report (as in most environmental impact documents), dB units refer to A-weighted sound levels.

Noise potentially becomes an issue when its intensity exceeds the ambient or background sound pressures. Ambient background noise in metropolitan, urbanized areas typically varies from 60 to 70 dB and can be as high as 80 dB or greater; quiet suburban neighborhoods experience ambient noise levels of approximately 45-50 dB (U.S. Environmental Protection Agency (EPA) 1978).

Figure A-2 is a chart of A-weighted sound levels from typical sounds. Some noise sources (air conditioner, vacuum cleaner) are continuous sounds which levels are constant for some time. Some (automobile, heavy truck) are the maximum sound during a vehicle pass-by. Some (urban daytime, urban nighttime) are averages over extended periods. A variety of noise metrics have been developed to describe noise over different time periods, as discussed below.

Aircraft noise consists of two major types of sound events: aircraft takeoffs and landings, and engine maintenance operations. The former can be described as intermittent sounds and the latter as continuous. Noise levels from flight operations exceeding background noise typically occur beneath main approach and departure corridors, in local air traffic patterns around the airfield, and in areas immediately adjacent to parking ramps and aircraft staging areas. As aircraft in flight gain altitude, their noise contribution drops to lower levels, often becoming indistinguishable from the background.

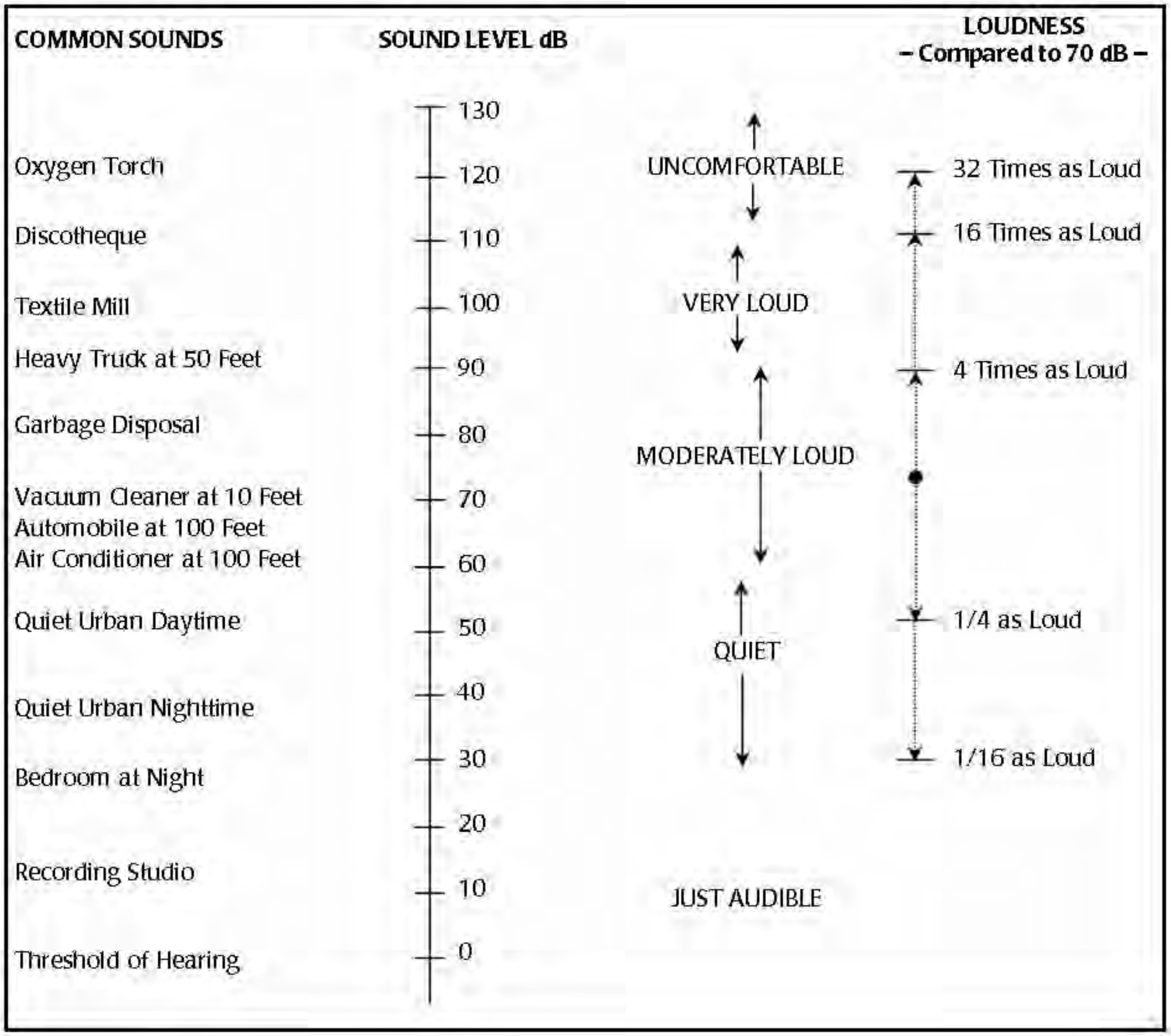
C-weighted Sound Level

Sound levels measured using a C-weighting are most appropriately called C-weighted sound levels (and denoted dBC). C-weighting is nearly flat throughout the audible frequency range, hardly de-emphasizing the low frequency. This weighting scale is generally used to describe impulsive sounds. Sounds that are characterized as impulsive generally contain low frequencies. Impulsive sounds may induce secondary effects, such as shaking of a structure, rattling of windows, inducing vibrations. These secondary effects can cause additional annoyance and complaints.

The following definitions in the American National Standard Institute (ANSI) Report S12.9, Part 4 provide general concepts helpful in understanding impulsive sounds (ANSI 1996).

Impulsive Sound: Sound characterized by brief excursions of sound pressure (acoustic impulses) that significantly exceeds the ambient environmental sound pressure. The duration of a single impulsive sound is usually less than one second (ANSI 1996).

Highly Impulsive Sound: Sound from one of the following enumerated categories of sound sources: small-arms gunfire, metal hammering, wood hammering, drop hammering, pile driving, drop forging, pneumatic hammering, pavement breaking, metal impacts during rail-yard shunting operation, and riveting.



SOURCE: Handbook of Noise Control, *C.M. Harris, Editor McGraw-Hill Book Co., 1979, and FICAN 1997*

Figure A-2. Typical A-weighted Sound Levels of Common Sounds

High-energy Impulsive Sound: Sound from one of the following enumerated categories of sound sources: quarry and mining explosions, sonic booms, demolition and industrial processes that use high explosives, military ordnance (e.g., armor, artillery and mortar fire, and bombs), explosive ignition of rockets and missiles, explosive industrial circuit breakers, and any other explosive source where the equivalent mass of dynamite exceeds 25 grams.

2 Noise Metrics

In general, a metric is a statistic for measuring or quantifying. A noise metric quantifies the noise environment. There are three families of noise metrics described herein – one for single noise events such as an aircraft flyby, one for cumulative noise events such as a day's worth of aircraft activity and one which quantifies the events or time relative to single noise events.

Within the single noise event family, metrics described below include Peak Sound Pressure Level, Maximum Sound Level and Sound Exposure Level. Within the cumulative noise events family, metrics described below include Equivalent Sound Level, Day-Night Average Sound Level and several others. Within the events/time family, metrics described below include Number of Events Above a Threshold Level and Time Above a Specified Level.

2.1 Maximum Sound Level (L_{max})

The highest A-weighted integrated sound level measured during a single event in which the sound level changes value with time (e.g., an aircraft overflight) is called the maximum A-weighted sound level or Maximum Sound Level.

During an aircraft overflight, the noise level starts at the ambient or background noise level, rises to the maximum level as the aircraft flies closest to the observer, and returns to the background level as the aircraft recedes into the distance. The L_{max} indicates the maximum sound level occurring for a fraction of a second. For aircraft noise, the "fraction of a second" over which the maximum level is defined is generally one-eighth of a second, and is denoted as "fast" response (ANSI 1988). Slowly varying or steady sounds are generally measured over a period of one second, denoted "slow" response. The L_{max} is important in judging the interference caused by a noise event with conversation, TV or radio listening, sleep, or other common activities. Although it provides some measure of the intrusiveness of the event, it does not completely describe the total event, because it does not include the period of time that the sound is heard.

2.2 Peak Sound Pressure Level (L_{pk})

The Peak Sound Pressure Level, is the highest instantaneous level obtained by a sound level measurement device. The L_{pk} is typically measured using a 20 microseconds or faster sampling rate, and is typically based on unweighted or linear response of the meter.

2.3 Sound Exposure Level (SEL)

Sound Exposure Level is a composite metric that represents both the intensity of a sound and its duration. Individual time-varying noise events (e.g., aircraft overflights) have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. SEL provides a measure of the net impact of the entire acoustic event, but it does not directly represent the sound level heard at any given time. During an aircraft flyover, SEL would include both the L_{max} and the lower noise levels produced during onset and recess periods of the overflight.

SEL is a logarithmic measure of the total acoustic energy transmitted to the listener during the event. Mathematically, it represents the sound level of a constant sound that would, in one second, generate the same acoustic energy as the actual time-varying noise event. For sound from aircraft overflights, which typically lasts more than one second, the SEL is usually greater than the L_{max} because an individual overflight takes seconds and the L_{max} occurs instantaneously. SEL represents the best metric to compare noise levels from overflights.

2.4 Equivalent Sound Level (L_{eq})

A cumulative noise metric useful in describing noise is the Equivalent Sound Level. L_{eq} is the continuous sound level that would be present if all of the variations in sound level occurring over a specified time period were smoothed out as to contain the same total sound energy.

Just as SEL has proven to be a good measure of the noise impact of a single event, L_{eq} has been established to be a good measure of the impact of a series of events during a given time period. Also, while L_{eq} is defined as an average, it is effectively a sum over that time period and is, thus, a measure of the cumulative impact of noise. For example, the sum of all noise-generating events during the period of 7 a.m. to 4 p.m. could provide the relative impact of noise generating events for a school day.

2.5 Day-Night Average Sound Level (DNL or L_{dn}) and Community Noise Equivalent Level (CNEL)

Day-Night Average Sound Level and Community Noise Equivalent Level are composite metrics that account for all noise events in a 24-hour period. In order to account for increased human sensitivity to noise at night, a 10 dB penalty is applied to nighttime events (10:00 p.m. to 7:00 a.m. time period). A variant of the DNL, the CNEL includes a 5 dB penalty on noise during the 7:00 a.m. to 10:00 p.m. time period, and a 10 dB penalty on noise during the 10:00 p.m. to 7:00 a.m. time period. The notations DNL and L_{dn} are both used for Day-Night Average Sound Level and are equivalent.

Like L_{eq}, DNL and CNEL without their penalties are average quantities, mathematically representing the continuous A-weighted or C-weighted sound level that would be present if all of the variations in sound level that occur over a 24-hour period were smoothed out so as to contain the same total sound energy. These composite single-measure time-average metrics account for the SELs, L_{max}, the duration of the events (sorties or operations), and the number of events that occur over a 24-hour period but do not provide specific information on the number of noise events or the individual sound levels that occur during the 24-hour day. Like SEL, neither DNL nor CNEL represent the sound level heard at any particular time, but quantifies the total sound energy received. While it is normalized as an average, it represents all of the sound energy, and is therefore a cumulative measure.

The nighttime penalties in both DNL and CNEL account for 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. The evening penalty in CNEL accounts for the added intrusiveness of sounds during that period.

The inclusion of daytime, evening and nighttime periods in the computation of the DNL and CNEL reflects their basic 24-hour definition. They can, however, be applied over periods of multiple days. For application to civil airports, where operations are consistent from day to day, DNL and CNEL are usually applied as an annual average.

The logarithmic nature of the decibel unit causes the noise levels of the loudest events to control the 24-hour average. A DNL of 65 dB could result from a very few noisy events or a large number of quieter events.

As a simple example of this characteristic, consider a case in which only one aircraft overflight occurs during the daytime over 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 65.9 dB. Assume, as a second example that 10 such 30-second overflights occur during 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 75.5 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.

Daily average sound levels are typically used for the evaluation of community noise effects (i.e., long-term annoyance), and particularly aircraft noise effects. In general, scientific studies and social surveys have found a high correlation between the percentages of groups of people highly annoyed and the level of average noise exposure measured in DNL (EPA 1978 and Schultz 1978).

2.6 Onset-Rate Adjusted Monthly Day-Night Average Sound Level (L_{dnmr}) and Onset-Rate Adjusted Monthly Community Noise Equivalent Level ($CNEL_{mr}$)

Military aircraft utilizing Special Use Airspace (SUA) such as Military Training Routes (MTRs), Military Operating Areas (MOAs) and Restricted Areas/Ranges generate a noise environment that is somewhat different from that associated with airfield operations. As opposed to patterned or continuous noise environments associated with airfields, flight activity in SUAs is highly sporadic and often seasonal ranging from ten per hour to less than one per week. Individual military overflight events also differ from typical community noise events in that noise from a low-altitude, high-airspeed flyover can have a rather sudden onset, exhibiting a rate of increase in sound level (onset rate) of up to 150 dB per second.

To represent these differences, the conventional SEL metric is adjusted to account for the "surprise" effect of the sudden onset of aircraft noise events on humans with an adjustment ranging up to 11 dB above the normal SEL (Stusnick, et al. 1992). Onset rates between 15 to 150 dB per second require an adjustment of 0 to 11 dB, while onset rates below 15 dB per second require no adjustment. The adjusted SEL is designated as the onset-rate adjusted sound exposure level (SEL_r).

Because of the sporadic characteristic of SUA activity and so as not to dilute the resultant noise exposure, the month with the most operations or sorties from a yearly tabulation for the given SUA is examined -- the so-called busiest month. The cumulative exposure to noise in these areas is computed by DNL over the busy month, but using SEL_r instead of SEL. This monthly average is denoted L_{dnmr}. If onset rate adjusted DNL is computed over a period other than a month, it would be designated L_{dnr} and the period must be specified. In the state of California, a variant of the L_{dnmr} includes a penalty for evening operations (7 p.m. to 10 p.m) and is denoted $CNEL_{mr}$.

2.7 Number-of-Events Above (NA) a Threshold Level (L)

The Number-of-events Above metric (NA) provides the total number of noise events that exceed the selected noise level threshold during a specified period of time. Combined with the selected threshold level (L), the NA metric is symbolized as NAL. The threshold L can be defined in terms of either the SEL or L_{max} metric, and it is important that this selection is reflected in the nomenclature. When labeling a contour line or point of interest (POI) on a map the NAL will be followed by the number of events in parentheses for that line or POI. For example, the noise environment at a location where 10 events exceed an SEL of 90 dB, over a given period of time, would be represented by the nomenclature NA90SEL(10). Similarly, for L_{max} it would be NA90L_{max}(10). The period of time can be an average 24-hour day, daytime, nighttime, school day, or any other time period appropriate to the nature and application of the analysis.

NA can be portrayed for single or multiple locations, or by means of noise contours on a map similar to the common DNL contours. A threshold level is selected that best meets the need for that situation. An L_{max} threshold is normally selected to analyze speech interference, whereas an SEL threshold is normally selected for analysis of sleep disturbance.

The NA metric is the only supplemental metric that has been developed that combines single-event noise levels with the number of aircraft operations. In essence, it answers the question of how many aircraft (or range of aircraft) fly over a given location or area at or above a selected threshold noise level.

2.8 Time Above (TA) a Specified Level (L)

The Time Above (TA) metric is a measure of the total time that the A-weighted aircraft noise level is at or above a defined sound level threshold. Combined with the selected threshold level (L), the TA metric is symbolized as TAL. TA is not a sound level, but rather a time expressed in minutes. TA values can be calculated over a full 24-hour annual average day, the 15-hour daytime and 9-hour nighttime periods, a school day, or any other time period of interest, provided there is operational data to define the time period of interest.

TA has application for describing the noise environment in schools, particularly when comparing the classroom or other noise sensitive environments for different operational scenarios. TA can be portrayed by means of noise contours on a map similar to the common DNL contours.

The TA metric is a useful descriptor of the noise impact of an individual event or for many events occurring over a certain time period. When computed for a full day, the TA can be compared alongside the DNL in order to determine the sound levels and total duration of events that contribute to the DNL. TA analysis is usually conducted along with NA analysis so the results show not only how many events occur above the selected threshold(s), but also the total duration of those events above those levels for the selected time period.

3 Noise Effects

This noise effects section includes discussions of annoyance, speech interference and sleep disturbance, and the effects of noise on hearing, health, performance, learning, animals, property values, terrain and archaeological sites.

3.1 Annoyance

The primary effect of aircraft noise on exposed communities is one of long-term annoyance, defined by the Environmental Protection Agency (EPA) as any negative subjective reaction on the part of an individual or group. The scientific community has adopted the use of long-term annoyance as a primary indicator of community response because it attempts to account for all negative aspects of effects from noise, e.g., increased annoyance due to being awakened the previous night by aircraft and interference with everyday conversation.

Numerous laboratory studies and field surveys have been conducted to measure annoyance and to account for a number of variables, many of which are dependent on a person's individual circumstances and preferences. Laboratory studies of individual response to noise have helped isolate a number of the factors contributing to annoyance, such as the intensity level and spectral characteristics of the noise, duration, the presence of impulses, pitch, information content, and the degree of interference with activity. Social surveys of community response to noise have allowed the development of general dose-response relationships that can be used to estimate the proportion of people who will be highly annoyed by a given noise level. The results of these studies have formed the basis for criteria established to define areas of compatible land use.

A wide variety of responses have been used to determine intrusiveness of noise and disturbances of speech, sleep, audio/video entertainment, and outdoor living; but the most useful metric for assessing peoples' responses to noise is the percentage of the population expected to be "highly annoyed." The concept of "percent highly annoyed" has provided the most consistent response of a community to a particular noise environment. In his synthesis of several different social surveys that employed different response scales, Schultz (1978) defined "highly annoyed" respondents as those respondents whose self-described annoyance fell within the upper 28 percent of the response scale where the scale was numerical or un-named. For surveys where the response scale was named, Schultz counted those who claimed to be highly annoyed, combining the responses of "very annoyed" and "extremely annoyed." Schultz's definition of "percent highly annoyed" (%HA) became the basis for the Federal policy on environmental noise. Daily average sound levels are typically used for the evaluation of community noise effects, such as long-term annoyance.

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In general, scientific studies and social surveys have found a correlation between the percentages of groups of people highly annoyed and the level of average noise exposure. Thus, the results are expressed as the average %HA at various exposure levels measured in DNL. The classic analysis is Schultz's original 1978 study, whose results are shown in Figure A-3. This figure is commonly referred to as the Schultz curve. It represents the synthesis of a large number of social surveys (161 data points in all), that relates the long-term community response to various types of noise sources, measured using the DNL metric.

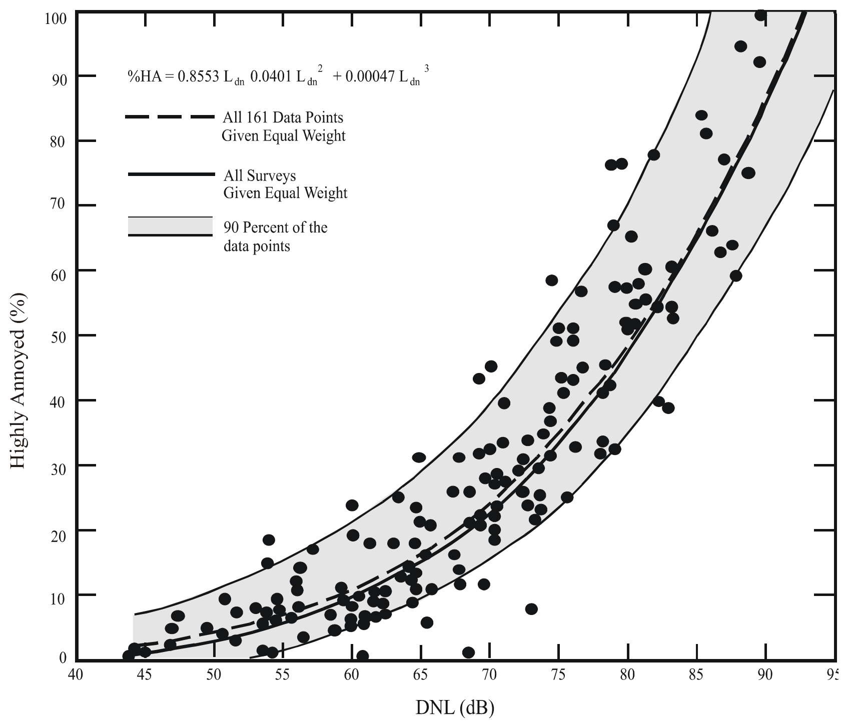
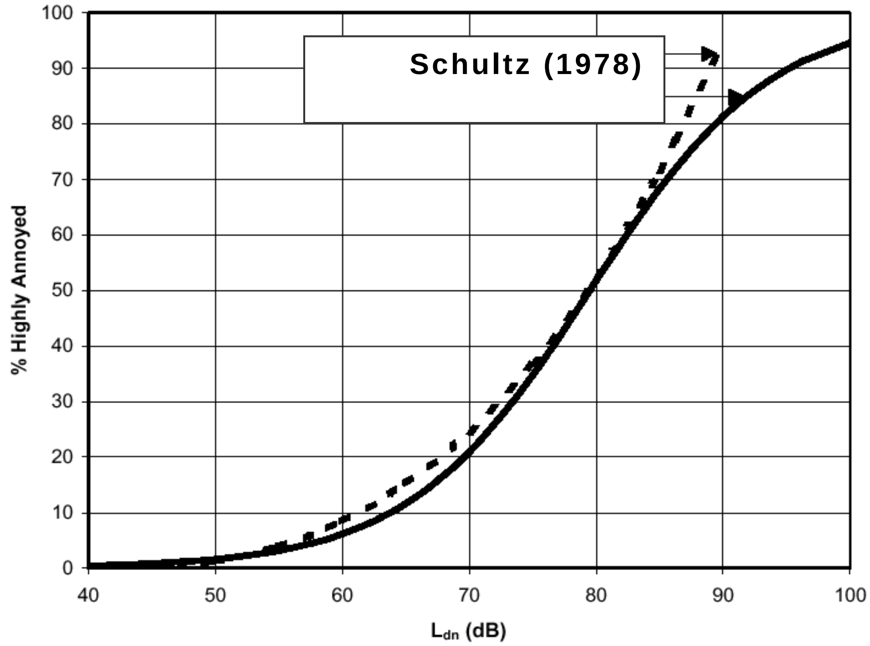


Figure A-3. Community Surveys of Noise Annoyance

An updated study of the original Schultz data based on the analysis of 400 data points collected through 1989 essentially reaffirmed this relationship. Figure A-4 shows an updated form of the curve fit in comparison with the original Schultz curve (Finegold 1994). The updated fit, which does not differ substantially from the original, is the preferred form in the U.S. The relationship between %HA and DNL is:

$$\%HA = 100/[1 + \exp(11.13 - 0.141L_{dn})]$$



SOURCE:(Schultz, 1978) and Current (Finegold, et al. 1994) Curve Fits

Figure A-4. Response of Communities to Noise; Comparison of Original

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. However, the correlation coefficients for the annoyance of individuals are relatively low, 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.

A number of non-acoustic factors have been identified that may influence the annoyance response of an individual. Newman and Beattie (1985) divided these factors into emotional and physical variables.

Emotional Variables:

- Feelings about the necessity or preventability of the noise;
- Judgment of the importance and value of the activity that is producing the noise;
- Activity at the time an individual hears the noise;
- Attitude about the environment;
- General sensitivity to noise;
- Belief about the effect of noise on health; and
- Feeling of fear associated with the noise.
- Physical Variables:
- Type of neighborhood;
- Time of day;

- Season;
- Predictability of noise;
- Control over the noise source; and
- Length of time an individual is exposed to a noise.

The low correlation coefficients for individuals' reactions reflect the large amount of scatter among the data drawn from the various surveys and point to the substantial uncertainty associated with the equation representing the relationship between %HA and DNL. Based on the results of surveys it has been observed that noise exposure can explain less than 50 percent of the observed variance in annoyance, indicating that non-acoustical factors play a major role. As a result, it is not possible to accurately predict individual annoyance in any specific community based on the aircraft noise exposure. Nevertheless, changes in %HA can be useful in giving the decision maker more information about the relative effects that different alternatives may have on the community.

The original Schultz curve and the subsequent updates do not separate out the annoyance from aircraft noise and other transportation noise sources. This was an important element, in that it allowed Schultz to obtain some consensus among the various social surveys from the 1960s and 1970s that were synthesized in the analysis. In essence, the Schultz curve assumes that the effects of long-term annoyance on the general population are the same, regardless of whether the noise source is road, rail, or aircraft. In the years after the classical Schultz analysis, additional social surveys have been conducted to better understand the annoyance effects of various transportation sources.

Miedema & Vos (1998) present synthesis curves for the relationship between DNL and percentage "Annoyed" and percentage "Highly Annoyed" for three transportation noise sources. Separate, non-identical curves were found for aircraft, road traffic, and railway noise. Table A-1 illustrates that, for a DNL of 65 dB, the percent of the people forecasted to be Highly Annoyed is 28 percent for air traffic, 18 percent for road traffic, and 11 percent for railroad traffic. For an outdoor DNL of 55 dB, the percent highly annoyed would be close to 12 percent if the noise is generated by aircraft operations, but only 7 percent and 4 percent, respectively, if the noise is generated by road or rail traffic. Comparing the levels on the Miedema & Vos curve to those on the updated Schultz curve indicates that the percentage of people highly annoyed by aircraft noise may be higher than previously thought when the noise is solely generated by aircraft activity.

Table A-1. Percent Highly Annoyed for Different Transportation Noise Sources

DNL (dB)	Percent Hightly Annoyed (% HA)			
	Miedema and Vos			Schultz Combined
	Air	Road	Rail	
55	12	7	4	3
60	19	12	7	6
65	28	18	11	12
70	37	29	16	22
75	48	40	22	36

Source: Miedema & Vos 1998

As noted by the World Health Organization (WHO), even though aircraft noise seems to produce a stronger annoyance response than road traffic, caution should be exercised when interpreting synthesized data from different studies (WHO 2000). The WHO noted that five major parameters should be randomly distributed for the analyses to be valid: personal, demographic, and lifestyle factors, as well as the duration of noise exposure and the population experience with noise.

The FICON found that the updated Schultz curve remains the best available source of empirical dosage effect information to predict community response to transportation noise without any segregation by transportation source (FICON 1992); a position held by the FICAN in 1997 (FICAN 1997). However, FICON also recommended further research to investigate the differences in perceptions of aircraft noise, ground transportation noise (highways and railroads), and general background noise.

3.2 Speech Interference

Speech interference associated with aircraft noise is a primary cause of annoyance for communities. 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 particularly important in classrooms and offices. In industrial settings it can cause fatigue and vocal strain in those who attempt to communicate over the noise.

The disruption of speech in the classroom is a primary concern, due to the potential for adverse effects on children's learning ability. There are two aspects to speech comprehension:

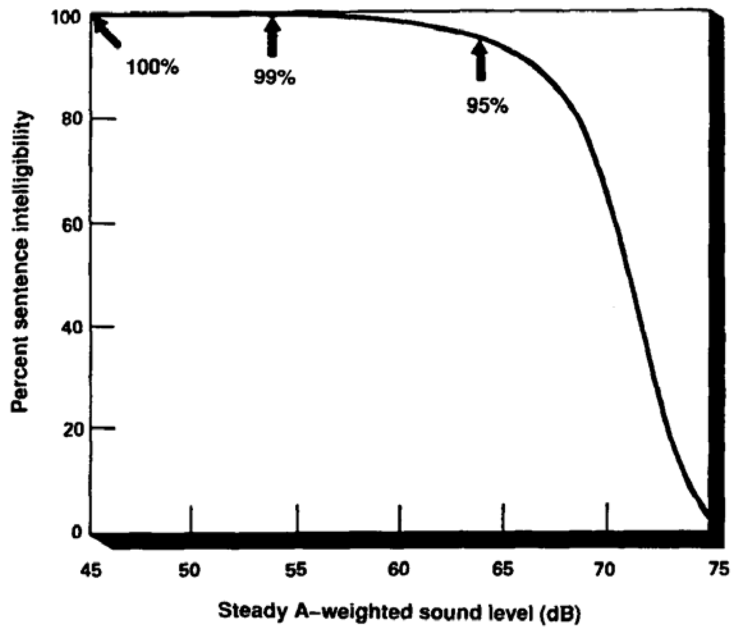
1. *Word Intelligibility* - the percent of words transmitted and received. This might be important for students in the lower grades who are learning the English language, and particularly for students who have English as a Second Language.
2. S*entence Intelligibility* – the percent of sentences transmitted and understood. This might be important for high-school students and adults who are familiar with the language, and who do not necessarily have to understand each word in order to understand sentences.

For teachers to be clearly understood by their students, it is important that regular voice communication is clear and uninterrupted. Not only does the background sound level have to be low enough for the teacher to be clearly heard, but intermittent outdoor noise events also need to be minimized. It is therefore important to evaluate the steady background level, the level of voice communication, and the single-event level due to aircraft overflights that might interfere with speech.

Several research studies have been conducted and guideline documents been developed resulting in a fairly consistent set of noise level criteria for speech interference. This section provides an overview of the results of these studies.

U.S. Federal Criteria for Interior Noise

In 1974, the EPA identified a goal of an indoor 24-hour average sound level $L_{eq(24)}$ of 45 dB to minimize speech interference based on the intelligibility of sentences in the presence of a steady background noise (EPA 1974). Intelligibility pertains to the percentage of speech units correctly understood out of those transmitted, and specifies the type of speech material used, i.e. sentences or words. The curve displayed in Figure A-5 shows the effect of steady indoor background sound levels on sentence intelligibility. For an average adult with normal hearing and fluency in the language, steady background sound levels indoors of less than 45 dB L_{eq} are expected to allow 100 percent intelligibility of sentences.



Source: EPA 1974

Figure A-5. Speech Intelligibility Curve

The curve shows 99 percent sentence intelligibility for background levels at a L_{eq} of 54 dB, and less than 10 percent intelligibility for background levels above a L_{eq} of 73 dB. Note that the curve is especially sensitive to changes in sound level between 65 dB and 75 dB - an increase of 1 dB in background sound level from 70 dB to 71 dB results in a 14 percent decrease in sentence intelligibility, whereas a 1 dB increase in background sound level from 60 dB to 61 dB results in less than 1 percent decrease in sentence intelligibility.

Classroom Criteria

For listeners with normal hearing and fluency in the language, complete sentence intelligibility can be achieved when the signal-to-noise ratio (i.e., the difference between the speech level and the level of the interfering noise) is in the range 15-18 dB (Lazarus 1990).

Both the ANSI and the American Speech-Language-Hearing Association (ASHLA) recommend at least a 15 dB signal-to-noise ratio in classrooms, to ensure that children with hearing impairments and language disabilities are able to enjoy high speech intelligibility (ANSI 2002; ASHLA 1995). As such, provided that the average adult male or female voice registers a minimum of 50 dB L_{max} in the rear of the classroom, the ANSI standard requires that the continuous background noise level indoors must not exceed a L_{eq} of 35 dB (assumed to apply for the duration of school hours).

The WHO reported for a speaker-to-listener distance of about 1 meter, empirical observations have shown that speech in relaxed conversations is 100 percent intelligible in background noise levels of about 35 dB, and speech can be fairly well understood in the presence of background levels of 45 dB. The WHO recommends a guideline value of 35 dB L_{eq} for continuous background levels in classrooms during school hours (WHO 2000).

Bradley suggests that in smaller rooms, where speech levels in the rear of the classroom are approximately 50 dB L_{max}, steady-state noise levels above 35 dB L_{eq} may interfere with the intelligibility of speech (Bradley 1993).

For the purposes of determining eligibility for noise insulation funding, the Federal Aviation Administration (FAA) guidelines state that the design objective for a classroom environment is 45 dB L_{eq} resulting from aircraft operations during normal school hours (FAA 1985).

However, most aircraft noise is not continuous and consists of individual events where the sound level exceeds the background level for a limited time period as the aircraft flies over. Since speech interference in the presence of aircraft noise is essentially determined by the magnitude and frequency of individual aircraft flyover events, a time-averaged metric alone, such as L_{eq}, is not necessarily appropriate when evaluating the overall effects. In addition to the background level criteria described above, single-event criteria, which account for those sporadic intermittent outdoor noisy events, are also essential to specifying speech interference criteria.

In 1984, a report to the Port Authority of New York and New Jersey recommended utilizing the Speech Interference Level (SIL) metric for classroom noise criteria (Sharp and Plotkin 1984). This metric is based on the maximum sound levels in the frequency range (approximately 500 Hz to 2,000 Hz) that directly affects speech communication. The study identified an SIL (the average of the sound levels in the 500, 1000, and 2000 Hz octave-bands) of 45 dB as the desirable goal, which was estimated to provide 90 percent word intelligibility for the short time periods during aircraft over-flights. Although early classroom level criteria were defined in terms of SIL, the use and measurement of L_{max} as the primary metric has since become more popular. Both metrics take into consideration the L_{max} associated with intermittent noise events and can be related to existing background levels when determining speech interference percentages. An SIL of 45 dB is approximately equivalent to an A-weighted L_{max} of 50 dB for aircraft noise (Wesler 1986).

In 1998, a report also concluded that if an aircraft noise event's indoor L_{max} reached the speech level of 50 dB, 90 percent of the words would be understood by students seated throughout the classroom (Lind, Pearsons, and Fidell 1998). Since intermittent aircraft noise does not appreciably disrupt classroom communication at lower levels and other times, the authors also adopted an indoor L_{max} of 50 dB as the maximum single-event level permissible in classrooms. Note that this limit was set based on students with normal hearing and no special needs; at-risk students may be adversely affected at lower sound levels.

Bradley recommends SEL as a better indicator of indoor estimated speech interference in the presence of aircraft overflights (Bradley 1985). For acceptable speech communication using normal vocal efforts, Bradley suggests that the indoor SEL be no greater than 64 dB. He assumes a 26 dB outdoor-to-indoor noise reduction that equates to 90 dB SEL outdoors. Aircraft events producing outdoor SEL values greater than 90 dB would result in disruption to indoor speech communication. Bradley's work indicates that, for speakers talking with a casual vocal effort, 95 percent intelligibility would be achieved when indoor SEL values did not exceed 60 dB, which translates approximately to an L_{max} of 50 dB.

In the presence of intermittent noise events, ANSI states that the criteria for allowable background noise level can be relaxed since speech is impaired only for the short time when the aircraft noise is close to its maximum value. Consequently, they recommend when the background noise level of the noisiest hour is dominated by aircraft noise, the indoor criteria (35 dB L_{eq} for continuous background noise) can be increased by 5 dB to an Leq of 40 dB, as long as the noise level does not exceed 40 dB for more than 10 percent of the noisiest hour. (ANSI 2002).

The WHO does not recommend a specific indoor L_{max} criterion for single-event noise, but does place a guideline value at L_{eq} of 35 dB for overall background noise in the classroom. However, WHO does report that "for communication distances beyond a few meters, speech interference starts at sound pressure levels below 50 dB for octave bands centered on the main speech frequencies at 500 Hz, 1kHz, and 2 kHz." (WHO 2000). One can infer this can be approximated by an L_{max} value of 50 dB.

The United Kingdom Department for Education and Skills (UKDFES) established in its classroom acoustics guide a 30-minute time-averaged metric [$L_{eq(30min)}$] for background levels and $L_{A1,30}$ min for intermittent noises, at thresholds of 30-35 dB and 55 dB, respectively. $L_{A1,30}$ min represents the A-weighted sound level that is exceeded one percent of the time (in this case, during a 30 minute teaching session) and is generally equivalent to the L_{max} metric (UKDFES 2003).

Summary

As the previous section demonstrates, research indicates that it is not only important to consider the continuous background levels using time-averaged metrics, but also the intermittent events, using single-event metrics such as L_{max}. Table A-2 provides a summary of the noise level criteria recommended in the scientific literature.

Table A-2. Indoor Noise Level Criteria Based on Speech Intelligibility

Source	Metric/Level (dB)	Effects and Notes
U.S. FAA (1985)	L_{eq}(during school hours) = 45 dB	Federal assistance criteria for school sound insulation; supplemental single-event criteria may be used
Lind et al. (1998), Sharp and Plotkin (1984), Wesler (1986)	L_{max} = 50 dB / SIL 45	Single event level permissible in the classroom
WHO (1999)	L_{eq} = 35 dB L_{max} = 50 dB	Assumes average speech level of 50 dB and recommends signal to noise ratio of 15 dB
U.S. ANSI (2002)	L_{eq} = 40 dB, Based on Room Volume	Acceptable background level for continuous noise/ relaxed criteria for intermittent noise in the classroom
U.K. DFES (2003)	$L_{eq(30min)}$ = 30-35 dB L_{max} = 55 dB	Minimum acceptable in classroom and most other learning environs

When considering intermittent noise caused by aircraft overflights, a review of the relevant scientific literature and international guidelines indicates that an appropriate criteria is a limit on indoor background noise levels of 35 to 40 dB L_{eq} and a limit on single events of 50 dB L_{max}.

3.3 Sleep Disturbance

The disturbance of sleep is a major concern for communities exposed to nighttime aircraft noise. There have been numerous research studies that have attempted to quantify the complex effects of noise on sleep. This section provides an overview of the major noise-induced sleep disturbance studies that have been conducted, with particular emphasis placed on those studies that have influenced U.S. federal noise policy. The studies have been separated into two groups:

1. Initial studies performed in the 1960s and 1970s, where the research was focused on laboratory sleep observations.
2. Later studies performed in the 1990s up to the present, where the research was focused on field observations, and correlations to laboratory research were sought.

Initial Studies

The relationship between noise levels and sleep disturbance is complex and not fully understood. The disturbance depends not only on the depth of sleep, but also on the previous exposure to aircraft noise, familiarity with the surroundings, the physiological and psychological condition of the recipient, and a host of other situational factors. The most readily measurable effect of noise on sleep is the number of arousals or awakenings, and so the body of scientific literature has focused on predicting the percentage of the population that will be awakened at various noise levels. Fundamentally, regardless of the tools used to measure the degree of sleep disturbance (awakenings, arousals, etc.), these studies have grouped the data points into bins to predict the percentage of the population likely to be disturbed at various sound level thresholds.

FICON produced a guidance document that provided an overview of the most pertinent sleep disturbance research that had been conducted throughout the 1970s (FICON 1992). Literature reviews and meta-analysis conducted between 1978 and 1989 made use of the existing datasets that indicated the effects of nighttime noise on various sleep-state changes and awakenings (Lukas 1978; Griefahn 1978; Peasons et. al. 1989). FICON noted that various indoor A-weighted sound levels – ranging from 25 to 50 dB were observed to be thresholds below which significant sleep effects were not expected. Due to the large variability in the data, FICON did not endorse the reliability of the results.

However, FICON did recommend the use of an interim dose-response curve—awaiting future research—which predicted the percent of the exposed population expected to be awakened as a function of the exposure to single event noise levels expressed in terms of SEL. This curve was based on the research conducted for the U.S. Air Force (Finegold 1994). The dataset included most of the research performed up to that point, and predicted that ten percent of the population would be awakened when exposed to an interior SEL of approximately 58 dB. The data utilized to derive this relationship were primarily the results of controlled laboratory studies.

Recent Sleep Disturbance Research – Field and Laboratory Studies

It was noted in the early sleep disturbance research that the controlled laboratory studies did not account for many factors that are important to sleep behavior, such as habituation to the environment and previous exposure to noise and awakenings from sources other than aircraft noise. In the early 1990s, field studies were conducted to validate the earlier laboratory work. The most significant finding from these studies was that an estimated 80 to 90 percent of sleep disturbances were not related to individual outdoor noise events, but were instead the result of indoor noise sources and other non-noise-related factors. The results showed that there was less of an effect of noise on sleep in real-life conditions than had been previously reported from laboratory studies.

FICAN

The interim FICON dose-response curve that was recommended for use in 1992 was based on the most pertinent sleep disturbance research that was conducted through the 1970s, primarily in laboratory settings. After that time, considerable field research was conducted to evaluate the sleep effects in peoples' normal, home environment. Laboratory sleep studies tend to show higher values of sleep disturbance than field studies because people who sleep in their own homes are habituated to their environment and, therefore, do not wake up as easily (FICAN 1997).

Based on the new information, FICAN updated its recommended dose-response curve in 1997, depicted as the lower curve in Figure A-6. This figure is based on the results of three field studies (Ollerhead 1992; Fidell et. al. 1994; Fidell et al. 1995a and 1995b), along with the datasets from six previous field studies.

The new relationship represents the higher end, or upper envelope, of the latest field data. It should be interpreted as predicting the "maximum percent of the exposed population expected to be behaviorally awakened" or the "maximum percent awakened" for a given residential population. According to this relationship, a maximum of 3 percent of people would be awakened at an indoor SEL of 58 dB, compared to 10 percent using the 1992 curve. An indoor SEL of 58 dB is equivalent to outdoor SEL's of 73 and 83 dB respectively assuming 15 and 25 dB noise level reduction from outdoor to indoor with windows open and closed, respectively.

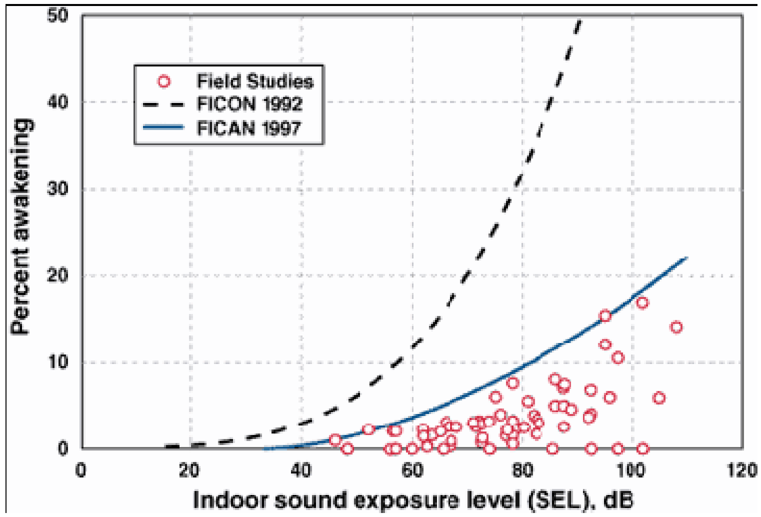


Figure A-6. FICAN's 1997 Recommended Sleep Disturbance Dose-Response Relationship

The FICAN 1997 curve is represented by the following equation:

$$\text{Percent Awakenings} = 0.0087 \times [\text{SEL} - 30]^{1.79}$$

Note the relatively low percentage of awakenings to fairly high noise levels. People think they are awakened by a noise event, but usually the reason for awakening is otherwise. For example, the 1992 UK CAA study found the average person was awakened about 18 times per night for reasons other than exposure to an aircraft noise – some of these awakenings are due to the biological rhythms of sleep and some to other reasons that were not correlated with specific aircraft events.

Number of Events and Awakenings

In recent years, there have been studies and one proposal that attempted to determine the effect of multiple aircraft events on the number of awakenings. The German Aerospace Center (DLR) conducted an extensive study focused on the effects of nighttime aircraft noise on sleep and other related human performance factors (Basner 2004). The DLR study was one of the largest studies to examine the link between aircraft noise and sleep disturbance and involved both laboratory and in-home field research phases. The DLR investigators developed a dose-effect curve that predicts the number of aircraft events at various values of L_{max} expected to produce one additional awakening over the course of a night. The dose-effect curve was based on the relationships found in the field studies.

In July 2008 ANSI and the Acoustical Society of America (ASA) published a method to estimate the percent of the exposed population that might be awakened by multiple aircraft noise events based on statistical assumptions about the probability of awakening (or not awakening) (ANSI 2008). This method relies on probability theory rather than direct field research/experimental data to account for multiple events.

Figure A-7 depicts the awakenings data that form the basis and equations of ANSI S12.9-2008. The curve labeled 'Eq. (B1)' is the relationship between noise and awakening endorsed by FICAN in 1997. The ANSI recommended curve labeled 'Eq. (1)' quantifies the probability of awakening for a population of sleepers who are exposed to an outdoor noise event as a function of the associated indoor SEL in the bedroom. This curve was derived from studies of behavioral awakenings associated with noise events in "steady state" situations where the population has been exposed to the noise long enough to be habituated. The data points in Figure A-7 come from these studies. Unlike the FICAN curve, the ANSI 2008 curve represents the average of the field research data points.

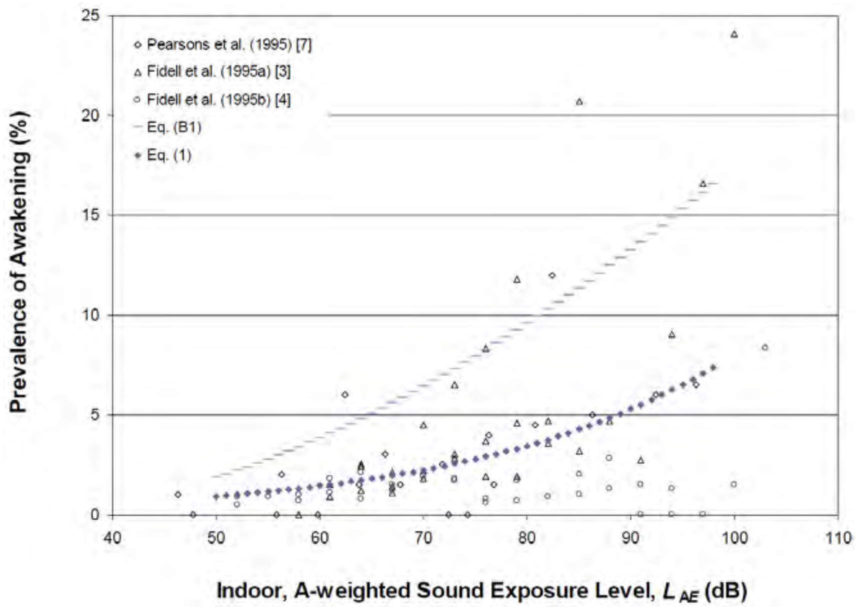


Figure A-7. Plot of Sleep Awakening Data versus Indoor SEL

In December 2008, FICAN recommended the use of this new estimation procedure for future analyses of behavioral awakenings from aircraft noise. In that statement, FICAN also recognized that additional sleep disturbance research is underway by various research organizations, and results of that work may result in additional changes to FICAN's position. Until that time, FICAN recommends the use of ANSI S12.9-2008.

3.4 Noise-Induced Hearing Impairment

Residents in surrounding communities express concerns regarding the effects of aircraft noise on hearing. This section provides a brief overview of hearing loss caused by noise exposure. The goal is to provide a sense of perspective as to how aircraft noise (as experienced on the ground) compares to other activities that are often linked with hearing loss.

Hearing Threshold Shifts

Hearing loss is generally interpreted as a decrease in the ear's sensitivity or acuity to perceive sound; i.e. a shift in the hearing threshold to a higher level. This change can either be a Temporary Threshold Shift (TTS), or a Permanent Threshold Shift (PTS) (Berger 1995).

TTS can result from exposure to loud noise over a given amount of time, yet the hearing loss is not necessarily permanent. An example of TTS might be a person attending a loud music concert. After the concert is over, the person may experience a threshold shift that may last several hours, depending upon the level and duration of exposure. While experiencing TTS, the person becomes less sensitive to low-level sounds, particularly at certain frequencies in the speech range (typically near 4,000 Hz). Normal hearing ability eventually returns, as long as the person has enough time to recover within a relatively quiet environment.

PTS usually results from repeated exposure to high noise levels, where the ears are not given adequate time to recover from the strain and fatigue of exposure. A common example of PTS is the result of working in a loud environment such as a factory. It is important to note that a temporary shift (TTS) can eventually become permanent (PTS) over time with continuous exposure to high noise levels. Thus, even if the ear is given time to recover from TTS, repeated occurrence of TTS may eventually lead to permanent hearing loss. The point at which a Temporary Threshold Shift results in a Permanent Threshold Shift is difficult to identify and varies with a person's sensitivity.

Criteria for Permanent Hearing Loss

Considerable data on hearing loss have been collected and analyzed by the scientific/medical community. It has been well established that continuous exposure to high noise levels will damage human hearing (EPA 1978). The Occupational Safety and Health Administration (OSHA) regulation of 1971 standardizes the limits on workplace noise exposure for protection from hearing loss as an average level of 90 dB over an 8-hour work period or 85 dB over a 16-hour period (the average level is based on a 5 dB decrease per doubling of exposure time) (US Department of Labor 1970). Even the most protective criterion (no measurable hearing loss for the most sensitive portion of the population at the ear's most sensitive frequency, 4,000 Hz, after a 40-year exposure) is an average sound level of 70 dB over a 24-hour period.

The US EPA established 75 dB for an 8-hour exposure and 70 dB for a 24-hour exposure as the average noise level standard requisite to protect 96 percent of the population from greater than a 5 dB PTS (EPA 1978). The National Academy of Sciences Committee on Hearing, Bioacoustics, and Biomechanics identified 75 dB as the minimum level at which hearing loss may occur (CHABA 1977). Finally, the WHO has concluded that environmental and leisure-time noise below an L_{eq24} value of 70 dB "will not cause hearing loss in the large majority of the population, even after a lifetime of exposure" (WHO 2000).

Hearing Loss and Aircraft Noise

The 1982 EPA Guidelines report specifically addresses the criteria and procedures for assessing the noise-induced hearing loss in terms of the Noise-Induced Permanent Threshold Shift (NIPTS), a quantity that defines the permanent change in hearing level, or threshold, caused by exposure to noise (EPA, 1982). Numerically, the NIPTS is the change in threshold averaged over the frequencies 0.5, 1, 2, and 4 kHz that can be expected from daily exposure to noise over a normal working lifetime of 40 years, with the exposure beginning at an age of 20 years. A grand average of the NIPTS over time (40 years) and hearing sensitivity (10 to 90 percentiles of the exposed population) is termed the Average NIPTS or Ave NIPTS for short. The Average Noise Induced Permanent Threshold Shift (Ave. NIPTS) that can be expected for noise exposure as measured by the DNL metric is given in Table A-3.

Table A-3. Ave. NIPTS and 10th Percentile NIPTS as a Function of DNL

DNL	Ave. NIPTS dB*	10th Percentile NIPTS dB*
75-76	1.0	4.0
76-77	1.0	4.5
77-78	1.6	5.0
78-79	2.0	5.5
79-80	2.5	6.0
80-81	3.0	7.0
81-82	3.5	8.0
82-83	4.0	9.0
83-84	4.5	10.0
84-85	5.5	11.0

* Rounded to the nearest 0.5 dB

For example, for a noise exposure of 80 dB DNL, the expected lifetime average value of NIPTS is 2.5 dB, or 6.0 dB for the 10^{th} percentile. Characterizing the noise exposure in terms of DNL will usually overestimate the assessment of hearing loss risk as DNL includes a 10 dB weighting factor for aircraft operations occurring between 10 p.m. and 7 a.m. If, however, flight operations between the hours of 10 p.m. and 7 a.m. account for 5 percent or less of the total 24-hour operations, the overestimation is on the order of 1.5 dB.

From a civilian airport perspective, the scientific community has concluded that there is little likelihood that the resulting noise exposure from aircraft noise could result in either a temporary or permanent hearing loss. Studies on community hearing loss from exposure to aircraft flyovers near airports showed that there is no danger, under normal circumstances, of hearing loss due to aircraft noise (Newman and Beattie 1985). The EPA criterion (L_{eq24} = 70 dBA) can be exceeded in some areas located near airports, but that is only the case outdoors. Inside a building, where people are more likely to spend most of their time, the average noise level will be much less than 70 dBA (Eldred and von Gierke 1993). Eldred and von Gierke also report that "several studies in the U.S., Japan, and the U.K. have confirmed the predictions that the possibility for permanent hearing loss in communities, even under the most intense commercial take-off and landing patterns, is remote."

With regard to military airbases, as individual aircraft noise levels are increasing with the introduction of new aircraft, a 2009 DoD policy directive requires that hearing loss risk be estimated for the at risk population, defined as the population exposed to DNL greater than or equal to 80 dB and higher (DoD 2009). Specifically, DoD components are directed to "*use the 80 Day-Night A-Weighted (DNL) noise contour to identify populations at the most risk of potential hearing loss*". This does not preclude populations outside the 80 DNL contour, i.e. at lower exposure levels, from being at some degree of risk of hearing loss. However, the analysis should be restricted to populations within this contour area, including residents of on-base housing. The exposure of workers inside the base boundary area should be considered occupational and evaluated using the appropriate DoD component regulations for occupational noise exposure.

With regard to military airspace activity, studies have shown conflicting results. A 1995 laboratory study measured changes in human hearing from noise representative of low-flying aircraft on MTRs (Nixon, et al. 1993). The potential effects of aircraft flying along MTRs is of particular concern because of maximum overflight noise levels can exceed 115 dB, with rapid increases in noise levels exceeding 30 dB per second. In this study, participants were first subjected to four overflight noise exposures at A-weighted levels of 115 dB to 130 dB. Fifty percent of the subjects showed no change in hearing levels, 25 percent had a temporary 5 dB *increase* in sensitivity (the people could hear a 5 dB wider range of sound than before exposure), and 25 percent had a temporary 5 dB decrease in sensitivity (the people could hear a 5 dB narrower range of sound than before exposure). In the next phase, participants were subjected to a single overflight at a maximum level of 130 dB for eight successive exposures, separated by 90 seconds or until a temporary shift in hearing was observed. The temporary hearing threshold shifts showed an *increase* in sensitivity of up to 10 dB.

In another study of 115 test subjects between 18 and 50 years old in 1999, temporary threshold shifts were measured after laboratory exposure to military low-altitude flight noise (Ising, et al. 1999). According to the authors, the results indicate that repeated exposure to military low-altitude flight noise with L_{max} greater than 114 dB, especially if the noise level increases rapidly, may have the potential to cause noise induced hearing loss in humans.

Summary

Aviation and typical community noise levels near airports are not comparable to the occupational or recreational noise exposures associated with hearing loss. Studies of aircraft noise levels associated with civilian airport activity have not definitively correlated permanent hearing impairment with aircraft activity. It is unlikely that airport neighbors will remain outside their homes 24 hours per day, so there is little likelihood of hearing loss below an average sound level of 75 dB DNL. Near military airbases, average noise levels above 75 dB may occur, and while new DoD policy dictates that NIPTS be evaluated, no research results to date have definitively related permanent hearing impairment to aviation noise.

3.5 Nonauditory Health Effects

Studies have been conducted to determine whether correlations exist between noise exposure and cardiovascular problems, birth weight, and mortality rates. The nonauditory effect of noise on humans is not as easily substantiated as the effect on hearing. The results of studies conducted in the United States, primarily concentrating on cardiovascular response to noise, have been contradictory (Cantrell 1974). Cantrell concluded that the results of human and animal experiments show that average or intrusive noise can act as a stress-provoking stimulus. Prolonged stress is known to be a contributor to a number of health disorders. Kryter and Poza (1980) state, "It is more likely that noise-related general ill-health effects are due to the psychological annoyance from the noise interfering with normal everyday behavior, than it is from the noise eliciting, because of its intensity, reflexive response in the autonomic or other physiological systems of the body." Psychological stresses may cause a physiological stress reaction that could result in impaired health.

The National Institute for Occupational Safety and Health and EPA commissioned CHABA in 1981 to study whether established noise standards are adequate to protect against health disorders other than hearing defects. CHABA's conclusion was that:

Evidence from available research reports is suggestive, but it does not provide definitive answers to the question of health effects, other than to the auditory system, of long-term exposure to noise. It seems prudent, therefore, in the absence of adequate knowledge as to whether or not noise can produce effects upon health other than damage to auditory system, either directly or mediated through stress, that insofar as feasible, an attempt should be made to obtain more critical evidence.

Since the CHABA report, there have been more recent studies that suggest that noise exposure may cause hypertension and other stress-related effects in adults. Near an airport in Stockholm, Sweden, the prevalence of hypertension was reportedly greater among nearby residents who were exposed to energy averaged noise levels exceeding 55 dB and maximum noise levels exceeding 72 dB, particularly older subjects and those not reporting impaired hearing ability (Rosenlund, et al. 2001). A study of elderly volunteers who were exposed to simulated military low-altitude flight noise reported that blood pressure was raised by L_{max} of 112 dB and high speed level increase (Michalak, et al. 1990). Yet another study of subjects exposed to varying levels of military aircraft or road noise found no significant relationship between noise level and blood pressure (Pulles, et al. 1990).

The U.S. Department of the Navy prepared a programmatic Environmental Assessment (EA) for the continued use of non-explosive ordnance on the Vieques Inner Range. Following the preparation of the EA, it was learned that research conducted by the University of Puerto Rico, Ponce School of Medicine, suggested that Vieques fishermen and their families were experiencing symptoms associated with vibroacoustic disease (VAD) (U.S. Department of the Navy 2002). The study alleged that exposure to noise and sound waves of large pressure amplitudes within lower frequency bands, associated with Navy training activities—specifically, air-to-ground bombing or naval fire support—was related to a larger prevalence of heart anomalies within the Vieques fishermen and their families. The Ponce School of Medicine study compared the Vieques group with a group from Ponce Playa. A 1999 study conducted on Portuguese aircraft-manufacturing workers from a single factory reported effects of jet aircraft noise exposure that involved a wide range of symptoms and disorders, including the cardiac issues on which the Ponce School of Medicine study focused. The 1999 study identified these effects as VAD.

Johns Hopkins University (JHU) conducted an independent review of the Ponce School of Medicine study, as well as the Portuguese aircraft workers study and other relevant scientific literature. Their findings concluded that VAD should not be accepted as a syndrome, given that exhaustive research across a number of populations has not yet been conducted. JHU also pointed out that the evidence supporting the existence of VAD comes largely from one group of investigators and that similar results would have to be replicated by other investigators. In short, JHU concluded that it had not been established that noise was the causal agent for the symptoms reported and no inference can be made as to the role of noise from naval gunfire in producing echocardiographic abnormalities (U.S. Department of the Navy 2002).

Most studies of nonauditory health effects of long-term noise exposure have found that noise exposure levels established for hearing protection will also protect against any potential nonauditory health effects, at least in workplace conditions. One of the best scientific summaries of these findings is contained in the lead paper at the National Institutes of Health Conference on Noise and Hearing Loss, held on 22 to 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 8-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" (von Gierke 1990).

Although these findings were specifically directed at noise effects in the workplace, 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 that purport to find such health effects use time-average noise levels of 75 dB and higher for their research.

For example, two UCLA researchers apparently found a relationship between aircraft noise levels under the approach path to Los Angeles International Airport (LAX) and increased mortality rates among the exposed residents by using an average noise exposure level greater than 75 dB for the "noise-exposed" population (Meacham and Shaw 1979). Nevertheless, three other UCLA professors analyzed those same data and found no relationship between noise exposure and mortality rates (Frerichs, et al. 1980).

As a second example, two other UCLA researchers used this same population near LAX to show a higher rate of birth defects for 1970 to 1972 when compared with a control group residing away from the airport (Jones and Tauscher 1978). Based on this report, a separate group at the Center for Disease Control performed a more thorough study of populations near Atlanta's Hartsfield International Airport (ATL) for 1970 to 1972 and found no relationship in their study of 17 identified categories of birth defects to aircraft noise levels above 65 dB (Edmonds, et al. 1979).

In summary, there is no scientific basis for a claim that potential health effects exist for aircraft time-average sound levels below 75 dB.

The potential for noise to affect physiological health, such as the cardiovascular system, has been speculated; however, no unequivocal evidence exists to support such claims (Harris 1997). Conclusions drawn from a review of health effect studies involving military low-altitude flight noise with its unusually high maximum levels and rapid rise in sound level have shown no increase in cardiovascular disease (Schwartze and Thompson 1993). Additional claims that are unsupported include flyover noise producing increased mortality rates and increases in cardiovascular death, aggravation of post-traumatic stress syndrome, increased stress, increase in admissions to mental hospitals, and adverse effects on pregnant women and the unborn fetus (Harris 1997).

3.6 Performance Effects

The effect of noise on the performance of activities or tasks has been the subject of many studies. Some of these studies have established links between continuous high noise levels and performance loss. Noise-induced performance losses are most frequently reported in studies employing noise levels in excess of 85 dB. Little change has been found in low-noise cases. It has been cited that moderate noise levels appear to act as a stressor for more sensitive individuals performing a difficult psychomotor task.

While the results of research on the general effect of periodic aircraft noise on performance have yet to yield definitive criteria, several general trends have been noted including:

- A periodic intermittent noise is more likely to disrupt performance than a steady-state continuous noise of the same level. Flyover noise, due to its intermittent nature, might be more likely to disrupt performance than a steady-state noise of equal level.
- Noise is more inclined to affect the quality than the quantity of work.
- Noise is more likely to impair the performance of tasks that place extreme demands on the worker.

3.7 Noise Effects on Children

In response to noise-specific and other environmental studies, Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks (1997), requires federal agencies to ensure that policies, programs, and activities address environmental health and safety risks to identify any disproportionate risks to children.

A review of the scientific literature indicates that there has not been a tremendous amount of research in the area of aircraft noise effects on children. The research reviewed does suggest that environments with sustained high background noise can have variable effects, including noise effects on learning and cognitive abilities, and reports of various noise-related physiological changes.

3.7.1 Effects on Learning and Cognitive Abilities

In 2002 ANSI refers to studies that suggest that loud and frequent background noise can affect the learning patterns of young children (ANSI 2002). ANSI provides discussion on the relationships between noise and learning, and stipulates design requirements and acoustical performance criteria for outdoor-to-indoor noise isolation. School design is directed to be cognizant of, and responsive to surrounding land uses and the shielding of outdoor noise from the indoor environment. The ANSI acoustical performance criteria for schools include the requirement that the one-hour-average background noise level shall not exceed 35 dBA in core learning spaces smaller than 20,000 cubic-feet and 40 dBA in core learning spaces with enclosed volumes exceeding 20,000 cubic-feet. This would require schools be constructed such that, in quiet neighborhoods indoor noise levels are lowered by 15 to 20 dBA relative to outdoor levels. In schools near airports, indoor noise levels would have to be lowered by 35 to 45 dBA relative to outdoor levels (ANSI 2002).

The studies referenced by ANSI to support the new standard are not specific to jet aircraft noise and the potential effects on children. However, there are references to studies that have shown that children in noisier classrooms scored lower on a variety of tests. Excessive background noise or reverberation within schools causes interferences of communication and can therefore create an acoustical barrier to learning (ANSI 2002). Studies have been performed that contribute to the body of evidence emphasizing the importance of communication by way of the spoken language to the development of cognitive skills. The ability to read, write, comprehend, and maintain attentiveness, are, in part, based upon whether teacher communication is consistently intelligible (ANSI 2002).

Numerous studies have shown varying degrees of effects of noise on the reading comprehension, attentiveness, puzzle-solving, and memory/recall ability of children. It is generally accepted that young children are more susceptible than adults to the effects of background noise. Because of the developmental status of young children (linguistic, cognitive, and proficiency), barriers to hearing can cause interferences or disruptions in developmental evolution.

Research on the impacts of aircraft noise, and noise in general, on the cognitive abilities of school-aged children has received more attention in recent years. Several studies suggest that aircraft noise can affect the academic performance of schoolchildren. Although many factors could contribute to learning deficits in school-aged children (e.g., socioeconomic level, home environment, diet, sleep patterns), evidence exists that suggests that chronic exposure to high aircraft noise levels can impair learning.

Specifically, elementary school children attending schools near New York City's two airports demonstrated lower reading scores than children living farther away from the flight paths (Green, et al. 1982). Researchers have found that tasks involving central processing and language comprehension (such as reading, attention, problem solving, and memory) appear to be the most affected by noise (Evans and Lepore 1993; Hygge 1994; and Evans, et al. 1998). It has been demonstrated that chronic exposure of first- and second-grade children to aircraft noise can result in reading deficits and impaired speech perception (i.e., the ability to hear common, low-frequency [vowel] sounds but not high frequencies [consonants] in speech) (Evans and Maxwell 1997).

The Evans and Maxwell (1997) study found that chronic exposure to aircraft noise resulted in reading deficits and impaired speech perception for first- and second-grade children. Other studies found that children residing near the Los Angeles International Airport had more difficulty solving cognitive problems and did not perform as well as children from quieter schools in puzzle-solving and attentiveness (Bronzaft 1997; Cohen, et al. 1980). Children attending elementary schools in high aircraft noise areas near London's Heathrow Airport demonstrated poorer reading comprehension and selective cognitive impairments (Haines, et al. 2001a, and 2001b). Similarly, a 1994 study found that students exposed to aircraft noise of approximately 76 dBA scored 20% lower on recall ability tests than students exposed to ambient noise of 42-44 dBA (Hygge 1994). Similar studies involving the testing of attention, memory, and reading comprehension of school children located near airports showed that their tests exhibited reduced performance results compared to those of similar groups of children who were located in quieter environments (Evans, et al. 1998; Haines, et al. 1998). The Haines and Stansfeld study indicated that there may be some long-term effects associated with exposure, as one-year follow-up testing still demonstrated lowered scores for children in higher noise schools (Haines, et al. 2001a, and 2001b). In contrast, a 2002 study found that although children living near the old Munich airport scored lower in standardized reading and long-term memory tests than a control group, their performance on the same tests was equal to that of the control group once the airport was closed. (Hygge, et al. 2002).

Finally, although it is recognized that there are many factors that could contribute to learning deficits in school-aged children, there is increasing awareness that chronic exposure to high aircraft noise levels may impair learning. This awareness has led the World Health Organization and a North Atlantic Treaty Organization working group to conclude that daycare centers and schools should not be located near major sources of noise, such as highways, airports, and industrial sites (World Health Organization 2000; North Atlantic Treaty Organization 2000).

3.7.2 Health Effects

Physiological effects in children exposed to aircraft noise and the potential for health effects have also been the focus of limited investigation. Studies in the literature include examination of blood pressure levels, hormonal secretions, and hearing loss.

As a measure of stress response to aircraft noise, authors have looked at blood pressure readings to monitor children's health. Children who were chronically exposed to aircraft noise from a new airport near Munich, Germany, had modest (although significant) increases in blood pressure, significant increases in stress hormones, and a decline in quality of life (Evans, et al. 1998). Children attending noisy schools had statistically significant average systolic and diastolic blood pressure ($p<0.03$). Systolic blood pressure means were 89.68 mm for children attending schools located in noisier environments compared to 86.77 mm for a control group. Similarly, diastolic blood pressure means for the noisier environment group were 47.84 mm and 45.16 for the control group (Cohen, et al. 1980).

Although the literature appears limited, studies focused on the wide range of potential effects of aircraft noise on school children have also investigated hormonal levels between groups of children exposed to aircraft noise compared to those in a control group. Specifically, two studies analyzed cortisol and urinary catecholamine levels in school children as measurements of stress response to aircraft noise (Haines, et al. 2001b and 2001c). In both instances, there were no differences between the aircraft-noise-exposed children and the control groups.

Other studies have reported hearing losses from exposure to aircraft noise. Noise-induced hearing loss was reportedly higher in children who attended a school located under a flight path near a Taiwan airport, as compared to children at another school far away (Chen, et al. 1997). Another study reported that hearing ability was reduced significantly in individuals who lived near an airport and were frequently exposed to aircraft noise (Chen and Chen 1993). In that study, noise exposure near the airport was reportedly uniform, with DNL greater than 75 dB and maximum noise levels of about 87 dB during overflights. Conversely, several other studies that were reviewed reported no difference in hearing ability between children exposed to high levels of airport noise and children located in quieter areas (Fisch 1977; Andrus, et al. 1975; Wu, et al. 1995).

3.8 Effects on Domestic Animals and Wildlife

Hearing is critical to an animal's ability to react, compete, reproduce, hunt, forage, and survive in its environment. While the existing literature does include studies on possible effects of jet aircraft noise and sonic booms on wildlife, there appears to have been little concerted effort in developing quantitative comparisons of aircraft noise effects on normal auditory characteristics. Behavioral effects have been relatively well described, but the larger ecological context issues, and the potential for drawing conclusions regarding effects on populations, has not been well developed.

The relationships between potential auditory/physiological effects and species interactions with their environments are not well understood. Manci, et al. (1988), assert that the consequences that physiological effects may have on behavioral patterns is vital to understanding the long-term effects of noise on wildlife. Questions regarding the effects (if any) on predator-prey interactions, reproductive success, and intra-inter specific behavior patterns remain.

The following discussion provides an overview of the existing literature on noise effects (particularly jet aircraft noise) on animal species. The literature reviewed here involves those studies that have focused on the observations of the behavioral effects that jet aircraft and sonic booms have on animals.

A great deal of research was conducted in the 1960's and 1970's on the effects of aircraft noise on the public and the potential for adverse ecological impacts. These studies were largely completed in response to the increase in air travel and as a result of the introduction of supersonic jet aircraft. According to Manci, et al. (1988), the foundation of information created from that focus does not necessarily correlate or provide information specific to the impacts to wildlife in areas overflown by aircraft at supersonic speed or at low altitudes.

The abilities to hear sounds and noise and to communicate assist wildlife in maintaining group cohesiveness and survivorship. Social species communicate by transmitting calls of warning, introduction, and other types that are subsequently related to an individual's or group's responsiveness.

Animal species differ greatly in their responses to noise. Noise effects on domestic animals and wildlife are classified as primary, secondary, and tertiary. Primary effects are direct, physiological changes to the auditory system, and most likely include the masking of auditory signals. Masking is defined as the inability of an individual to hear important environmental signals that may arise from mates, predators, or prey. There is some potential that noise could disrupt a species' ability to communicate or could interfere with behavioral patterns (Manci, et al. 1988). Although the effects are likely temporal, aircraft noise may cause masking of auditory signals within exposed faunal communities. Animals rely on 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. Other primary effects, such as ear drum rupture or temporary and permanent hearing threshold shifts, are not as likely given the subsonic noise levels produced by aircraft overflights. Secondary effects may include non-auditory effects such as stress and hypertension; behavioral modifications; interference with mating or reproduction; and impaired ability to obtain adequate food, cover, or water. Tertiary effects are the direct result of primary and secondary effects, and include population decline and habitat loss. Most of the effects of noise are mild enough that they may never be detectable as variables of change in population size or population growth against the background of normal variation (Bowles 1995). Other environmental variables (e.g., predators, weather, changing prey base, ground-based disturbance) also influence secondary and tertiary effects, and confound the ability to identify the ultimate factor in limiting productivity of a certain nest, area, or region (Smith, et al. 1988). Overall, the literature suggests that species differ in their response to various types, durations, and sources of noise (Manci, et al. 1988).

Many scientific studies have investigated the effects of aircraft noise on wildlife, and some have focused on wildlife "flight" due to noise. Apparently, animal responses to aircraft are influenced by many variables, including size, speed, proximity (both height above the ground and lateral distance), engine noise, color, flight profile, and radiated noise. The type of aircraft (e.g., fixed wing versus rotor-wing [helicopter]) and type of flight mission may also produce different levels of disturbance, with varying animal responses (Smith, et al. 1988). Consequently, it is difficult to generalize animal responses to noise disturbances across species.

One result of the 1988 Manci, et al., literature review was the conclusion that, while behavioral observation studies were relatively limited, a general behavioral reaction in animals from exposure to aircraft noise is the startle response. The intensity and duration of the startle response appears to be dependent on which species is exposed, whether there is a group or an individual, and whether there have been some previous exposures. Responses range from flight, trampling, stampeding, jumping, or running, to movement of the head in the apparent direction of the noise source. Manci, et al. (1988), reported that the literature indicated that avian species may be more sensitive to aircraft noise than mammals.

3.8.1 Domestic Animals

Although some studies report that the effects of aircraft noise on domestic animals is inconclusive, a majority of the literature reviewed indicates that domestic animals exhibit some behavioral responses to military overflights but generally seem to habituate to the disturbances over a period of time. Mammals in particular appear to react to noise at sound levels higher than 90 dB, with responses including the startle response, freezing (i.e., becoming temporarily stationary), and fleeing from the sound source. Many studies on domestic animals suggest that some species appear to acclimate to some forms of sound disturbance (Manci, et al. 1988). Some studies have reported such primary and secondary effects as reduced milk production and rate of milk release, increased glucose concentrations, decreased levels of hemoglobin, increased heart rate, and a reduction in thyroid activity. These latter effects appear to represent a small percentage of the findings occurring in the existing literature.

Some reviewers have indicated that earlier studies, and claims by farmers linking adverse effects of aircraft noise on livestock, did not necessarily provide clear-cut evidence of cause and effect (Cottereau 1978). In contrast, many studies conclude that there is no evidence that aircraft overflights affect feed intake, growth, or production rates in domestic animals.

Cattle

In response to concerns about overflight effects on pregnant cattle, milk production, and cattle safety, the U.S. Air Force prepared a handbook for environmental protection that summarizes the literature on the impacts of low-altitude flights on livestock (and poultry) and includes specific case studies conducted in numerous airspaces across the country. Adverse effects have been found in a few studies but have not been reproduced in other similar studies. One such study, conducted in 1983, suggested that 2 of 10 cows in late pregnancy aborted after showing rising estrogen and falling progesterone levels. These increased hormonal levels were reported as being linked to 59 aircraft overflights. The remaining eight cows showed no changes in their blood concentrations and calved normally (U.S. Air Force 1994b). A similar study reported abortions occurred in three out of five pregnant cattle after exposing them to flyovers by six different aircraft (U.S. Air Force 1994b). Another study suggested that feedlot cattle could stampede and injure themselves when exposed to low-level overflights (U.S. Air Force 1994b).

A majority of the studies reviewed suggests that there is little or no effect of aircraft noise on cattle. Studies presenting adverse effects to domestic animals have been limited. A number of studies (Parker and Bayley 1960; Casady and Lehmann 1967; Kovalcik and Sottnik 1971) investigated the effects of jet aircraft noise and sonic booms on the milk production of dairy cows. Through the compilation and examination of milk production data from areas exposed to jet aircraft noise and sonic boom events, it was determined that milk yields were not affected. This was particularly evident in those cows that had been previously exposed to jet aircraft noise.

A study examined the causes of 1,763 abortions in Wisconsin dairy cattle over a one-year time period and none were associated with aircraft disturbances (U.S. Air Force 1993). In 1987, Anderson contacted seven livestock operators for production data, and no effects of low-altitude and supersonic flights were noted. Three out of 43 cattle previously exposed to low-altitude flights showed a startle response to an F/A-18 aircraft flying overhead at 500 feet above ground level and 400 knots by running less than 10 meters. They resumed normal activity within one minute (U.S. Air Force 1994b). Beyer (1983) found that helicopters caused more reaction than other low-aircraft overflights, and that the helicopters at 30 to 60 feet overhead did not affect milk production and pregnancies of 44 cows and heifers in a 1964 study (U.S. Air Force 1994b).

Additionally, Beyer reported that five pregnant dairy cows in a pasture did not exhibit fright-flight tendencies or disturb their pregnancies after being overflown by 79 low-altitude helicopter flights and 4 low-altitude, subsonic jet aircraft flights (U.S. Air Force 1994b). A 1956 study found that the reactions of dairy and beef cattle to noise from low-altitude, subsonic aircraft were similar to those caused by paper blowing about, strange persons, or other moving objects (U.S. Air Force 1994b).

In a report to Congress, the U. S. Forest Service concluded that "evidence both from field studies of wild ungulates and laboratory studies of domestic stock indicate that the risks of damage are small (from aircraft approaches of 50 to 100 meters), as animals take care not to damage themselves (U.S. Forest Service 1992). If animals are overflown by aircraft at altitudes of 50 to 100 meters, there is no evidence that mothers and young are separated, that animals collide with obstructions (unless confined) or that they traverse dangerous ground at too high a rate." These varied study results suggest that, although the confining of cattle could magnify animal response to aircraft overflight, there is no proven cause-and-effect link between startling cattle from aircraft overflights and abortion rates or lower milk production.

Horses

Horses have also been observed to react to overflights of jet aircraft. Several of the studies reviewed reported a varied response of horses to low-altitude aircraft overflights. Observations made in 1966 and 1968 noted that horses galloped in response to jet flyovers (U.S. Air Force 1993). Bowles (1995) cites Kruger and Erath as observing horses exhibiting intensive flight reactions, random movements, and biting/kicking behavior. However, no injuries or abortions occurred, and there was evidence that the mares adapted somewhat to the flyovers over the course of a month (U.S. Air Force 1994b). Although horses were observed noticing the overflights, it did not appear to affect either survivability or reproductive success. There was also some indication that habituation to these types of disturbances was occurring.

LeBlanc, et al. (1991), studied the effects of F-14 jet aircraft noise on pregnant mares. They specifically focused on any changes in pregnancy success, behavior, cardiac function, hormonal production, and rate of habituation. Their findings reported observations of "flight-fright" reactions, which caused increases in heart rates and serum cortisol concentrations. The mares, however, did habituate to the noise. Levels of anxiety and mass body movements were the highest after initial exposure, with intensities of responses decreasing thereafter. There were no differences in pregnancy success when compared to a control group.

Swine

Generally, the literature findings for swine appear to be similar to those reported for cows and horses. While there are some effects from aircraft noise reported in the literature, these effects are minor. Studies of continuous noise exposure (i.e., 6 hours, 72 hours of constant exposure) reported influences on short-term hormonal production and release. Additional constant exposure studies indicated the observation of stress reactions, hypertension, and electrolyte imbalances (Dufour 1980). A study by Bond, et al. (1963), demonstrated no adverse effects on the feeding efficiency, weight gain, ear physiology, or thyroid and adrenal gland condition of pigs subjected to observed aircraft noise. Observations of heart rate increase were recorded, noting that cessation of the noise resulted in the return to normal heart rates. Conception rates and offspring survivorship did not appear to be influenced by exposure to aircraft noise.

Similarly, simulated aircraft noise at levels of 100 dB to 135 dB had only minor effects on the rate of feed utilization, weight gain, food intake, or reproduction rates of boars and sows exposed, and there were no injuries or inner ear changes observed (Manci, et al. 1988; Gladwin, et al. 1988).

Domestic Fowl

According to a 1994 position paper by the U.S. Air Force on effects of low-altitude overflights (below 1,000 ft) on domestic fowl, overflight activity has negligible effects (U.S. Air Force 1994a). The paper did recognize that given certain circumstances, adverse effects can be serious. Some of the effects can be panic reactions, reduced productivity, and effects on marketability (e.g., bruising of the meat caused during "pile-up" situations).

The typical reaction of domestic fowl after exposure to sudden, intense noise is a short-term startle response. The reaction ceases as soon as the stimulus is ended, and within a few minutes all activity returns to normal. More severe responses are possible depending on the number of birds, the frequency of exposure, and environmental conditions. Large crowds of birds, and birds not previously exposed, are more likely to pile up in response to a noise stimulus (U.S. Air Force 1994a). According to studies and interviews with growers, it is typically the previously unexposed birds that incite panic crowding, and the tendency to do so is markedly reduced within five exposures to the stimulus (U.S. Air Force 1994a). This suggests that the birds habituate relatively quickly. Egg productivity was not adversely affected by infrequent noise bursts, even at exposure levels as high as 120 to 130 dBA.

Between 1956 and 1988, there were 100 recorded claims against the Navy for alleged damage to domestic fowl. The number of claims averaged three per year, with peak numbers of claims following publications of studies on the topic in the early 1960s (U.S. Air Force 1994a). Many of the claims were disproved or did not have sufficient supporting evidence. The claims were filed for the following alleged damages: 55% for panic reactions, 31% for decreased production, 6% for reduced hatchability, 6% for weight loss, and less than 1% for reduced fertility (U.S. Air Force 1994a).

Turkeys

The review of the existing literature suggests that there has not been a concerted or widespread effort to study the effects of aircraft noise on commercial turkeys. One study involving turkeys examined the differences between simulated versus actual overflight aircraft noise, turkey responses to the noise, weight gain, and evidence of habituation (Bowles, et al. 1990a). Findings from the study suggested that turkeys habituated to jet aircraft noise quickly, that there were no growth rate differences between the experimental and control groups, and that there were some behavioral differences that increased the difficulty in handling individuals within the experimental group.

Low-altitude overflights were shown to cause turkey flocks that were kept inside turkey houses to occasionally pile up and experience high mortality rates due to the aircraft noise and a variety of disturbances unrelated to aircraft (U.S. Air Force 1994a).

3.8.2 Wildlife

Studies on the effects of overflights and sonic booms on wildlife have been focused mostly on avian species and ungulates such as caribou and bighorn sheep. Few studies have been conducted on marine mammals, small terrestrial mammals, reptiles, amphibians, and carnivorous mammals. Generally, species that live entirely below the surface of the water have also been ignored due to the fact they do not experience the same level of sound as terrestrial species (National Park Service 1994). Wild ungulates appear to be much more sensitive to noise disturbance than domestic livestock (Manci, et al. 1988). This may be due to previous exposure to disturbances. One common factor appears to be that low-altitude flyovers seem to be more disruptive in terrain where there is little cover (Manci, et al. 1988).

3.8.2.1 MAMMALS

Terrestrial Mammals

Studies of terrestrial mammals have shown that noise levels of 120 dBA can damage mammals' ears, and levels at 95 dBA can cause temporary loss of hearing acuity. Noise from aircraft has affected other large carnivores by causing changes in home ranges, foraging patterns, and breeding behavior. One study recommended that aircraft not be allowed to fly at altitudes below 2,000 feet above ground level over important grizzly and polar bear habitat (Dufour 1980). Wolves have been frightened by low-altitude flights that were 25 to 1,000 feet off the ground. However, wolves have been found to adapt to aircraft overflights and noise as long as they were not being hunted from aircraft (Dufour 1980).

Wild ungulates (American bison, caribou, bighorn sheep) appear to be much more sensitive to noise disturbance than domestic livestock (Weisenberger, et al. 1996). Behavioral reactions may be related to the past history of disturbances by such things as humans and aircraft. Common reactions of reindeer kept in an enclosure exposed to aircraft noise disturbance were a slight startle response, raising of the head, pricking ears, and scenting of the air. Panic reactions and extensive changes in behavior of individual animals were not observed. Observations of caribou in Alaska exposed to fixed-wing aircraft and helicopters showed running and panic reactions occurred when overflights were at an altitude of 200 feet or less. The reactions decreased with increased altitude of overflights, and, with more than 500 feet in altitude, the panic reactions stopped. Also, smaller groups reacted less strongly than larger groups. One negative effect of the running and avoidance behavior is increased expenditure of energy. For a 90-kg animal, the calculated expenditure due to aircraft harassment is 64 kilocalories per minute when running and 20 kilocalories per minute when walking. When conditions are favorable, this expenditure can be counteracted with increased feeding; however, during harsh winter conditions, this may not be possible. Incidental observations of wolves and bears exposed to fixed-wing aircraft and helicopters in the northern regions suggested that wolves are less disturbed than wild ungulates, while grizzly bears showed the greatest response of any animal species observed.

It has been proven that low-altitude overflights do induce stress in animals. Increased heart rates, an indicator of excitement or stress, have been found in pronghorn antelope, elk, and bighorn sheep. As such reactions occur naturally as a response to predation, infrequent overflights may not, in and of themselves, be detrimental. However, flights at high frequencies over a long period of time may cause harmful effects. The consequences of this disturbance, while cumulative, is not additive. It may be that aircraft disturbance may not cause obvious and serious health effects, but coupled with a harsh winter, it may have an adverse impact. Research has shown that stress induced by other types of disturbances produces long-term decreases in metabolism and hormone balances in wild ungulates.

Behavioral responses can range from mild to severe. Mild responses include head raising, body shifting, or turning to orient toward the aircraft. Moderate disturbance may be nervous behaviors, such as trotting a short distance. Escape is the typical severe response.

Marine Mammals

The physiological composition of the ear in aquatic and marine mammals exhibits adaptation to the aqueous environment. These differences (relative to terrestrial species) manifest themselves in the auricle and middle ear (Manci, et al. 1988). Some mammals use echolocation to perceive objects in their surroundings and to determine the directions and locations of sound sources (Simmons 1983 in Manci, et al. 1988).

In 1980, the Acoustical Society of America held a workshop to assess the potential hazard of manmade noise associated with proposed Alaska Arctic (North Slope-Outer Continental Shelf) petroleum operations on marine wildlife and to prepare a research plan to secure the knowledge necessary for proper assessment of noise impacts (Acoustical Society of America, 1980). Since 1980 it appears that research on responses of aquatic mammals to aircraft noise and sonic booms has been limited. Research conducted on northern fur seals, sea lions, and ringed seals indicated that there are some differences in how various animal groups receive frequencies of sound. It was observed that these species exhibited varying intensities of a startle response to airborne noise, which was habituated over time. The rates of habituation appeared to vary with species, populations, and demographics (age, sex). Time of day of exposure was also a factor (Muyberg 1978 in Manci, et al. 1988).

Studies accomplished near the Channel Islands were conducted near the area where the space shuttle launches occur. It was found that there were some response differences between species relative to the loudness of sonic booms. Those booms that were between 80 and 89 dBA caused a greater intensity of startle reactions than lower-intensity booms at 72 to 79 dBA. However, the duration of the startle responses to louder sonic booms was shorter (Jehl and Cooper 1980 in Manci, et al. 1988).

Jehl and Cooper (1980) indicated that low-flying helicopters, loud boat noises, and humans were the most disturbing to pinnipeds. According to the research, while the space launch and associated operational activity noises have not had a measurable effect on the pinniped population, it also suggests that there was a greater "disturbance level" exhibited during launch activities. There was a recommendation to continue observations for behavioral effects and to perform long-term population monitoring (Jehl and Cooper 1980).

The continued presence of single or multiple noise sources could cause marine mammals to leave a preferred habitat. However, it does not appear likely that overflights could cause migration from suitable habitats as aircraft noise over water is mobile and would not persist over any particular area. Aircraft noise, including supersonic noise, currently occurs in the overwater airspace of Eglin, Tyndall, and Langley AFBs from sorties predominantly involving jet aircraft. Survey results reported in Davis, et al. (2000), indicate that cetaceans (i.e., dolphins) occur under all of the Eglin and Tyndall marine airspace. The continuing presence of dolphins indicates that aircraft noise does not discourage use of the area and apparently does not harm the locally occurring population.

In a summary by the National Parks Service (1994) on the effects of noise on marine mammals, it was determined that gray whales and harbor porpoises showed no outward behavioral response to aircraft noise or overflights. Bottlenose dolphins showed no obvious reaction in a study involving helicopter overflights at 1,200 to 1,800 feet above the water. Neither did they show any reaction to survey aircraft unless the shadow of the aircraft passed over them, at which point there was some observed tendency to dive (Richardson, et al. 1995). Other anthropogenic noises in the marine environment from ships and pleasure craft may have more of an effect on marine mammals than aircraft noise (U.S. Air Force 2000). The noise effects on cetaceans appear to be somewhat attenuated by the air/water interface. The cetacean fauna along the coast of California have been subjected to sonic booms from military aircraft for many years without apparent adverse effects (Tetra Tech, Inc. 1997).

Manatees appear relatively unresponsive to human-generated noise to the point that they are often suspected of being deaf to oncoming boats [although their hearing is actually similar to that of pinnipeds (Bullock, et al. 1980)]. Little is known about the importance of acoustic communication to manatees, although they are known to produce at least ten different types of sounds and are thought to have sensitive hearing (Richardson, et al. 1995). Manatees continue to occupy canals near Miami International Airport, which suggests that they have become habituated to human disturbance and noise (Metro-Dade County 1995). Since manatees spend most of their time below the surface and do not startle readily, no effect of aircraft overflights on manatees would be expected (Bowles, et al. 1991b).

3.8.2.2 BIRDS

Auditory research conducted on birds indicates that they fall between the reptiles and the mammals relative to hearing sensitivity. According to Dooling (1978), within the range of one to five kHz, birds show a level of hearing sensitivity similar to that of the more sensitive mammals. In contrast to mammals, bird sensitivity falls off at a greater rate to increasing and decreasing frequencies. Passive observations and studies examining aircraft bird strikes indicate that birds nest and forage near airports. Aircraft noise in the vicinity of commercial airports apparently does not inhibit bird presence and use.

High-noise events (like a low-altitude aircraft overflight) may cause birds to engage in escape or avoidance behaviors, such as flushing from perches or nests (Ellis, et al. 1991). These activities impose an energy cost on the birds that, over the long term, may affect survival or growth. In addition, the birds may spend less time engaged in necessary activities like feeding, preening, or caring for their young because they spend time in noise-avoidance activity. However, the long-term significance of noise-related impacts is less clear. Several studies on nesting raptors have indicated that birds become habituated to aircraft overflights and that long-term reproductive success is not affected (Grubb and King 1991; Ellis, et al. 1991). Threshold noise levels for significant responses range from 62 dB for Pacific black brant (Branta bernicla nigricans) (Ward and Stehn 1990) to 85 dB for crested tern (Sterna bergii) (Brown 1990).

Songbirds were observed to become silent prior to the onset of a sonic boom event (F-111 jets), followed by "raucous discordant cries." There was a return to normal singing within 10 seconds after the boom (Higgins 1974 in Manci, et al. 1988). Ravens responded by emitting protestation calls, flapping their wings, and soaring.

Manci, et al. (1988), reported a reduction in reproductive success in some small territorial passerines (i.e., perching birds or songbirds) after exposure to low-altitude overflights. However, it has been observed that passerines are not driven any great distance from a favored food source by a nonspecific disturbance, such as aircraft overflights (U.S. Forest Service 1992). Further study may be warranted.

A recent study, conducted cooperatively between the DoD and the USFWS, assessed the response of the red-cockaded woodpecker to a range of military training noise events, including artillery, small arms, helicopter, and maneuver noise (Pater, et al. 1999). The project findings show that the red-cockaded woodpecker successfully acclimates to military noise events. Depending on the noise level that ranged from innocuous to very loud, the birds responded by flushing from their nest cavities. When the noise source was closer and the noise level was higher, the number of flushes increased proportionately. In all cases, however, the birds returned to their nests within a relatively short period of time (usually within 12 minutes). Additionally, the noise exposure did not result in any mortality or statistically detectable changes in reproductive success (Pater, et al. 1999). Red-cockaded woodpeckers did not flush when artillery simulators were more than 122 meters away and SEL noise levels were 70 dBA.

Lynch and Speake (1978) studied the effects of both real and simulated sonic booms on the nesting and brooding eastern wild turkey (Meleagris gallopavo silvestris) in Alabama. Hens at four nest sites were subjected to between 8 and 11 combined real and simulated sonic booms. All tests elicited similar responses, including quick lifting of the head and apparent alertness for between 10 and 20 seconds. No apparent nest failure occurred as a result of the sonic booms.

Twenty-one brood groups were also subjected to simulated sonic booms. Reactions varied slightly between groups, but the largest percentage of groups reacted by standing motionless after the initial blast. Upon the sound of the boom, the hens and poults fled until reaching the edge of the woods (approximately 4 to 8 meters). Afterward, the poults resumed feeding activities while the hens remained alert for a short period of time (approximately 15 to 20 seconds). In no instances were poults abandoned, nor did they scatter and become lost. Every observation group returned to normal activities within a maximum of 30 seconds after a blast.

3.8.2.2.1 RAPTORS

In a literature review of raptor responses to aircraft noise, Manci, et al. (1988), found that most raptors did not show a negative response to overflights. When negative responses were observed they were predominantly associated with rotor-winged aircraft or jet aircraft that were repeatedly passing within 0.5 mile of a nest.

Ellis, et al. (1991), performed a study to estimate the effects of low-level military jet aircraft and mid- to high-altitude sonic booms (both actual and simulated) on nesting peregrine falcons and seven other raptors (common black-hawk, Harris' hawk, zone-tailed hawk, red-tailed hawk, golden eagle, prairie falcon, bald eagle). They observed responses to test stimuli, determined nest success for the year of the testing, and evaluated site occupancy the following year. Both long- and short-term effects were noted in the study. The results reported the successful fledging of young in 34 of 38 nest sites (all eight species) subjected to low-level flight and/or simulated sonic booms. Twenty-two of the test sites were revisited in the following year, and observations of pairs or lone birds were made at all but one nest.

Nesting attempts were underway at 19 of 20 sites that were observed long enough to be certain of breeding activity. Reoccupancy and productivity rates were within or above expected values for self-sustaining populations.

Short-term behavior responses were also noted. Overflights at a distance of 150 m or less produced few significant responses and no severe responses. Typical responses consisted of crouching or, very rarely, flushing from the perch site. Significant responses were most evident before egg laying and after young were "well grown." Incubating or brooding adults never burst from the nest, thus preventing egg breaking or knocking chicks out of the nest. Jet passes and sonic booms often caused noticeable alarm; however, significant negative responses were rare and did not appear to limit productivity or reoccupancy. Due to the locations of some of the nests, some birds may have been habituated to aircraft noise. There were some test sites located at distances far from zones of frequent military aircraft usage, and the test stimuli were often closer, louder, and more frequent than would be likely for a normal training situation.

Manci, et al. (1988), noted that a female northern harrier was observed hunting on a bombing range in Mississippi during bombing exercises. The harrier was apparently unfazed by the exercises, even when a bomb exploded within 200 feet. In a similar case of habituation/non-disturbance, a study on the Florida snail-kite stated the greatest reaction to overflights (approximately 98 dBA) was "watching the aircraft fly by." No detrimental impacts to distribution, breeding success, or behavior were noted.

Bald Eagle

A study by Grubb and King (1991) on the reactions of the bald eagle to human disturbances showed that terrestrial disturbances elicited the greatest response, followed by aquatic (i.e., boats) and aerial disturbances. The disturbance regime of the area where the study occurred was predominantly characterized by aircraft noise. The study found that pedestrians consistently caused responses that were greater in both frequency and duration. Helicopters elicited the highest level of aircraft-related responses. Aircraft disturbances, although the most common form of disturbance, resulted in the lowest levels of response. This low response level may have been due to habituation; however, flights less than 170 meters away caused reactions similar to other disturbance types. Ellis, et al. (1991), showed that eagles typically respond to the proximity of a disturbance, such as a pedestrian or aircraft within 100 meters, rather than the noise level. Fleischner and Weisberg (1986) stated that reactions of bald eagles to commercial jet flights, although minor (e.g., looking), were twice as likely to occur when the jets passed at a distance of 0.5 mile or less. They also noted that helicopters were four times more likely to cause a reaction than a commercial jet and 20 times more likely to cause a reaction than a propeller plane.

The USFWS advised Cannon AFB that flights at or below 2,000 feet AGL from October 1 through March 1 could result in adverse impacts to wintering bald eagles (U.S. Fish and Wildlife Serice 1998). However, Fraser, et al. (1985), suggested that raptors habituate to overflights rapidly, sometimes tolerating aircraft approaches of 65 feet or less.

Osprey

A study by Trimper, et al. (1998), in Goose Bay, Labrador, Canada, focused on the reactions of nesting osprey to military overflights by CF-18 Hornets. Reactions varied from increased alertness and focused observation of planes to adjustments in incubation posture. No overt reactions (e.g., startle response, rapid nest departure) were observed as a result of an overflight. Young nestlings crouched as a result of any disturbance until they grew to 1 to 2 weeks prior to fledging. Helicopters, human presence, float planes, and other ospreys elicited the strongest reactions from nesting ospreys. These responses included flushing, agitation, and aggressive displays. Adult osprey showed high nest occupancy rates during incubation regardless of external influences.

The osprey observed occasionally stared in the direction of the flight before it was audible to the observers. The birds may have been habituated to the noise of the flights; however, overflights were strictly controlled during the experimental period. Strong reactions to float planes and helicopter may have been due to the slower flight and therefore longer duration of visual stimuli rather than noise-related stimuli.

Red-tailed Hawk

Anderson, et al. (1989), conducted a study that investigated the effects of low-level helicopter overflights on 35 red-tailed hawk nests. Some of the nests had not been flown over prior to the study. The hawks that were naïve (i.e., not previously exposed) to helicopter flights exhibited stronger avoidance behavior (nine of 17 birds flushed from their nests) than those that had experienced prior overflights. The overflights did not appear to affect nesting success in either study group. These findings were consistent with the belief that red-tailed hawks habituate to low-level air traffic, even during the nesting period.

3.8.2.2.2 MIGRATORY WATERFOWL

A study of caged American black ducks was conducted by Fleming, et al. in 1996. It was determined that noise had negligible energetic and physiologic effects on adult waterfowl. Measurements included body weight, behavior, heart rate, and enzymatic activity. Experiments also showed that adult ducks exposed to high noise events acclimated rapidly and showed no effects.

The study also investigated the reproductive success of captive ducks, which indicated that duckling growth and survival rates at Piney Island, North Carolina, were lower than those at a background location. In contrast, observations of several other reproductive indices (i.e., pair formation, nesting, egg production, and hatching success) showed no difference between Piney Island and the background location. Potential effects on wild duck populations may vary, as wild ducks at Piney Island have presumably acclimated to aircraft overflights. It was not demonstrated that noise was the cause of adverse impacts. A variety of other factors, such as weather conditions, drinking water and food availability and variability, disease, and natural variability in reproduction, could explain the observed effects. Fleming noted that drinking water conditions (particularly at Piney Island) deteriorated during the study, which could have affected the growth of young ducks. Further research would be necessary to determine the cause of any reproductive effects.

Another study by Conomy, et al. (1998) exposed previously unexposed ducks to 71 noise events per day that equaled or exceeded 80 dBA. It was determined that the proportion of time black ducks reacted to aircraft activity and noise decreased from 38 percent to 6 percent in 17 days and remained stable at 5.8 percent thereafter. In the same study, the wood duck did not appear to habituate to aircraft disturbance. This supports the notion that animal response to aircraft noise is species-specific. Because a startle response to aircraft noise can result in flushing from nests, migrants and animals living in areas with high concentrations of predators would be the most vulnerable to experiencing effects of lowered birth rates and recruitment over time. Species that are subjected to infrequent overflights do not appear to habituate to overflight disturbance as readily.

Black brant studied in the Alaska Peninsula were exposed to jets and propeller aircraft, helicopters, gunshots, people, boats, and various raptors. Jets accounted for 65% of all the disturbances. Humans, eagles, and boats caused a greater percentage of brant to take flight. There was markedly greater reaction to Bell-206-B helicopter flights than fixed wing, single-engine aircraft (Ward, et al. 1986).

The presence of humans and low-flying helicopters in the Mackenzie Valley North Slope area did not appear to affect the population density of Lapland longspurs, but the experimental group was shown to have reduced hatching and fledging success and higher nest abandonment. Human presence appeared to have a greater impact on the incubating behavior of the black brant, common eider, and Arctic tern than fixed-wing aircraft (Gunn and Livingston 1974).

Gunn and Livingston (1974) found that waterfowl and seabirds in the Mackenzie Valley and North Slope of Alaska and Canada became acclimated to float plane disturbance over the course of three days. Additionally, it was observed that potential predators (bald eagle) caused a number of birds to leave their nests. Non-breeding birds were observed to be more reactive than breeding birds. Waterfowl were affected by helicopter flights, while snow geese were disturbed by Cessna 185 flights. The geese flushed when the planes were under 1,000 feet, compared to higher flight elevations. An overall reduction in flock sizes was observed. It was recommended that aircraft flights be reduced in the vicinity of premigratory staging areas.

Manci, et al. 1988 reported that waterfowl were particularly disturbed by aircraft noise. The most sensitive appeared to be snow geese. Canada geese and snow geese were thought to be more sensitive than other animals such as turkey vultures, coyotes, and raptors (Edwards, et al. 1979).

3.8.2.2.3 WADING AND SHORE BIRDS

Black, et al. (1984), studied the effects of low-altitude (less than 500 feet AGL) military training flights with sound levels from 55 to 100 dBA on wading bird colonies (i.e., great egret, snowy egret, tricolored heron, and little blue heron). The training flights involved three or four aircraft, which occurred once or twice per day. This study concluded that the reproductive activity--including nest success, nestling survival, and nestling chronology--was independent of F-16 overflights. Dependent variables were more strongly related to ecological factors, including location and physical characteristics of the colony and climatology. Another study on the effects of circling fixed-wing aircraft and helicopter overflights on wading bird colonies found that at altitudes of 195 to 390 feet, there was no reaction in nearly 75 percent of the 220 observations. Ninety percent displayed no reaction or merely looked toward the direction of the noise source. Another 6 percent stood up, 3 percent walked from the nest, and 2 percent flushed (but were without active nests) and returned within 5 minutes (Kushlan 1978). Apparently, non-nesting wading birds had a slightly higher incidence of reacting to overflights than nesting birds. Seagulls observed roosting near a colony of wading birds in another study remained at their roosts when subsonic aircraft flew overhead (Burger 1981). Colony distribution appeared to be most directly correlated to available wetland community types and was found to be distributed randomly with respect to military training routes. These results suggest that wading bird species presence was most closely linked to habitat availability and that they were not affected by low-level military overflights (U.S. Air Force 2000).

Burger (1986) studied the response of migrating shorebirds to human disturbance and found that shorebirds did not fly in response to aircraft overflights, but did flush in response to more localized intrusions (i.e., humans and dogs on the beach). Burger (1981) studied the effects of noise from JFK Airport in New York on herring gulls that nested less than 1 kilometer from the airport. Noise levels over the nesting colony were 85 to 100 dBA on approach and 94 to 105 dBA on takeoff. Generally, there did not appear to be any prominent adverse effects of subsonic aircraft on nesting, although some birds flushed when the concorde flew overhead and, when they returned, engaged in aggressive behavior. Groups of gulls tended to loaf in the area of the nesting colony, and these birds remained at the roost when the Concorde flew overhead. Up to 208 of the loafing gulls flew when supersonic aircraft flew overhead. These birds would circle around and immediately land in the loafing flock (U.S. Air Force 2000).

In 1970, sonic booms were potentially linked to a mass hatch failure of Sooty Terns on the Dry Tortugas (Austin, et al. 1970). The cause of the failure was not certain, but it was conjectured that sonic booms from military aircraft or an overgrowth of vegetation were factors. In the previous season, Sooties were observed to react to sonic booms by rising in a "panic flight," circling over the island, then usually settling down on their eggs again. Hatching that year was normal. Following the 1969 hatch failure, excess vegetation was cleared and measures were taken to reduce supersonic activity. The 1970 hatch appeared to proceed normally. A colony of Noddies on the same island hatched successfully in 1969, the year of the Sooty hatch failure.

Subsequent laboratory tests of exposure of eggs to sonic booms and other impulsive noises (Bowles, et al. 1991a; Bowles, et al. 1994; Cottereau 1972; Cogger and Zegarra 1980) failed to show adverse effects on hatching of eggs. A structural analysis (Ting, et al. 2002) showed that, even under extraordinary circumstances, sonic booms would not damage an avian egg.

Burger (1981) observed no effects of subsonic aircraft on herring gulls in the vicinity of JFK International Airport. The Concorde aircraft did cause more nesting gulls to leave their nests (especially in areas of higher density of nests), causing the breakage of eggs and the scavenging of eggs by intruder prey. Clutch sizes were observed to be smaller in areas of higher-density nesting (presumably due to the greater tendency for panic flight) than in areas where there were fewer nests.

3.8.3 Fish, Reptiles, and Amphibians

The effects of overflight noise on fish, reptiles, and amphibians have been poorly studied, but conclusions regarding their expected responses have involved speculation based upon known physiologies and behavioral traits of these taxa (Gladwin, et al. 1988). Although fish do startle in response to low-flying aircraft noise, and probably to the shadows of aircraft, they have been found to habituate to the sound and overflights. Reptiles and amphibians that respond to low frequencies and those that respond to ground vibration, such as spadefoots (genus Scaphiopus), may be affected by noise. Limited information is available on the effects of short-duration noise events on reptiles. Dufour (1980) and Manci, et al. (1988), summarized a few studies of reptile responses to noise. Some reptile species tested under laboratory conditions experienced at least temporary threshold shifts or hearing loss after exposure to 95 dB for several minutes. Crocodilians in general have the most highly developed hearing of all reptiles. Crocodile ears have lids that can be closed when the animal goes under water. These lids can reduce the noise intensity by 10 to 12 dB (Wever and Vernon 1957). On Homestead Air Reserve Station, Florida, two crocodilians (the American Alligator and the Spectacled Caiman) reside in wetlands and canals along the base runway suggesting that they can coexist with existing noise levels of an active runway including DNLs of 85 dB.

3.8.4 Summary

Some physiological/behavioral responses such as increased hormonal production, increased heart rate, and reduction in milk production have been described in a small percentage of studies. A majority of the studies focusing on these types of effects have reported short-term or no effects.

The relationships between physiological effects and how species interact with their environments have not been thoroughly studied. Therefore, the larger ecological context issues regarding physiological effects of jet aircraft noise (if any) and resulting behavioral pattern changes are not well understood.

Animal species exhibit a wide variety of responses to noise. It is therefore difficult to generalize animal responses to noise disturbances or to draw inferences across species, as reactions to jet aircraft noise appear to be species-specific. Consequently, some animal species may be more sensitive than other species and/or may exhibit different forms or intensities of behavioral responses. For instance, wood ducks appear to be more sensitive and more resistant to acclimation to jet aircraft noise than Canada geese in one study. Similarly, wild ungulates seem to be more easily disturbed than domestic animals.

The literature does suggest that common responses include the “startle” or “fright” response and, ultimately, habituation. It has been reported that the intensities and durations of the startle response decrease with the numbers and frequencies of exposures, suggesting no long-term adverse effects. The majority of the literature suggests that domestic animal species (cows, horses, chickens) and wildlife species exhibit adaptation, acclimation, and habituation after repeated exposure to jet aircraft noise and sonic booms.

Animal responses to aircraft noise appear to be somewhat dependent on, or influenced by, the size, shape, speed, proximity (vertical and horizontal), engine noise, color, and flight profile of planes. Helicopters also appear to induce greater intensities and durations of disturbance behavior as compared to fixed-wing aircraft. Some studies showed that animals that had been previously exposed to jet aircraft noise exhibited greater degrees of alarm and disturbance to other objects creating noise, such as boats, people, and objects blowing across the landscape. Other factors influencing response to jet aircraft noise may include wind direction, speed, and local air turbulence; landscape structures (i.e., amount and type of vegetative cover); and, in the case of bird species, whether the animals are in the incubation/nesting phase.

3.9 Property Values

Property within a noise zone (or Accident Potential Zone) may be affected by the availability of federally guaranteed loans. According to U.S. Department of Housing and Urban Development (HUD), Federal Housing Administration (FHA), and Veterans Administration (VA) guidance, sites are acceptable for program assistance, subsidy, or insurance for housing in noise zones of less than 65 dB DNL, and sites are conditionally acceptable with special approvals and noise attenuation in the 65 to 75 dB DNL noise zone and the greater than 75 dB DNL noise zone. HUD's position is that noise is not the only determining factor for site acceptability, and properties should not be rejected only because of airport influences if there is evidence of acceptability within the market and if use of the dwelling is expected to continue. Similar to the Navy's and Air Force's Air Installation Compatible Use Zone Program, HUD, FHA, and VA recommend sound attenuation for housing in the higher noise zones and written disclosures to all prospective buyers or lessees of property within a noise zone (or Accident Potential Zone).

Newman and Beattie (1985) reviewed the literature to assess the effect of aircraft noise on property values. One paper by Nelson (1978), reviewed by Newman and Beattie, suggested a 1.8 to 2.3 percent decrease in property value per decibel at three separate airports, while at another period of time, they found only a 0.8 percent devaluation per decibel change in DNL. However, Nelson also noted a decline in noise depreciation over time which he theorized could be due to either noise sensitive people being replaced by less sensitive people or the increase in commercial value of the property near airports; both ideas were supported by Crowley (1978). Ultimately, Newman and Beattie summarized that while an effect of noise was observed, noise is only one of the many factors that is part of a decision to move close to, or away from, an airport, but which is sometimes considered an advantage due to increased opportunities for employment or ready access to the airport itself. With all the issues associated with determining property values, their reviews found that decreases in property values usually range from 0.5 to 2 percent per decibel increase of cumulative noise exposure.

More recently Fidell, et al. (1996) studied the influences of aircraft noise on actual sale prices of residential properties in the vicinity of two military facilities and found that equations developed for one area to predict residential sale prices in areas unaffected by aircraft noise worked equally well when applied to predicting sale prices of homes in areas with aircraft noise in excess of 65 dB DNL. Thus, the model worked equally well in predicting sale prices in areas with and without aircraft noise exposure. This indicates that aircraft noise had no meaningful effect on residential property values. In some cases, the average sale prices of noise exposed properties were somewhat higher than those elsewhere in the same area. In the vicinity of Davis-Monthan AFB in Tucson, AZ, Fidell found the homes near the AFB were much older, smaller and in poorer condition than homes elsewhere. These factors caused the equations developed for predicting sale prices in areas further away from the base to be inapplicable with those nearer the AFB. However, again Fidell found that, similar to other researchers, differences in sale prices between homes with and without aircraft noise were frequently due to factors other than noise itself.

3.10 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, especially in mountainous areas, causing landslides or avalanches. There are no known instances of such effects, and it is considered improbable that such effects would result from routine, subsonic aircraft operations.

3.11 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. Particularly in older structures, seemingly insignificant surface cracks initiated by vibrations from aircraft noise may lead to greater damage from natural forces (Hanson, et al. 1991). 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 Concorde airplane at Dulles (Wesler 1977). There was 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 conventional structures, assessments of noise exposure levels for normally compatible land uses should also be protective of historic and archaeological sites.

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Appendix B

Land Use Compatibility Recommendations

Adapted from the Air Installations Compatible Use Zones Program
Office of the Chief of Naval Operations Instruction
(OPNAVINST) 11010.36C
U.S. Department of the Navy, October 9, 2008

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Table B-1
Land Use Compatibility Recommendations

Land Use		Accident Potential Areas[1]			Noise Levels			
SLUCM No.	Name	Clear Zone	APZ I	APZ II	65 to 70 DNL	70 to 75 DNL	75 to 80 DNL	80 to 85 DNL
10	Residential							
11	Household units	NA	NA	NA	N[26]	N[26]	N	N
11.11	Single units; detached	N	N	Y[2]	N[26]	N[26]	N	N
11.12	Single units; semidetached	N	N	N	N[26]	N[26]	N	N
11.13	Single units; attached row	N	N	N	N[26]	N[26]	N	N
11.21	Two units; side-by-side	N	N	N	N[26]	N[26]	N	N
11.22	Two units; one above the other	N	N	N	N[26]	N[26]	N	N
11.31	Apartments; walk up	N	N	N	N[26]	N[26]	N	N
11.32	Apartments; elevator	N	N	N	N[26]	N[26]	N	N
12	Group quarters	N	N	N	N[26]	N[26]	N	N
13	Residential hotels	N	N	N	N[26]	N[26]	N	N
14	Mobile home parks or courts	N	N	N	N	N	N	N
15	Transient lodgings	N	N	N	N[26]	N[26]	N[26]	N
16	Other residential	N	N	N	N[26]	N[26]	N	N
20	Manufacturing [3]							
21	Food and kindred products; manufacturing	N	N	Y[4]	Y	Y[27]	Y[22]	Y[29]
22	Textile mill products; manufacturing	N	N	Y[4]	Y	Y[27]	Y[28]	Y[29]
23	Apparel and other finished products made from fabrics, leather, and similar materials; manufacturing	N	N	N	Y	Y[27]	Y[28]	Y[29]
24	Lumber and wood products (except furniture); manufacturing	N	Y[5]	Y[5]	Y	Y[27]	Y[28]	Y[29]
25	Furniture and fixtures; manufacturing	N	Y[5]	Y[5]	Y	Y[27]	Y[28]	Y[29]
26	Paper and allied products; manufacturing	N	Y[5]	Y[5]	Y	Y[27]	Y[28]	Y[29]
27	Printing, publishing, and allied industries	N	Y[5]	Y[5]	Y	Y[27]	Y[28]	Y[29]
28	Chemicals and allied products; manufacturing	N	N	N	Y	Y[27]	Y[28]	Y[29]
29	Petroleum refining and related industries	N	N	N	Y	Y[27]	Y[28]	Y[29]
30	Manufacturing (cont'd) [3]							Y[29]
31	Rubber and misc. plastic products; manufacturing	N	N	N	Y	Y[27]	Y[28]	Y[29]
32	Stone, clay, and glass products; manufacturing	N	N	Y[5]	Y	Y[27]	Y[28]	Y[29]
33	Primary metal products; manufacturing	N	N	Y[5]	Y	Y[27]	Y[28]	Y[29]
34	Fabricated metal products; manufacturing	N	N	Y[5]	Y	Y[27]	Y[28]	Y[29]

Table B-1
Land Use Compatibility Recommendations

Land Use		Accident Potential Areas[1]			Noise Levels			
SLUCM No.	Name	Clear Zone	APZ I	APZ II	65 to 70 DNL	70 to 75 DNL	75 to 80 DNL	80 to 85 DNL
35	Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks; manufacturing	N	N	N	Y	25	30	N
39	Miscellaneous manufacturing	N	Y[6]	Y[6]	Y	Y[27]	Y[28]	Y[29]
40	Transportation, communication and utilities [3,6]					Y[27]		
41	Railroad, rapid rail transit, and street railway transportation	N	Y [3,7]	Y[3]	Y	Y[27]	Y[28]	Y[29]
42	Motor vehicle transportation	N	Y [3,7]	Y[3]	Y	Y[27]	Y[28]	Y[29]
43	Aircraft transportation	N	Y [3,7]	Y[3]	Y	Y[27]	Y[28]	Y[29]
44	Marine craft transportation	N	Y [3,7]	Y[3]	Y	Y[27]	Y[28]	Y[29]
45	Highway and street right-of-way	N	Y [3,7]	Y[3]	Y	Y[27]	Y[28]	Y[29]
46	Automobile parking	N	Y [3,7]	Y[3]	Y	Y[27]	Y[28]	Y[29]
47	Communication	N	Y [3,7]	Y[3]	Y	25,30	30,30	N
48	Utilities	N	Y [3,7]	Y[3]	Y	Y[27]	Y[28]	Y[29]
485	Solid waste disposal (landfills, incineration, etc.)	N	N	N	NA	NA	NA	NA
49	Other transportation, communication, and utilities	N	Y [3,7]	Y[3]	Y	25,30	30,30	N
50	Trade							
51	Wholesale trade	N	Y[5]	Y[5]	Y	Y[27]	Y[28]	Y[29]
52	Retail trade – building materials, hardware, and farm equipment	N	Y[8]	Y[8]	Y	Y[27]	Y[28]	Y[29]
53	Retail trade – shopping centers	N	N[9]	Y[9]	Y	25	30	N
54	Retail trade – food	N	N	Y[10]	Y	25	30	N
55	Retail trade – automotive, marine craft, aircraft, and accessories	N	Y[8]	Y[8]	Y	25	30	N
56	Retail trade – apparel and accessories	N	N	Y[11]	Y	25	30	N
57	Retail trade – furniture, home furnishings, and equipment	N	N	Y[11]	Y	25	30	N
58	Retail trade – eating and drinking establishments	N	N	N	Y	25	30	N
59	Other retail trade	N	N	Y[9]	Y	25	30	N
60	Services [12]							
61	Finance, insurance, and real estate services	N	N	Y[13]	Y	25	30	N
62	Personal services	N	N	Y[14]	Y	25	30	N
62.4	Cemeteries	N	Y[15]	Y[15]	Y	Y[27]	Y[28]	Y [29,24]

Table B-1 Land Use Compatibility Recommendations								
Land Use		Accident Potential Areas[1]			Noise Levels			
SLUCM No.	Name	Clear Zone	APZ I	APZ II	65 to 70 DNL	70 to 75 DNL	75 to 80 DNL	80 to 85 DNL
63	Business services	N	N	Y[16]	Y	25	30	N
63.7	Warehousing and storage	N	Y[17]	Y[17]	Y	Y[27]	Y[28]	Y[29]
64	Repair services	N	Y[18]	Y[18]	Y	Y[27]	Y[28]	Y[29]
65	Professional services	N	N	Y[9]	Y	25	30	N
65.1	Hospitals, other medical facilities	N	N	N	25	30	N	N
65.16	Nursing homes	N	N	N	N[26]	N[26]	N	N
66	Contract construction services	N	Y[18]	Y[18]	Y	25	30	N
67	Governmental services	N	N	Y[10]	Y[26]	25	30	N
68	Educational services	N	N	N	25	30	N	N
69	Miscellaneous services	N	N	Y[9]	Y	25	30	N
70	Cultural, entertainment and recreational							
71	Cultural activities (including churches)	N	N	N	25	30	N	N
71.2	Nature exhibits	N	Y[19]	Y[19]	Y[26]	N	N	N
72	Public assembly	N	N	N	Y	N	N	N
72.1	Auditoriums, concert halls	N	N	N	25	30	N	N
72.11	Outdoor music shells, amphitheaters	N	N	N	N	N	N	N
72.2	Outdoor sports arenas, spectator sports	N	N	N	Y[31]	Y[31]	N	N
73	Amusements (including fairgrounds, miniature golf, driving ranges, amusement parks)	N	N	Y	Y	Y	N	N
74	Recreational activities (including golf courses, riding stables, water recreation)	N	Y[18,19]	Y[18,19]	Y[26]	25	30	N
75	Resorts and group camps	N	N	N	Y[26]	Y[26]	N	N
76	Parks	N	Y[18,19]	Y[18,19]	Y[26]	Y[26]	N	N
79	Other cultural, entertainment and recreation	N	Y[18,19]	Y[18,19]	Y[26]	Y[26]	N	N
80	Resource production and extraction							
81	Agriculture (except livestock)	Y[6]	Y[20]	Y[20]	Y[32]	Y[33]	Y[34]	Y[34,35]
81.5, 81.7	Livestock farming and animal breeding	N	Y[20,21]	Y[20,21]	Y[32]	Y[33]	N	N
82	Agricultural related activities	N	Y[20,22]	Y[20,22]	Y[32]	Y[33]	Y[34]	Y[34,35]
83	Forestry activities and related services [23]	N	Y[22]	Y[22]	Y[32]	Y[33]	Y[34]	Y[34,35]
84	Fishing activities and related services [24]	N[24]	Y[22]	Y[22]	Y	Y	Y	Y
85	Mining activities and related services	N	Y[22]	Y[22]	Y	Y	Y	Y

Table B-1 Land Use Compatibility Recommendations								
Land Use		Accident Potential Areas[1]			Noise Levels			
SLUCM No.	Name	Clear Zone	APZ I	APZ II	65 to 70 DNL	70 to 75 DNL	75 to 80 DNL	80 to 85 DNL
89	Other resource production and extraction	N	Y[22]	Y[22]	Y	Y	Y	Y
90	Other							
91	Undeveloped land	Y	Y	Y	NA	NA	NA	NA
93	Water areas	N[25]	N[25]	N[25]	NA	NA	NA	NA

Source: U.S. Department of the Navy 2008.

Notes:

1. A “Yes” or a “No” designation for compatible land use is to be used only for general comparison. Within each, uses exist where further evaluation may be needed in each category as to whether it is clearly compatible, normally compatible, or not compatible due to the variation of densities of people and structures. In order to assist installations and local governments, general suggestions as to floor/area ratios (FAR) are provided in OPNAVINST 11010.36C as a guide to density in some categories. In general, land use restrictions that limit commercial, services, or industrial buildings or structure occupants to 25 per acre in APZ I and 50 per acre in APZ II are the range of occupancy levels considered to be low density. Outside events should normally be limited to assemblies of not more than 25 people per acre in APZ I, and maximum assemblies of 50 people per acre in APZ II.
2. The suggested maximum density for detached single-family housing is 1 to 2 dwelling units per acre (Du/Ac). In a Planned Unit Development (PUD) of single-family detached units where clustered housing development results in large open areas, this density could possibly be increased, provided the amount of surface area covered by structures does not exceed 20% of the PUD total area. PUD encourages clustered development that leaves large open areas.
3. Other factors to be considered: Labor intensity, structural coverage, explosive characteristics, air pollution, electronic interference with aircraft, height of structures, and potential glare.
4. Maximum FAR of 0.56.
5. Maximum FAR of 0.28 in APZ I and 0.56 in APZ II.
6. No structures (except airfield lighting), buildings or aboveground utility/communications lines should normally be located in clear zone areas on or off the installation. The clear zone is subject to severe restrictions. See NAVFAC P-80.3 or Tri-Service Manual AFM 32-1123(I); TM 5-803-7, NAVFAC P-971 “Airfield and Heliport Planning & Design” dated 17 November 2008 for specific design details.
7. No passenger terminals and no major aboveground transmission lines in APZ I.
8. Maximum FAR of 0.14 in APZ I and 0.28 in APZ II.
9. Maximum FAR of 0.22.
10. Maximum FAR of 0.24.
11. Maximum FAR of 0.28.
12. Low intensity office uses only. Accessory uses such as meeting places, auditoriums, etc., are not recommended.
13. Maximum FAR of 0.22 for “General Office/Office Park.”
14. Office uses only. Maximum FAR of 0.22.
15. No chapels are allowed within APZ I or APZ II.
16. Maximum FAR of 0.22 in APZ II.
17. Maximum FAR of 1.0 in APZ I and 2.0 in APZ II.
18. Maximum FAR of 0.11 in APZ I and 0.22 in APZ II.
19. Facilities must be low intensity and provide no tot lots, etc. Facilities such as clubhouses, meeting places, auditoriums, large classes, etc., are not recommended.
20. Includes livestock grazing but excludes feedlots and intensive animal husbandry. Activities that attract concentrations of birds creating a hazard to aircraft operations should be excluded.
21. Includes feedlots and intensive animal husbandry.
22. Maximum FAR of 0.28 in APZ I and 0.56 in APZ II. No activity that produces smoke or glare or involves explosives.
23. Lumber and timber products removed due to establishment, expansion, or maintenance of clear zones will be disposed of in accordance with appropriate DoD Natural Resources Instructions.
24. Controlled hunting and fishing may be permitted for the purpose of wildlife management.
25. Naturally occurring water features (e.g., rivers, lakes, streams, wetlands) are compatible.
26. a. Although local conditions regarding the need for housing may require residential use in these zones, residential use is discouraged in DNL 65-69 and strongly discouraged in DNL 70-74.

Table B-1 Land Use Compatibility Recommendations								
Land Use		Accident Potential Areas[1]			Noise Levels			
SLUCM No.	Name	Clear Zone	APZ I	APZ II	65 to 70 DNL	70 to 75 DNL	75 to 80 DNL	80 to 85 DNL

The absence of viable alternative development options should be determined and an evaluation should be conducted prior to approvals indicating that a demonstrated community need for the residential use would not be met if development were prohibited in these zones.

b. Where the community determines that residential uses must be allowed, measures to achieve outdoor to indoor noise level reduction (NLR) of at least 25 dB (DNL 65-69) and 30 dB (DNL 70-74) should be incorporated into building codes and be considered in individual approvals; for transient housing a NLR of at least 35 dB should be incorporated in DNL 75-79.

c. Normal permanent construction can be expected to provide an NLR of 20 dB; thus, the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation, upgraded Sound Transmission Class (STC) ratings in windows and doors and closed windows year round. Additional consideration should be given to modifying NLR levels based on peak noise levels or vibrations.

d. NLR criteria will not eliminate outdoor noise problems. However, building location and site planning, design, and use of berms and barriers can help mitigate outdoor exposure, particularly from ground level sources. Measures that reduce noise at a site should be used wherever practical in preference to measures which only protect interior spaces.

27. Measures to achieve an NLR of 25 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.
28. Measures to achieve an NLR of 30 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.
29. Measures to achieve an NLR of 35 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.
30. If the project or proposed development is noise sensitive, use indicated NLR; if not, land use is compatible without NLR.
31. Land use compatible, provided special sound reinforcement systems are installed.
32. Residential buildings require an NLR of 25.
33. Residential buildings require an NLR of 30.
34. Residential buildings not permitted.
35. Land use not recommended, but if the community decides use is necessary, hearing protection devices should be worn by personnel.

Key:
Y (Yes) = Land use and related structures compatible without restrictions.
N (No) = Land use and related structures are not compatible and should be prohibited.
Y^x (Yes with restrictions) = The land use and related structures are generally compatible. However, see notes indicated by superscript.
N^x (No with restrictions) = The land use and related structures are generally incompatible. However, see notes indicated by superscript.
SLUCM = Standard Land Use Coding Manual.
NLR (Noise Level Reduction) = Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.
DNL = Day-night average sound level.
NA = Not Applicable (no data available for that category).
25, 30, or 35 = Land use and related structures generally compatible; measures to achieve NLR of 25, 30, or 35 must be incorporated into design and construction of structure.