

# Air Installations Compatible Use Zones Study

## for NAS Pensacola and NOLF Saufley

2010

Prepared by:

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




# Air Installations Compatible Use Zones Study for Naval Air Station Pensacola and Navy Outlying Landing Field Saufley

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# Table of Contents

**Section** **Page**

**Section** **Page**

**Section** **Page**

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# List of Tables

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# List of Illustrations

## List of Illustrations, *continued*

# Acronyms, Abbreviations, and Definitions

| | |
|---|---|
| AICUZ | Air Installations Compatible Use Zones |
| AIPD | Air Influence Planning District |
| ALF | Auxiliary Landing Field |
| ANSI | American National Standards Institute |
| APZ | Accident Potential Zone |
| BASH | Bird/Animal Aircraft Strike Hazard |
| CNEL | Community Noise Exposure Level |
| CNET | Chief of Naval Education and Training |
| CNATRA | Chief of Naval Air Training |
| CSO | Combat Systems Officer |
| CY | Calendar Year |
| dB | decibel |
| dBA | A-weighted decibel |
| DNL | day-night average sound level |
| DoD | United States Department of Defense |
| EA | environmental assessment |
| EIS | environmental impact statement |
| EMI | electromagnetic interference |
| EPA | U.S. Environmental Protection Agency |
| EUL | Enhanced Use Lease |
| FAA | Federal Aviation Administration |

## Acronyms, Abbreviations, and Definitions, *continued*

| | |
|---|---|
| FCLP | Field Carrier Landing Practice |
| FDEP | Florida Department of Environmental Protection |
| FEMA | Federal Emergency Management Agency |
| FICON | Federal Interagency Committee on Noise |
| FICUN | Federal Interagency Committee on Urban Noise |
| FTG | Flying Training Group |
| GCA | ground control approach |
| ha | hectares |
| HSU | Helicopter Support Unit |
| HUD | Housing and Urban Development |
| IFLOS | Improved Fresnel Lens Optical System |
| IFR | instrument flight rules |
| JLUS | Joint Land Use Study |
| JPATS | Joint Primary Aircraft Training System |
| JSF | Joint Strike Fighter |
| km | kilometer |
| LDC | Land Development Code |
| LSA | Logistical Staging Area |
| MATSG | Marine Aviation Training Support Group |
| MOA | Military Operating Area |
| MSL | Mean Sea Level |
| MWR | Morale, Welfare, and Recreation |
| NAMI | Naval Aerospace Medical Institute |
| NAMRL | Naval Aerospace Medical Research Laboratory |
| NAS | Naval Air Station |
| NASC | Naval Aviation Schools Command |

### Acronyms, Abbreviations, and Definitions, *continued*

| | |
|---|---|
| NATC | Naval Air Training Command |
| NATTC | Naval Air Technical Training Center |
| Navy | United States Department of the Navy |
| NEPA | National Environmental Policy Act |
| NETC | Naval Education & Training Command |
| NETPDTC | Naval Education & Training Program Development & Technology Center |
| NFO | Naval Flight Officer |
| NOLF | Navy Outlying Landing Field |
| NOMI | Naval Operational Medicine Institute |
| NORU | Naval Orientation Recruiting Unit |
| NWFWMD | North West Florida Water Management District |
| OLF | Outlying Landing Field |
| OPNAVINST | Chief of Naval Operations Instruction |
| SHP | shaft horsepower |
| STOVL | short takeoff and vertical-landing variant |
| SUA | Special Use Airspace |
| TDR | Transfer of Development Rights |
| TRAWING | Training Air Wing |
| USAF | United States Air Force |
| U.S.C. | United States Code |
| VFR | visual flight rules |
| WWII | World War II |

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# 1 Introduction

Historically, military bases were established in rural areas of the country. However, over time, many of these areas have experienced associated population growth and increased development in close proximity to the military installation. This growth can be seen immediately outside facility fence lines as well as throughout the surrounding areas, and the developments primarily take the form of new housing and commercial sites. New homes are constructed close to the installation to allow both military and civilian personnel to live near their employer. Similarly, businesses are established near the facility to take advantage of the large workforce that becomes a strong consumer base for goods and services.

As the number of residences, commercial developments, and other land uses around the military installations rise, the potential for the establishment of incompatible land uses can also increase. If the growth of a community is not controlled by local government through the use of comprehensive zoning and land use planning that takes the operational activities of a military airfield into account, both the mission of the military field and the well-being of the community can be adversely impacted.

> The goal of the AICUZ Program is to protect military operational capabilities and the health, safety, and welfare of the public by achieving compatible land use patterns and activities in the vicinity of a military installation.

The United States Department of Defense (DoD) initiated the Air Installations Compatible Use Zones (AICUZ) Program to help governmental entities and communities anticipate, identify, and promote compatible land use and development near military installations. The goal of this program is to protect the health, safety, and welfare of those living or working near military air installations, as well as protect the military operational capabilities of the air station. This is achieved by promoting compatible land use patterns and activities in the vicinity of a military installation.

The AICUZ Program recommends that noise levels, Accident Potential Zones (APZs), and flight clearance requirements associated with military airfield operations be incorporated into local community planning programs in order to maintain the airfield's operational requirements while minimizing the impact to residents in the surrounding community. Mutual cooperation between military airfield planners and community-based counterparts 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 government on land use planning, zoning, and similar matters that could affect the installations' operations or missions.

This AICUZ study has been prepared for Naval Air Station (NAS) Pensacola and Navy Outlying Landing Field (NOLF) Saufley, both of which are located in Pensacola, Florida. This 2010 AICUZ looks comprehensively at past, present, and future operational requirements and expectations for the two fields, in association with current and proposed land use trends within Escambia County. The purpose of this document is to assist Navy and community planners in ensuring compatible development around NAS Pensacola and NOLF Saufley, while simultaneously maintaining the operational integrity of both airfields into the foreseeable future.

This study provides background on the AICUZ Program and historical data from previous AICUZ studies for both NAS Pensacola and NOLF Saufley (Section 1) and describes locations and features of these facilities (Section 2). Section 3 discusses present-day and projected aircraft operations. Section 4 presents the updated aircraft noise contours, outlining the methodology for how the noise contours were determined, what changes have occurred, and what the future expectations are for change, as well as what measures have been implemented by the Navy to mitigate any community noise concerns. Aircraft safety issues and the development of APZs are discussed in Section 5. Section 6 evaluates the compatibility of both current and proposed land uses as provided by Escambia County. Finally, Section 7 provides recommendations to Navy installation planners for promoting land use compatibility consistent with the goals of the AICUZ Program.

## 1.1 AICUZ Program Requirements

In the early 1970s, the DoD established the AICUZ Program to balance the need for aircraft operations and community concerns over aircraft noise and accident potential. The AICUZ Program was developed in response to growing incompatible urban development (encroachment) around military airfields. The objectives of the AICUZ Program, according to the Chief of Naval Operations Instruction (OPNAVINST 11010.36C), are as follows:

- To protect the health, safety, and welfare of civilians and military personnel by encouraging land use which 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.

Noise zones and APZs are planning tools for both the air installation and local planning departments. These zones represent areas that are vital to the continuing operations of the air installation. Since they may extend beyond the "fence line" of the installation, presentation of the most current dimensions of noise zones and APZs through development of an updated AICUZ study to community-based planners is essential to fostering mutually beneficial land use.

In addition to the Navy AICUZ instruction, the Federal Aviation Administration (FAA) and DoD also have developed specific instructions and guidance to encourage local communities to restrict development or land uses that could endanger aircraft in the vicinity of the airfield, 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. These issues are discussed in greater detail in Section 5 of this study.

Key documents that outline the authority for the establishment and implementation of the NAS Pensacola and NOLF Saufley AICUZ Programs, as well as guidance on facility requirements, are derived from:

- DoD Instruction 4165.57, "Air Installations Compatible Use Zones," dated November 8, 1977;
- OPNAVINST 11010.36C, "Air Installations Compatible Use Zones Program," dated October 9, 2008;
- Unified Facilities Criteria 3-260-01, "Airfield and Heliport Planning and Design," dated May 19, 2006;
- Naval Facilities Engineering Command P-80.3, "Facility Planning Factor Criteria for Navy and Marine Corps Shore Installations: Airfield Safety Clearances," dated January 1982; and
- United States Department of Transportation, FAA Regulations, Code of Federal Regulations, Title 14, Part 77, "Objects Affecting Navigable Airspace."

## 1.2 Purpose, Scope, and Authority

The AICUZ study analyzes community development trends, land-use tools, and mission requirements to develop a recommended strategy for communities to prevent incompatible land development adjacent to the installation.

The purpose of the ACIUZ Program is to achieve compatibility between air installations and neighboring communities. OPNAVINST 11010.36C is the current Navy guidance document that governs the AICUZ Program. To satisfy the purpose of the AICUZ Program, the military installation must work with the local community to discourage incompatible development of lands adjacent to the installation. As development encroaches upon the airfield, more people are potentially exposed to noise and accident potential associated with aircraft operations. The scope of the AICUZ study includes an analysis of:

- Aircraft noise zones for existing conditions and future-year forecasts, as well as APZs;

- Land use compatibility;
- Operational alternatives;
- Noise reduction strategies; and
- Possible solutions to existing and potential incompatible land use problems.

The AICUZ study uses an analysis of community development trends, land use tools, and mission requirements at the airfield to develop a recommended strategy for communities that prevents incompatible land development adjacent to the installation. AICUZ considerations are based on the impacts of noise, the safety considerations of aircraft accidents, and economic considerations relating to public funds and local economic viability. The basis for implementing AICUZ guidelines lies in the air installation commander's cooperation with the local governments to protect the installation's mission requirements while simultaneously protecting and promoting the public's health, safety, and welfare.

## 1.3 Responsibility for Compatible Land Use

Ensuring land use compatibility within the AICUZ is the responsibility of many organizations, including the DoD and Navy, the local naval air installation command, local planning and zoning agencies, real estate agencies, residents, developers, and builders. Military installations and local government agencies with planning and zoning authority share the responsibility for preserving land use compatibility near the military installation. Cooperative action by all parties is essential to prevent land use incompatibility and hazards to the neighboring community. Table 1-1 identifies some responsibilities for various community stakeholders residing in proximity to an installation.

**Table 1-1 Responsibility for Compatible Land Uses**

| | |
|---|---|
| Navy | ▪ Examine air mission for operation changes that could reduce impacts.<br>▪ Conduct noise and APZ studies.<br>▪ Develop AICUZ maps.<br>▪ Examine local land uses and growth trends.<br>▪ Make land use recommendations.<br>▪ Release an AICUZ study.<br>▪ Work with local governments and private citizens.<br>▪ Monitor operations and noise complaints.<br>▪ Update AICUZ plans, as required. |
| Local Government | ▪ Incorporate AICUZ guidelines into a comprehensive development plan and zoning ordinance.<br>▪ Regulate height and obstruction concerns through an airport ordinance.<br>▪ Regulate acoustical treatment in new construction.<br>▪ 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.<br>▪ Identify AICUZ considerations in all property transactions.<br>▪ 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.<br>▪ When working with builders/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 land use facilities which are compatible with aircraft operations (e.g., sound attenuation features, densities, occupations). |

# 1.4 Previous AICUZ Efforts and Studies

The original, complete AICUZ for NAS Pensacola was approved by the Chief of Naval Operations and published in January 1976. This study was partially updated through various addenda, studies, and technical memoranda between 1983 and 1990. These addenda were developed to account for changes in aircraft that were being used at the facilities, changes in operational parameters such as revised flight tracks, and changes derived from revisions to the Navy AICUZ instructions.

The following list highlights the NAS Pensacola AICUZ timeline along with key changes which triggered the modifications to the 1976 AICUZ study:

- **1976 AICUZ Study for NAS Pensacola.** This original AICUZ was a result of exhaustive analysis of all known methods of reducing noise impacts on the surrounding community and incorporated flight patterns, increased and modified operations, and methods for achieving compatible land uses within the impact areas. "Aircraft Noise Study Naval Station Pensacola, Florida," from June 1972, was the source for existing composite noise rating zones and some of the flight operations.

- **1988 AICUZ Technical Memorandum for NAS Pensacola.** This memorandum was an update to the 1976 AICUZ study and provided a historical assessment of flight operations between 1976 and 1987, which validated the accuracy of prior updates. This memorandum collectively presented data that was made available in the following updates for NAS Pensacola:

  - *1983 AICUZ Noise Footprint Update.* This update was completely superseded in 1986 due to a change in flight operations and changes in aircraft.

  - *1987 AICUZ Noise Footprint Update.* Airfield field noise measurements were collected in 1986 to support this study. In addition, detailed data on numbers of operations, percent use of each arrival, departure, and pattern, aircraft power settings, speed and altitudes, and number and duration of run-ups were collected. No records summarizing this type of detailed information were collected or kept at NAS Pensacola prior to this update.

- **1990 AICUZ Addendum for NAS Pensacola.** This update to the 1976 AICUZ included the use of revised noise methodology, operations that are flown by quieter aircraft, new APZ guidelines, and changes in runway utilization. The update also included data made available from the 1987 update.

A noise study was completed for NOLF Saufley in 1986 as part of a larger study for NAS Whiting Field and several other outlying landing fields (OLFs) in Florida and Alabama. The noise study for NOLF Saufley was revised in 2000 and again in 2007 through updates that were developed to assess the impacts of replacing the T-34 "Turbomentor" aircraft with the T-6 "Texan" Joint Primary Aircraft Training System (JPATS). There is limited information for activities for NOLF Saufley prior to the 1986 noise study. Therefore, early operational activities are based on historic accounts and not necessarily AICUZ or noise study specific documents.

Previous AICUZ documents for NAS Pensacola and NOLF Saufley were examined and used as the baseline for the Escambia County 2003 JLUS.

The noise contours for NAS Pensacola (1990 AICUZ addendum) and the noise contours for NOLF Saufley (2000 noise study update) were utilized in the 2003 JLUS.

## 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. The history of prior AICUZ studies and the changes that resulted in revisions to earlier AICUZ documents were described in the previous section.

In accordance with OPNAVINST 11010.36C, this AICUZ update has been prepared to reflect changes in airfield operations at NAS Pensacola since the last AICUZ update (prepared in 1976) including changes in aircraft type, to incorporate NOLF Saufley into the study, to examine any reasonable projected mission changes over the next five years, and to incorporate the Joint Strike Fighter (JSF) as a transient aircraft as it is expected to be operational within this decade.

### 1.5.1 Changes in Operations Level

The primary mission of NAS Pensacola in 1976 was associated with aviation, naval training, and aircraft research. As a result, flight activities at NAS Pensacola were extremely varied, from student pilots making their first jet aircraft flight, to experienced pilots flying the Navy's most advanced aircraft. In 1976, NAS Pensacola also trained helicopter pilots to fly the large twin-rotor HH-46 Boeing Sea Knight aircraft. Navigation and radar training was also conducted at NAS Pensacola. Due to training missions, flight operations over this time period varied depending on the number of student aviators at NAS Pensacola. The five-year average between 1970 and 1974 was 187,539 annual flights.

Currently, NAS Pensacola conducts significant naval aviation training and serves as the home field for all Training Air Wing

(TRAWING) 6 operations. Fixed-wing and rotary-wing operations are also generated by the Blue Angels Flight Demonstration Team training, 479th Flying Training Group, fleet detachments, and transient aircraft. Touch-and-go, emergency landing practice and instrument approach practice account for the bulk of NAS Pensacola operations (Table 1-2).

**Table 1-2 Annual Military and Civilian Operations by Year at NAS Pensacola**

| Calendar Year | Annual Operations | | | | |
|---|---|---|---|---|---|
| | Military | | Civilian | | Total |
| | Navy | Other | Air Carrier | General Aviation | |
| 2008 | 79,954 | 8,534 | 144 | 880 | 89,512 |
| 2007 | 77,188 | 7,977 | 8 | 166 | 85,339 |
| 2006 | 76,025 | 6,799 | 23 | 874 | 83,721 |
| 2005 | 88,025 | 9,100 | 68 | 1,682 | 98,875 |
| 2004 | 86,958 | 9,117 | 53 | 2,133 | 98,261 |
| 2003 | 119,996 | 8,685 | 74 | 1,200 | 129,955 |
| 2002 | 99,115 | 9,021 | 75 | 1,375 | 109,586 |
| 2001 | 94,203 | 7,342 | 43 | 1,013 | 102,601 |
| 2000 | 96,433 | 10,177 | 44 | 1,541 | 108,135 |
| 1999 | 89,549 | 13,613 | 119 | 1,138 | 104,419 |

Source: Adapted from Wyle August 2008 and NAS Pensacola 2009

Over time, the operational tempo at NOLF Saufley has fluctuated. NOLF Saufley has been redesignated several times, and most recently has been used in coordination with the Federal Emergency Management Agency (FEMA) in response to Hurricane Ivan in 2004. Additionally, NOLF Saufley has been used as a NOLF to support TRAWING 5 of NAS Whiting Field and TRAWING 6 of NAS Pensacola. Prior to Hurricane Ivan, during 2002, NOLF Saufley generated 43,093 flight operations.

### 1.5.2 Changes in Aircraft Mix

Aircraft mix at NAS Pensacola has changed significantly since the 1976 AICUZ. At that time, 11 types of aircraft used the airfield and, by 1985, there were 16 types. For Calendar Year (CY) 2008, there were

27 types of aircraft that utilized NAS Pensacola and NOLF Saufley. Table 1-3 outlines the mix of both permanently stationed and transient aircraft operating from the two airfields being studied.

### 1.5.3 Changes in Flight Tracks and Procedures

There have been notable changes that have occurred in flight tracks and procedures for NAS Pensacola since the 1976 AICUZ Study and 1990 AICUZ update were published. Flight tracks established by NAS Pensacola are dependent on aircraft mix, operational level, runway usage, and control measures. As summarized in Table 1-3, there has been a significant change in aircraft mix, which results in changes in flight tracks and procedures as each individual aircraft has specific requirements for operation. Additionally, as summarized in Table 1-2, the operational level over time has changed which, in turn, results in changes in flight tracks and procedures.

Since its designation as an OLF in 1976, NOLF Saufley has had notable changes in flight tracks and procedures due to previous inconsistent use as an OLF, changes in runway conditions, and changes in aircraft that use the field. However, today, NOLF Saufley is an established NOLF used regularly by NAS Whiting Field and NAS Pensacola.

### Table 1-3 Aircraft Types at NAS Pensacola and NOLF Saufley by Year

| 1976 | 1985 | 2008 | 2012* |
|---|---|---|---|
| **Permanent** | **Permanent** | **Permanent** | **Permanent** |
| T-2 | T-2 | T-6 | **T-6** |
| A-4 | A-4 | T-39 | T-39 |
| TA-4 | TA-4 | T-1 | T-1 |
| T-39 | T-39 | T-2 | T-45 |
| H-34 | HH-46A | F/A-18A/B | F/A 18-C/D |
| A-6 | A-6 | H-60 | **Transient** |
| F-14 | F-14 | **Transient** | F/A-18E/F |
| T-28 | T-34 | T-45 | F-35A/B/C |
| F-9 | T-47 | **TH-57** | T-45 |
| S-2 | P-3 | **T-34** | BE20 |
| A-7 | C-130 | AV-8 | **TH-57** |
| T-39 | C-141 | F-5 | P-3C |
| F-4 | C-5 | P-3 | **H-60** |
| VT-4 | F/A-18 | H-60 | T-38 |
| VT-10 | UH-IN | T-38 | H-3 |
| HH-46 | SH-3D | H-3 | BE-9 |
| | | BE-9 | F-16 |
| | | F-16 | C-40 |
| | | S-3 | C-130 |
| | | DC-9 | B-190 |
| | | C-130 | C-2 |
| | | B-190 | C-560 |
| | | B-737 | EA-18G |
| | | C-2 | EA-6B |
| | | C-560 | F-15 |
| | | EA-6B | F-22 |
| | | F/A-18E/F | UAVs (RQ-4, MQ-8) |
| | | F-15 | P-8 |
| | | C-40 | |
| | | BE-20 | |

Source: AICUZ 1976; AICUZ Addendum 1985; Wyle Noise Study August 2008
Notes:
* = All foreseeable projections out to 2012 and includes projections of the F-35 as transient aircraft which are expected to occur this decade
**Bold** = also at NOLF Saufley.

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# 2 NAS Pensacola & NOLF Saufley

## 2.1 Location

Naval Air Station (NAS) Pensacola and Navy Outlying Landing Field (NOLF) Saufley are located in Escambia County in the Florida Panhandle. NAS Pensacola is located on a peninsula within the Pensacola Bay system between Pensacola Bay and Bayou Grande, approximately 5 miles (8.3 kilometers [km]) from downtown Pensacola, Florida (Figure 2-1). NAS Pensacola comprises approximately 5,800 acres (2,350 hectares [ha]) and Corry Station comprises an additional 2,623 acres (1,060 ha), collectively known as the NAS Pensacola Complex. NOLF Saufley, comprises approximately 970 acres (392 ha.) and is geographically separated from, but part of, the NAS Pensacola Complex. It is located approximately 10 miles (16 km) north of NAS Pensacola and approximately 8 miles (12.8 km) west of Pensacola Regional Airport (Figure 2-1) and borders Tarklin Bayou.

## 2.2 Mission

NAS Pensacola supports many activities, including headquarters and staff of Chief of Naval Education and Training (CNET), Training Air Wing (TRAWING) 6, Naval Operational Medicine Institute (NOMI), Naval Aerospace Medical Institute (NAMI), Naval Aerospace Medical Research Laboratory (NAMRL), Naval Orientation Recruiting Unit (NORU), Naval Air Technical Training Center (NATTC), Naval Aviation Schools Command (NASC), Naval Computer and Telecommunications Station, Marine Aviation Training Support Group (MATSG-21), USAF 479th Flying Training Group, and the Navy Flight Demonstration Squadron (Blue Angels).

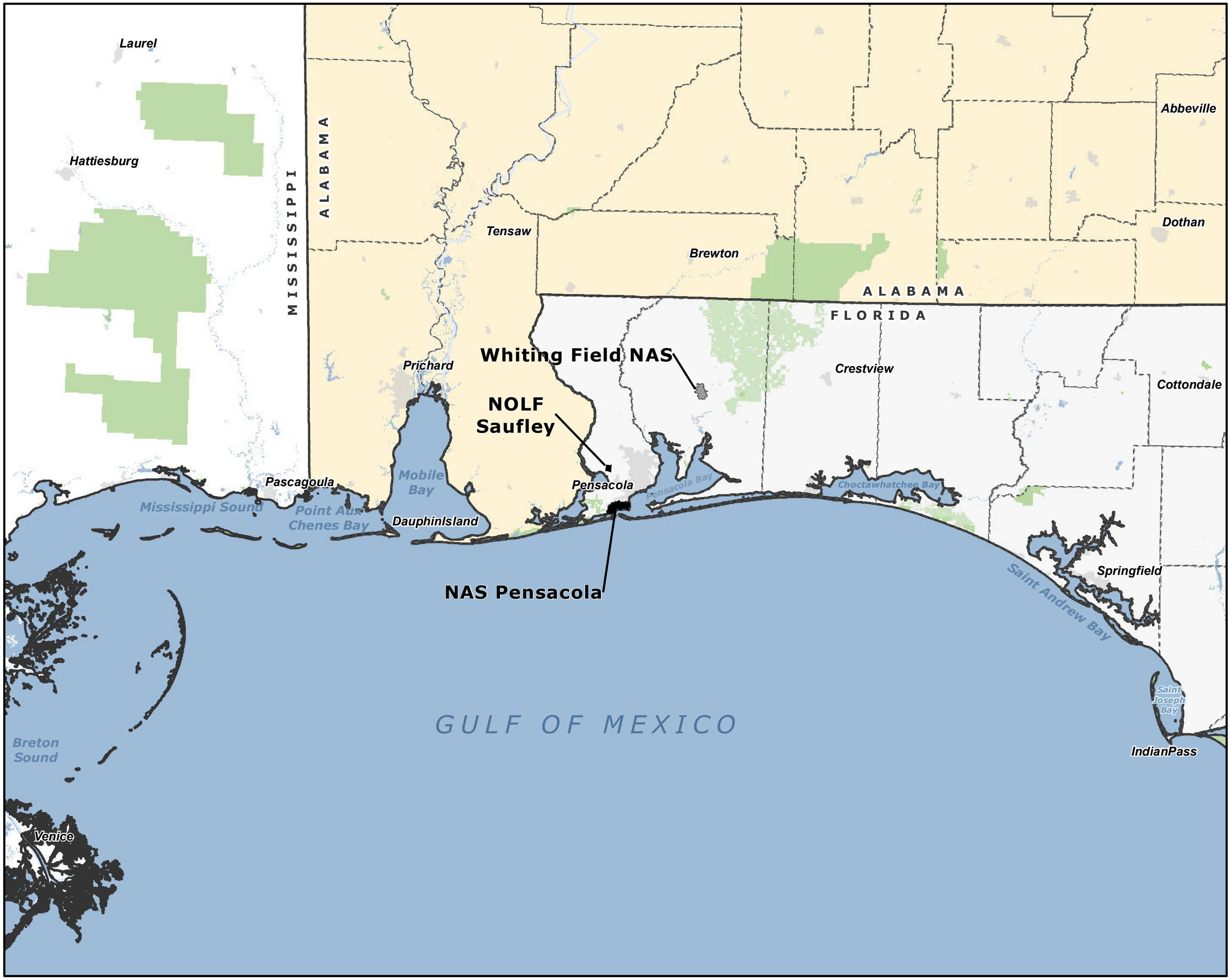


Figure 2-1
Regional Location Map
NAS Pensacola and
NOLF Saufley Field

**Legend**

- NAS Pensacola
- Water Bodies
- Parks
- Alabama Counties
- Florida Counties
- State Boundary

Source:
ESRI, 2005

0 10 20 40
Miles

NAS Pensacola also supports non-defense related tenants including the National Park Service, Barrancas National Cemetery (administered by Veterans Affairs), the Federal Aviation Administration (FAA), and the National Museum of Naval Aviation. Support services located on NAS Pensacola include bachelor officers' quarters, morale, welfare, and recreation (MWR), a family services center, security, a commissary, and exchanges.

NOLF Saufley is used for practice landings and takeoffs ("touch-and-go's") by training aircraft from NAS Pensacola and other fields. Currently, NOLF Saufley hosts the Naval Education and Training Program Development and Technology Center (NETPDTC), a subordinate command of the Naval Education & Training Command (NETC), and is also home to a minimum-security federal prison camp, a Naval Reserve Center, and NETC's Professional and Technology Center.

## 2.3 History

The Navy's presence was first established at the site of NAS Pensacola in 1825 when President John Quincy Adams and Secretary of the Navy, Samuel Southard, arranged to build a Navy Yard on the southern tip of Escambia County. Construction of the Pensacola Navy Yard began in 1826 and grew to be one of the best equipped naval stations in the country. The Navy Yard was decommissioned in 1911. However, in 1914, the first U.S. NAS was established on the abandoned Navy Yard site and has become the primary installation providing aviation training to the Navy. In 1971, NAS Pensacola was selected as the headquarters site for CNET, a new command that combined the direction and control of all Navy education and training. The Naval Air Basic Training Command was absorbed by the Naval Air Training Command (NATC) (which moved to Corpus Christi, Texas) and is known as Chief of Naval Air Training (CNATRA); NAS Pensacola provides support for the operation of the Chief of Naval Air Training. Known as the "Cradle of Naval Aviation," the air station serves as the launching point for the flight training of every Naval Aviator, Naval

> Both NAS Pensacola and NOLF Saufley are established and recognized airfields in the Florida Panhandle region.

Flight Officer (NFO), and enlisted air crewman. In addition, it is the Navy's premier location for enlisted aviation technical training.

What was originally known as "Felton's Field," NOLF Saufley was constructed in 1933 as a satellite airfield for NAS Pensacola. Due to pre-World War II (WWII) military build-up, the Navy significantly expanded the airfield, officially opening Saufley Field in 1940. It conducted primary training, instrument training, and fighter training. Then, in 1943, Saufley Field was commissioned as a Naval Auxiliary Air Station used for a variety of training in SNJ-1 Texans and N2S Kaydet aircraft. In 1944, the number of aircraft peaked at 160 with over 2,200 personnel, and remained open following the end of WWII. Saufley Field was then redesignated as a NAS in 1968 having four active runways, was decommissioned less then 10 years later in 1976, and became a NOLF. Saufley Field was again reactivated in 1979 when NETPDTC, a subordinate command of NETC, relocated to Saufley Field and when NAS Whiting Field (TRAWING 5) began to use Saufley Field as a NOLF for pilot training.

In 2004, the United States Department of Defense (DoD) and the Federal Emergency Management Agency (FEMA) designated NOLF Saufley as a temporary Logistical Staging Area (LSA) for federal, state, and non-governmental agencies in response to Hurricane Ivan. Hundreds of 18-wheeled trucks filled with ice, food, and drinking water were staged on NOLF Saufley ramps to provide relief for victims of Hurricane Ivan. Continuing through 2006, NOLF Saufley's north/south runway was used to house FEMA trailers for victims displaced by the hurricane. Flying operations were temporarily suspended while the runways were being used by FEMA.

Today, NOLF Saufley is an active runway and spans an area of approximately 860 acres (348 ha). The site currently has 63 buildings and three aircraft hangars. As of 2008, two runways were active and serve as an NOLF for Training Air Wings 5 and 6, where the facility is used for practice landings and take-offs of T-34C and T-6A aircraft. Other flight activities include touch-and-go operations by the TH-57 aircraft.

## 2.4 Operational Areas

Figures 2-2 and 2-3 provide a depiction of NAS Pensacola and NOLF Saufley airfields, respectively. The landing area at NAS Pensacola, also commonly called Sherman Field, consists of three runways, Runway 01/19, Runway 07L/25R, and Runway 07R/25L. As of July 2007, the field elevation at NAS Pensacola averaged 28 feet (8.5 meters) above Mean Sea Level (MSL). The landing area at NOLF Saufley consists of two runways, Runway 05/23 and Runway 14/32, and one helicopter pad. Runways are numbered according to their magnetic heading for aircraft on approach or departure. For example, on Runway 01/19, the numbers 01 and 19 signify that this runway is most closely aligned with a compass heading of 10 and 190 degrees, respectively. Table 2-1 provides detailed information about the length and width of each runway.

**Table 2-1 NAS Pensacola and NOLF Saufley Runways**

| NAS Pensacola Runway | Length (feet) | Width (feet) |
|---|---|---|
| 01/19 | 7,137 | 200 |
| 07L/25R | 8,000 | 200 |
| 07R/25L | 8,000 | 200 |
| **NOLF Saufley Runway** | **Length (feet)** | **Width (feet)** |
| 05/23 | 4,000 | 200 |
| 14/32 | 4,000 | 200 |

Source: NAS Pensacola 2008

## 2.5 Local Economic Impacts

Similar to other areas where major military bases are located, the NAS Pensacola Complex has a significant impact on the economy in the greater Pensacola area. The jobs associated with NAS Pensacola and its tenants, the salaries paid to its workers, and the spending associated with both the workers and the facility ripple through the entire region's economy.

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\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 2-2 Pensacola Airfield Map.mxd


# Figure 2-2
# NAS Pensacola Airfield Map

## Legend

- Gate
- Runway
- NAS Pensacola
- County Boundary
- Water Bodies

Source:
ESRI, 2005

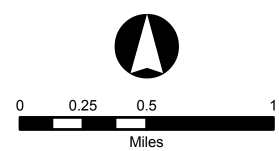
0 0.25 0.5 1
Miles


Figure 2-3
NOLF Saufley
Airfield Map

**Legend**

- Gate
- NOLF Saufley
- Runway
- County Boundary
- Water Bodies

Source:
ESRI, 2005



NAS Pensacola is the employer of a combined workforce of approximately 23,000 military and civilian personnel (NAS Pensacola, 2008). The DoD (including NAS Pensacola) is the largest economic engine in the greater Pensacola area, with more than $5.1 billion in salary and wages produced (Pensacola Bay Area Chamber of Commerce 2008). Specifically, the economic benefits are from the following sources:

- Jobs;
- Worker salaries or personal income;
- Local sales to workers and their families;
- Revenues to local businesses; and
- Residential property in the community owned or occupied by military personnel and employees of the facilities.

# 3 Aircraft Operations

Aircraft noise consists of two major sound sources: flight operations and ground engine maintenance "run-ups" which are associated with pre-flight and maintenance checks. Navy Outlying Landing Field (NOLF) Saufley does not have any ground engine maintenance "run-up" locations, since there are no aircraft permanently stationed at the airfield and maintenance is done at either Naval Air Station (NAS) Whiting Field or NAS Pensacola.

The level of noise exposure modeled is related to a number of variables including the aircraft type, engine power setting, altitude, direction of the aircraft, duration of run-ups, flight tracks, temperature, relative humidity, frequency, and time of operations. Generally, these factors fluctuate from year to year. Small fluctuations in the annual number of operations of like aircraft will not have a significant effect on community noise exposure.

NAS Pensacola primarily is utilized for pilot and navigation training for Navy and sister service pilots and navigators. NOLF Saufley is used primarily for touch-and-go operations by Whiting Field Training Air Wing (TRAWING) 5, and NAS Pensacola TRAWING 6, T-34s and T-6s. Below is a representation of the some of the more prominent aircraft that utilize NAS Pensacola and NOLF Saufley. Additionally included are some of the new aircraft that may be stationed at NAS Pensacola and NOLF Saufley in the coming months and years.

> A fixed-wing aircraft is an aircraft whose lift is generated not by wing motion relative to the aircraft, but by forward motion through the air. The term is used to distinguish from rotary-wing aircraft.

## 3.1 Aircraft Types

Aircraft types that typically utilize NAS Pensacola and NOLF Saufley are described in the following subsections.

## 3.1.1 Fixed-Wing Aircraft

**T-6A Texan II.** The T-6A Texan II is a military, single-engine trainer used by the United States Department of the Navy (Navy) and the United States Air Force (USAF) to train pilots, Naval Flight Officers (NFOs), and Combat System Officers (CSOs). The 5,000-pound (2,268-kilogram) air craft is powered by a Pratt & Whitney PT-6A-68 turboprop engine that generates 1,100 horsepower. With a wingspan of 33 feet (10 meters) and a length of 33 feet (10 meters), this aircraft can reach speeds of 270 knots at altitudes of 31,000 feet (945 kilometers [km]). The Texan II operates with a crew of two and has a range of 850 nautical miles.

**T-39N/G Sabreliners.** The T-39 Sabreliner is a multi-purpose, low-wing, twin-engine, jet trainer whose mission is to train Navy and Marine Corps flight officers. The 15 T-39Ns—derivatives of the commercial Sabre model 265-40—are used for training undergraduate military flight officer students in radar navigation and airborne radar-intercept procedures. These aircraft replaced Cessna T-47As during the early 1990s. The eight T-39Gs—derivatives of the commercial Sabre model 265-60—are used for student non-radar training. These aircraft began replacing USAF T-1A Jayhawks in Navy training squadrons in mid-1999.

**T-1A Jayhawks.** The T-1A Jayhawk is a medium-range, twin-engine, jet trainer used in the advanced phase of specialized undergraduate pilot and navigator training for USAF students selected to fly airlift or tanker aircraft. The swept-wing T-1A is a military version of the Beech 400A. It has cockpit seating for an instructor and two students and is powered by twin turbofan engines capable of an operating speed of Mach .73. The T-1A differs from its commercial counterpart with structural enhancements that provide for a large number of landings per flight hour, increased bird strike resistance, and an additional fuselage fuel tank.

**F/A-18 A/B Hornet.** The F/A-18 Hornet, an all-weather aircraft, is used as an attack aircraft as well as a fighter. In its fighter mode, the F/A-18 is used primarily as a fighter escort and for fleet air defense; in its attack mode, it is used for force projection, interdiction, and close and deep air support. The Navy's Blue Angels Flight Demonstration Squadron proudly flies them. It is projected that by 2012, the F/A-18 A/B model will be replaced by the FA-18 C/D model for the Blue Angels.

**T-38 Talon.** The Talon is a twin-engine, high-altitude, supersonic, jet trainer used primarily for undergraduate pilot and pilot instructor training. Student pilots fly the T-38A to learn supersonic techniques, aerobatics, formation, night and instrument flying, and cross-country navigation. Advanced training for the bomber-fighter track is accomplished using the T-38 Talon and prepares pilots for the transition to fighter and bomber aircraft. The T-38 needs as little as 2,300 feet (695 meters) of runway to take off and can climb from sea level to nearly 30,000 feet (9,068 meters) in one minute.

**T-45 Goshawks.** The T-45A aircraft 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 replaced the T-2 Buckeye trainer and the TA-4 trainer with an integrated training system that includes the T-45A Goshawk aircraft, operations and instrument fighter simulators, academics, and a training integration system.

**F/A-18 E/F Super Hornet.** The newest model of F/A-18, the Super Hornet (F/A-18 E/F), is highly capable across the full mission spectrum: air superiority, fighter escort, reconnaissance, aerial refueling, close air support, air defense suppression, and day/night precision strike. Compared to the original F/A-18 A through D models, the Super Hornet has longer range, an aerial refueling capability, increased survivability/ lethality, and improved carrier suitability. The F/A-18 E/F Super Hornet is a combat-proven strike fighter with built-in versatility. The Super Hornet's suite of integrated and networked systems provides enhanced interoperability and total force support for the combatant commander and for the troops on the ground. The F/A -18 E/F uses NAS Pensacola's runways as a transient aircraft.

**T-34C Turbo Mentor.** The T-34C is a two-seat, tandem cockpit, turboprop, fixed-wing aircraft used to train Navy and Marine Corps pilots. The aircraft is powered by a Pratt & Whitney model PT6A-25 engine and has a wingspan of 34 feet (10 meters), length of 29 feet (8.8 meters), and weight of 4,000 pounds (1,814 kilograms). The T-34C can reach airspeeds of 280 knots, an altitude of 25,000 feet (7,620 meters), and can fly up to 740 nautical miles during a single flight.

**C-12 King Air.** The C-12 is a twin turboprop, fixed-wing aircraft used for flight training operations. The aircraft is powered by two Pratt & Whitney PT-6A-42 engines that produce 850 shaft horsepower (SHP) each. The C-12 is 44 feet (13 meters) long with a height of 15 feet (4.6 meters) and a maximum gross take-off weight of 15,000 pounds (6,804 kilograms). The range of the aircraft is approximately 1,974 nautical miles with a maximum airspeed of 294 knots and has a flight ceiling of 35,000 feet (10,668 meters).

**C-9 Skytrain.** The C-9 fleet is located throughout the continental United States, Europe, and Asia. The Navy and Marine Corps C-9 aircraft provide cargo and passenger transportation as well as forward deployment logistics support. The Air Force C-9s are used for medical evacuation, passenger transportation, and special missions.

## Projected Missions

**F-35 A/B/C Joint Strike Fighter, Lightning II.** The F-35 has three different variants: the first is the conventional takeoff and landing variant (Air Force F-35 A); the second is a short takeoff and vertical-landing variant (STOVL) (Marine F-35 B); and the third is a carrier-based variant (Navy F-35 C). The F-35 C carrier variant will have a larger, folding wing and larger control surfaces for improved low-speed control, and stronger landing gear for the stresses of carrier landings. The F-35 B is the STOVL variant aircraft. The F-35 B is similar in size to the Air Force F-35 A, trading fuel volume for vertical flight systems. The F-35 is not anticipated to be stationed at NAS Pensacola or NOLF Saufley; however, all three variants are expected to use NAS Pensacola's runways as a transient aircraft.

**Unmanned Aerial Vehicles (UAVs).** UAVs include such aircraft as RQ-2A (Pioneer), MQ-8 (Fire Scout) the MQ-1 (Predator) and (Global Hawk). A UAV is a remotely piloted or self-piloted aircraft that can carry cameras, sensors, communications equipment, weapons or other payloads. UAVs can be both fixed and rotary-wing and vary in size and range from the Global Hawk, which is approximately 44 feet in length and has a performance range of 36 hours to the small UAV such as the Pioneer, which is about 14 feet long and has a range of four to five hours. UAV missions are diverse ranging from data collection and surveillance to target acquisition support.

## 3.1.2 Rotary-Wing Aircraft

**TH-57 Sea Ranger.** The TH-57 is a derivative of the commercial Bell Jet Ranger 206. Although primarily used for training, these aircraft are also used for photo, chase, and utility missions. The TH-57 Sea Ranger provides advanced instrument flight rules (IFR) training to several hundred aviation students a year at NAS Whiting Field.

**H-60 and Other Variants.** The H-60 is a twin-engine, four-bladed, single-rotor helicopter. The aircraft's primary function and performance specifics vary by user. The aircraft is 64 feet (19.5 meters) long, has a height of 18 feet (5.5 meters), a rotor diameter of 54 feet (16.5 meters), and weight that varies from 21,000 to 23,000 pounds (9,525 to 10,433 kilograms), depending on variation. Its operational ceiling is 19,000 feet (5,791 meters), and it has a general operational range of approximately 380 nautical miles. The H-60 comes in many variants, including: the UH-60A/L Blackhawk; the SH-60B/F Seahawk; the MH-60R/S Multi-Mission Helicopter; and the HH-60H Jayhawk.

## 3.2 Airspace

The use of airspace over NAS Pensacola is dictated by the Federal Aviation Administration (FAA) National Airspace System (Figure 3-1). This system is designed to ensure the safe, orderly, and efficient flow of commercial, private, and military aircraft. NAS Pensacola is located in the airspace assigned to Jacksonville Center by the FAA. NAS Pensacola is located within Class C airspace. All visual flight rules (VFR) departures must have clearance to depart. VFR arrivals must contact Pensacola Approach prior to entering the Class C airspace for radar services and sequencing over the appropriate VFR entry points.

Pensacola Tower airspace is that airspace within a 5-nautical-mile radius of the center of the airport extending from the surface up to and including 4,200 feet (1,280 km) Mean Sea Level (MSL).

Airspace over NOLF Saufley is administrated by NAS Pensacola. NOLF Saufley is located within Class C airspace.

NAS Pensacola and NOLF Saufley have limited airspace to fulfill their mission. NAS Pensacola and NOLF Saufley's operational areas include Special Use Airspace (SUA). SUA in the region includes Alert Areas, Military Operating Areas (MOAs), Restricted Areas, and Warning Areas (Figure 3-1). NAS Pensacola and NOLF Saufley SUA includes:

- **Alert Area 292.** Located north and east of NAS Pensacola.
- **Pensacola North and South MOA.** Located over NAS Pensacola and north of NAS Whiting Field.
- **Restricted Area 7908**. Located approximately 35 nautical miles southwest of NAS Pensacola
- **Warning Areas W-155A/W-155B/W155C/W-453.** Located approximately 30, 50, and 100 nautical miles south and southwest of NAS Pensacola, respectively.

© Ecology & Environment, Inc. GIS Department    Project #
\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 3-1 Special Use Airspace.mxd

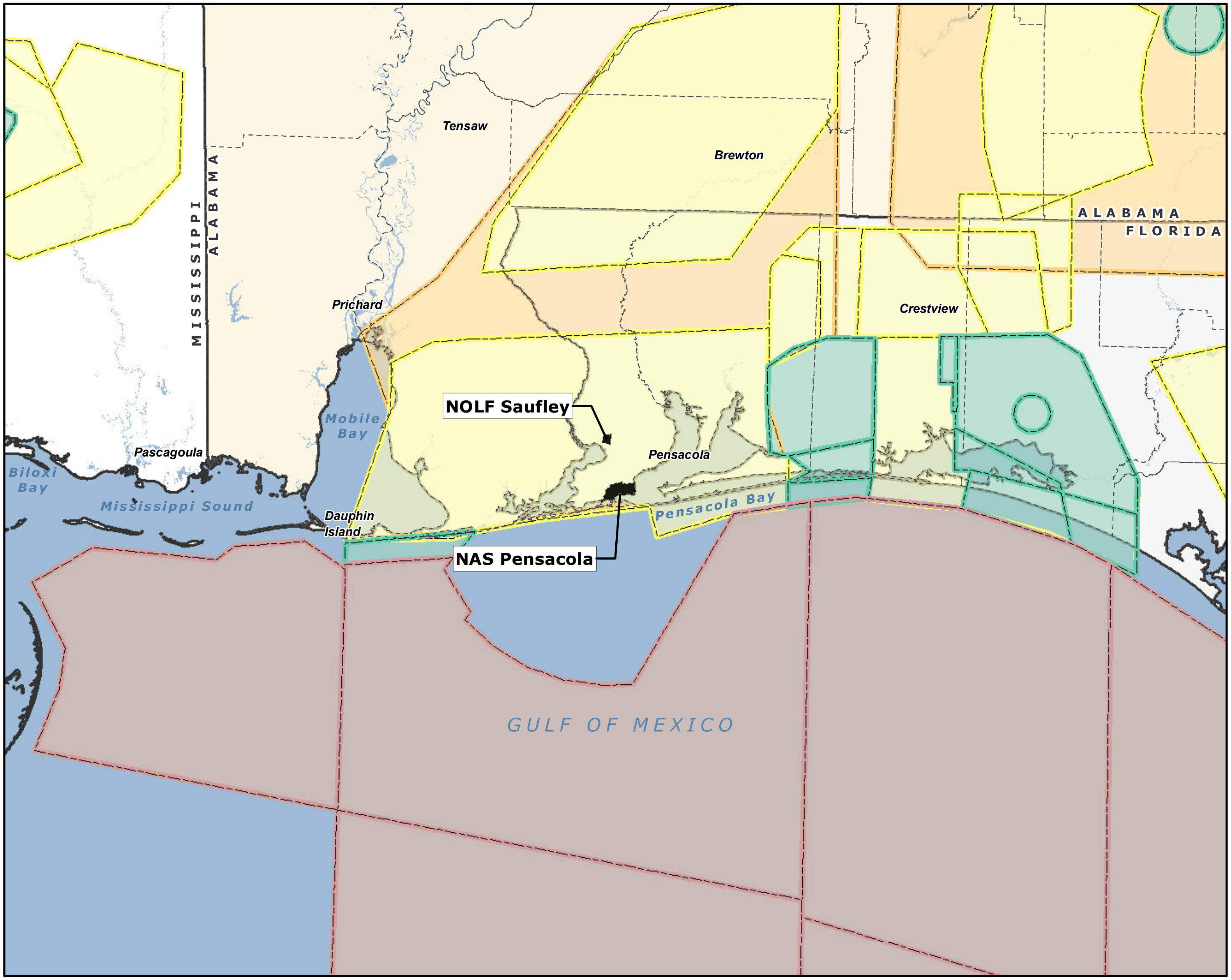



Figure 3-1
Special Use Air Space
NAS Pensacola and
NOLF Saufley

**Legend**

- NAS Pensacola and NOLF Saufley Boundaries
- Water Bodies
- Alabama Counties
- Florida Counties
- State Boundary

**Special Use Airspace**

- Alert Area
- MOA
- Restricted Area
- Warning Area

Source:
ESRI, 2005

0 7.5 15 30
Miles

## 3.3 Aircraft Operations

The main noise sources at NAS Pensacola and NOLF Saufley are aircraft operations, including engine run-up operations, flight arrivals, departures, and touch-and-go patterns.

### 3.3.1 Engine Run-Up Locations

Engine maintenance run-up operations conducted at NAS Pensacola are associated with TRAWING 6, 479th Flying Training Group, and the Blue Angels Flight Demonstration Team (Table 3-1 and Figure 3-2). There are no engine maintenance run-up operations at NOLF Saufley.

**Table 3-1 NAS Pensacola Run-Up Locations**

| Location ID | Run-Up Operation | Aircraft Serviced |
|---|---|---|
| HP T6 | High Power Pad | T-6 |
| BA FW | Blast Area | T-45, T-39 |
| FL T1 | South Ramp and Blast Fence (Hanger 3260) | T-1 |
| BLUE LO | Blue Angel Low Power Turns | F/A-18 A/B |
| FL T2 T39 | Flight Line | T-45, T-39 |
| WR T2 T39 | Wash Rack | T-45, T-39 |
| 1853 LINE | 1853 Line | T-6 |
| BLUE HI | Blue Angel High Power Turns | F/A-18 A/B |
| WR H3 H60 | Wash Rack | H-60 |

### 3.3.2 Flight Operations

A “flight operation” refers to anytime an aircraft crosses over the runway threshold at an airfield. The takeoff and landing may be part of a training maneuver (or pattern) associated with the runway or may be associated with a departure or arrival of an aircraft to or from defense-related, special-use airspace. Certain flight operations are conducted as patterns (e.g., touch-and-go, etc.). Departures and arrivals each count as one operation and a pattern counts as two. Basic flight operations at NAS Pensacola and NOLF Saufley are:

© Ecology & Environment, Inc. GIS Department Project #
\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 3-2 Pensacola Aircraft Runup Locations.mxd

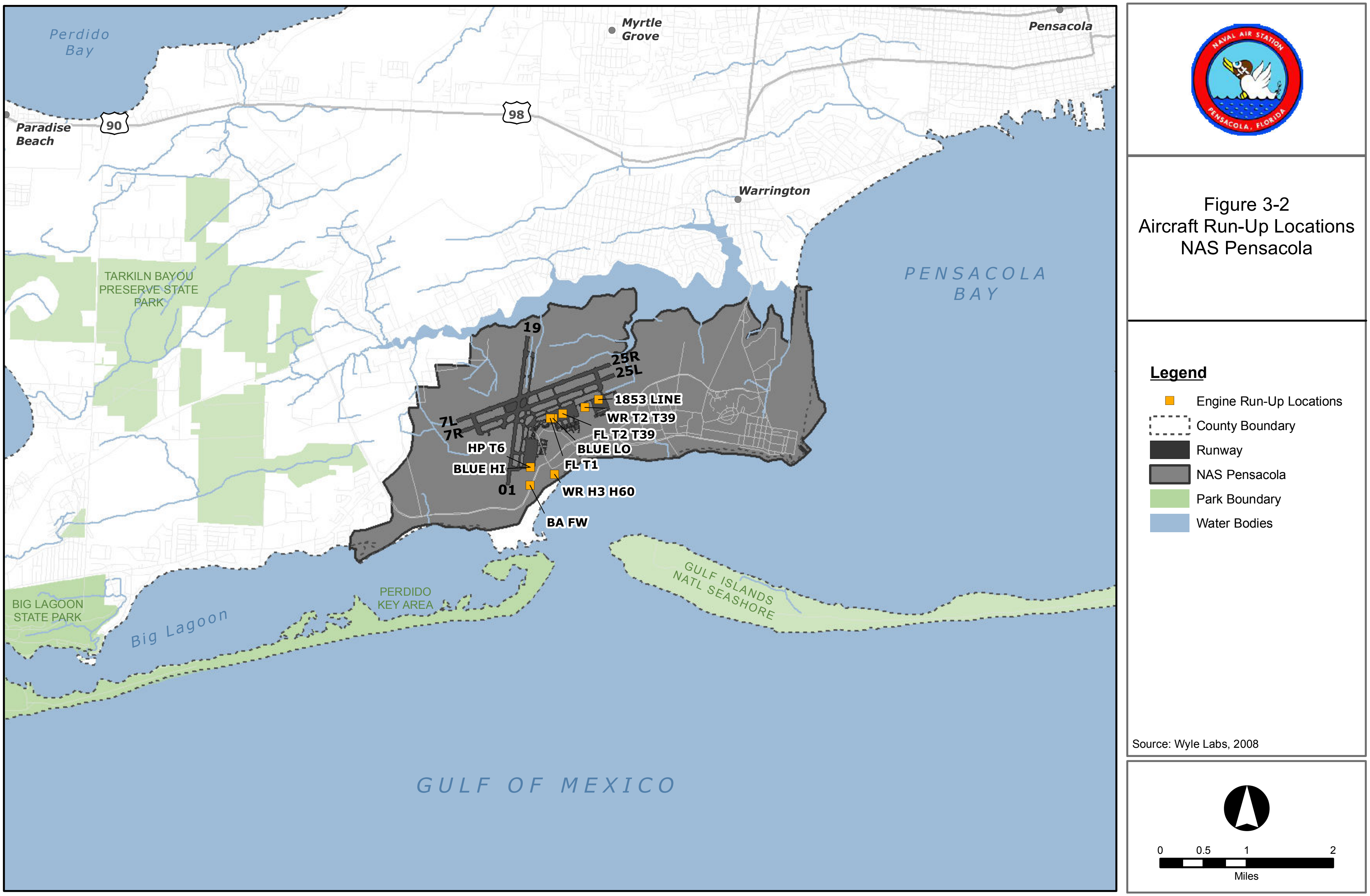



Figure 3-2
Aircraft Run-Up Locations
NAS Pensacola

- **Departure.** An aircraft taking off to a local training area, a non-local training area, or as part of a training maneuver (i.e., touch-and-go).
- **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 visual flight rules. An aircraft approaches the runway 500 feet (152 meters) 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.
- **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 actually is counted as two operations—the landing is counted as one operation, and the takeoff is counted as another.

### 3.3.3 NAS Pensacola Operations

Flight operations at NAS Pensacola have generally decreased over the past nine years. Annual operations for Calendar Year (CY) 2012 were established based on assumptions provided by NAS Pensacola personnel. All foreseeable missions were projected to 2012 and include projections for the F-35 as transient aircraft, as they are expected to be operational within this decade. Within this timeframe, NAS Pensacola would be expected to experience a total of approximately 110,226 operations annually. The flight operations for 2012 are utilized in this study to develop the 2010 AICUZ Noise Contours (see Section 4, Aircraft Noise) and Accident Potential Zones (APZs) (see Section 5, Aircraft Safety). Annual operations for CY2012 include the USAF CSO Training Squadron. The USAF 479th Flying Training Group (FTG) will consist of three squadrons and, for purposes of the study, their operations are included under TRAWING 6 operations.

Table 3-2 presents the total projected annual flight operations at NAS Pensacola. Flight operations grouped by aircraft and flight track can be found in the 2008 Wyle Noise Study (WR 08-23). Departure and arrival portions of ground control approach (GCA) flight patterns at NAS

**Table 3-2 Projected Annual Air Operations for NAS Pensacola**

| Category | Operation Type | Day 0700-2200 | Night 2200-0700 | Total |
|---|---|---|---|---|
| T-6* | Departure | 20,300 | 1,364 | 21,664 |
| | Arrival | 20,042 | 1,622 | 21,664 |
| | Touch-and-Go | 9,094 | 630 | 9,724 |
| | **Total** | **49,436** | **3,616** | **53,052** |
| T-39 | Departure | 4,733 | 207 | 4,940 |
| | Arrival | 4,070 | 870 | 4,940 |
| | Touch-and-Go | 578 | 80 | 658 |
| | **Total** | **9,381** | **1,157** | **10,538** |
| T-1 | Departure | 6,479 | 281 | 6,760 |
| | Arrival | 6,301 | 459 | 6,760 |
| | Touch-and-Go | 960 | 80 | 1,040 |
| | **Total** | **13,740** | **820** | **14,560** |
| T-45* | Departure | 6,037 | 740 | 6,777 |
| | Arrival | 6,162 | 615 | 6,777 |
| | Touch-and-Go | 2,738 | 188 | 2,926 |
| | **Total** | **14,937** | **1,543** | **16,480** |
| F/A-18 E/F | Departure | 1,348 | 59 | 1,407 |
| | Arrival | 1,236 | 171 | 1,407 |
| | Touch-and-Go | 30 | 0 | 30 |
| | **Total** | **2,614** | **230** | **2,844** |
| F-35 A/B/C | Departure | 1,938 | 365 | 2,303 |
| | Arrival | 2,028 | 275 | 2,303 |
| | Touch-and-Go | 22 | 0 | 22 |
| | **Total** | **3,988** | **640** | **4,628** |
| T-38 | Departure | 253 | 0 | 253 |
| | Arrival | 253 | 0 | 253 |
| | Touch-and-Go | 0 | 0 | 0 |
| | **Total** | **506** | **0** | **506** |
| Other Transient Aircraft | Departure | 2,684 | 569 | 3,253 |
| | Arrival | 2,796 | 457 | 3,253 |
| | Touch-and-Go | 657 | 455 | 1,112 |
| | **Total** | **6,137** | **1,481** | **7,618** |
| **Grand Total** | Departure | 43,772 | 3,585 | 47,357 |
| | Arrival | 42,888 | 4,469 | 47,357 |
| | Touch-and-Go | 14,079 | 1,433 | 15,512 |
| | **Total** | **100,739** | **9,487** | **110,226** |

Sources: Wyle Noise Study November 2008
Notes: Arrivals include both straight-in and overhead break.
Touch-and-go counted as two operations—a takeoff and a landing.
* Total of TRAWING 6 and Transient Aircraft

Pensacola are included in the departure and arrival flight tracks. Pensacola Approach's GCA box pattern is assigned to each runway at NAS Pensacola.

### 3.3.4 NOLF Saufley Operations

Annual operations for CY2012 were established based on assumptions provided by NAS Pensacola personnel. Within this timeframe, NOLF Saufley would be expected to experience a total of approximately 71,238 operations annually. The flight operations for 2012 are utilized in this study to develop the 2010 AICUZ Noise Contours (see Section 4, Aircraft Noise) and APZs (see Section 5, Aircraft Safety).

Table 3-3 presents the total projected annual flight operations at NOLF Saufley. Flight operations grouped by aircraft and flight track can be found in the 2008 Wyle Noise Study (WR 08-23).

**Table 3-3 Projected Annual Air Operations for NOLF Saufley**

| Category | Operation Type | Day | Night | Total |
|---|---|---|---|---|
| | | 0700-2200 | 2200-0700 | |
| T-6 | Departure | 4,429 | 0 | 4,429 |
| | Arrival | 4,429 | 0 | 4,429 |
| | Touch-and-Go | 41,304 | 0 | 41,304 |
| | **Total** | **50,162** | **0** | **50,162** |
| TH-57 | Departure | 1,861 | 0 | 1,861 |
| | Arrival | 1,861 | 0 | 1,861 |
| | Touch-and-Go | 17,354 | 0 | 17,354 |
| | **Total** | **21,076** | **0** | **21,076** |
| **Grand Total** | Departure | 6,290 | 0 | 6,290 |
| | Arrival | 6,290 | 0 | 6,290 |
| | Touch-and-Go | 58,658 | 0 | 58,658 |
| | **Total** | **71,238** | **0** | **71,238** |

Sources: Wyle Noise Study November 2008
Notes: Arrivals include both Straight-in and Overhead Break.

### 3.3.5 Runway and Flight Track Utilization

Aircraft approaching or departing from the air stations are assigned specific routes or flight tracks. The designated runways for the airfields are identified in Section 2.4. Flight tracks are represented as single lines, but flights vary due to aircraft performance, pilot technique, and weather conditions, such that the actual flight track is a band, often one-half to several miles wide. The flight tracks shown in this AICUZ study are idealized representations. Predominant arrival, departure, and pattern flight tracks for NAS Pensacola and NOLF Saufley are shown on Figures 3-3 through 3-8 (presented at the end of Section 3).

As discussed in Section 3.3.1, flight operations include departure, straight-in arrival, overhead break arrival, and touch-and-go operations. Abbreviations for the flight operations are:

- Departure – D
- Straight-In Arrival – A
- Overhead Break Arrival – O
- Touch-and-Go Pattern – T

The flight operations at NAS Pensacola are conducted on Runways 19, 25R, 25L, 01, 07R, or 07L. Abbreviations used to distinguish the parallel runways are:

- Left – L
- Right – R

Flight operations at NOLF Saufley are conducted on Runways 05, 23, 14, or 32. Section 2.4 provided a discussion and explanation of runway names. Individual flight track IDs are labeled according to the runway used, flight operation, and flight rules used while conducting the operation. Example flight track IDs for NAS Pensacola and NOLF Saufley are provided below and color-coded for example purposes only:

- NAS Pensacola Flight Track ID: **01D1**
  Runway: 01
  Flight Operation: Departure
  Flight Rules: VFR (visual flight rules)

- NOLF Saufley Flight Track ID: **23T1**
  Runway: 23
  Flight Operation: Touch-and-Go Pattern
  Flight Rules: Touch-and-Go

Tables 3-4 and 3-5 identify flight tracks at NAS Pensacola and NOLF Saufley, respectively.

**Table 3-4 NAS Pensacola Flight Tracks**

| Operation Type | Runway | Flight Track ID | Flight Track Rule |
|---|---|---|---|
| Departure | 01 | 01D1 | VFR |
| | | 01D2 | IFR/Jet |
| | 07L | 7LD1 | VFR |
| | | 7LD2 | IFR/Jet |
| | 07R | 7RD1 | VFR |
| | | 7RD2 | IFR/Jet |
| | 19 | 19D1 | VFR |
| | | 19D2 | IFR/Jet |
| | 25L | 5LD1 | VFR |
| | | 5LD2 | IFR/Jet |
| | 25R | 5RD1 | VFR |
| | | 5RD2 | IFR/Jet |
| Overhead Break Arrival | 01 | 01O1 | Break |
| | | 01O2 | Break |
| | | 01O3 | Short Break |
| | 07R | 7RO1 | Break |
| | | 7RO2 | Break |
| | | 7RO3 | Short Break |
| | 19 | 19O1 | Break |
| | | 19O2 | Break |
| | | 19O3 | Short Break |
| | 25L | 5LO1 | Break |
| | | 5LO2 | Break |
| | | 5LO3 | Short Break |

**Table 3-4 NAS Pensacola Flight Tracks**

| Operation Type | Runway | Flight Track ID | Flight Track Rule |
|---|---|---|---|
| Straight-In Arrival | 01 | 01A1 | IFR |
| | | 01A2 | VFR |
| | 07L | 7LA1 | IFR |
| | | 7LA2 | VFR |
| | 07R | 7RA1 | IFR |
| | | 7RA2 | VFR |
| | 19 | 19A1 | IFR |
| | | 19A2 | VFR |
| | 25L | 5LA1 | IFR |
| | | 5LA2 | VFR |
| | 25R | 5RA2 | VFR |
| Touch-and-Go Pattern | 01 | 01T1 | Prop |
| | | 01T2 | Jet |
| | 07R | 7RT1 | Prop |
| | | 7RT2 | Jet |
| | 19 | 19T1 | Prop |
| | | 19T2 | Jet |
| | 25L | 5LT1 | Prop |
| | | 5LT2 | Jet |

Notes:
VFR - Visual Flight Rules
IFR - Instrument Flight Rules
Prop - Propeller Aircraft
Jet - Jet Aircraft

**Table 3-5 NOLF Saufley Flight Tracks**

| Operation Type | Runway | Flight Track ID | Flight Track Rule |
|---|---|---|---|
| Departure | **05** | 05D1 | Departure to Relay Tower - 600/900 ft |
| | **23** | 23D1 | Departure to Relay Tower - 600/900 ft |
| | **14** | 14D1 | Departure to Relay Tower - 600/900 ft |
| | **32** | 32D1 | Departure to Relay Tower - 600/900 ft |
| Arrival | **05** | 05O1 | Overhead Break Arrival from Grassy Point - 900/1200 ft entry |
| | **23** | 23O1 | Overhead Break Arrival from Grassy Point - 900/1200 ft entry |
| | **14** | 14O1 | Overhead Break Arrival from Grassy Point - 900/1200 ft entry |
| | **32** | 32O1 | Overhead Break Arrival from Grassy Point - 900/1200 ft entry |
| Touch-and-Go Pattern | **05** | 05T1 | Touch-and-Go |
| | **23** | 23T1 | Touch-and-Go |
| | **14** | 14T1 | Touch-and-Go |
| | **32** | 32T1 | Touch-and-Go |

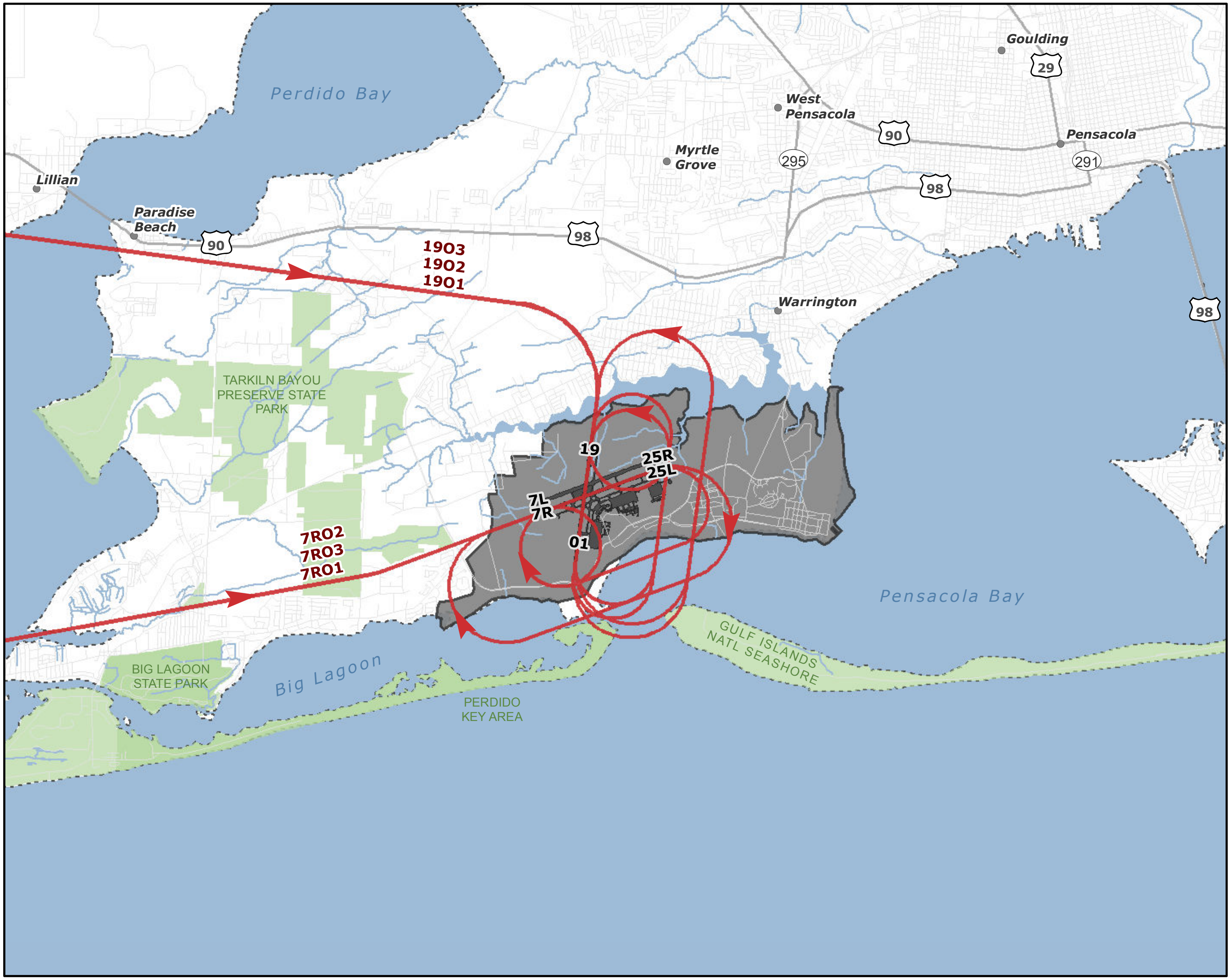



Figure 3-3a
Overhead Break
Arrival Flight Tracks
NAS Pensacola

**Legend**

- Overhead Break Arrival Flight Tracks
- Runway
- NAS Pensacola
- Park Boundary
- Water Bodies
- County Boundary

Source: Wyle Labs, 2008

© Ecology & Environment, Inc. GIS Department Project #
\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 3-3b Pensacola Overhead Break Arrival Flight Tracks.mxd

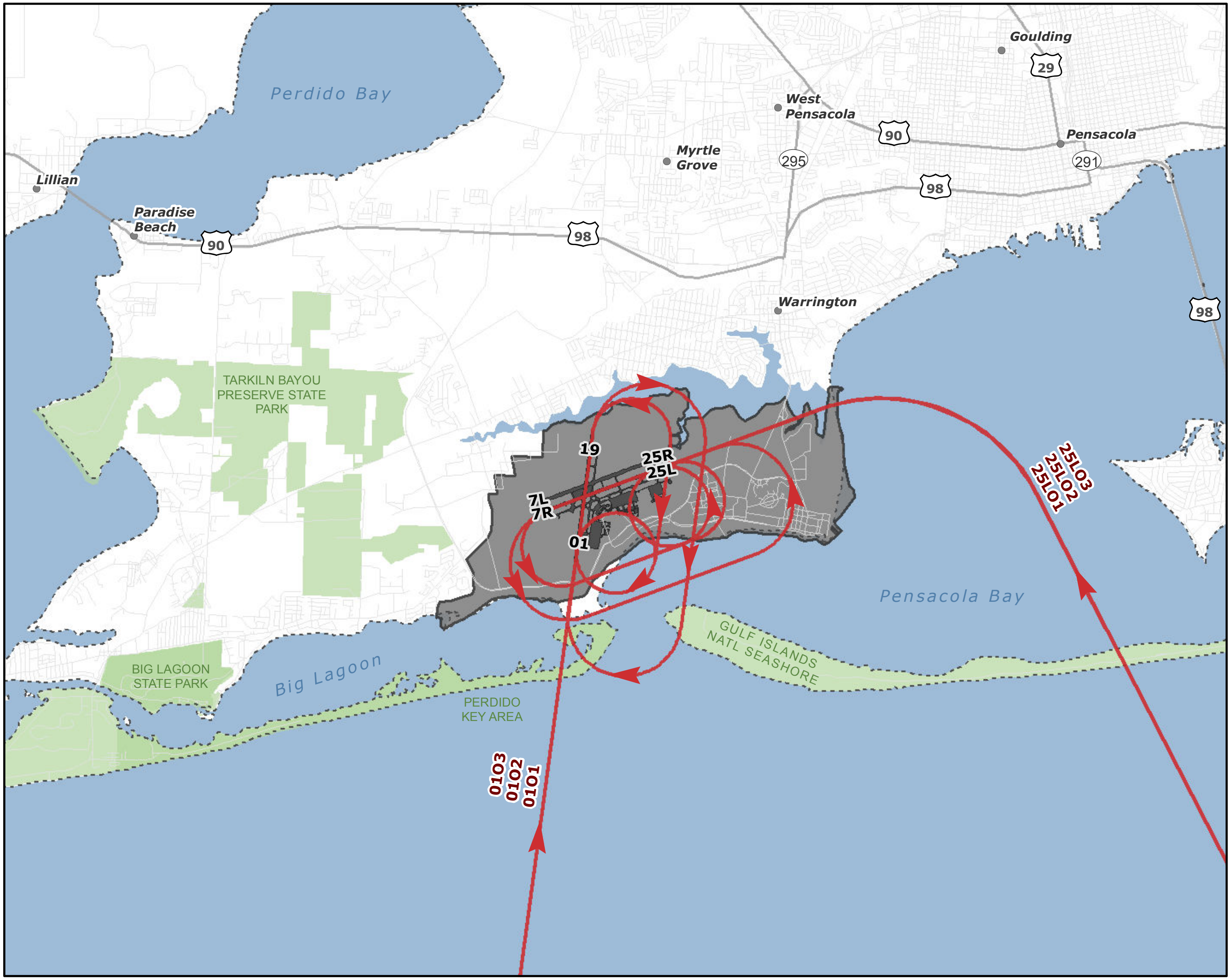



Figure 3-3b
Overhead Break
Arrival Flight Tracks
NAS Pensacola

**Legend**

- Overhead Break Arrival Flight Tracks
- Runway
- NAS Pensacola
- Park Boundary
- County Boundary

Source: Wyle Labs, 2008

0 0.5 1 2
Miles

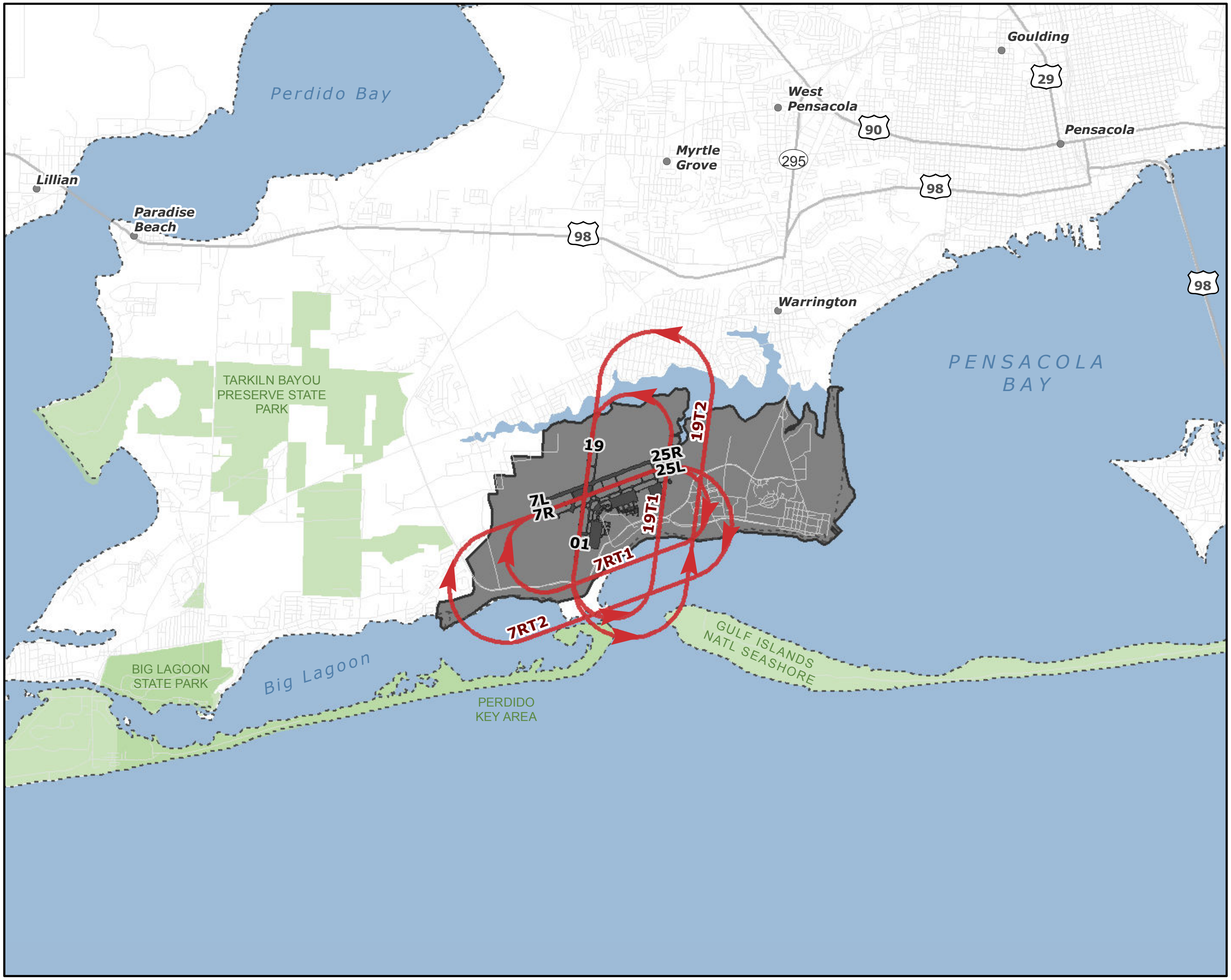



Figure 3-4a
Pattern (Touch-and-Go)
Flight Tracks
NAS Pensacola

**Legend**

- Touch-and-Go Flight Tracks
- Runway
- NAS Pensacola
- County Boundary
- Park Boundary
- Water Bodies

Source: Wyle Labs, 2008

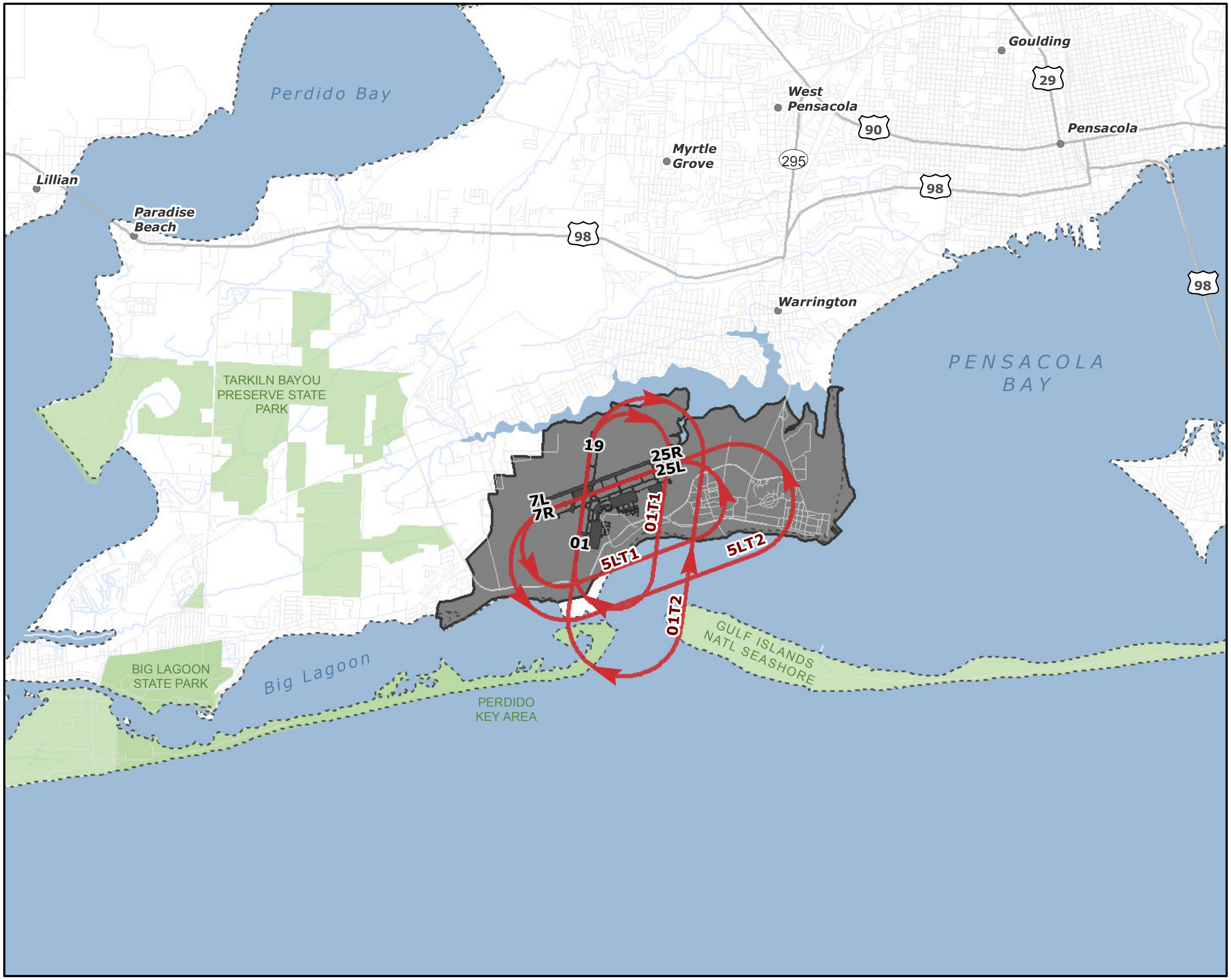
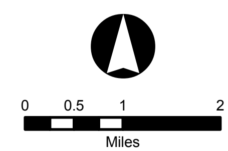



Figure 3-4b
Pattern (Touch-and-Go) Flight Tracks
NAS Pensacola

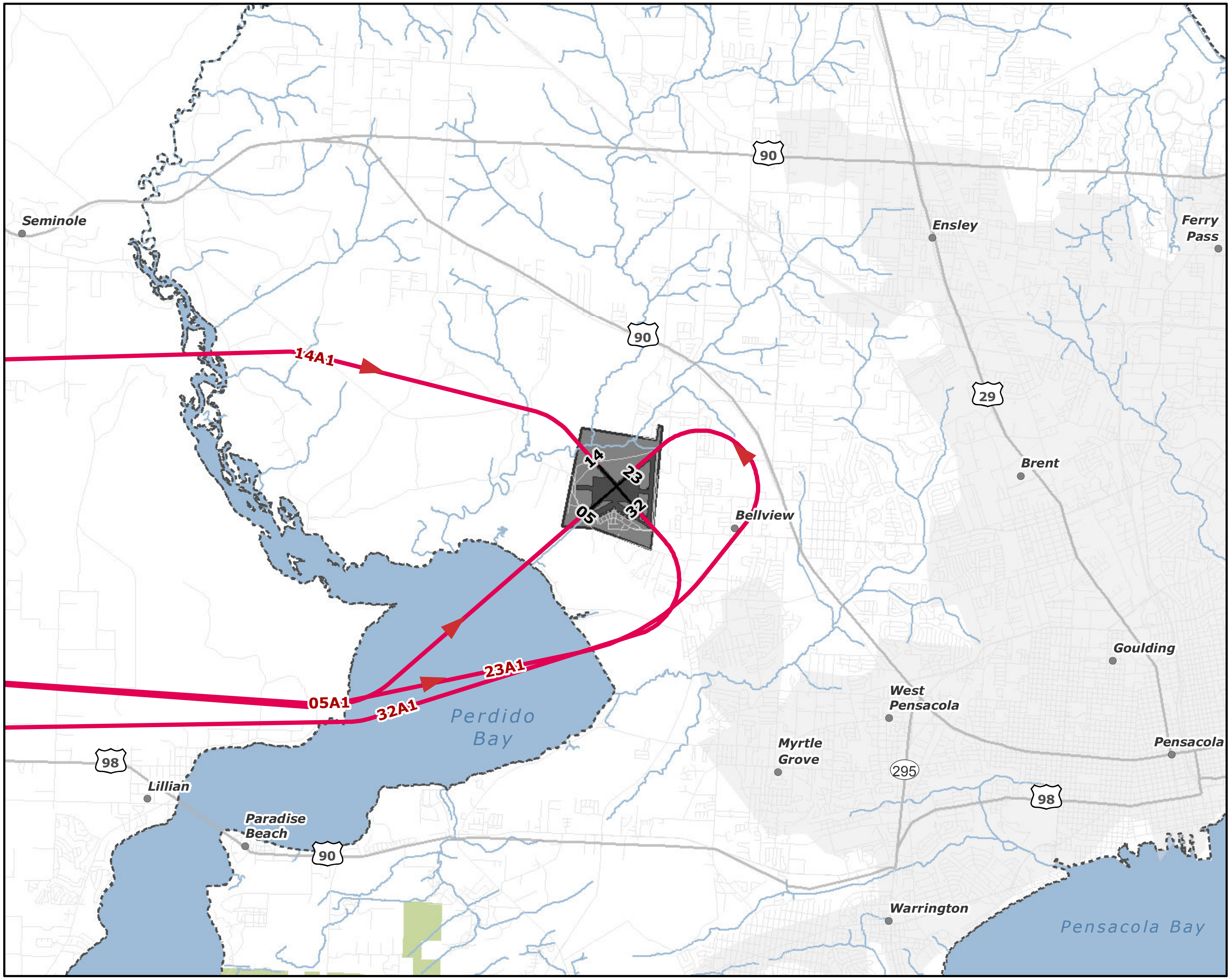
**Legend**

- Touch-and-Go Flight Tracks
- County Boundary
- Runway
- NAS Pensacola
- Park Boundary
- Water Bodies

Source: Wyle Labs, 2008



© Ecology & Environment, Inc. GIS Department    Project #
\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 3-5 Saufley Arrival Flight Tracks.mxd




# Figure 3-5
# Arrival Flight Tracks
# NOLF Saufley

**Legend**

- Arrival Flight Tracks
- Runway
- NOLF Saufley
- Park Boundary
- Water Bodies
- County Boundary

Source: Wyle Labs, 2008

0 0.5 1 2
Miles

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\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 3-6 Saufley Overhead Break Arrival Flight Tracks.mxd

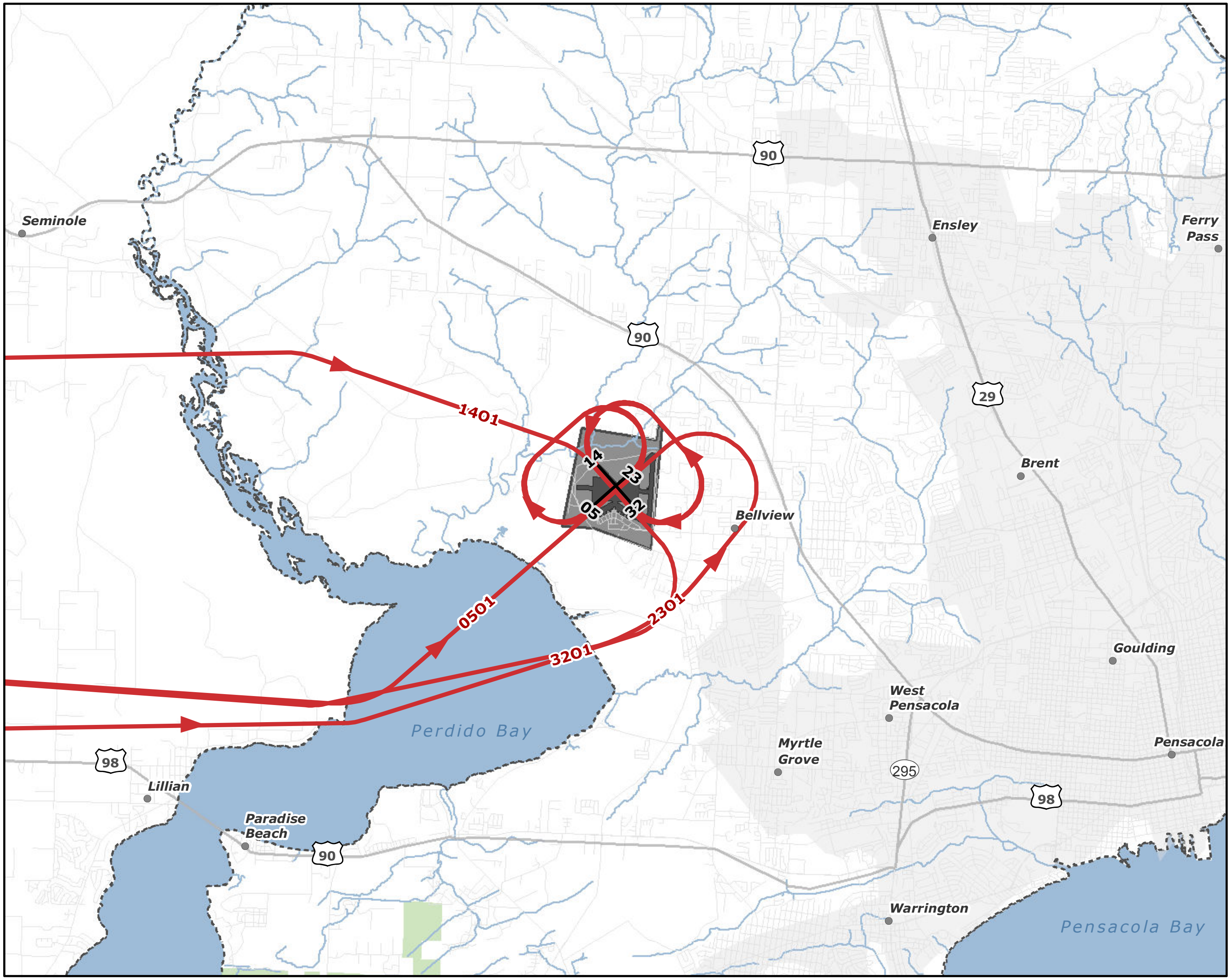
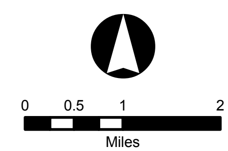



Figure 3-6
Overhead Break Arrival
Flight Tracks
NOLF Saufley

**Legend**

- Overhead Break Arrival Flight Tracks
- Runway
- NOLF Saufley
- Park Boundary
- Water Bodies
- County Boundary

Source: Wyle Labs, 2008



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\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 3-7 Saufley Departure Flight Tracks.mxd

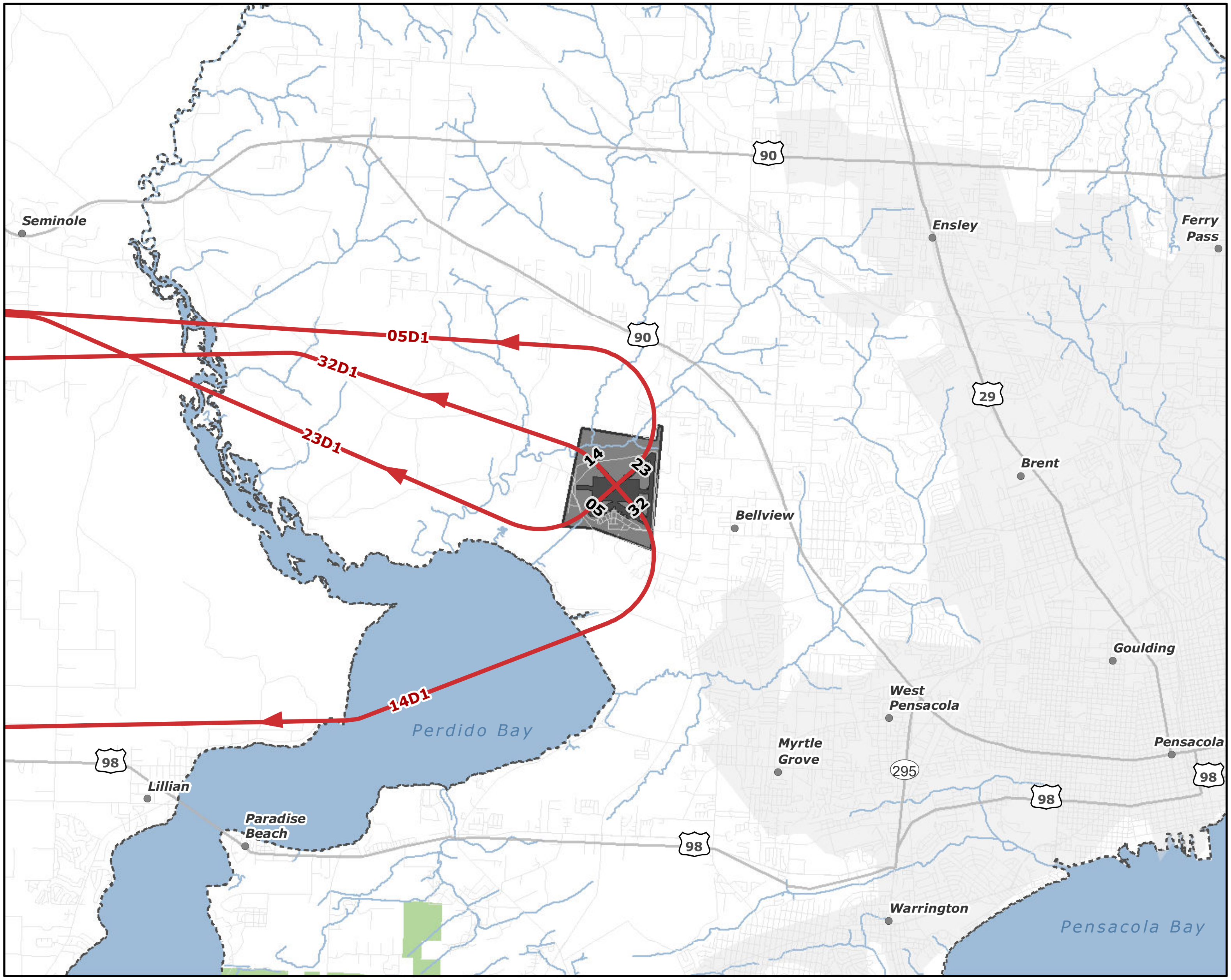


Figure 3-7
Departure Flight Tracks
NOLF Saufley

## Legend

- Departure Flight Tracks
- Runway
- NOLF Saufley
- Park Boundary
- County Boundary

Source: Wyle Labs, 2008

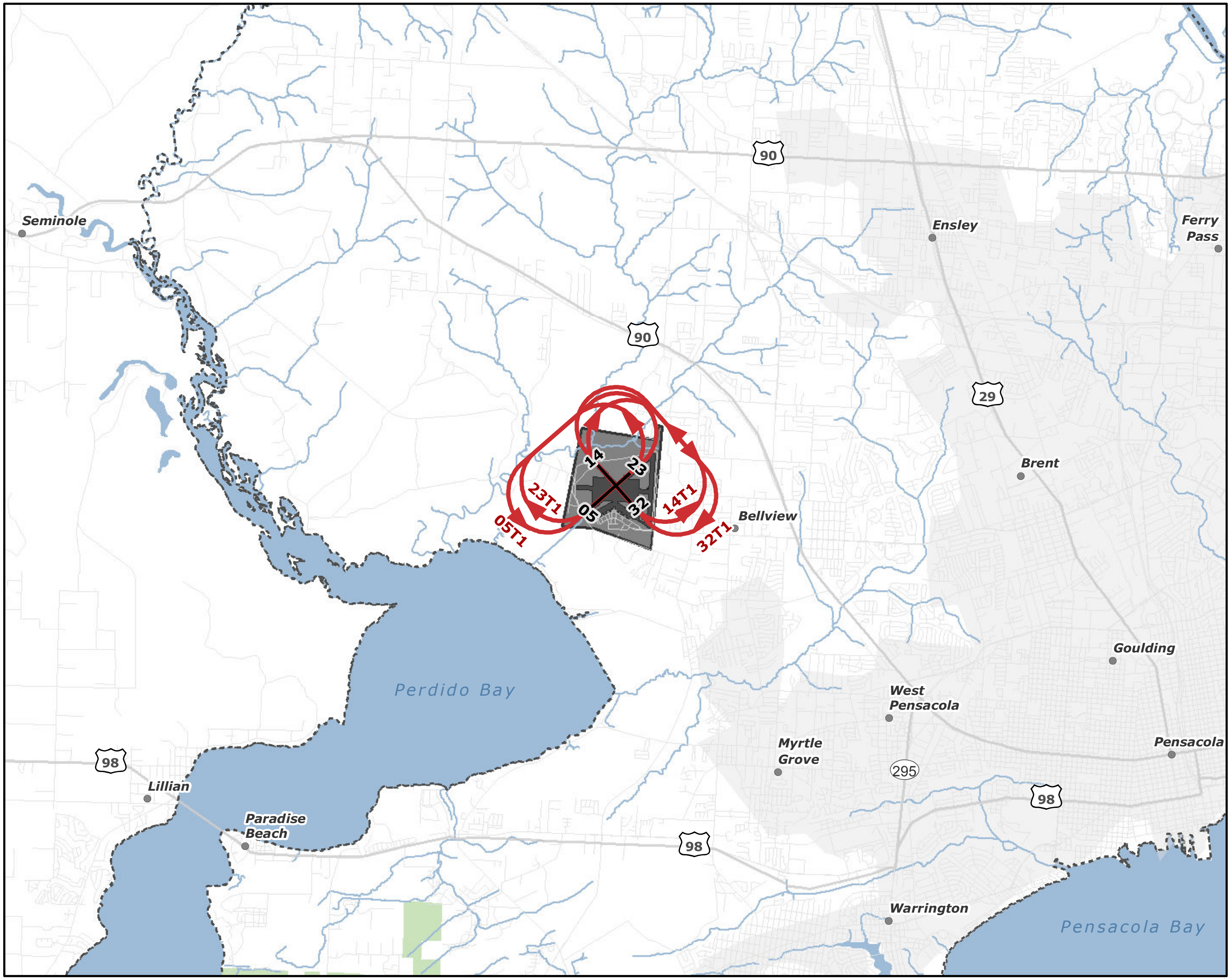


Figure 3-8
Pattern (Touch-and-Go)
Flight Tracks
NOLF Saufley

**Legend**

- Touch-and-Go Flight Tracks
- Runway
- NOLF Saufley
- Park Boundary
- Water Bodies
- County Boundary

Source: Wyle Labs, 2008

0 0.5 1 2
Miles

# 4 Aircraft Noise

The impact of aircraft noise is a critical factor in the planning of future land use near air facilities. Because the noise from aircraft operations may significantly impact areas surrounding an installation, NAS Pensacola has defined certain areas as noise zones under the AICUZ Program. This section discusses noise associated with aircraft operations at NAS Pensacola, including average noise levels, noise complaints, noise abatement/flight procedures, and noise contours.

## 4.1 What is Sound/Noise?

Noise exposure at NAS Pensacola and NALF Saufley is measured using the daynight average sound level (DNL) noise metric.

Sound is vibrations in the air, which can be generated by a multitude of sources. Some of the potential sources of noise include roadway traffic, land use activities, railway activities, and aircraft operations. Noise occurs when the sound is judged unwanted. Generally, sound becomes noise to a listener when it interferes with normal activities. For further discussion of noise and its effect on people and the environment, see Appendix A.

In this document, all sound or noise levels are measured in A-weighted decibels (dBA), which represents sound pressure adjusted to the range of human hearing with an intensity greater than barely audible sound, which is set at 0 dB. Normal speech has a sound level of approximately 60 to 65 dBA. Generally, a sound level above 120 dBA will begin to provide discomfort to a listener (Berglund and Lindvall 1995), and the threshold of pain is 140 dBA.

The noise exposure from aircraft at NAS Pensacola, as with other installations, is measured using the day-night average sound level (DNL) noise metric. The DNL noise metric, established in 1980 by the Federal Interagency Committee on Urban Noise (FICUN), presents a reliable measure of community sensitivity to aircraft noise and has become the standard metric used in the United States (except California, which uses the Community Noise Exposure Level [CNEL]). DNL averages the sound energy from aircraft operations at a location over a 24-hour period. DNL also adds an additional 10 decibels to events occurring between 10:00 p.m. to 7:00 a.m. This 10-decibel "penalty" represents the added intrusiveness of sounds occurring during normal sleeping hours, both because of the increased sensitivity to noise during those hours and because ambient sound levels at night are typically lower.

By combining factors most noticeable about noise annoyance—maximum noise levels, duration, and the number of events over a 24-hour period—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 [ANSI] 1990, Federal Interagency Committee on Noise [FICON] 1992).

For land-use planning purposes, noise zones are grouped into three noise zones:

—Noise Zone 1 (less than 65 DNL) generally considered an area of low or no noise impact.

—Noise Zone 2 (65 to 75 DNL) is an area of moderate impact, where some land-use controls are required.

—Noise Zone 3 (greater than 75 DNL) is the most severely impacted area and requires the greatest degree of land-use control.

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. The AICUZ Program generally divides noise exposure into three categories known as noise zones:

- **Noise Zone 1:** Less than 65 DNL;
- **Noise Zone 2:** 65 to 75 DNL; and
- **Noise Zone 3:** Greater than 75 DNL.

Noise Zone 1 (less than 65 DNL) is generally considered an area of low or no noise impact. Noise Zone 2 (65 to 75 DNL) is an area of moderate impact, where some land use controls are required. Noise

> Aircraft noise consists of two major sources: flight operations and ground engine maintenance "run-ups."

Zone 3 (greater than 75 DNL) is the most severely impacted area and requires the greatest degree of land use control.

## 4.2 Airfield Noise Sources

The main sources of noise at airfields are flight operations and pre-flight and/or maintenance run-ups. Computer models are used to develop noise contours, based on information about these operations, including:

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

## 4.3 Noise Complaints

Noise complaints originating from operations at NAS Pensacola are handled through representatives at NAS Pensacola and Navy Outlying Landing Field (NOLF) Saufley. The Noise Hotline has been established for the public to notify Navy officials of 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. Noise complaints can arise from a variety of causes, often related to the intensity and frequency of the events, wind speed, wind direction, and cloud cover, as well as the individual sensitivity of the person complaining. They often also arise outside the areas depicted by noise contours. This is frequently due to a single event that is unusual, such as a loud plane flying over an area not commonly overflown. In some cases, the complaints outside the areas included in the noise contours are due to the fact that noise contours and land use recommendations are based on average annoyance responses of a population, and some people have greater noise sensitivity than others. There is only an occasional complaint received at NAS Pensacola, normally related to the Blue Angels practice sessions. These complaints are investigated by the NAS Pensacola Aviation Safety Officer and the Blue Angels.

If there are concerns or complaints about aircraft noise in the area, citizens are encouraged to contact representatives at the appropriate hotline number:

**NAS Pensacola and NOLF Saufley**
Aviation Safety Officer
(850) 452-4231 extension 3130 or 3116

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 4-1.

**Table 4-1 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 |

## 4.4 Noise Abatement/Flight Procedures

NAS Pensacola and NOLF Saufley actively pursue operational measures to reduce noise. The purpose of these procedures is to minimize noise in recognition of community response to aircraft noise at NAS Pensacola and NOLF Saufley. All naval aviators are held to high standards of professionalism and are required to comply with noise abatement procedures. Procedures used to reduce noise upon takeoff include securing afterburners no later than the airfield boundary and climbing rapidly on departure, taking the noise away from the

Flight crews are periodically briefed by Air Traffic Control personnel who provide briefs to the air crews regarding airspace issues, flight patterns and operational restrictions.

community. Flight crews are periodically briefed by Air Traffic Control personnel who provide briefs to the air crews regarding airspace issues, flight patterns and operational restrictions. Night operations are limited to those that are necessary and essential (NAS Pensacola AICUZ 2008). Noise abatement procedures also apply to engine run-up operations.

## 4.5 Noise Contours

The Navy periodically conducts noise studies to assess the noise impacts of aircraft operations. The need to conduct a noise study is generally prompted by a significant change in aircraft operations—either by the number of operations conducted at the airfield, the number and type of aircraft using the airfield, or the flight paths used for airfield departure/arrival changes.

The Navy uses NOISEMAP – a computer model to project noise impacts.

The Navy uses NOISEMAP, a widely accepted computer model that projects noise impacts around military airfields. NOISEMAP calculates DNL contours resulting from aircraft operations using such variables as power settings, aircraft model and type, maximum sound levels, and duration and flight profiles for a given airfield. The contours connect points of equal value. Noise contours on the AICUZ map are normally shown in 5-decibel (dB) increments from 60 DNL to 85 DNL, as appropriate. The area between two specific contours is known as a noise zone. The noise exposure area is divided into noise zones that are shown on the AICUZ maps and are as follows:

- Less than 65 DNL;
- 65-70 DNL;
- 70-75 DNL; and
- Greater than 75 DNL.

Calculated noise contours do not represent exact measurements. Noise levels inside a contour may be similar to those outside a contour line. If the contour lines are close together, the change in noise level is greater. If the lines are far apart, the change in noise level is gradual (NAS Pensacola AICUZ 2008).

## 4.5.1 NAS Pensacola

The main noise sources at NAS Pensacola are aircraft operations. This section describes the historic noise contours (1988 and 1990 as provided in the 2003 Escambia County Joint Land Use Study (JLUS) [EDAW, Inc. 2003]) and the 2010 AICUZ noise contours (modeled Calendar Year (CY) 2012. The AICUZ process calls for the modeling and analysis of existing conditions and any future aircraft operational changes that can be reasonably predicted for the air station. Prospective flight operations, including noise associated with run-up locations, were modeled as part of the 2010 noise contours. Also important to note is that the noise contours presented in this study include augmented F-35 aircraft noise data. This AICUZ study includes the most current noise measurement data gathered at Edward AFB for the F- 35 and provided to the Navy by the USAF.

Prospective flight operations at NAS Pensacola that were modeled as part of the 2010 noise contours include increased training of T-6s for Training Air Wing (TRAWING) 6, replacement of the T-2 with the T-45, phase-out of aircraft (EA-6, S-3, T-34, and DC-9), and the addition of the F-35 (Joint Strike Fighter [JSF]) operations. The F-35 is not anticipated to be stationed at NAS Pensacola or NOLF Saufley; however, all three variants (Navy [F-35C], Marine Corps [F-35B], and Air Force [F-35A]) are expected to use NAS Pensacola's runways as transient aircraft.

### 4.5.1.1 2010 AICUZ Noise Contours

The 2010 AICUZ noise contours (modeled CY2012, including F-35 as transient aircraft) have increased in overall size from the 1988 and 1990 AICUZ noise contours as provided in the 2003 Escambia County JLUS (EDAW, Inc. 2003) (Figure 4-1). The concentrations of the 2010 AICUZ noise contours are on Runways 07L/25R and 07R/25L. The 65- as well as some of the 75 DNL noise contours extend off-station, specifically at the edge of Runway 01/19 and the western edge of Runways 07L/25R and 07R/25L (see Figure 4-1).

© Ecology & Environment, Inc. GIS Department Project #
\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 4-1 Pensacola 2010 Noise Contours.mxd

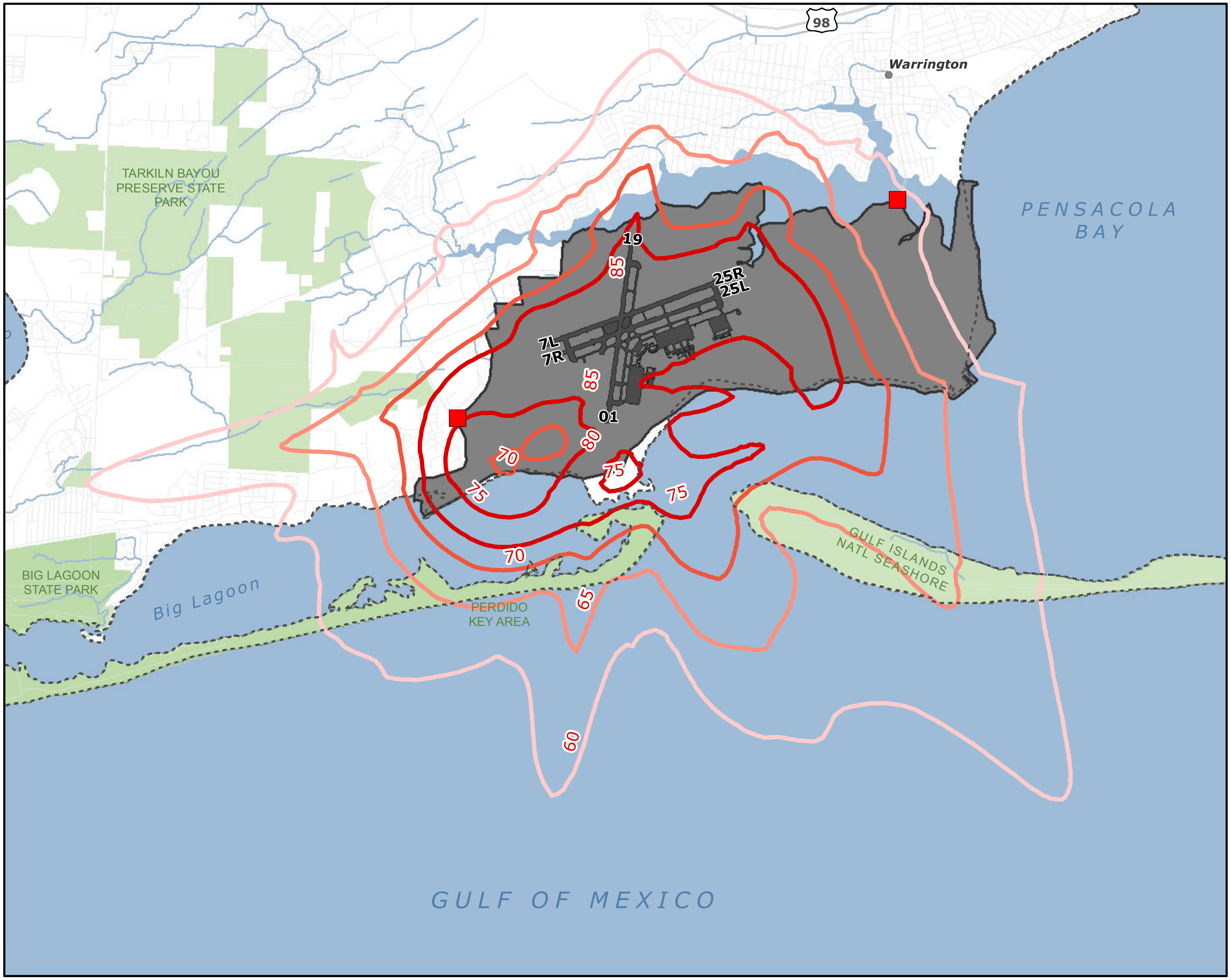


Figure 4-1
2010 AICUZ
Noise Contours
NAS Pensacola

**Legend**

**2010 Noise Countour**

- 60 DNL
- 65 DNL
- 70 DNL
- 75+ DNL
- Gate
- Park Boundary
- Water Bodies
- County Boundary

Source: Wyle Labs, 2008

0 0.5 1 2
Miles

The total amount of off-station acreage within the 65 DNL noise contour is approximately 5,000 acres (2,023 ha). Figure 4-2, provides a DNL color gradient of the noise propagating from NAS Pensacola into the surrounding community. The highest noise levels are concentrated within the installation and decrease to much lower levels into the surrounding community. The figure also depicts the noise outside the 65 DNL noise contours, which are deemed minimal by the AICUZ Program.

As previously mentioned, the 2010 noise contours include noise associated with engine run-up locations. The engine run-up locations are within the 85 DNL noise contours concentrations (Figure 4-3).

#### 4.5.1.2 Comparison of 1988/1990 and 2010 AICUZ Noise Contours

The 2010 AICUZ noise contours have changed in size and location from the 1988 and 1990 AICUZ noise contours (see Figure 4-4 and Table 4-2). A complete study methodology was not provided in the 2003 JLUS or previous AICUZ documents. Sufficient information now exists to conduct a thorough comparative analysis of the two sets of noise contours.

**Table 4-2 Areas within Noise Zones (DNL), NAS Pensacola**

| Noise Zone | TOTAL LAND AREA | |
|---|---|---|
| | 1988 and 1990 AICUZ Noise Zones (acres) | 2010 AICUZ Noise Zones (acres) |
| 65-70 DNL | 3,795 | 4,778 |
| 70-75 DNL | 1,582 | 3,048 |
| 75-80 DNL | (75 + DNL) 2,548 | 2,066 |
| 80+ DNL | NA | 2,119* |
| **TOTAL AREA** | **7,926** | **12,011** |

Source: E & E 2009
Notes:
NA = Data Not Available
*= All on station land area

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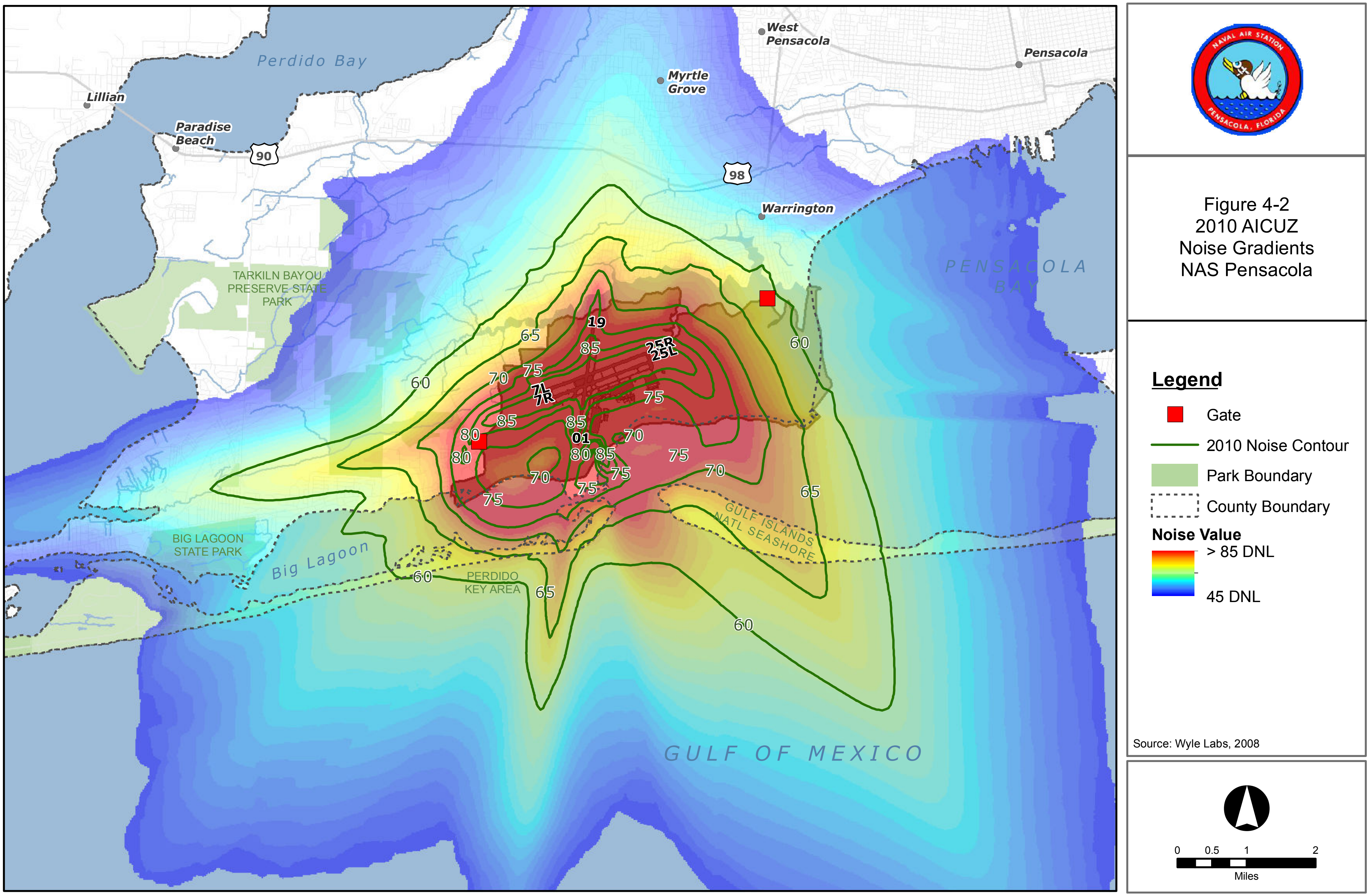
\L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\Oct2009\Figure 4-2 Pensacola 2012 Noise Gradient.mxd



© Ecology & Environment, Inc. GIS Department    Project #
\L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April2009\Figure 4-3 Pensacola Aircraft Runup Locations.mxd


Figure 4-3
Engine Run-Up Locations and 2010 AICUZ Noise Contours
NAS Pensacola

**Legend**

**2010 Noise Countour**

- 60 DNL
- 65 DNL
- 70 DNL
- 75+ DNL
- Engine Run-Up Locations
- NAS Pensacola
- Runway

Source: Wyle Labs, 2008.
Florida Department of Revenue, 2007.

0 0.125 0.25 0.5
Miles

© Ecology & Environment, Inc. GIS Department Project #
\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 4-4 Pensacola Noise Contour Comparison.mxd

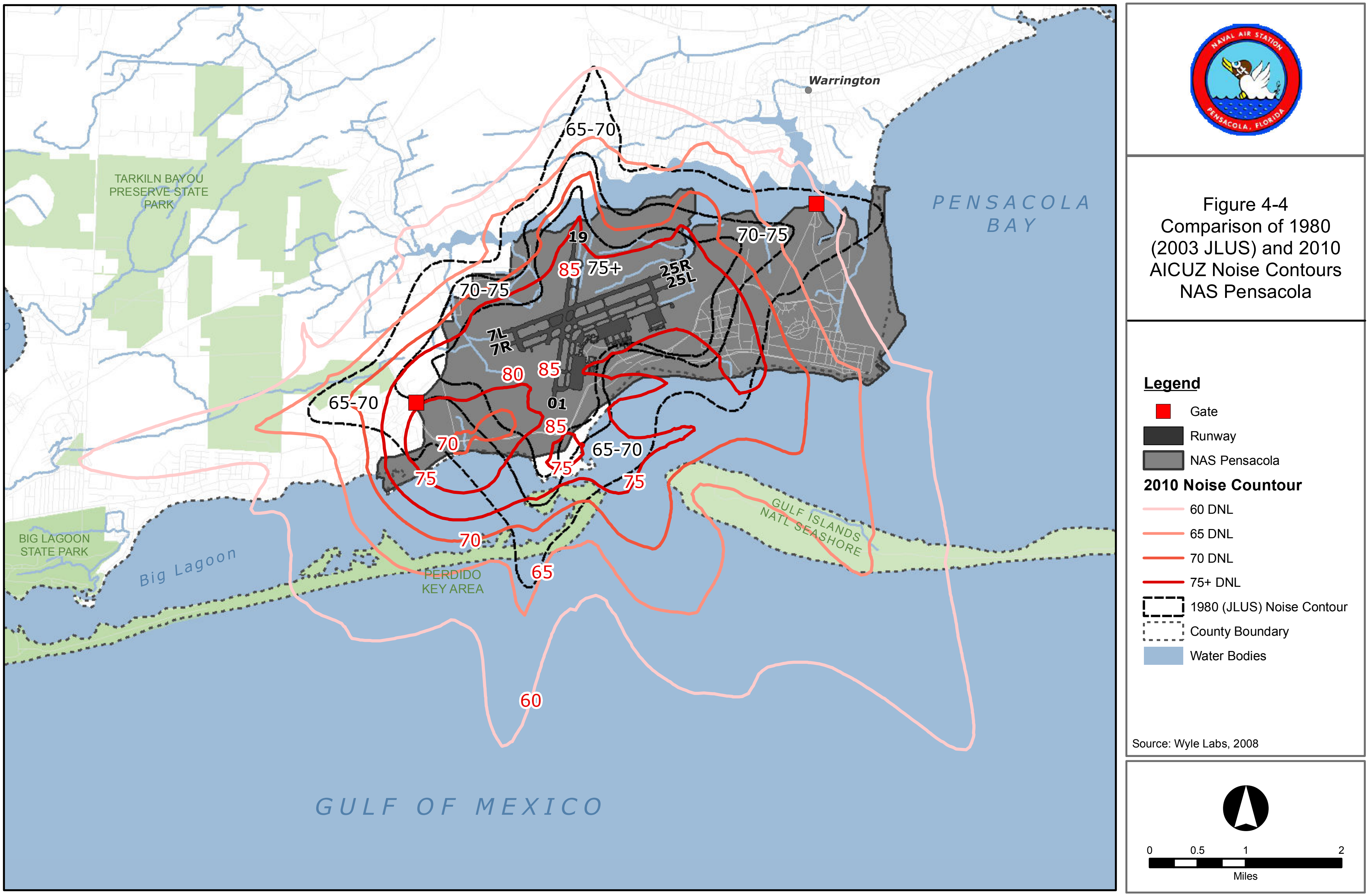



Figure 4-4
Comparison of 1980 (2003 JLUS) and 2010 AICUZ Noise Contours NAS Pensacola

The 65 DNL noise contour under the 1988 and 1990 AICUZ noise contours extended significantly off base to the north from Runway 01/19, and moderately off base to the south from Runway 01/19. At the north end of Runway 01/19, the 2010 AICUZ 65 DNL noise contour does not extend as far off base as the previous contours; however, it extends further off base to the south and southeast over the barrier islands and the Gulf of Mexico.

The 65 DNL noise contour extends approximately 1 mile (1.6 kilometer [km]) north of the installation, 2.45 miles (3.94 km) south of the installation, and 2.04 miles (3.28 km) west of the installation (distances measured from the installation boundary to the furthest directional extent of the contour).

The 75 DNL noise contour under the 1988 and 1990 AICUZ noise contours are contained primarily on base. The 2010 AICUZ noise contour of 75 DNL is also contained primarily on base except where it minimally extends off base to the southwest.

The 75 DNL noise contour extends approximately 0.2 mile (0.32 km) north of the installation, 1.09 miles (1.75 km) south of the installation, and 0.47 mile (0.76 km) west of the installation (distances measured from the installation boundary to the furthest directional extent of the contour). Noise contours do not extend off the installation to the east.

As described above and depicted in Figure 4-4, the 2010 AICUZ noise contours have changed in size and location from the 1988 and 1990 AICUZ noise contours. The changes are due, in part, to a change in aircraft mix, flight patterns, operational level, and improved noise mapping techniques. Noise contours, as discussed in Section 4.5, incorporate aircraft specific noise data, including aircraft operations using such variables as power settings, aircraft model and type, maximum sound levels, and duration and flight profiles for a given airfield. Therefore, the addition and/or removal of an aircraft from the installation will result in a change in the noise contours. As such, each aircraft has specific operational profiles that determine flight patterns. As mapped, noise propagates from the flight pattern and, as such, will vary from aircraft to aircraft and pattern to pattern as they change over time. As a result, aircraft mix and flight patterns have changed since the 1988 and 1990 AICUZ noise contours and the 2010 AICUZ contours, resulting in changes in size and location of noise contours. Additionally, improvements in the noise model contribute to changes in the size and location of the 2010 noise contours.

The operational tempo of an installation also impacts the noise contours. As the operational tempo of an installation varies over time, so do the noise contours. However, noise contours are not a direct reflection of the operational tempo. If operations decrease, the noise contours do not necessarily decrease; likewise, if operations increase the noise contours do not necessarily increase. This is true with respect to the aircraft mix at the installation as noise associated with specific aircraft varies.

NOISEMAP, as specified in Chief of Naval Operations Instruction (OPNAVINST) 11010.36C was used to calculate and plot the 60 through 85 DNL noise contours for the 2010 AICUZ noise contours. The 1988 and 1990 noise contours used in the 2003 JLUS were modeled based on requirements in OPNAVINST 11010.36A. Noise mapping technology has significantly progressed since the 1988 and 1990 noise contours were developed. Advancements in noise mapping technology contribute to the changes in size and location of the 2010 noise contours.

### 4.5.2 NOLF Saufley

The main noise sources at NOLF Saufley are touch-and-go aircraft operations. This section describes the historic noise contours (2000 noise study update as provided in the 2003 Escambia County JLUS [EDAW, Inc. 2003]) and the 2010 AICUZ noise contours (modeled CY2012). The AICUZ process calls for the modeling and analysis of existing conditions and any future aircraft operational changes that can be reasonably predicted for the air station.

Prospective flight operations modeled for NOLF Saufley include replacement of the T-34 with the T-6 and reduction of night operations to zero.

#### 4.5.2.1 2010 AICUZ Noise Contours

The 2010 AICUZ noise contours have significantly increased the overall size of the 2000 AICUZ noise contours (see Figure 4-5). The concentrations of the 2010 AICUZ noise contours increased to the north, east, and west, and with no notable differences in the contours to the south. The 55 DNL did not increase from the 2000 AICUZ noise contours, as 55 DNL remains the highest noise contour in the 2010 study. The total amount of off-station acreage within the 55 DNL noise contour is approximately 1,750 acres (708 ha). The 65 DNL noise contour does not extend off the installation. The 55 DNL noise contour is shown for informational purposes since it is considered an area of low or no noise impact and no land use controls are required. Figure 4-6, provides a DNL color gradient of the noise propagating from NOLF Saufley into the surrounding community. The highest noise levels are concentrated within the installation and decrease to much lower levels into the surrounding community. The figure also depicts the noise outside the 55 DNL noise contours, which are deemed minimal by the AICUZ Program.

#### 4.5.2.2 Comparison of 2000 and 2010 AICUZ Noise Contours

The 2010 AICUZ noise contours have changed in size and location from the 2000 AICUZ noise contours (Figure 4-7). The 55 DNL noise contour under the 2000 AICUZ extended significantly off base in the direction of the runways, in an 'X' shape, with wider coverage to the north. The off-base portion of the 55 DNL noise contour in the 2010 AICUZ surrounds the airfield, includes a larger area, and extends further north than the 2000 AICUZ noise contours (see Table 4-3). The 55 DNL noise contour is shown for only informational purposes since it is considered an area of low or no noise impact and no land use controls are required. See Section 4.5.1.2 for further explanation of changes in size and location of noise contours.

**Table 4-3 Areas within Noise Zones (DNL), NOLF Saufley**

| Noise Zone | TOTAL LAND AREA | |
|---|---|---|
| | 2000 AICUZ Noise Zones (acres) | 2010 AICUZ Noise Zones (acres) |
| 55-60 DNL | 703 | 1,750 |
| 60-65 DNL | 272 | 830 |
| 65-70 DNL | (65+ DNL) 80 | 184 |
| 70+ DNL | NA | 26 |
| **TOTAL AREA** | **1,055** | **2,790** |

Source: E & E 2009
Notes:
NA = Data Not Available

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\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 4-5 Saufley 2010 Noise Contours.mxd


# Figure 4-5
# 2010 AICUZ Noise Contours NOLF Saufley

## Legend

- Gate

**2010 AICUZ Noise Contour**

- 55 DNL
- 60 DNL
- 65+ DNL
- Runway
- County Boundary
- NOLF Saufley
- Water Bodies

Source: Wyle Labs, 2008

0 0.25 0.5 1
Miles

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\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 4-6 Saufley 2010 Noise Gradient.mxd

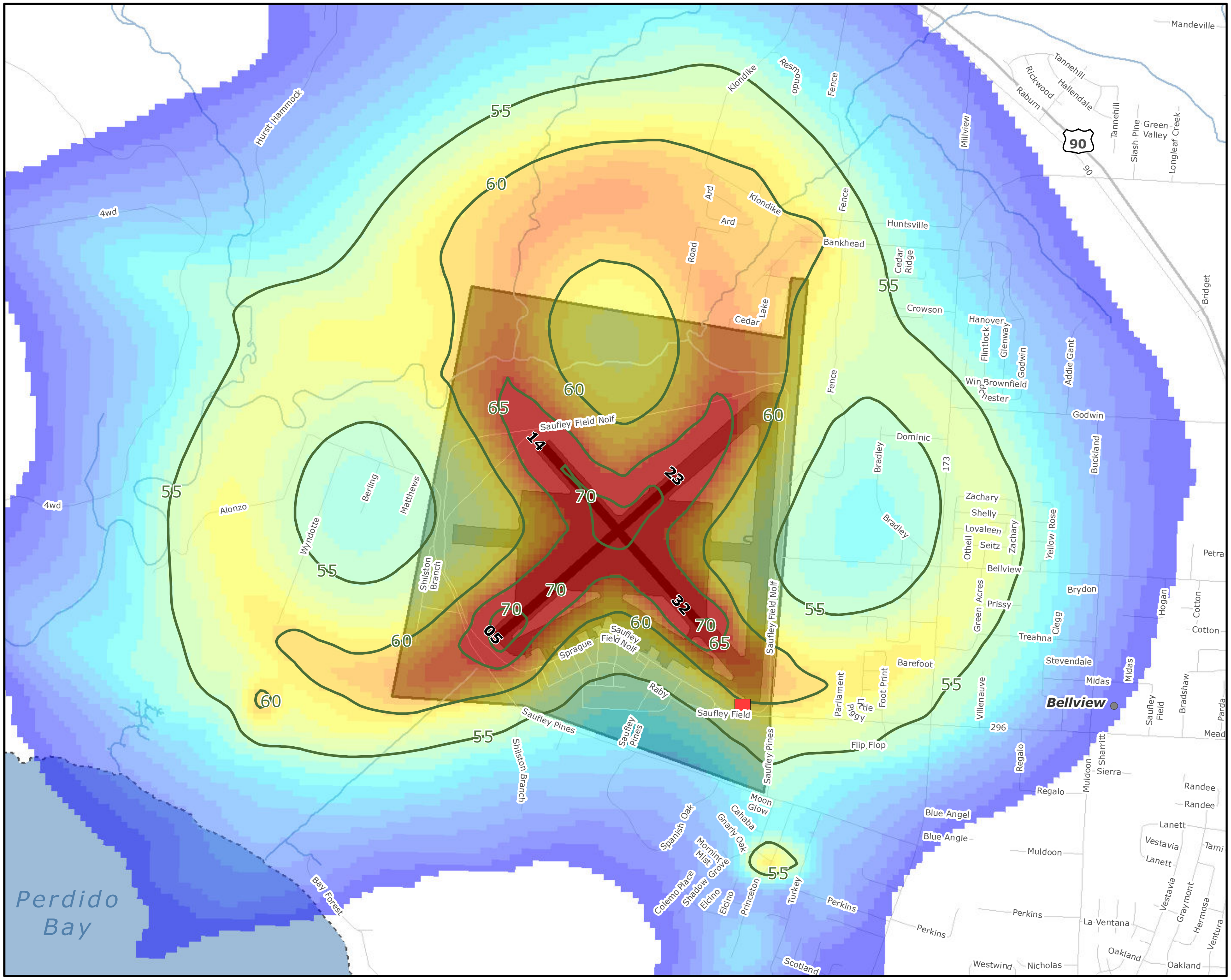


Figure 4-6
2010 AICUZ
Noise Gradients
NOLF Saufley

## Legend

- Gate
- 2010 AICUZ Noise Contour
- Runway
- County Boundary
- NOLF Saufley
- Water Bodies

**Noise Value**

> 73 DNL

45 DNL

Source: Wyle Labs, 2008

0 0.125 0.25 0.5
Miles

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\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 4-7 Saufley 2012-1980 Noise Contour Comparison.mxd

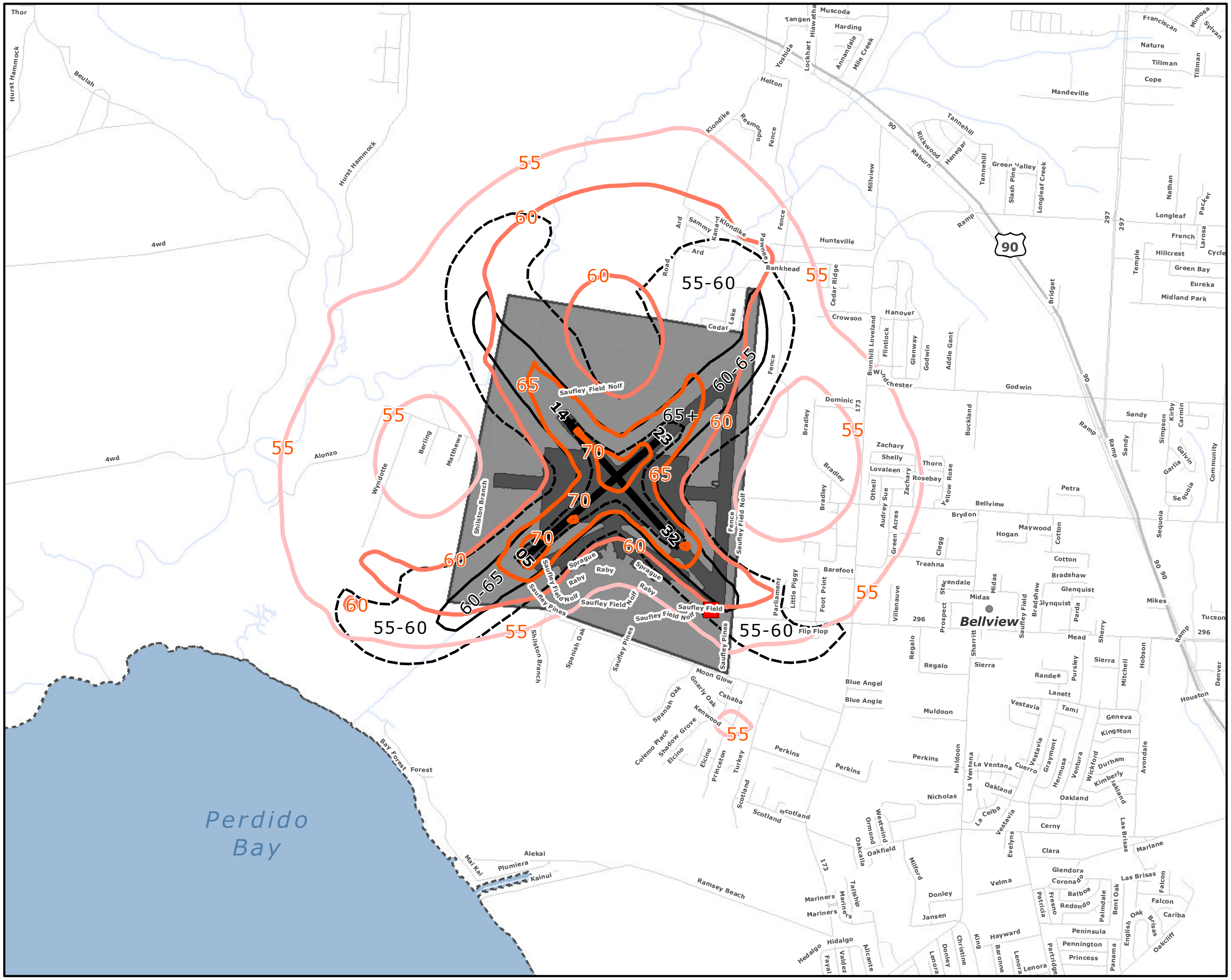



Figure 4-7
Comparison of 2003 JLUS and 2010 AICUZ Noise Contours
NOLF Saufley

**Legend**

- Gate

**2010 AICUZ Noise Contour**

- 55 DNL
- 60 DNL
- 65+ DNL
- 2003 JLUS Noise Contour
- Runway
- NOLF Saufley
- Water Bodies
- County Boundary

Source: Wyle Labs, 2008

0 0.25 0.5 1
Miles

# 5 Airfield Safety

The United States Department of the Navy (Navy) has identified airfield safety issues to assist the community in developing land uses compatible with airfield operations. These issues include accident potential and hazards within the airfield vicinity that obstruct or interfere with aircraft and departures, pilot vision, communications, or aircraft electronics.

While the likelihood of an aircraft mishap occurring is remote, the Navy identifies areas of accident potential to assist in land use planning. The Navy has identified Accident Potential Zones (APZs) around its runways based on historical data for aircraft mishaps. The Navy recommends certain land uses that concentrate large numbers of people—such as apartments, churches, and schools—be constructed outside the APZs.

In addition, the Federal Aviation Administration (FAA) and the military have defined flight safety zones (imaginary surfaces) below aircraft arrival and departure flight tracks and surrounding the airfield. For the safety of the aircraft, the heights of structures and vegetation are restricted in these zones. The flight safety zones are designed to minimize the potential harm if a mishap does occur.

Other hazards to flight safety that should be avoided in the airfield vicinity include:

- Uses that would attract birds, especially waterfowl;
- Lighting (direct or reflected) that would impair pilot vision;
- Uses that would generate smoke, steam, or dust; and
- Electromagnetic Interference (EMI) with aircraft communication, navigation, or other electrical systems.

# 5.1 Accident Potential Zones

## 5.1.1 Aircraft Mishaps

In the 1970s and 1980s, recognizing the need to identify areas of accident potential, 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 or along the centerline of the runway, diminishing in likelihood with distance. Based on the study, the United States Department of Defense (DoD) has identified APZs as areas where an aircraft accident is most likely to occur (if one was to occur); however, the APZs do not reflect the probability of an accident. APZs follow departure, arrival, and pattern flight tracks and are based upon analysis of historical data.

There are three categories of aircraft mishaps. The most severe is a Class A mishap. This is an accident in which the total cost of damage to property or aircraft exceeds $1 million, an aircraft is destroyed or missing, or any fatality or permanent total disability results from the direct involvement of naval aircraft.

There has been one Class A mishap at NAS Pensacola in the past 15 years according to the Naval Aircraft Safety Center (Naval Aircraft Safety Center 2007). This mishap occurred over the Gulf of Mexico during a Blue Angels practice session. There have been other, minor incidents at or around the airfield that are not considered Class A mishaps (Naval Air Station [NAS] Pensacola Aviation Safety Officer 2008). There have been zero Class A mishaps at Navy Outlying Landing Field (NOLF) Saufley in the past 15 years.

## 5.1.2 APZ Configurations and Areas

Clear Zones and APZs are areas in the vicinity of airfield runways where an aircraft mishap is most likely to occur (if one was to occur). While the likelihood of a mishap is remote, the Navy recommends land uses within APZs be minimal- or low-density to ensure the maximum protection of public health and property. The DoD uses two classes of fixed-wing runways (Class A and Class B) for the purpose of defining APZs. Class A runways are used primarily by light aircraft and do not have the potential for intensive use by heavy or high-performance aircraft. Class B runways are all other fixed-wing runways. NAS Pensacola has only Class B runways and NOLF Saufley has only Class A runways.

The components of standard APZs for Class A runways are defined (Chief of Naval Operations Instruction [OPNAVINST] 11010.36C) as follows:

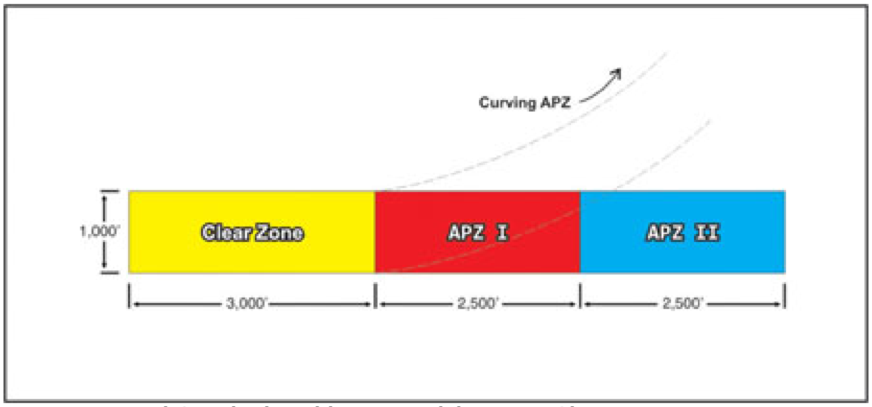
- **Clear Zone.** The Clear Zone measures 1,000 feet (305 meters) wide and extends 3,000 feet (914 meters) immediately beyond the runway and has the highest potential for accidents. A Clear Zone is required for all active runways and should remain undeveloped.

- **APZ I.** APZ I is not necessary for all Class A runways. It is required for runways/flight tracks that experience 5,000 or more annual operations (departures or approaches). APZ I is 1,000 feet (305 meters) wide and would extend 2,500 feet (762 meters) beyond the end of the Clear Zone, and may be altered to conform to the flight shadow.

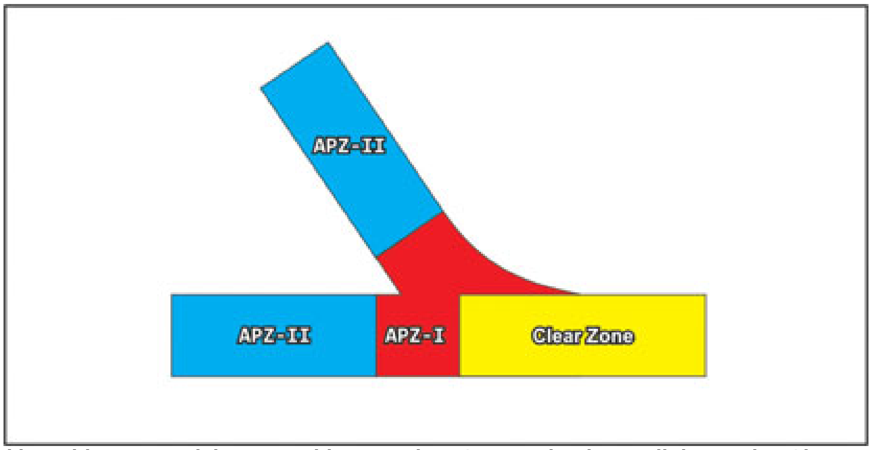
- **APZ II.** Similar to APZ I, APZ II is not necessary for all Class A runways. If APZ I is not warranted, APZ II may still be used if an analysis of operations and/or accidents indicates a need for it. As with APZ I, the geometric configuration of APZ II may also be curved, is 1,000 feet (305 meters) wide, and extends 2,500 feet (762 meters) beyond the end of APZ I. When Field Carrier Landing Practice (FCLP) is an active aspect of aircraft operations at an installation, APZ II extends the entire FCLP track beyond APZ I.

The components of standard APZs for Class A runways are identified on Figure 5-1.

**Figure 5-1 Accident Potential Zones for Class A Runways**




a) Standard Accident Potential Zones – Class A Runway




b) Accident Potential Zones With More Than One Predominant Flight Track – Class A Runway

The components of standard APZs for Class B runways are defined (OPNAVINST 11010.36C) as follows:

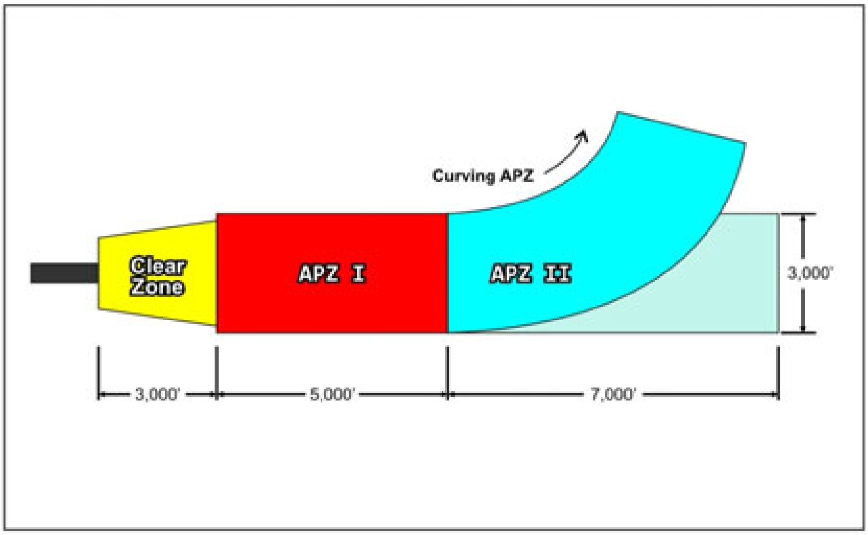
- **Clear Zone.** The Clear Zone is a trapezoidal area lying immediately beyond the end of the runway and outward along the extended runway centerline for a distance of 3,000 feet (914 meters). The Clear Zone measures 1,500 feet (457 meters) in width at the runway threshold and 2,284 feet (696 meters) 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 which still has a measurable potential for aircraft accidents relative to the Clear Zone. APZ I is provided under flight tracks which experience 5,000 or more annual operations (departures or approaches). APZ I is typically 3,000 feet (914 meters) in width and 5,000 feet (1,524 meters) in length and may be rectangular or curved to conform to the shape of the predominant flight track.

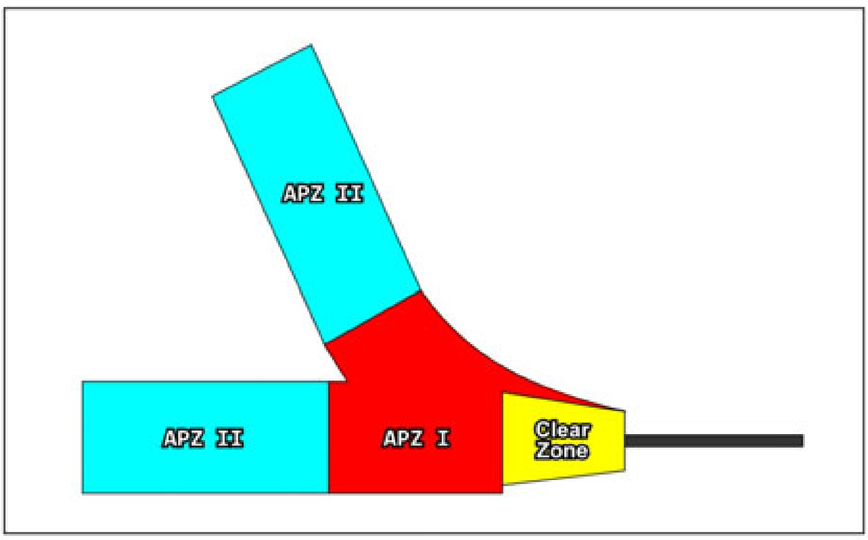
- **APZ II.** APZ II is the rectangular area beyond APZ I (or the Clear Zone if APZ I is not used) which has a measurable potential for aircraft accidents relative to APZ I or the Clear Zone. APZ II is always provided where APZ I is required. The dimensions of APZ II are typically 3,000 feet (914 meters) in width by 7,000 feet (2,134 meters) in length and, as with APZ I, may be curved to correspond with the predominant flight track.

The components of standard APZs for Class B runways are identified on Figure 5-2.

**Figure 5-2 Accident Potential Zones for Class B Runways**




a) Standard Accident Potential Zones




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

An accident is more likely to occur in APZ I than in APZ II, and is more likely to occur in the Clear Zone than in APZ I or APZ II. An APZ II area is designated whenever APZ I is required. 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 (see Figure 5-2).

Within the Clear Zone, most uses are incompatible with military aircraft operations. For this reason, the Navy's policy 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, etc.) should be restricted because of the greater risk in these areas. When events resulting in threats to the operational integrity from incompatible development (encroachment) occur, and when local communities are unwilling or unable to take the necessary steps to combat the encroachment threat via their own land use and zoning authority, consideration will be given by the Navy for land acquisition, with priority to Clear Zones and secondary priority to APZs (Navy 2008).

In addition to the Clear Zone, there is a lateral Clear Zone, also called the primary surface, that extends outwards from each side and for the length of the runway. The width of the primary surface area for Class A Runways is 1,000 feet (305 meters) and 1,500 feet (457 meters) for Class B Runways.

### 5.1.3 Comparison of 1980 (2003 JLUS) and 2010 AICUZ APZs

APZs, as modeled for part of this AICUZ, illustrate the 2010 APZs for NAS Pensacola and NOLF Saufley. The 2010 APZs were developed based on projected flight operations as provided by NAS Pensacola. The 2010 APZs were compared to the APZs as provided in the 2003 Joint Land Use Study (JLUS).

Table 5-1 identifies the total off-station land area for the Clear Zone, 2010 APZs, and 2003 JLUS APZs at NAS Pensacola and NOLF Saufley.

**Table 5-1 Land Area within Accident Potential Zones and Clear Zones**

| Airfield | Total Off-Station Land Area | |
|---|---|---|
| | NAS Pensacola | NOLF Saufley |
| 2010 AICUZ Clear Zone (acres) | 56 | 89 |
| 2010 AICUZ APZ I (acres) | 1,579 | 186 |
| 2010 AICUZ APZ II (acres) | 3,222 | 200 |
| **2010 APZ Total Area** | **4,857** | **475** |
| 2003 JLUS Clear Zone (acres) | 56 | 75 |
| 2003 JLUS APZ I (acres) | 2,038 | 211 |
| 2003 JLUS APZ II (acres) | 2,501 | 89 |
| **2003 JLUS APZ Total Area** | **4,595** | **375** |

Source: Adapted from EDAW, Inc. 2003

#### 5.1.3.1 NAS Pensacola

Figure 5-3 illustrates the modeled APZs generated as part of this AICUZ and Figure 5-4 compares the 2003 JLUS APZs and the 2010 AICUZ APZs at NAS Pensacola. Table 5-1, shown previously, provides a comparison of the acreages consumed by the Clear Zone and each APZ. Similar in size and shape, as the table illustrates, the 2003 JLUS APZs consumed approximately 262 less acres (106 ha) than the 2010 APZs.

The most apparent difference in the 2003 JLUS and the 2010 AICUZ APZs is the removal of APZ I and APZ II south of Runway 01/19. The 2003 JLUS included straight APZ I and APZ II south of Runway 01/19; however, due to changes in operational usage of the runway, only the Clear Zone was assigned to the end of the runway in the 2010 AICUZ APZs.

© Ecology & Environment, Inc. GIS Department Project #
Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 5-3 Pensacola 2010 APZs.mxd

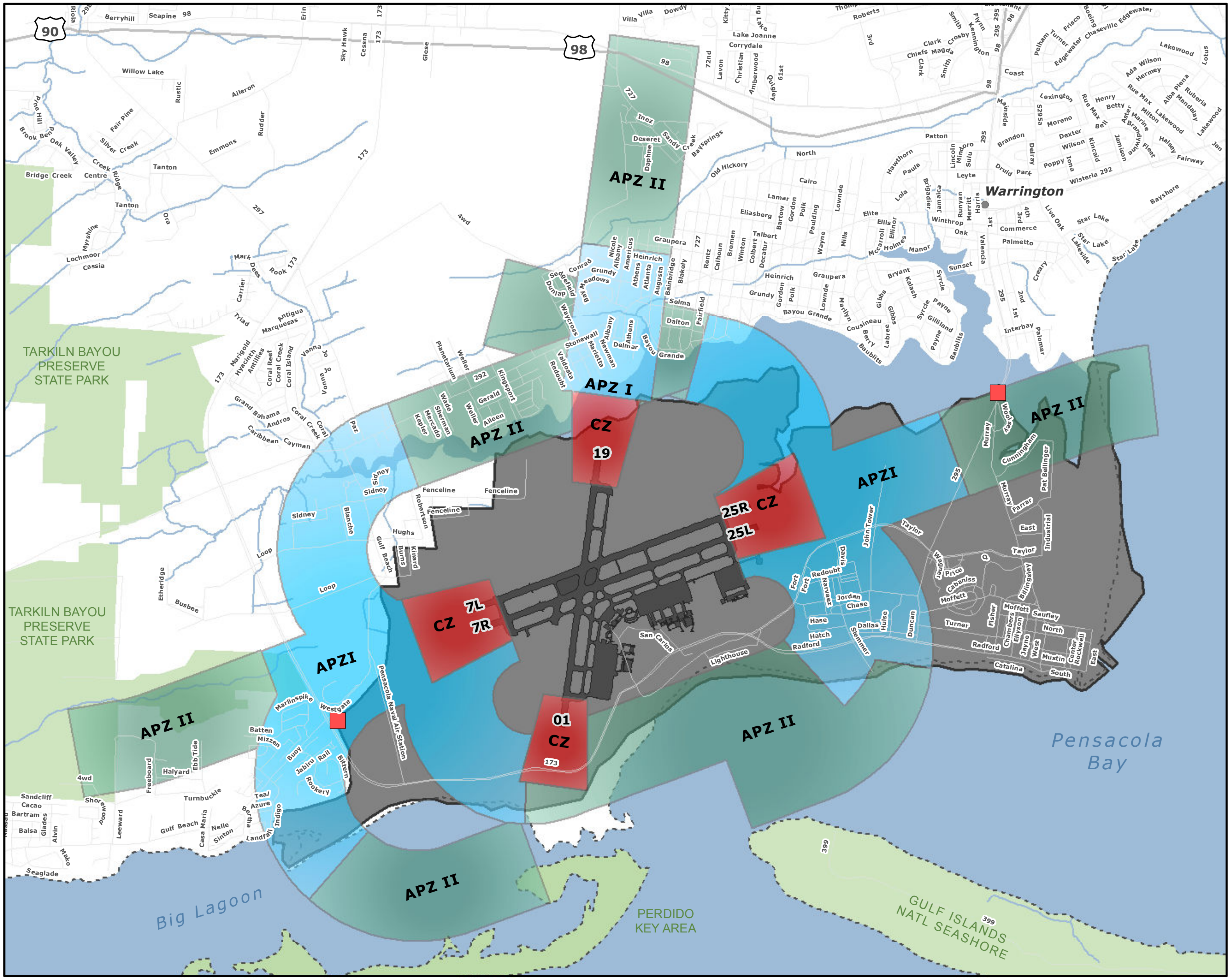



Figure 5-3
2010 AICUZ APZs
NAS Pensacola

**Legend**

- Gate

**Accident Potential Zone**

- Clear Zone
- APZ I
- APZ II
- County Boundary
- Runway
- NAS Pensacola
- Park Boundary
- Water Bodies

Source: Wyle Labs, 2008

0 0.25 0.5 1
Miles

© Ecology & Environment, Inc. GIS Department    Project #
\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 5-4 Pensacola_APZ_Comparison.mxd

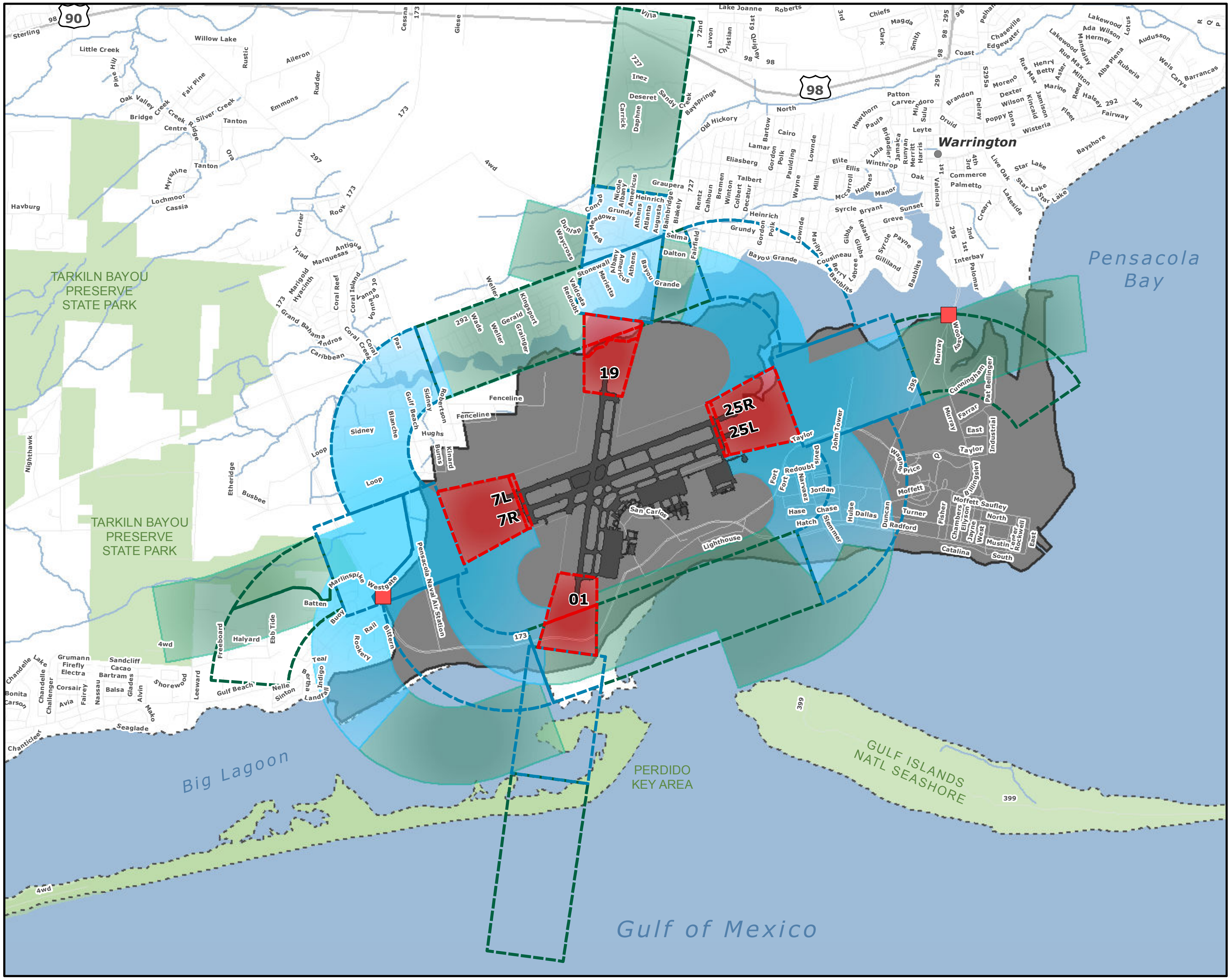



Figure 5-4
Comparison of 1980 (2003 JLUS) and 2010 AICUZ APZs
NAS Pensacola

## Legend

Gate

**1980 (2003 JLUS) APZ**

APZ I

APZ II

Clear Zone

**2010 AICUZ APZ**

Clear Zone

APZ I

APZ II

Runway

NAS Pensacola

County Boundary

Park Boundary

Water Bodies

Source: Wyle Labs, 2008

0 0.25 0.5 1
Miles

The 2010 AICUZ APZs south of the parallel runways remained a continuous zone, as illustrated in the 2003 JLUS, with the addition of a second non-continuous zone. The expanded zone in the 2010 AICUZ APZs south of the parallel runways is attributed to the overhead break arrival flight tracks conducted on Runway 07R and the departure flight track conducted on Runway 07L. Aircraft contributing to the majority of operations include the T-6, T-45, T-1, and T-39 aircraft.

The 2010 AICUZ APZs depicted straight off the ends of the parallel runways remained relatively similar when compared to the 2003 JLUS APZs. The 2010 APZ straight off the west end of the parallel runways is attributed to the straight-in arrival flight track predominantly associated with the T-1 and T-6 aircraft operations. The APZ off the east end of the parallel runway is attributed to the predominant departure flight track used by the majority of permanent and transient aircraft at NAS Pensacola.

It is noted that, while the annual operations on Runway 01/19 to the north were not projected to reach 5,000 operations per year in the present AICUZ study, significant numbers of flight operations and numerous flight tracks remain over the area currently zoned with local provisions for AICUZ protection. It is recommended that this area be maintained as an area of compatible land use concern for the Navy and the community.

The anticipated Field Carrier Landing Practice (FCLP) requirements provide rational for the continuous APZ zone to the northwest of the parallel runways. It is anticipated that the FCLP requirement will increase to meet Navy requirements and, in conjunction with the arrival of the Improved Fresnel Lens Optical System (IFLOS) and the operation of the JSF, it is recommended that this area, currently zoned with local provisions for AICUZ protection, also be maintained as an area of compatible land use concern for the Navy and the community.

#### 5.1.3.2 NOLF Saufley

Figure 5-5 illustrates the modeled APZs generated as part of this AICUZ and Figure 5-6 compares the 2003 JLUS APZs and the 2010 AICUZ APZs at NOLF Saufley. Table 5-1, shown previously, provides a comparison of the acreages consumed by the Clear Zone and each APZ. As the table illustrates, the 2003 JLUS APZ consumed 100 less acres (40.5 ha) than the 2010 APZs.

The 2010 APZs are similar in shape and size when compared to the 2003 JLUS APZs. The dominant aircraft and flight track incorporated into the 2003 JLUS APZs was the T-34. The T-6 is the only aircraft modeled in the 2010 AICUZ APZs. The difference in aircraft and associated flight tracks account for the slightly wider APZ flare off each runway end.

## 5.2 Flight Safety

Flight safety refers to important safety steps taken and/or measures implemented to ensure both pilot safety during aircraft operations and the safety of those on the ground in the community who live and work in the vicinity of an air station. This section discusses such flight safety issues as imaginary planes and transition surfaces, Bird/Animal Strike Hazard (BASH) issues, and measures to avoid other potential pilot interferences such as EMI, smoke, dust, steam, and lighting.

### 5.2.1 Imaginary Surfaces

Imaginary planes and transition surfaces define the required airspace that must remain free of obstructions to ensure safe flight approaches, departures, and patterns. Obstructions may include natural terrain and man-made features, such as buildings, towers, poles, and other vertical obstructions to airspace navigation. Brief descriptions of the imaginary surfaces for Class A and Class B fixed-wing runways are provided in Table 5-2 and Figure 5-7 and Figure 5-8.

© Ecology & Environment, Inc. GIS Department    Project #
\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 5-5 Saufley 2008 APZs.mxd

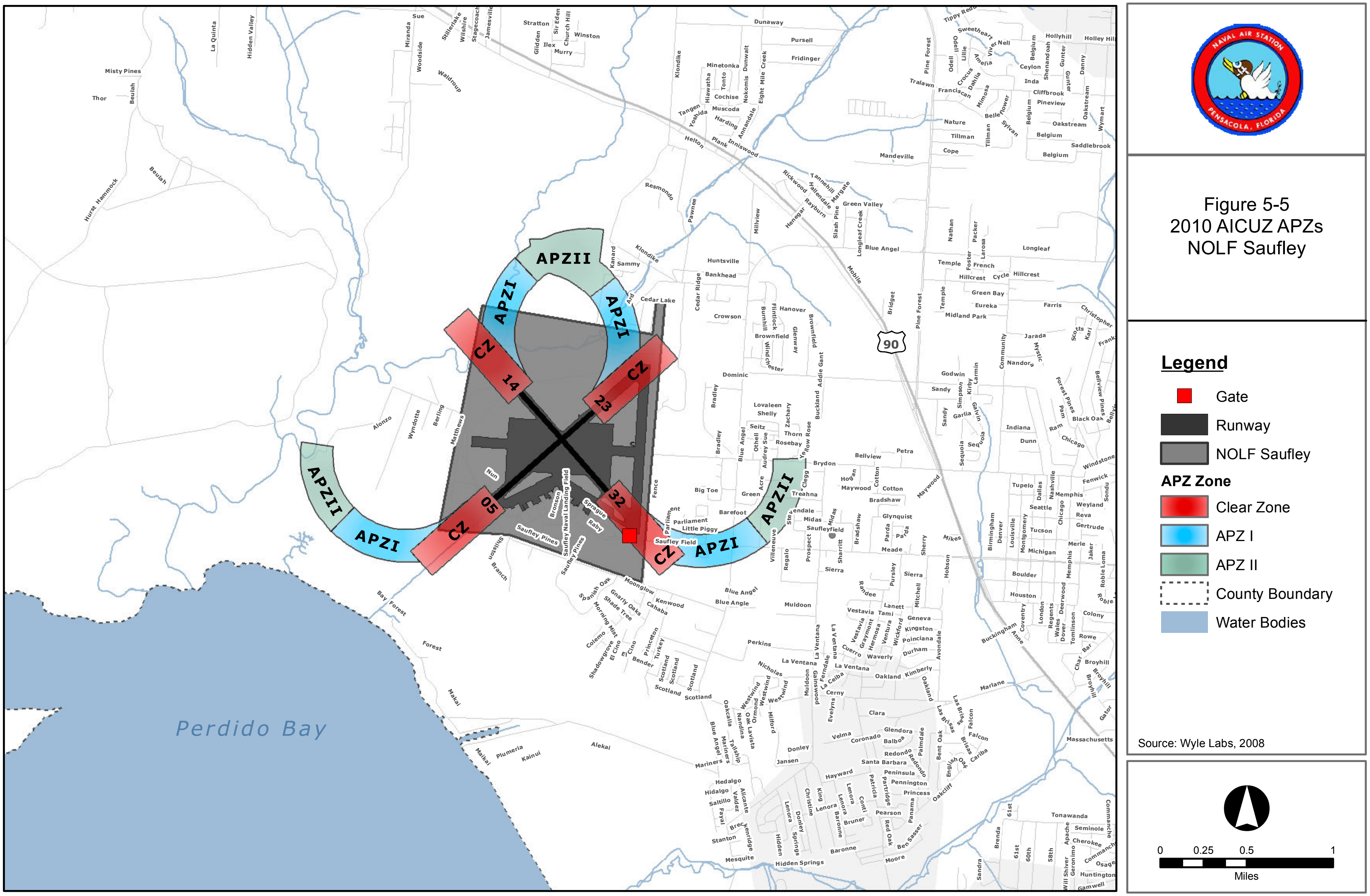
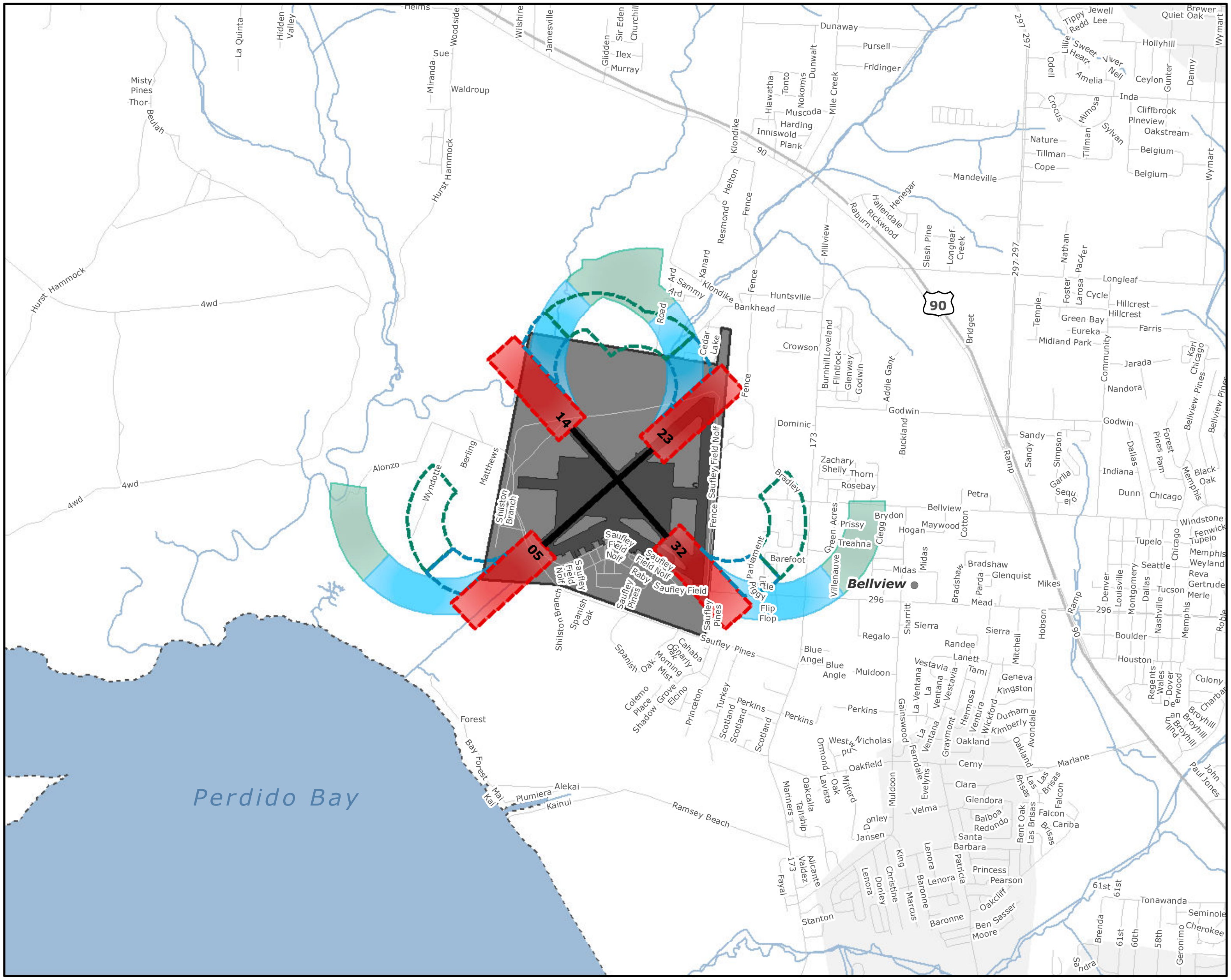



Figure 5-5
2010 AICUZ APZs
NOLF Saufley

\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 5-6 Saufley APZ Comparison.mxd




# Figure 5-6
# Comparison of 2003 JLUS and 2010 AICUZ APZs NOLF Saufley

## Legend

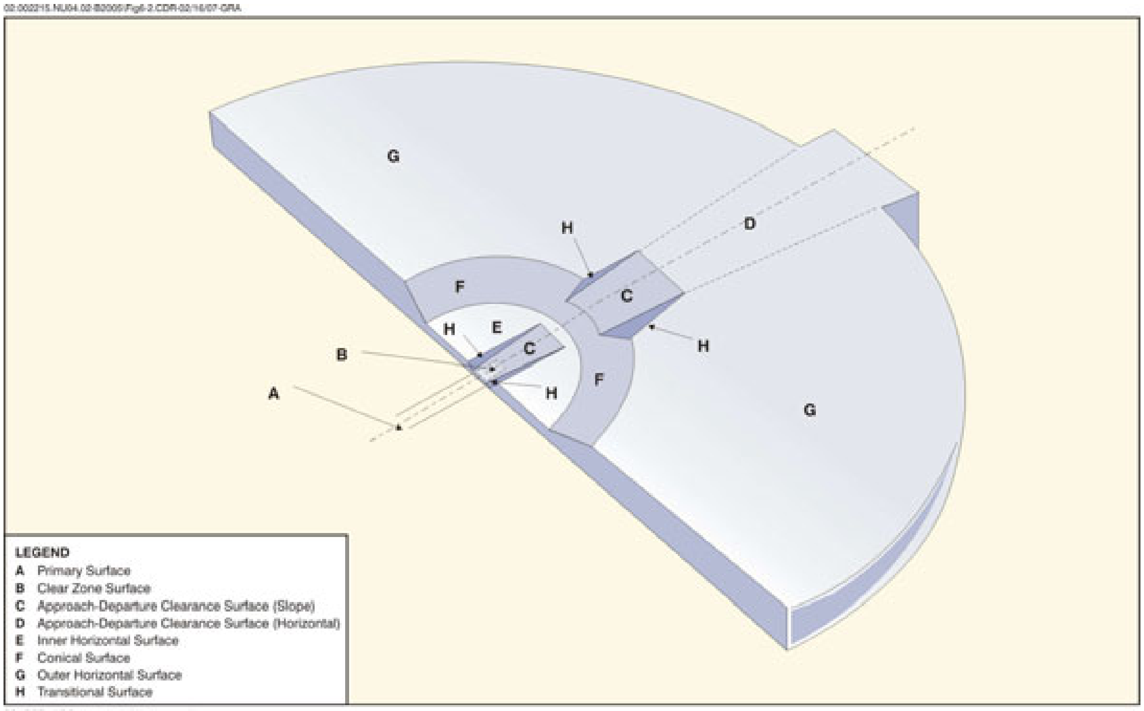
**2003 JLUS APZ**
- APZ I
- APZ II
- Clear Zone

**2010 AICUZ APZ**
- Clear Zone
- APZ I
- APZ II
- County Boundary
- Runway
- NOLF Saufley
- Water Bodies

Source: Wyle Labs, 2008

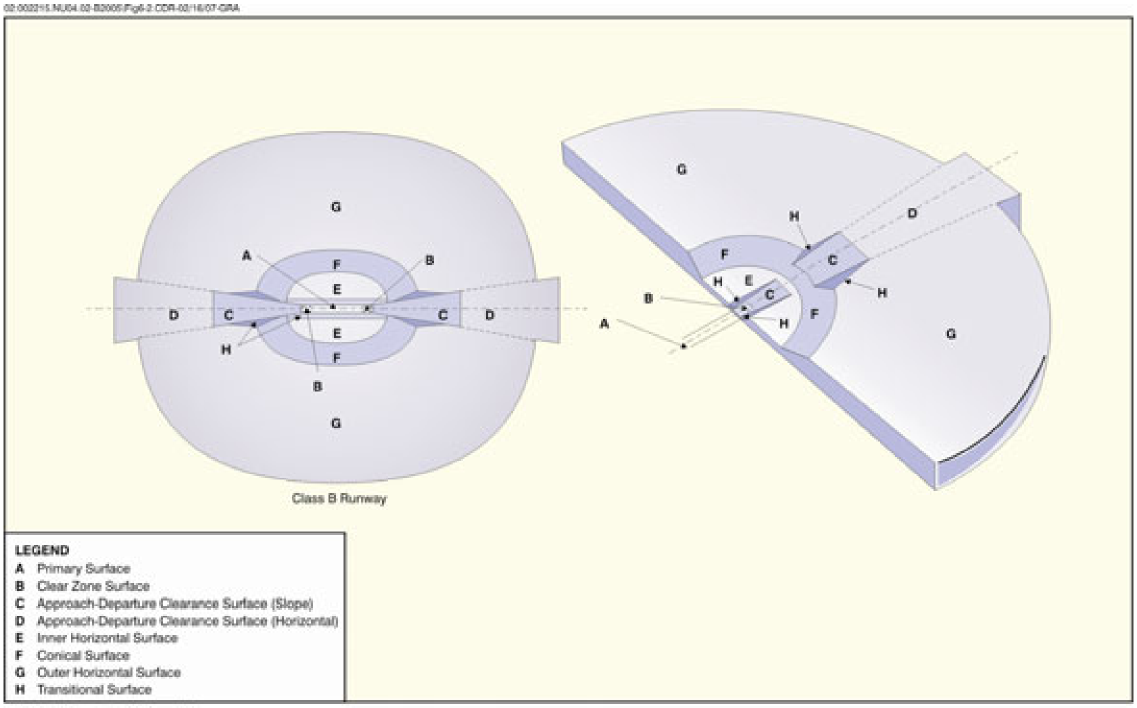
0 0.25 0.5 1
Miles

**Figure 5-7 Imaginary Surfaces and Transition Planes for Class A Fixed-Wing Runways**




SOURCE: US Department of the Navy 1999.

**Figure 5-8 Imaginary Surfaces and Transition Planes for Class B Fixed-Wing Runways**




SOURCE: US Department of the Navy 1999.

## Table 5-2 Imaginary Surfaces – Class A and B Fixed-Wing Runways

| Planes and Surfaces | Geographical Dimensions |
|---|---|
| **Class A** | |
| Primary Surface | Aligned (longitudinally) with each runway and extending 200 feet from each runway end. The width is 1,000 feet. |
| Clear Zone | Located immediately adjacent to the end of the runway and extends 3,000 feet beyond the end of the runway and 1,000 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 40:1 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 that extends from the inner horizontal surface outward and upward at a 20:1 slope and extends 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.<br><br>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. |
| **Class B** | |
| 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 extends 3,000 feet beyond the end of the runway and is 1,500 feet wide and flares out to 2,284 feet wide.. |
| Approach- Departure Clearance Surfaces | 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 that extends from the inner horizontal surface outward and upward at a 20:1 slope and extends 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.<br><br>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

### 5.2.2 Bird/Animal Strike Hazard

Wildlife represents a significant hazard to flight operations. Birds, in particular, are drawn to the open, grassy areas and warm pavement of airfields. Although most bird and animal strikes do not result in crashes, they cause structural and mechanical damage to aircraft. Most collisions occur when the aircraft is at an elevation of less than 1,000 feet (305 meters). Due to the speed of the aircraft, collisions with wildlife can happen with considerable force.

To reduce BASH, the FAA and the military recommend land uses that attract birds to be located at least 10,000 feet (3 kilometers [km]) from airfields. These land uses include:

- Waste disposal operations;
- Wastewater treatment facilities;
- Landfills;
- Golf courses;
- Wetlands;
- Dredge disposal sites;
- Seafood processing plants; and
- Stormwater ponds.

Design modifications also can be used to reduce the attractiveness of these types of land uses to birds and other wildlife.

### 5.2.3 Electromagnetic Interference

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 (ANSI) as any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics/electrical equipment. It can be induced intentionally, as in forms of electronic warfare, or unintentionally, as a result of spurious emissions and responses, such as high tension line leakage. Additionally, EMI may be caused by atmospheric phenomena, such as lightning and precipitation static, and by non-telecommunication equipment, such as vehicles and industry machinery.

### 5.2.4 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.

### 5.2.5 Smoke, Dust, and Steam

Industrial or agricultural sources of smoke, dust, and steam in the airfield vicinity could obstruct the pilot's vision during takeoff, landing, or other periods of low-altitude flight.

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# 6 Land Use Compatibility Analysis

**Composite AICUZ Map**
Defines the minimum recommended acceptable area within which land use controls are needed to protect the health, safety, and welfare of those living near a military airfield, and to preserve the defense flying mission.

The Accident Potential Zones (APZs) and noise zones comprise the composite AICUZ map for an air installation (see Figure 6-3). The composite AICUZ map defines the minimum recommended acceptable area within which land use controls are needed to protect the health, safety, and welfare of those living near a military airfield and to preserve the defense flying mission. The AICUZ map (and information derived from the map) is the fundamental tool necessary for the AICUZ planning process.

This section addresses land use compatibility within aircraft noise zones and APZs by examining existing and planned land uses near Naval Air Station (NAS) Pensacola and Navy Outlying Landing Field (NOLF) Saufley. This section begins with a description of the local planning authority that is in place in Escambia County, then provides a discussion of the generalized land use compatibility criteria used in AICUZ studies to evaluate land use compatibility. It is followed by a land use compatibility assessment.

## 6.1 Planning Authority

The development and control of lands outside of military installations is beyond the control of the base commander. Development of these lands is dictated by local comprehensive land use planning and regulations.

The local planning authority in Escambia County is the Development Services Bureau. The Bureau administers the Escambia

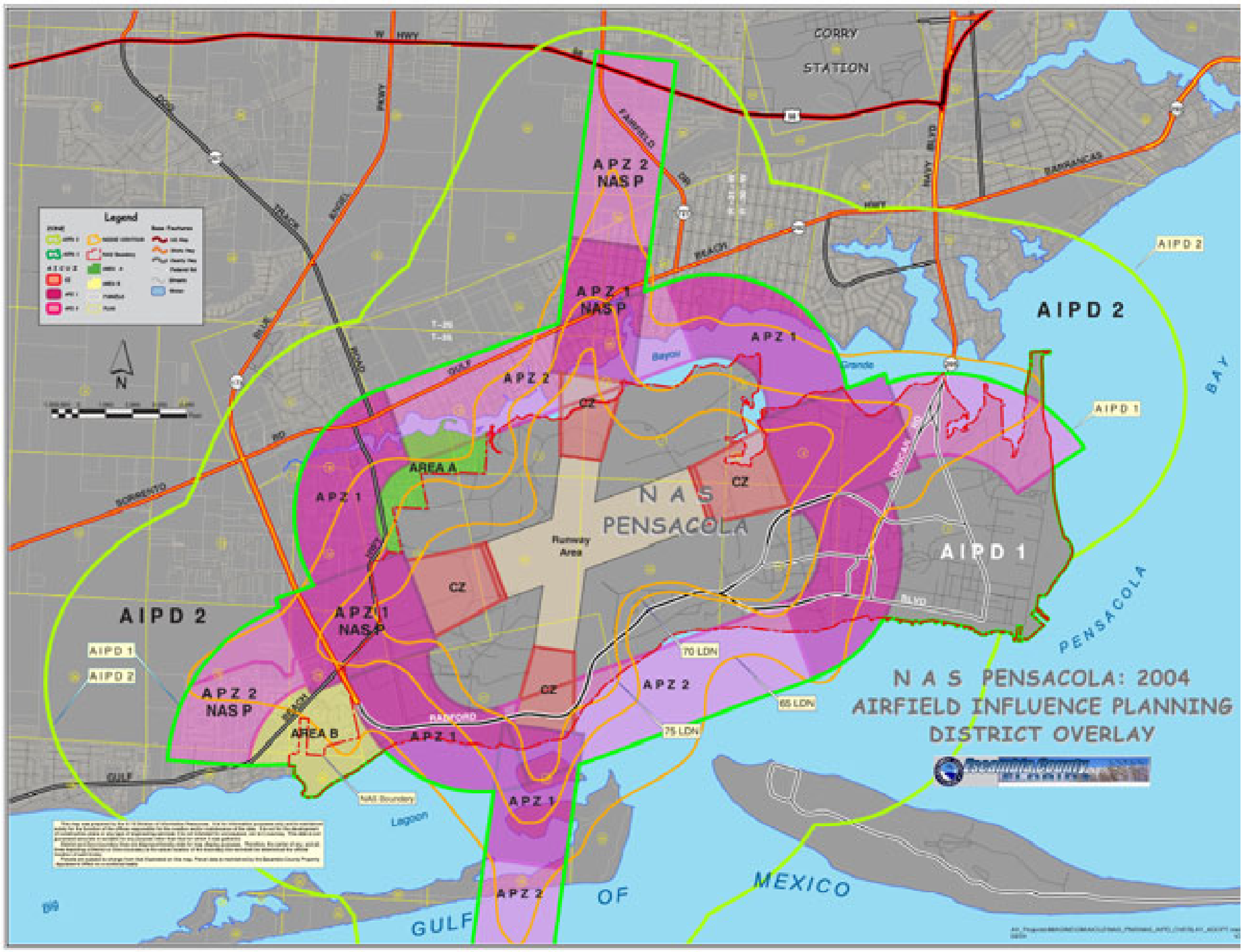
County Comprehensive Plan and Land Development Code. The primary role of the Bureau is to evaluate land use changes and all planning actions.

In 2003, Escambia County adopted the Joint Land Use Study (JLUS) which encourages partnership between NAS Pensacola/NOLF Saufley and the surrounding community, and promotes balanced development while protecting the military's operational mission. The 2003 JLUS also analyzed land uses surrounding NAS Pensacola and NOLF Saufley and indentified strategies to reduce encroachment and promote land use compatibility (EDAW, Inc. 2003).

Escambia County has established Land Development Codes (LDCs) to address, among other issues, planning and zoning in Escambia County. Article 11, "Airport Environs," of the Escambia County Land Development Code, sets forth regulations on land uses surrounding Pensacola Regional Airport, Ferguson and Coastal Airports, NOLF Site 8, NAS Pensacola, and NOLF Saufley. Article 11 states "that incompatible land uses have the potential for being hazardous to aircraft operations as well as to the persons and property on the ground in the vicinity of the incompatible land uses" (Escambia County, Florida 2006). Article 11 establishes land use compatibility regulations surrounding NAS Pensacola and NOLF Saufley and further discussion is provided in Section 6.3.4 Compatibility Concerns.

Escambia County has created and implemented Air Influence Planning Districts (AIPDs) as part of the 2003 JLUS to serve as a tool for land use regulations. AIPDs create a broader framework for making planning decisions around military airfields and to more accurately identify areas that affect or can be affected by military airfield operations. AIPD-1 for NAS Pensacola is a boundary that connects the outermost lines of the APZs and encloses the land between the APZs and the fenceline of NAS Pensacola (Figure 6-1). The AIPD-2 boundary is a 1-mile (1.6 kilometer [km]) buffer drawn outward from the 65 day-night average sound level (DNL) noise contour (EDAW, Inc. 2003).

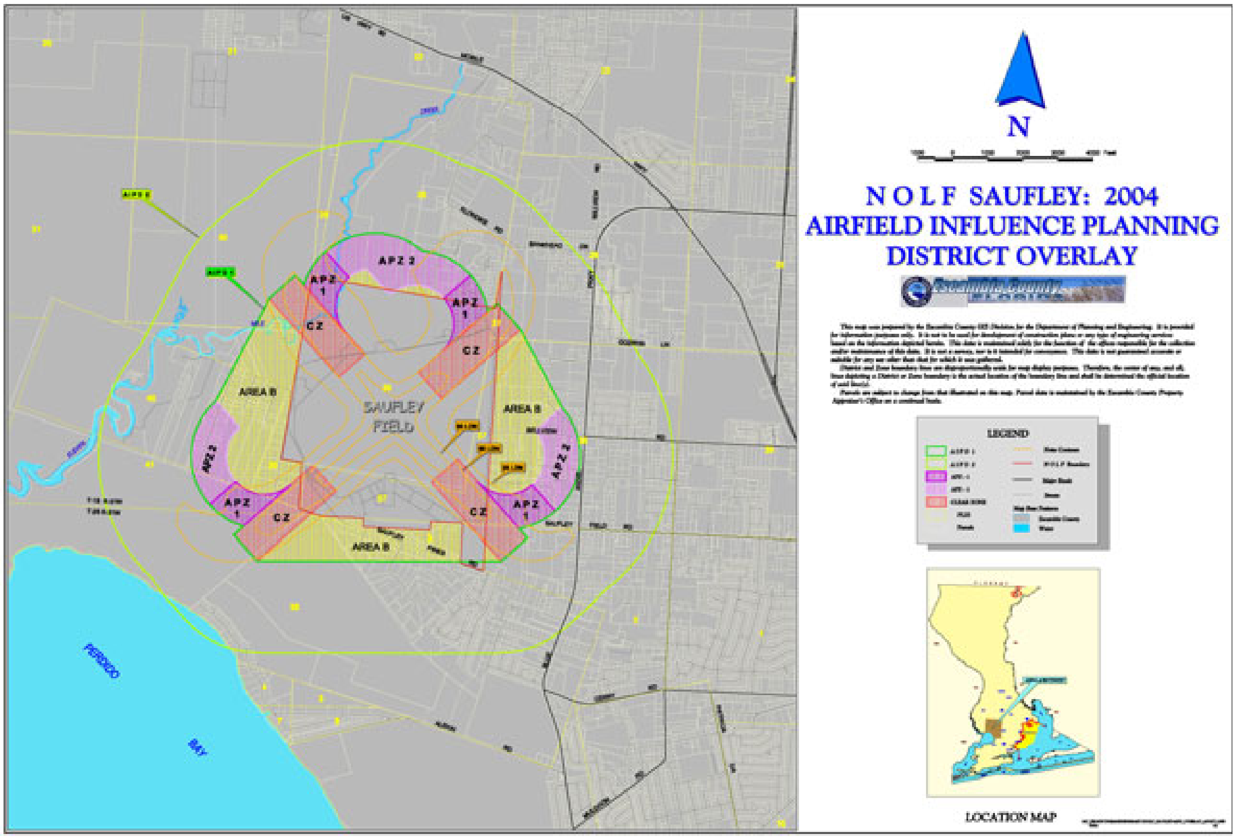
**Figure 6-1 NAS Pensacola: 2004 Airfield Influence Planning District Overlay**




Source: EDAW 2003

Escambia County also created and implemented AIPDs for NOLF Saufley as part of the 2003 JLUS. AIPD-1 for NOLF Saufley is a boundary that connects the outermost lines of the APZs and encloses the land between the APZs and the fenceline of NOLF Saufley (Figure 6-2). The AIPD-2 boundary is a 0.5-mile (0.8-km) buffer drawn outward from the AIPD-1 boundary (EDAW, Inc. 2003). Additionally, Escambia County's comprehensive plan, titled *Comprehensive Plan*, has been established as the guideline for the future growth of the community. The *Comprehensive Plan* deals with issues related to the appropriate uses of land, and addresses compatibility issues between various uses of land, the management and preservation of natural resources, identification and preservation of historically significant lands and structures, and adequate planning for infrastructure needs (Escambia County 2009).

**Figure 6-2 NOLF Saufley: 2004 Airfield Influence Planning District Overlay**




Source: EDAW 2003

> The Navy's land use compatibility guidelines recommend noise-sensitive land uses will be placed outside high-noise zones, and that people-intensive uses will not be placed in APZs.

## 6.2 Land Use Compatibility Guidelines and Classifications

The Navy has developed land use compatibility recommendations for APZs and noise zones. These recommendations, which are found in Chief of Naval Operations Instruction (OPNAVINST) 11010.36C, Air Installations Compatible Use Zones Program (United States Department of the Navy [Navy] 2008), are intended to serve as guidelines for placement of APZs and noise zones and for development of land uses around military air installations. The guidelines recommend noise-sensitive land uses (e.g., houses, churches, etc.) will be placed outside high-noise zones, and people-intensive uses (e.g., apartments, theaters, etc.) will not be placed in APZs. Certain land uses are considered incompatible with APZs and high-noise zones, while other land uses may be considered compatible or compatible under certain conditions (compatible with restrictions). The land use compatibility analysis conducted for NAS Pensacola and NOLF Saufley was based on the Navy's land use compatibility recommendations, which are presented in Appendix B.

Additionally, Table 6-1 shows existing land use classifications and the associated land use compatibility with each land use designation for noise zones and APZs.

**Table 6-1 Land Use Classifications and Compatibility Guidelines**

| | Land use Compatibility Noise Zone (DNL) | | | | | | Land use Compatibility with APZs | | |
|---|---|---|---|---|---|---|---|---|---|
| | Noise Zone 1 | | Noise Zone 2 | | Noise Zone 3 | | Clear Zone | APZ I | APZ II |
| | <55 | 55-65 | 65-70 | 70-75 | 75-80 | >80 | | | |
| Single-Unit, Detached (residential) | Compatible | Compatible | Incompatible | Incompatible | Incompatible | Incompatible | Incompatible | Incompatible | Compatible (1) |
| Multi-Family Residential, (apartment, transient lodging) | Compatible | Compatible | Incompatible | Incompatible | Incompatible | Incompatible | Incompatible | Incompatible | Incompatible |
| Public Assembly | Compatible | Compatible | Compatible | Incompatible | Incompatible | Incompatible | Incompatible | Incompatible | Incompatible |
| Schools and Hospitals | Compatible | Compatible | Compatible (2) | Compatible (2) | Incompatible | Incompatible | Incompatible | Incompatible | Incompatible |
| Manufacturing (ex. petrol/chem.; textile) | Compatible | Compatible | Compatible | Compatible | Incompatible | Incompatible | Incompatible | Incompatible | Compatible |
| Parks | 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. To determine specific land use compatibility, see Appendix B.

(1) Maximum density of 1-2 dwellings per acre.
(2) Land use and related structures generally compatible; however, measures to achieve NLR 25 or 30 must be incorporated into design and construction of the structures.
(3) Maximum Floor Area Ratio that limit people density may apply.
(4) Facilities must be low intensity.

Key:
Compatible
Incompatible

## 6.3 Existing Zoning and Land Use Compatibility

NAS Pensacola and NOLF Saufley are located in Pensacola, Escambia County, Florida. Escambia County has a total area of 661 square miles (1,712 square km) with an additional 100 square miles (259 square km) of water area. The county is moderately developed and zoned with a mix of residential, commercial, and industrial development. Land use patterns and zoning in the immediate vicinity of the installations are discussed below.

## 6.3.1 Existing Land Use

Land use is a term given to describe the management of land and the extent to which it has been modified. Typical uses include developed land, agricultural areas, open water, and forested areas. Patterns of land use arise naturally in communities through customs and practices, and regulations and designations from local government.

### 6.3.1.1 NAS Pensacola

Land use surrounding NAS Pensacola features a mix of developed areas, forest lands, wetland areas, barren land, and open water. Figure 6-3 illustrates the composite AICUZ map with land uses surrounding NAS Pensacola. Bayou Grande borders the installation to the north; however, the area north of Bayou Grande is developed with residential and commercial properties and special development. Development of residential subdivisions and commercial property steadily continues west of the installation; however, areas of largely forested land and wetlands remain. Big Lagoon State Park and Tarklin Bayou Preserve State Park (identified as a Special Development District) are state owned lands west of the installation. The Perdido Pitcher Plant Prairie (identified as a Special Development District), a portion of which is located adjacent to NAS Pensacola to the west, is managed by Tarklin Bayou Preserve State Park. The Intracoastal Waterway and the Gulf of Mexico create the installation's border to the south, and Pensacola Bay serves as the installation's border to the west. Along the entirety of the coast line are barrier islands which, in the vicinity of NAS Pensacola, are part of the Gulf Islands National Seashore, established by the U.S. National Park Service.

© Ecology & Environment, Inc. GIS Department Project #
\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 6-3 Pensacola Composite Escambia Current Existing Landuse.mxd

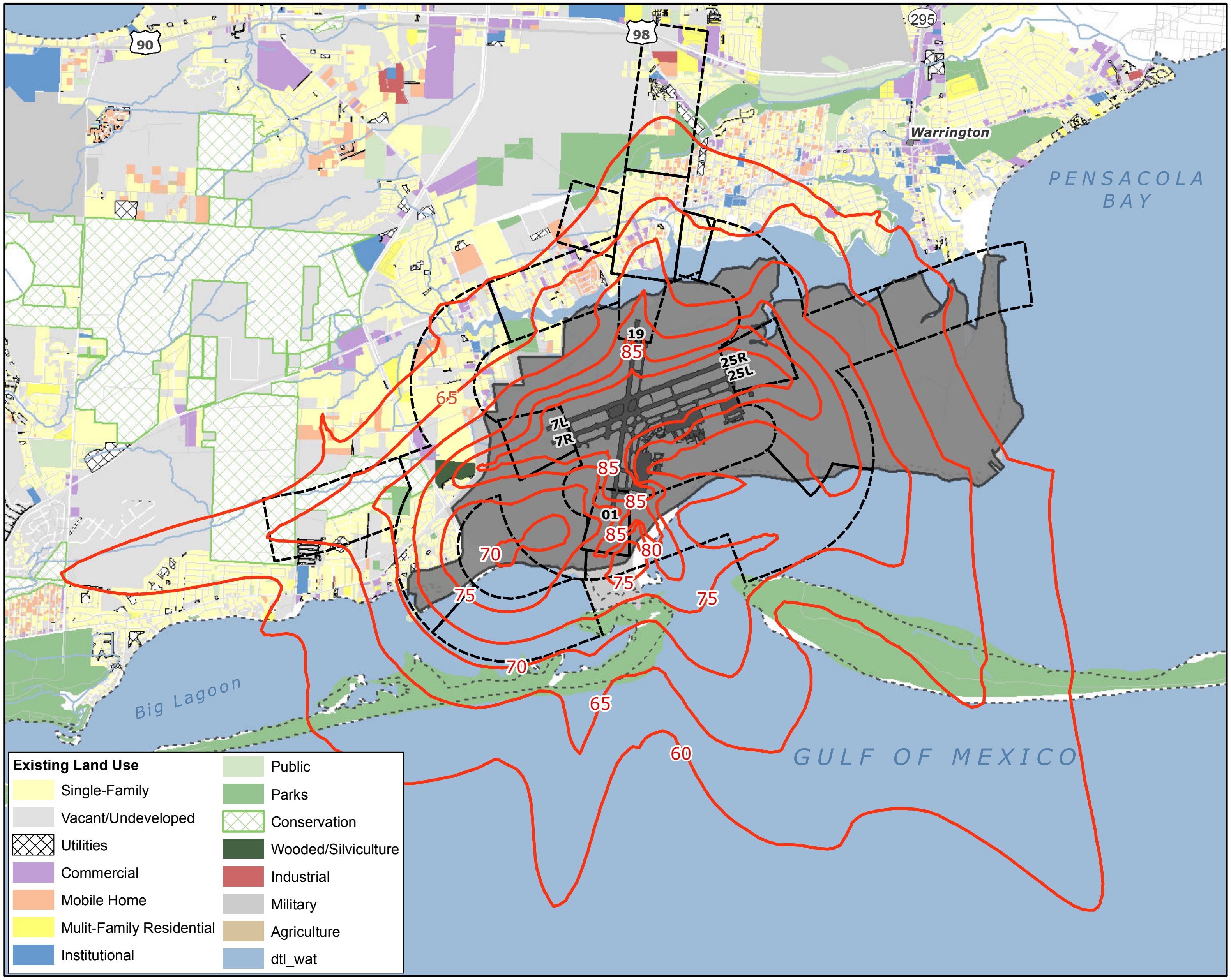
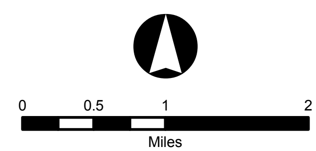



Figure 6-3
Composite AICUZ Map
with Existing Land Use
NAS Pensacola

**Legend**

- 2010 Noise Contour Line
- 2010 AICUZ APZ
- Runway
- NAS Pensacola
- County Boundary

Source: Escambia County GIS Division 2005; Wyle Labs, 2008.



#### 6.3.1.2 NOLF Saufley

Land use surrounding NOLF Saufley features low-intensity development, agricultural lands, forested lands, barren land, and open water. Figure 6-4 illustrates land uses surrounding NOLF Saufley. Land uses to the northwest and south are predominantly forested or agricultural lands and are bordered to the south by Perdido Bay. A majority of the developed area, including residential and commercial uses, are located east of the installation.

### 6.3.2 Existing Zoning

Zoning is a term used in urban planning for a system of land-use regulations. Zoning is the system used by governments to control the physical development of land and the type of uses to which each individual property may be utilized. Escambia County Development Services Bureau administers the zoning requirements, also referred to as zoning districts, for property in Escambia County and lands surrounding NAS Pensacola and NOLF Saufley.

With respect to zoning, Escambia County zoning ordinances address AICUZ guidelines and AIPDs at NAS Pensacola and NOLF Saufley through creation of Airfield Mixed-Use Districts. The Airfield Mixed-Use-1 District allows a compatible mix of certain types of commercial uses and single family residential uses within AIPD-1. AIPD-1 includes Clear Zones and APZs I and II. Additionally, the type of commercial use is limited to correspond to military recommendations and Escambia County requirements. The Airfield Mixed-Use-2 District allows a combination of certain commercial uses and residential development within AIPD-2. AIPD-2 includes land inside the 1-mile (1.6-km) buffer drawn from the 65 DNL noise contour (or for NOLF Saufley, land inside the 0.5-mile [0.8-km] buffer drawn from the boundary of AIPD-1).

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\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 6-4 Saufley Composite Escambia Current Existing Land Use.mxd

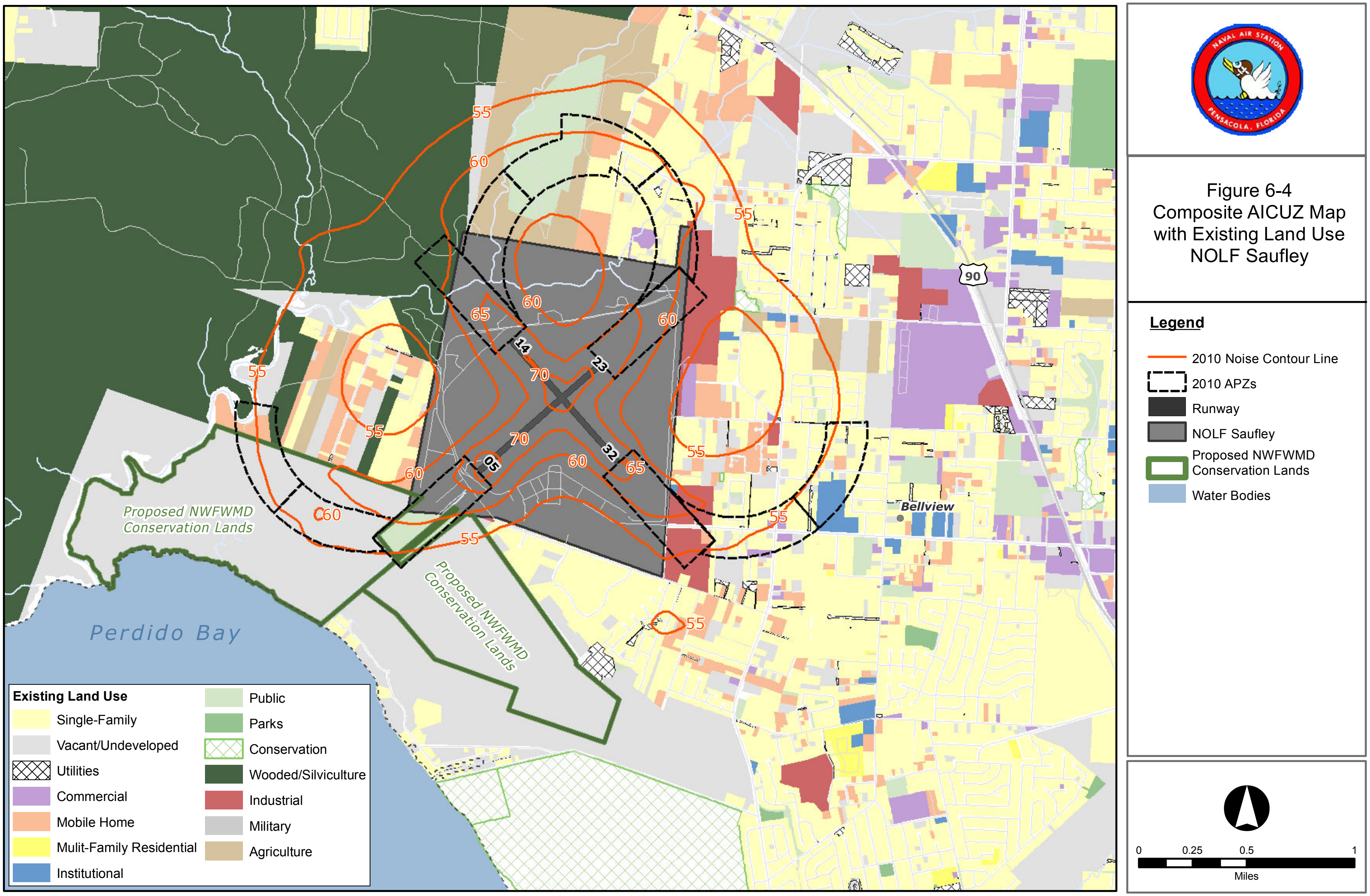



Figure 6-4
Composite AICUZ Map
with Existing Land Use
NOLF Saufley

Source: Escambia County GIS Division 2005;
Wyle Labs, 2008.

Additionally, the under-utilized portion of NOLF Saufley has been selected to become a part of the Navy's Enhanced Use Lease (EUL) program. The EUL program is an opportunity created though US statute (10 USC 2667) enabling Department of Defense to maximize their underutilized properties through out-leasing in exchange for in-kind services and/or facilities for the military and public benefit. The Saufley EUL area is located on the southern side of the property bounded by Saufley Field Road and Sprague Road. The EUL area includes approximately 104 acres and is comprised of 88 facilities (724,000 square feet). A business plan and lease agreement are currently under development for the site. The site will be utilized by similar compatible and mostly smaller sized tenants for among other things technology and educational uses. NOLF Saufley will continue to function as a training field and potential limited use of the runways by the tenants within the EUL may be considered and will be further defined and addressed in the final EUL.

#### 6.3.2.1 NAS Pensacola

Figure 6-5 portrays existing zoning in the areas around NAS Pensacola (from the installation boundary west to US-293 and north to US-98). Existing zoning patterns around NAS Pensacola include a mix of low-, medium-, and high-density residentially zoned property, commercial zoning, special development zoning (environmentally sensitive areas that have natural limitations to development), and recreational zoning. In general, much of the land surrounding NAS Pensacola remains vacant, with the primary development consisting of a pattern of mixed residential development, special development, commercial zoning, and (to the south of the installation) recreational development.

Development includes residential subdivisions, retail establishments, restaurants, schools, and churches. A majority of the development surrounding NAS Pensacola is designated as low-density residential districts. Additionally, located along the Intracoastal Waterway southwest of the installation, there are high-density high-rise condominiums.

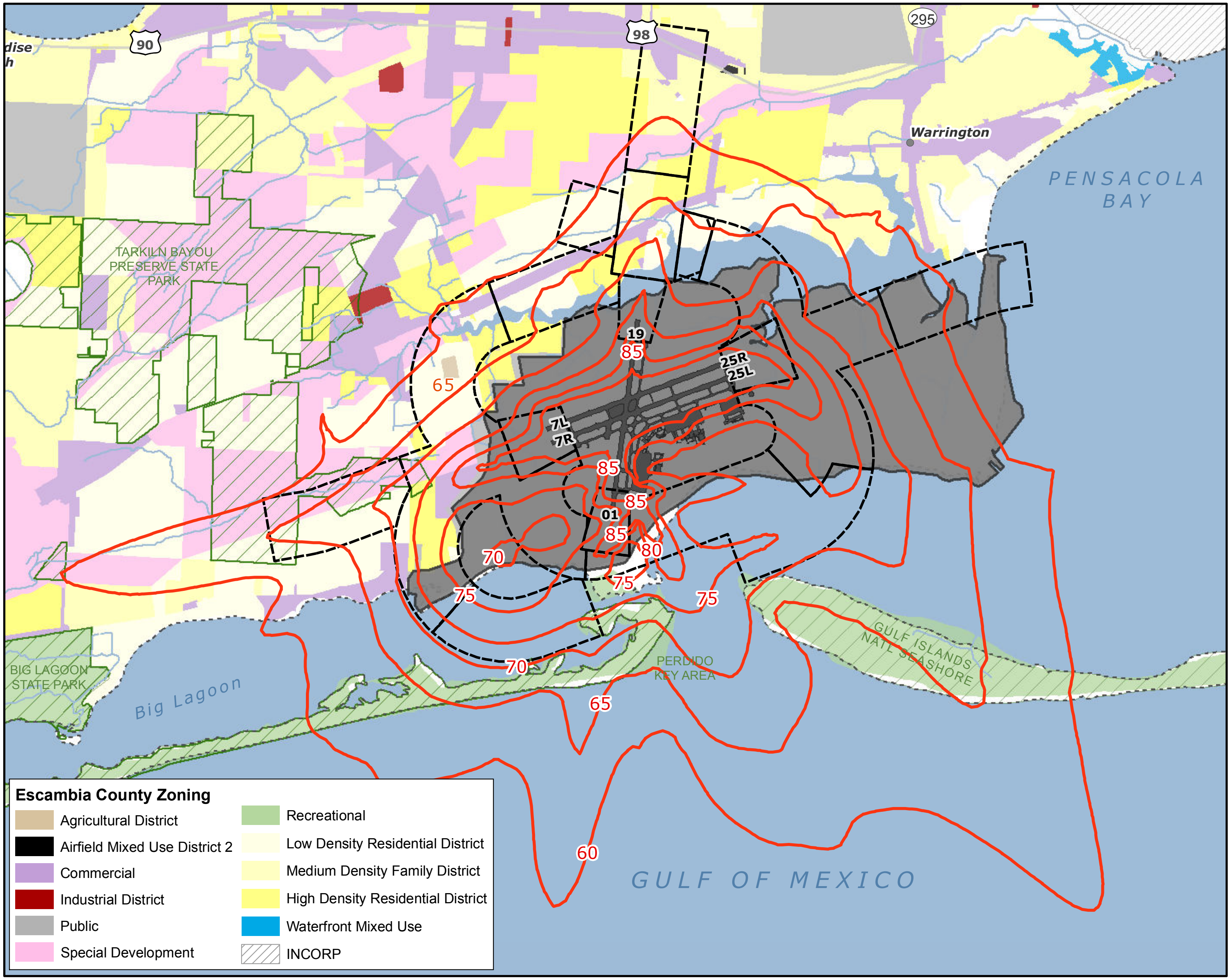
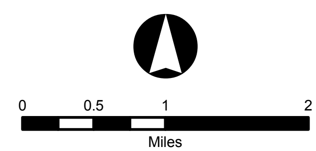



Figure 6-5
Composite AICUZ Map
with Zoning
NAS Pensacola

**Legend**

- 2010 Noise Contour Line
- 2010 AICUZ APZ
- Park Boundary
- Runway
- NAS Pensacola
- County Boundary

Source: Wyle Labs, 2008.



Located on the Gulf Islands National Seashore to the southeast of NAS Pensacola is Fort Pickens, a recreational destination designated by the U.S. National Park Service. Although heavily damaged by Hurricanes Ivan and Dennis, the park remains open to the public. The Intracoastal Waterway, Pensacola Bay, and the Gulf of Mexico surrounding NAS Pensacola serve as recreational areas for boating, fishing, and other water-related activities.

#### 6.3.2.2 NOLF Saufley

Figure 6-6 portrays existing zoning in the areas around NOLF Saufley (from the installation boundary east and north to US-90 and south to Perdido Bay). Existing zoning patterns around NOLF Saufley include a mix of low-, medium-, and high-density residentially zoned property, special development, agricultural districts, industrial districts, and commercial areas; however, much of the land surrounding NOLF Saufley remains vacant.

Special development compromises a majority of the zoning districts to the southwest of the installation and agricultural districts border the installation to the north. Development to the east of the installation includes single-family residences, light industrial area including a closed construction and demolition landfill, manufactured housing, and commercial districts. A majority of the development surrounding NOLF Saufley is designated as low-density residential districts.

### 6.3.3 Future Land Use

Escambia County, through the Comprehensive Plan, outlines future land use within in the county. The Escambia County Comprehensive Plan is revised annually with the latest revisions incorporated August 2009. Current revisions are under review and expected to be incorporated summer 2010. The revised plan, called the 2030 Comprehensive Plan, will incorporate new and revised goals, institute new policies, include revised maps, and revise proposed future land uses among other components. In general, future land use plans are tools used by local governments to develop land in a planned and

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\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 6-6 Saufley Composite Zoning.mxd

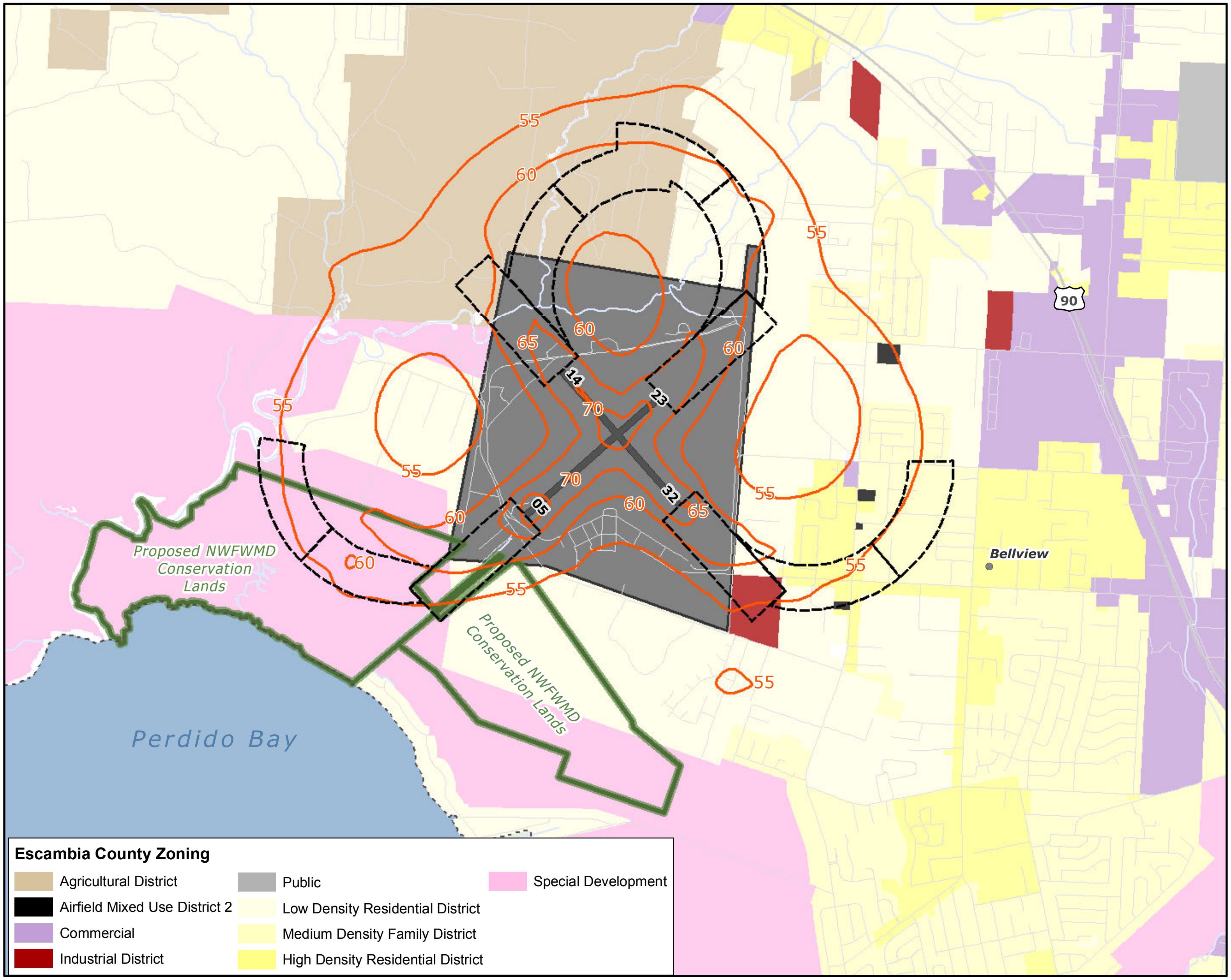


Figure 6-6
Composite AICUZ Map
with Zoning
NOLF Saufley

**Legend**

- 2010 Noise Contour Line
- 2010 APZs
- Runway
- NOLF Saufley
- Park Boundary
- Proposed NWFWMD Conservation Lands
- Water Bodies

Source: Wyle, 2008.

0 0.25 0.5 1
Miles

effective manner. The plans are influenced by economic and political factors and public participation and, as such, are subject to change and statutory limitations of only being modifiable twice a year.

#### 6.3.3.1 NAS Pensacola

Proposed future land use surrounding NAS Pensacola is expected to reflect current land use, zoning, and development patterns (See Figure 6-7). As such, community expansion to the southwest of the installation would be expected to continue development of low-density residential districts and commercial areas. The special development districts west of the installation, as well as the recreational areas south of the installation, have the potential to be further expanded as conservation lands. Development north of the installation is expected to follow current development trends of residential, commercial, and special development districts.

With respect to future land use in Escambia County, it generally reflects current land use and zoning patterns. For areas around NAS Pensacola, as shown in Figure 6-7, future land use is generally consistent with zoning (refer to Figure 6-5 for zoning near NAS Pensacola). One exception where future land use differs somewhat from zoning is in the area north of the air station where a large "Mixed Use" future land use category is designated. The zoning for this area allows for residential and some linear corridors identified as "Special Development" areas. The Mixed Use land use category identified on the future land use map includes categories of mixed use from MU-1 to MU-4. In these categories a mix of residential, commercial, recreation, tourism, and light industrial are allowable at various densities. From a land use compatibility standpoint some of the uses in the MU 1-4 categories would potentially be compatible in certain high noise zones and APZs (e.g. light industrial). To determine compatibility, an evaluation of specific land uses would need to be done based on a case by case basis and at the land parcel level and be based on the land use compatibility guidance provided in Appendix B of this report.

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Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 6-7 Official Pensacola Composite Generalized Land Use.mxd

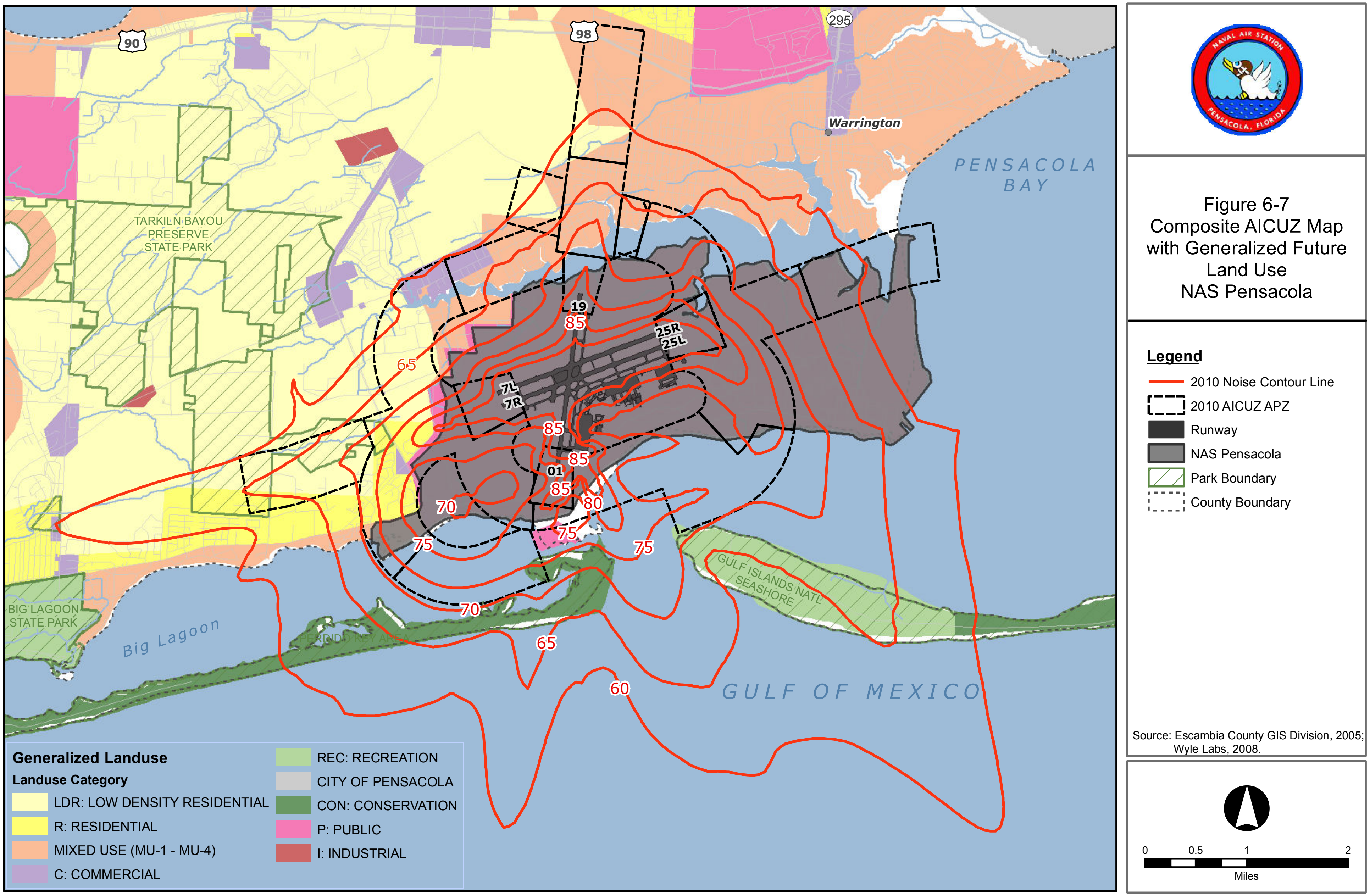


Figure 6-7
Composite AICUZ Map
with Generalized Future
Land Use
NAS Pensacola

Source: Escambia County GIS Division, 2005; Wyle Labs, 2008.

Source File: ESCAMBIA_gen_flu_2020.shp

#### 6.3.3.2 NOLF Saufley

Proposed future land use surrounding NOLF Saufley generally reflects current land use, zoning, and development patterns (see Figure 6-8). As such, the area is proposed to remain rural in character with limited, low-density, single-family, residential development and scattered agricultural and undeveloped/open space uses. It should be noted that area east of the station are zoned for residential use (see Figure 6-6), however the future land use for this area is designated as Mixed Use which could included a wider array of land uses, including some considered compatible in APZs and high noise zones. As is the case with NAS Pensacola an evaluation of specific land uses would need to be done based on a case by case basis and at the land parcel level and be based on the land use compatibility guidance provided in Appendix B of this report.

It should also be pointed out that land use northwest of the air station is zoned agriculture but that the future use is designated a low density residential. Navy land use compatibility guidelines state most uses are incompatible in Clear Zones. The future use of this area as low density residential would be incompatible within this clear zone and a serious compatibility concern.

Escambia County has initiated discussion of the possibility of purchasing the property where the closed construction and demolition landfill is located and excavating a portion of the landfill and ultimately constructing a park and a baseball complex. The Clear Zone to the southeast encompasses portions of the closed construction and demolition landfill and the proposed land uses are not compatible with clear zones.

The Northwest Florida Water Management District (NWFWMD) purchased approximately 800 acres (324 ha) of land south of NOLF Saufley. The land is being managed by the NWFWMD and are designated as conservation lands. A portion of these conservation lands are within APZ I and APZ II south of runway 05. Conservation lands, as described by the NWFWMD, are compatible with APZ I and APZ II.

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\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 6-8 Official Saufley Composite Generalized Land Use.mxd

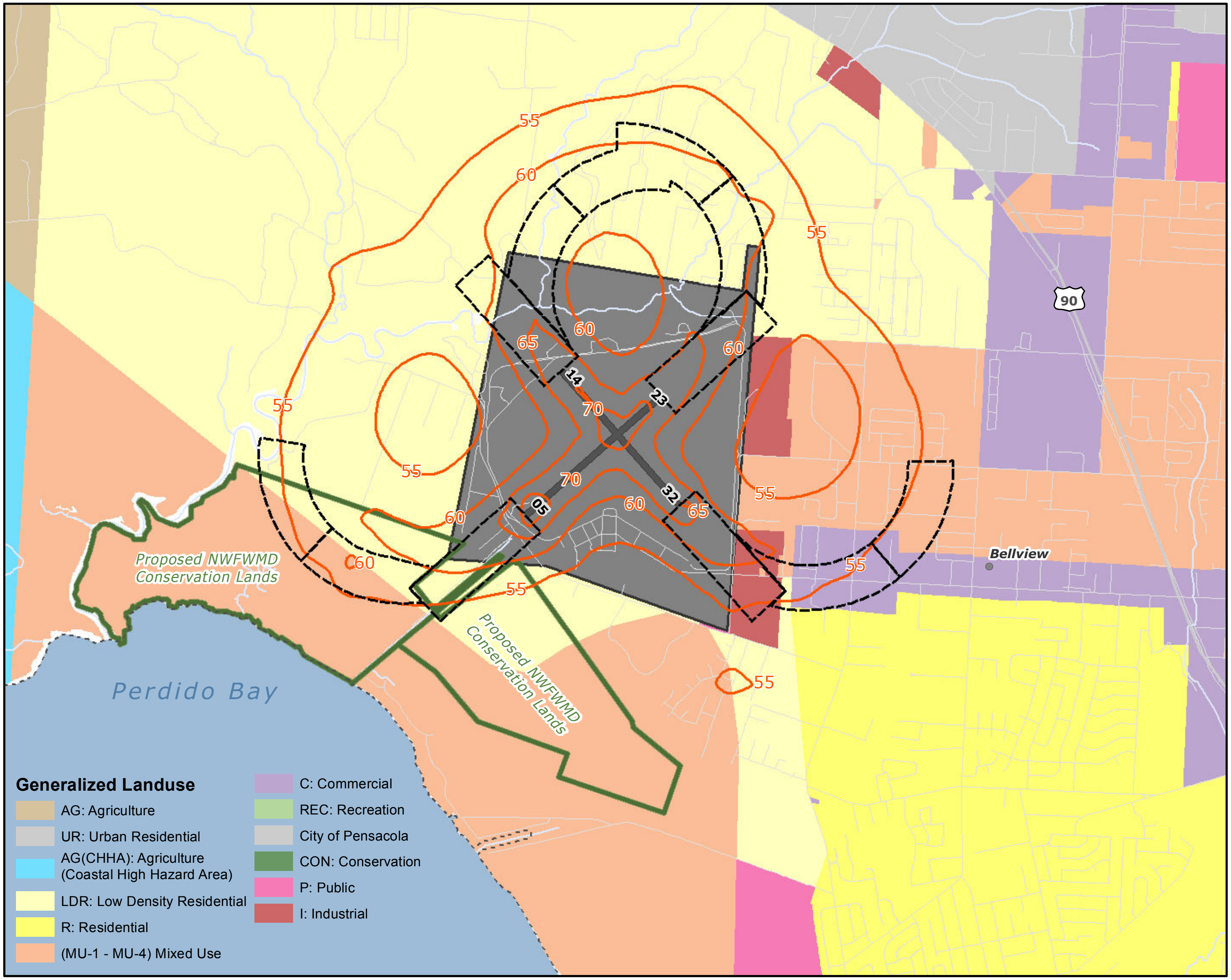



Figure 6-8
Composite AICUZ Map
with Generalized Future
Land Use
NOLF Saufley

**Legend**

- 2010 Noise Contour Line
- 2010 APZs
- Runway
- NOLF Saufley
- Proposed NWFWMD Conservation Lands
- Water Bodies

Source: Escambia County GIS Division 2005; Wyle Labs, 2008.

0 0.25 0.5 1
Miles

*Source File: ESCAMBIA_gen_flu_2020.shp*

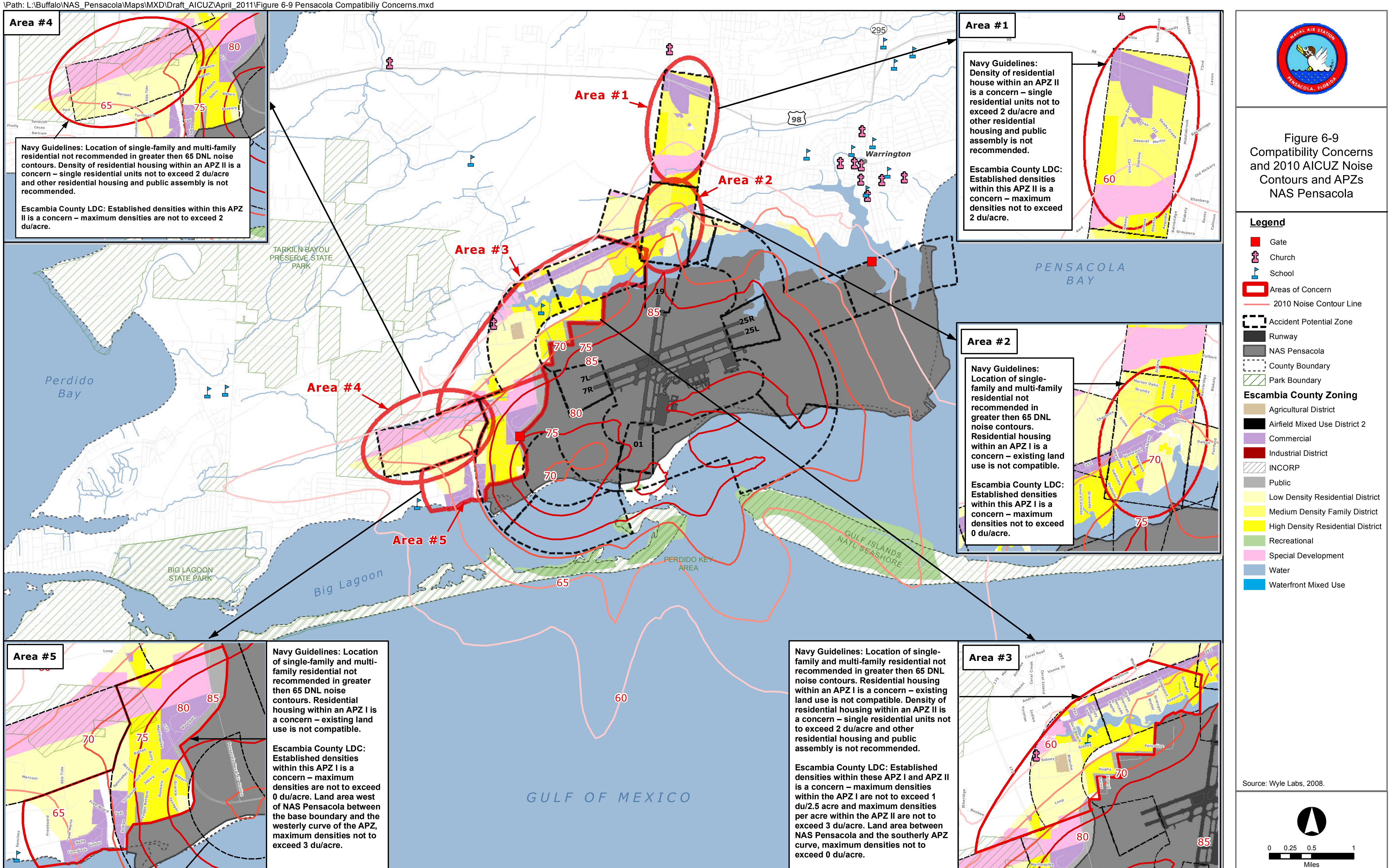
## 6.3.4 Compatibility Concerns

To determine land use compatibility within NAS Pensacola and NOLF Saufley noise zones and APZs, the Navy examined both existing and planned land uses near the installation. To determine whether existing land use is compatible with aircraft operations at NAS Pensacola and NOLF Saufley, the 2010 AICUZ noise contours, APZs, and Clear Zones were overlaid on current Escambia County parcel data that provides land use classification information. Escambia County Zoning and land use regulations, as stated in Article 11 of the LDC, were also used to determine whether existing land use is compatible with the 2010 AICUZ noise contours, APZs, and Clear Zones. Table 6-1 (on page 6-5) provides a generalized breakdown of land use compatibility, and Appendix B provides the Navy's land use compatibility classifications and the associated land use compatibility designations for noise zones and APZs from OPNAVINST 11011.36C.

### 6.3.4.1 NAS Pensacola

Land use compatibility concerns surrounding NAS Pensacola are to the north and west of the installation. Figure 6-9 shows areas of compatible and incompatible existing land uses within the APZs and noise zones surrounding NAS Pensacola. Table 4-2, provided in Section 4, presents the total land area within noise zones. Table 5-1, provided in Section 5, presents total off-station areas of the Clear Zone and APZs for NAS Pensacola. As noted in Section 5.1.3.1, flight operations on Runway 01/19 north of the installation do not exceed 5,000 operations; however, the area remains a land use concern for NAS Pensacola and the community and, as such, is included in the discussion below.

© Ecology & Environment, Inc. GIS Department    Project #
\Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 6-9 Pensacola Compatibiliy Concerns.mxd



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Noise contours that extend off the installation are primarily 60 to 65 DNL, with limited areas of the 70 to 75 DNL noise contour extending off the installation. Land southwest of the installation impacted by 65+ DNL noise contours consists primarily of low-density residential units, special development (Perdido Pitcher Plant Prairie), and commercial development on the waterfront. Residential districts are incompatible with 65+ DNL noise zones; however, commercial activities, such as office and retail areas, are compatible with the 65 to 70 DNL noise zone.

In 2003, utilizing the Preservation 2000 (now Florida Forever) funds, in partnership with the Florida Department of Environmental Protection (FDEP), the Nature Conservancy, and NAS Pensacola, 226 acres (91.5 ha) of Perdido Pitcher Plant Prairie were acquired as a conservation easement, in part as a safeguard from encroachment to NAS Pensacola. This area is compatible with restrictions for the 60 to 70 DNL noise contours (see Appendix B). Table 4-2, provided in Section 4, presents the total land area within noise zones.

Land north of the installation is more developed, consisting of a mix of residential districts and commercial districts. Noise contours that extend off the installation to the north are primarily the 60 to 65 DNL noise contours. All land use is compatible within the 60 DNL noise contour. Residential land use is not compatible within the 65+ noise contour; however, commercial uses such as office and retail areas are compatible and within in the 65 to 70 DNL noise contour.

Noise contours that extend off the installation to the south range from 60 to 75 DNL noise contours. However, land use to the south impacted by the 70 to 75 DNL noise contour consists of open water, which is a compatible land use. Portions of the 60 to 65 DNL noise contour extend over the barrier island, part of the Gulf Islands National Seashore. The barrier island west of the Pensacola Pass is not developed and only accessible by boat. The barrier island east of the Pensacola Pass is a recreational area (Fort Pickens) established by the U.S. National Park Service and is impacted by the 65 to 70 DNL noise contour. Outdoor parks and recreation areas are compatible with restrictions within this noise zone (see Appendix B). Noise contours do not extend east off the installation.

As illustrated in Figure 6-5, APZs for NAS Pensacola impact areas off the installation to the north and southwest. The Clear Zones for NAS Pensacola do not extend off the installation except for a minimal area to the north, which impacts Bayou Grande (open water). Both APZs I and II extend off the installation to the southwest. Areas impacted include a mix of residential, special development, and commercial districts.

A high-density residential district is located adjacent to the installation boundary and, as such, is incompatible with APZ I and II. Residential districts and some commercial districts are incompatible with APZ I; however, single-family residential areas and commercial districts are compatible with restrictions with APZ II (see Appendix B).

APZ I and II impact areas north of the installation. Areas impacted include a mix of residential, special development, and commercial districts. Residential districts and some commercial districts are incompatible with APZ I; however, single-family residential areas and commercial districts are compatible with restrictions with APZ II (see Appendix B).

#### 6.3.4.2 NOLF Saufley

Land use compatibility concerns surrounding NOLF Saufley are to the east and southwest of the installation. Figure 6-10 shows areas of compatible and incompatible existing land uses within the APZs and noise zones surrounding NOLF Saufley.

Noise contours that extend off the installation are primarily 55 DNL with limited areas of 60 DNL extending off the installation, both of which are compatible with all land uses. Table 4-3, presented in Section 4, provides the total land area within noise zones.

© Ecology & Environment, Inc. GIS Department Project #
Path: L:\Buffalo\NAS_Pensacola\Maps\MXD\Draft_AICUZ\April_2011\Figure 6-10 Saufley Compatibiliy Concerns.mxd

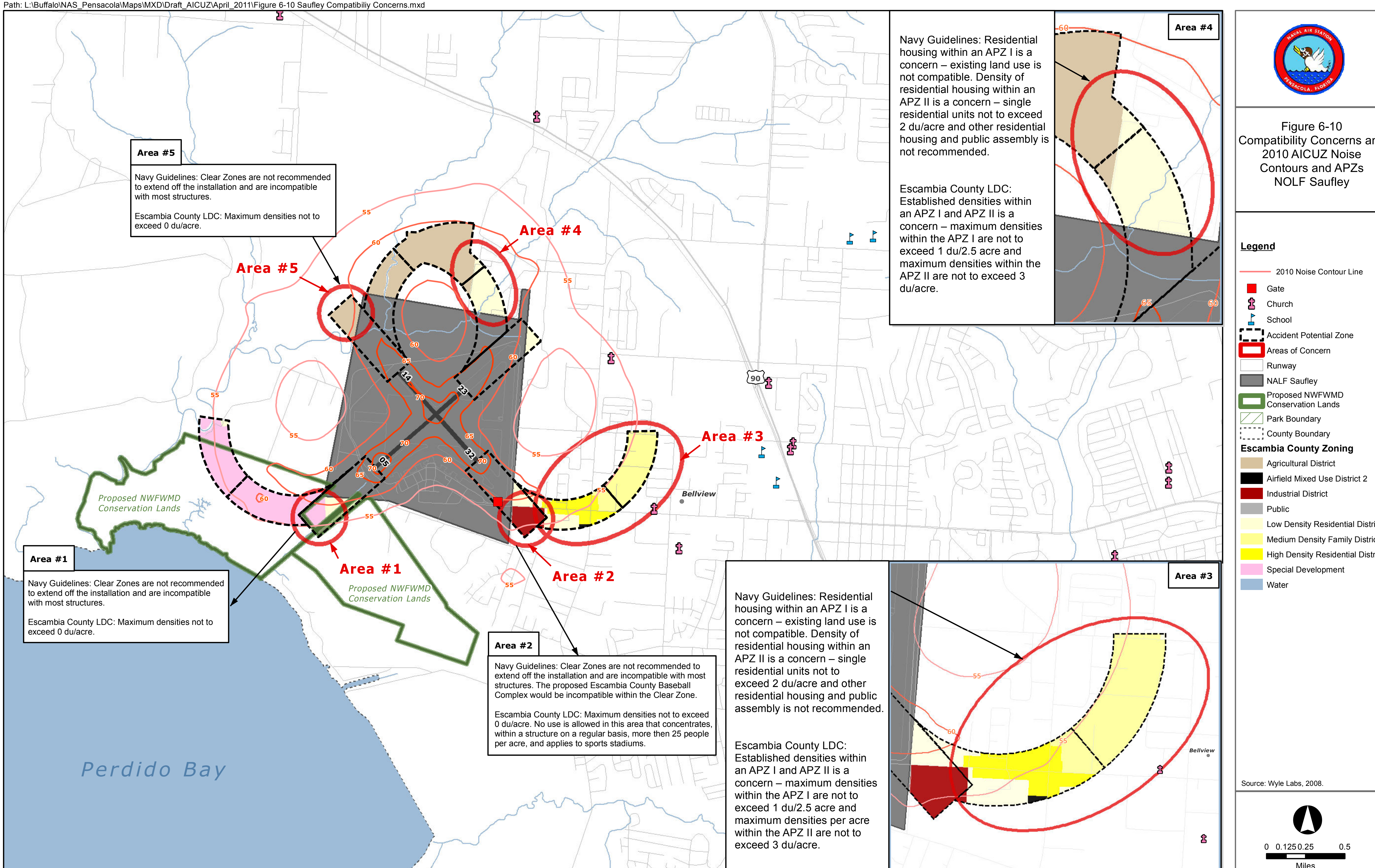

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Table 5-1, presented in Section 5, provides total off-station areas of the Clear Zone and APZs for NOLF Saufley. As illustrated in Figure 6-6, development around NOLF Saufley is rural in character. For Clear Zones, there will be approximately 90 acres (36 ha) off the installation that would be impacted. The Clear Zone to the southeast encompasses a minimal area of a low-density residential district and portions of the closed construction and demolition landfill. Should Escambia County proceed with plans to construct a park and baseball complex in the location of the closed construction and demolition landfill, land uses would not be compatible with Clear Zones, APZ I, or APZ II. With respect to Clear Zones, with few exceptions, structures are not recommended.

APZs to the southeast and northeast are over low- and medium-density residential districts. Approximately 186 acres (75 ha) of the installation are impacted by APZ I and 200 acres (81 ha) of the installation are impacted by APZ II; however, less than 25 percent of the acreage coincides with residential districts. Residential uses in APZ I are incompatible with airfield operations and uses for APZ II are compatible with restrictions (see Appendix B). Should residential development continue to the southwest of the installation, such type development would be incompatible with Clear Zones and APZs.

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# 7 Land Use Tools & 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 the United States Department of the Navy (Navy), local governments, private citizens, developers, real estate professionals, and others.

At the installation level, the Air Installation Commander is responsible for ensuring a successful AICUZ Program. Pursuant to Chief of Naval Operations Instruction (OPNAVINST) 11010.36C (AICUZ Program), the Air Installation Commander at Naval Air Station (NAS) Pensacola is committed to and shall:

- Implement an AICUZ Program for the Air Installation and associated Outlying Landing Fields (OLFs)/Auxiliary Landing Field (ALFs);
- Work with state and local planning officials to implement the objectives of the AICUZ Study;
- Designate the Community Planning Liaison Officer to assist in the execution of the AICUZ Study by the installation and to act as spokesperson for the Command in AICUZ matters;
- Provide assistance in developing AICUZ information, including operational data needed to update the AICUZ Study; and
- Work with local decision makers in Escambia County to evaluate and justify the retention of land or interest of land required for operational performance.

This section presents and describes land use planning tools and recommendations for implementing and achieving a successful AICUZ Program.

# 7.1 Tools for Implementing AICUZ

## 7.1.1 Federal Tools

**Environmental Review.** Environmental review deals with assessment of projects that may have some potential impact on land use and the public's interest. For example, 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 environmental assessment (EA), which is more limited in scope than an EIS. The environmental review process represents a procedure for incorporating the elements of the AICUZ in the planning review process.

**Executive Order 12372, Intergovernmental Review of Federal Programs (July 1982).** As a result of the Intergovernmental Cooperation Act of 1968, the United States Bureau of the Budget requires all Federal-Aid Development Projects must be coordinated with and reinforce state, regional, and local planning. Executive Order 12372 allows state governments to set up review periods and processes for federal projects.

**Housing and Urban Development (HUD) Circular 1390.2.** Approvals of mortgage loans from the Federal Housing Administration are subject to requirements of this Housing and Urban Development (HUD) circular. The circular sets forth a discretionary policy to withhold funds for housing projects when noise exposure exceeds prescribed levels. Residential construction may be permitted inside the 65-decible (dB) day-night average sound level (DNL) noise contour, provided sound attenuation is accomplished. However, the added construction expense of noise attenuation may make siting in these noise exposure areas financially less attractive. Because the HUD policy is discretionary, variances may also be permitted, depending on regional interpretation and local conditions. HUD also has a policy that prohibits funding for projects in Clear Zones and Accident Potential Zones (APZs), unless the project is compatible with the AICUZ.

**DoD Encroachment Partnering Program.** 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 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 Department of Defense (DoD) can share the real estate acquisition costs for projects that support the purchase of fee, a 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.

### 7.1.2 State Tools

The Florida Department of Community Affairs (DCA) is the Land Management Agency responsible for oversight of the Growth Management Laws of Florida. Sections 163.3175, 163.3177, 163.3187, and 163.3191, Florida Statutes, of the Growth Management Act (Chapter 163, Part II, Florida Statutes) require each county and associated municipality where a military base is located to present the commanding officer with information necessary for determining potential land use compatibility issues, including those involving local or other non-military jurisdictions that impact the base.

### 7.1.3 Local Government Tools

**Local Government Comprehensive Plans and Zoning Planning.** As stated in Section 6.1., the development and control of lands outside of military installations is beyond the control of the base commander. Development of these lands is dictated by local comprehensive land use planning and regulations. The local planning authority in Escambia County is the Escambia County Development Services Bureau.

**Capital Improvements Programs.** Capital improvements projects, such as potable water lines, sewage transmission lines, road paving and/or improvements, new right-of-way acquisition, and schools can be used to direct growth and types of growth toward areas compatible with the AICUZ Program. Local government agencies and organizations can develop capital improvement programs that avoid extending capital improvements into or near high-noise zones or APZs.

**Transfer of Development Rights (TDR).** The concept of Transfer Development Rights (TDR) involves purchasing property development rights from one property (i.e., an area proposed for incompatible residential development near an air station) and transferring those rights to another piece of property (i.e., to an area well outside of noise contours and APZs that is more conducive to residential development). Thus, development of the original property with incompatible residential homes is prevented near the air station. Another element of the TDR program is the potential for developers to receive approvals for increased densities in the receiving areas as an inducement to the developer for agreeing to a TDR. TDRs also require local governments to adopt a TDR ordinance identifying sending and receiving areas in the jurisdiction.

**Purchase of Development Rights.** The local government may consider the purchase of development rights.

**Building Code.** The local building code can be used to ensure the noise-attenuation measures of the AICUZ Program. Although this tool will not prevent incompatible development, building codes can ensure compatibility to the greatest extent possible.

In coordination with this AICUZ study document, a supplemental document, *A Guide to Real Estate Sales and Lease Disclosures in Escambia County, FL*, was developed as a tool to familiarize Navy officials and the community on the requirements of fair disclosure.

**Real Estate Disclosure.** Real estate disclosures allow prospective buyers, lessees, or renters of property in the vicinity of military operation areas to make informed decisions regarding the purchase or lease of property. The purpose is to protect the seller, real estate agent, buyer, local jurisdiction, and military. Disclosure of aviation noise and safety zones is a very important tool in informing the community about expected impacts of aviation noise and location of airfield safety zones, subsequently reducing frustration and anti-airport criticism by those who were not adequately informed prior to purchase of properties within impact areas.

**Public Land Acquisition Programs.** Public land acquisition programs can be used (as the conditions of the programs permit) for acquisition of land to support the AICUZ Program.

**Special Planning Districts.** Local governments have the power to create special planning districts, such as "military influence areas" or "airport overlay zones/districts" where local governments can either enact restrictions on land development or require notification for proposed development within the special planning area. Escambia County has adopted one such special planning district. Escambia County created and implemented AIPDs as part of the 2003 JLUS to serve as a tool for land use regulations.

### 7.1.4 Private Citizens/Real Estate Professionals/ Businesses

**Business-Development and Construction Loans to Private Contractors.** Lending institutions can limit financing for real estate purchases or construction incompatible with the AICUZ Program by restricting or prohibiting mortgage and/or other types of loans. The state and/or local government could designate restricted areas around the installation.

**Private Citizens.** Private citizens should make an informed decision when considering purchasing land within the AICUZ noise or APZ contours.

**Real Estate Professionals.** Real estate professionals in the Greater Pensacola area should ensure that prospective buyers or lessees are fully aware of what it means to be within a high-noise zone and/or APZ. Truth-in-sales and rental ordinances can be enacted to ensure adequacy in providing public disclosure of the impact in high noise and APZs. Real estate professionals also have the ability to show prospective buyers and lessees properties at a time when noise exposure is expected to peak in order to provide full disclosure. Real estate professionals in the Greater Pensacola area should use the NAS Pensacola AICUZ brochure as a tool to assist themselves and prospective homebuyers in understanding the location of homes in Pensacola and the region relative to the AICUZ for the air station.

# 7.2 Recommendations

## 7.2.1 NAS Pensacola and NOLF Saufley Recommendations

Although ultimate control over land use and development in the vicinity of NAS Pensacola and Navy Outlying Landing Field (NOLF) Saufley is the responsibility of Escambia County, the Navy has the ability and responsibility to conduct actions and implement programs in support of local efforts. To do so, NAS Pensacola should continue and/or consider the following:

**Air Operations Procedures.** Aircrew discipline in pattern operations should be enforced along with field noise abatement procedures, as set forth in Section 4.4. The Navy should continue to examine ways to improve noise abatement procedures.

**Noise Complaint Hotline.** Ensure the standard procedure is followed for noise complaints called into NAS Pensacola from operations at NAS Pensacola and NOLF Saufley. Update the NAS Pensacola AICUZ website to include NOLF Saufley with current contact information, APZs and noise contours.

Complaints should be collected in a standard format for plotting locations in a spatial database for future planning use. Recording these complaints can help:

- Document whether newly developing sites may be noise-sensitive in the future;
- Provide land use planning information for the local government;
- Determine which operational flight tracks may be responsible for the noise complaint and at what time most complaints occur; and
- Provide valuable information for real estate transactions.

**Community Outreach Activities.** Currently, there is a productive working relationship between NAS Pensacola and Escambia County. Several successful initiatives have been implemented and future initiatives aimed at further protecting Navy assets should continue or expand.

**Presentation of the AICUZ Program.** This presentation could be shown individually or collectively to community decision-makers, including local planning commissions, city councils, county legislatures, government councils, and other interested agencies. It would provide an opportunity to inform and educate individuals or groups who make land use decisions (e.g., infrastructure siting, schools, zoning changes, etc.) that can either protect or threaten NAS Pensacola and NOLF Saufley's mission. For this, the NAS Pensacola website could be expanded to include updated AICUZ-specific topics, and various materials for presentation and distribution should be developed or updated to include flight simulations, videos, poster boards, an electronic or slide presentation, and fact sheets. Presentation information could be used as part of the community outreach activities and would inform the general public on AICUZ issues, the installation's contribution to the local economy, and the need for responsible land use planning.

**Keep Engaged in the Local Planning Process.** NAS Pensacola should continue to attend public hearings and provide comments on actions that may affect AICUZ planning, including comprehensive plan and land development regulations updates and amendments.

**Local Plans, Regulations, and Policies.** NAS Pensacola should continue to be an active participant in local government and regional reviews, recommendations, and decision-making processes for land use decisions that may affect the operational integrity of the installation, including:

- Capital improvements plans, such as potable water lines, sewage transmission lines, road paving and/or improvements, and new right-of-way acquisition;
- Building code changes;
- Ensuring necessary ordinances and records-keeping capability to enact restriction within the AICUZ footprint;
- Community facilities construction (e.g., schools, stadiums, and churches);
- Establishment of local zoning ordinances and comprehensive plans or other such ordinances that may affect the installation; and
- Approvals for subdivisions, site plans, wetland permits, or other proposed approvals necessary for development.

### 7.2.2 Local Government and Agency Recommendations

**Communication.** While it is NAS Pensacola's responsibility to inform and educate community decision-makers about the AICUZ Program, community decision-makers should continue to actively inform and seek input from NAS Pensacola regarding land use decisions that potentially could affect the operational integrity of the installation.

To communicate with the public, local government websites should update information on the AICUZ Program for NAS Pensacola and NOLF Saufley and provide a link to the NAS Pensacola website for information on aircraft operations and a link to the NAS Pensacola AICUZ website.

**Decisions with Future Impacts.** It is recommended that, when local governments make land use decisions in proximity to the established AICUZ footprint, local governments recognize:

- Noise contours and APZs comprising the AICUZ footprint are dynamic, and the potential exists for changes in the AICUZ footprint as operational needs to satisfy the military mission change; and
- Because of the AICUZ Program's dynamics, it is recommended that local governments work with NAS Pensacola to establish a special planning area (or district) for areas outside the established APZ that are most likely to present compatibility problems given changes in operations at NAS Pensacola or NOLF Saufley. As a beginning point, it is recommended that local governments use the flight tracks presented in Section 3.3.5 to preserve the operational integrity of these flight tracks and protect the health and safety of the underlying population.

**Land use Plans and Regulations.** As discussed in Section 7.1.3, local governments currently within the AICUZ footprint recognize their responsibility in providing land use controls in areas encumbered by the AICUZ footprint to protect the health, safety, and general welfare of the population. It is recommended that Escambia County LDCs be updated to reflect the 2010 AICUZ noise contours, APZs and Clear Zones and OPNAVINST 11010.36C. The degree to which these land use controls are consistent with those recommended under Navy guidance varies greatly.

**Capital Improvement.** It is recommended all capital improvement projects in proximity to the installation be evaluated and reviewed for potential direct and indirect impacts that such improvements may have on the ability to implement a successful AICUZ Program.

**Building Codes.** Local building codes should be reviewed and/or modified to ensure consistency with noise attenuation recommendations of the AICUZ Program, as specified in OPNAVINST 11010.36C.

**Public Land Acquisition Programs.** These programs should be reviewed to ascertain whether they can be used in support of the AICUZ Program.

### 7.2.3 Private Citizens/Real Estate Professionals/ Businesses Recommendations

**Real Estate Professionals.** Real estate professionals should:

- Provide written disclosure to prospective purchasers, renters, or lessees when a property is located within an APZ or high-noise zone;
- Provide, on their websites, acknowledgement of the AICUZ Program for NAS Pensacola and NOLF Saufley and provide a link to the NAS Pensacola website for information on aircraft operations and the AICUZ Program;
- Provide an AICUZ brochure to prospective buyers and lessees; and
- To the greatest extent possible, make prospective buyers and lessees aware of the potential magnitude of noise exposures they might experience.

**Business - Development and Construction Loans to Private Contractors.** Lending institutions should consider whether to limit financing for real estate purchases or construction incompatible with the AICUZ Program. This strategy encourages review 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 Pensacola and NOLF Saufley and protect lenders and developers alike. Local banking and financial institutions should be encouraged to incorporate a "Due Diligence Review" of all loan applications, including determination of possible noise or APZ impacts on the mortgaged property. The Navy can play a role in this strategy by providing AICUZ seminars to lenders throughout the region.

**Citizens.** The citizens of the local community have a responsibility to:

- Become informed about the ACUIZ Program at NAS Pensacola and NOLF Saufley 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.

### 7.2.4 Summary

The AICUZ Program provides the tools necessary to promote compatible development and activities near military installations. As outlined in this section, responsibilities for disseminating relevant material, sharing knowledge, and developing cooperative relationships is the responsibility of numerous entities and individuals, not only the military and local government, but community members as well. By working together, the military and the community help to preserve the defense mission while improving the quality of life of those living around the installation.

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# Appendix A

# Discussion of Noise and Its Effects on the Environment

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## A.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.

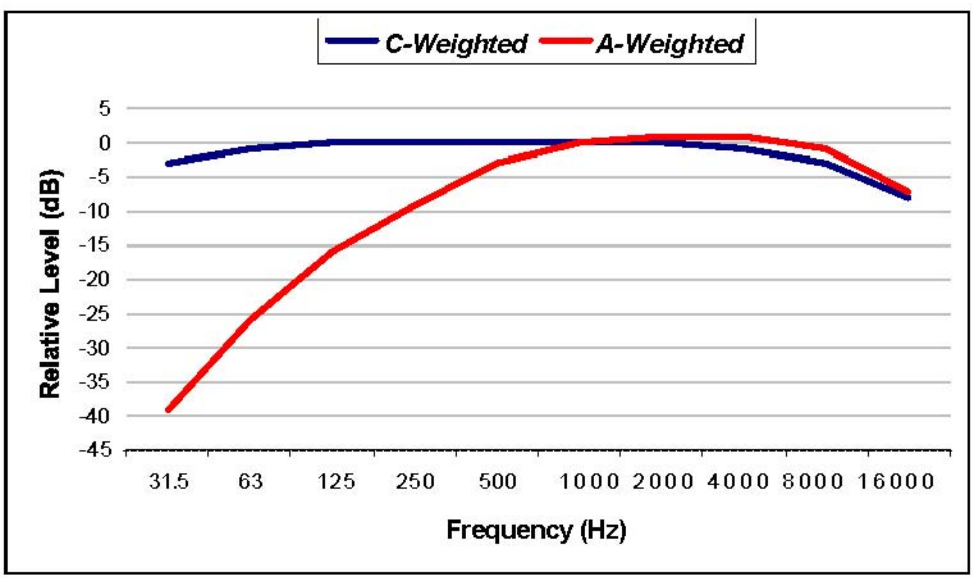
Second, the total sound level produced by two sounds of different levels is usually only slightly more than the higher of the two. For example:

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% decrease in sound intensity but only a 50% 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 S1.4 -1983 "Specification of Sound Level Meters"

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

### A.1.2 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 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.

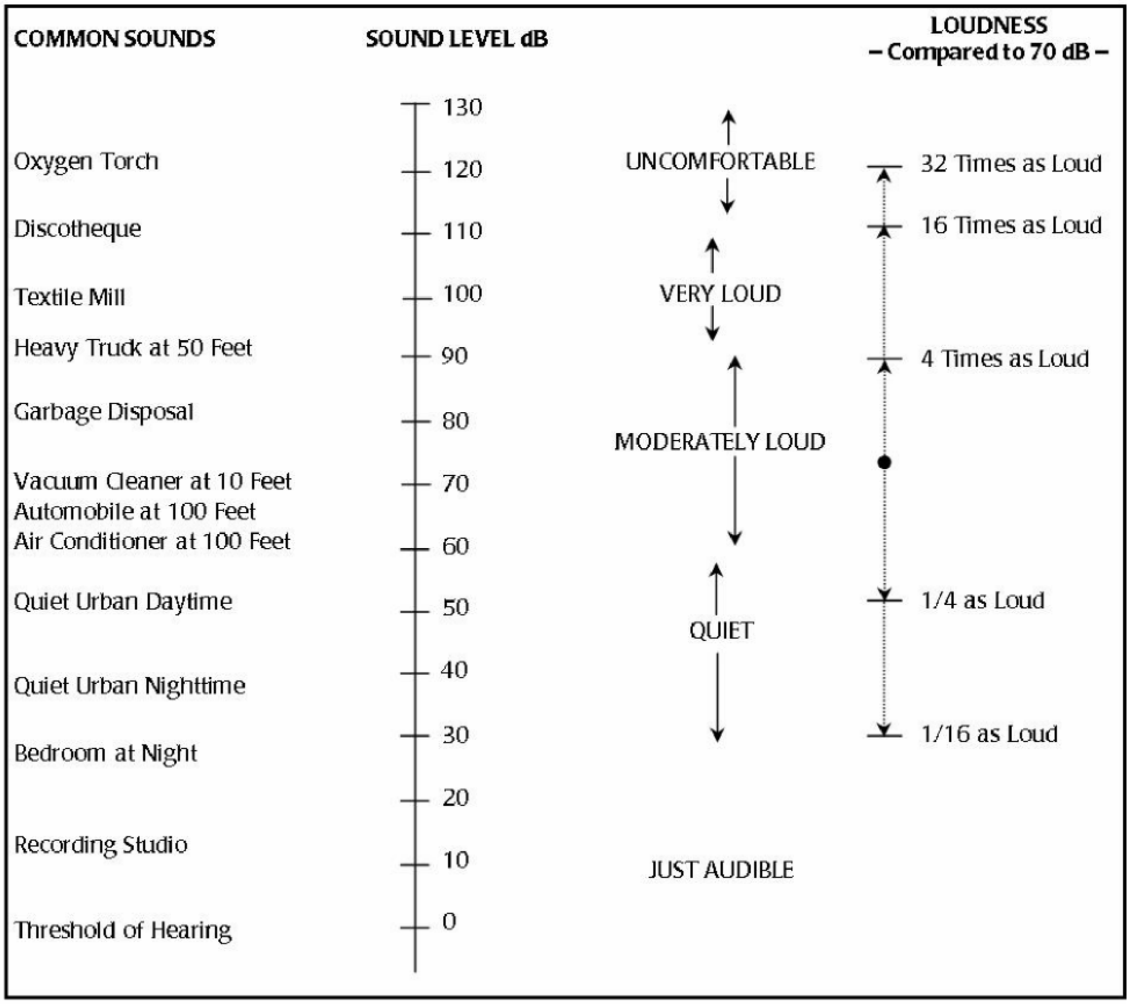
*C-weighted Sound Level*

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 (American National Standards Institute 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 (American National Standards Institute 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 1992.

**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.

## A.2 Noise Metrics

As used in environmental noise analyses, a metric refers to the unit or quantity that quantitatively measures the effect of noise on the environment. To quantify these effects, the Department of Defense and the Federal Aviation Administration use three noise-measuring techniques, or metrics: first, a measure of the highest sound level occurring during an individual aircraft overflight (single event); second, a combination of the maximum level of that single event with its duration; and third, a description of the noise environment based on the cumulative flight and engine maintenance activity. Single noise events can be described with Sound Exposure Level or Maximum Sound Level. Another measure of instantaneous level is the Peak Sound Pressure Level. The cumulative energy noise metric used is the Day/Night Average Sound Level. Metrics related to DNL include the Onset-Rate Adjusted Day/Night Average Sound Level, and the Equivalent Sound Level. In the state of California, it is mandated that average noise be described in terms of Community Noise Equivalent Level (State of California 1990). CNEL represents the Day/Evening/Night average noise exposure, calculated over a 24-hour period. Metrics and their uses are described below.

### A.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 maximum sound level 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 1/8 second, and is denoted as "fast" response (American National Standards Institute 1988). Slowly varying or steady sounds are generally measured over a period of one second, denoted "slow" response. The maximum sound level 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.

### A.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 peak sound pressure level is typically measured using a 20 microseconds or faster sampling rate, and is typically based on unweighted or linear response of the meter.

### A.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 maximum noise level 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 $_{Lmax}$ because an individual overflight takes seconds and the maximum sound level $_{(Lmax)}$ occurs instantaneously. SEL represents the best metric to compare noise levels from overflights.

### A.2.4 Day-Night Average Sound Level (DNL) and Community Noise Equivalent Level (CNEL)

Day-Night Average Sound Level and Community Noise Equivalent Level are composite metrics that account for SEL of 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 level includes a 5-decibel penalty on noise during the 7:00 p.m. to 10:00 p.m. time period, and a 10-decibel penalty on noise during the 10:00 p.m. to 7:00 a.m. time period.

The above-described metrics 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 metrics account for the maximum noise levels, the duration of the events (sorties or operations), and the number of events that occur over a 24-hour period. 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 penalties added to both the DNL and CNEL metrics 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 inclusion of daytime and nighttime periods in the computation of the DNL and CNEL reflects their basic 24-hour definition. It 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. For some military airbases, where operations are not necessarily consistent from day to day, a common practice is to compute a 24-hour DNL or CNEL based on an average busy day, so that the calculated noise is not diluted by periods of low activity.

Although DNL and CNEL provide a single measure of overall noise impact, they do not provide specific information on the number of noise events or the individual sound levels that occur during the 24-hour day. For example, a daily average sound level of 65 dB could result from a very few noisy events or a large number of quieter events.

Daily average sound levels are typically used for the evaluation of community noise effects (i.e., longterm 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 (U.S. Environmental Protection Agency 1978 and Schultz 1978). The correlation from Schultz's original 1978 study is shown in Figure A-3. It represents the results of a large number of social surveys relating community responses to various types of noises, measured in day-night average sound level.

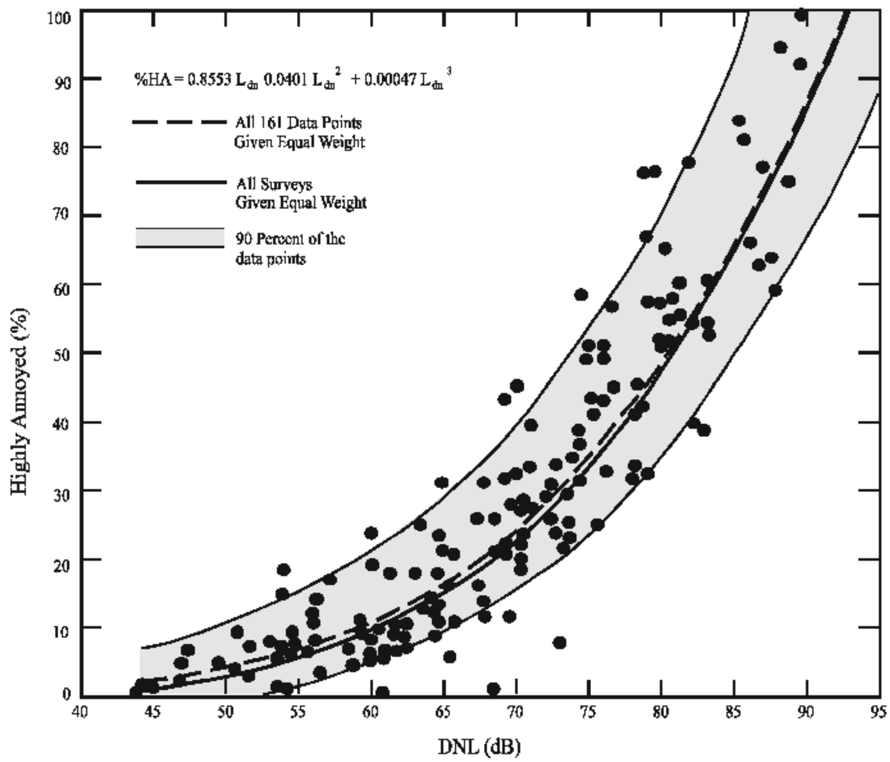



**Figure A-3. Community Surveys of Noise Annoyance**

A more recent study has reaffirmed this relationship (Fidell, et al. 1991). Figure A-4 (Federal Interagency Committee On Noise 1992) shows an updated form of the curve fit (Finegold, et al. 1994) in comparison with the original. The updated fit, which does not differ substantially from the original, is the current preferred form. In general, correlation coefficients of 0.85 to 0.95 are found between the percentages of groups of people highly annoyed and the level of average noise exposure. The correlation coefficients for the annoyance of individuals are relatively low, however, on the order of 0.5 or less. This is not surprising, considering the varying personal factors that influence the manner in which individuals react to noise. However, for the evaluation of community noise impacts, the scientific community has endorsed the use of DNL (American National Standards Institute 1980; American National Standards Institute 1988; U.S. Environmental Protection Agency 1974; Federal Interagency Committee On Urban Noise 1980 and Federal Interagency Committee On Noise 1992).

The use of DNL (CNEL in California) has been criticized as not accurately representing community annoyance and land-use compatibility with aircraft noise. Much of that criticism stems from a lack of understanding of the basis for the measurement or calculation of DNL. One frequent criticism is based on the inherent feeling that people react more to single noise events and not as much to “meaningless” time-average sound levels.

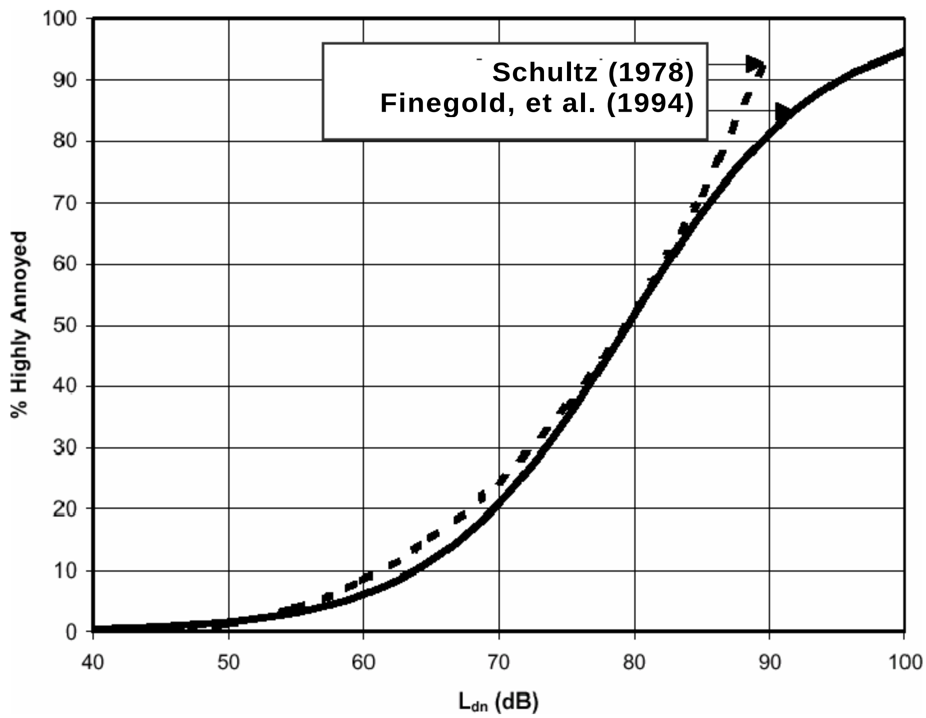



**Figure A-4. Response of Communities to Noise; Comparison of Original (Schultz, 1978) and Current (Finegold, et al. 1994) Curve Fits**

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

As a simple example of this characteristic, consider a case in which only one aircraft overflight occurs 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 day- night average sound level 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 day-night average sound level 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.

### A.2.5 Equivalent Sound Level ($L_{eq}$)

Another cumulative noise metric that is useful in describing noise is the equivalent sound level. $L_{ea}$ is calculated to determine the steady-state noise level over a specified time period. The $L_{ea}$ metric can provide a more accurate quantification of noise exposure for a specific period, particularly for daytime periods when the nighttime penalty under the DNL metric is inappropriate.

Just as SEL has proven to be a good measure of the noise impact of a single event, $L_{ea}$ has been established to be a good measure of the impact of a series of events during a given time period. Also, while $L_{ea}$ 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.

### A.2.6 Rate Adjusted Day-Night Average Sound Level ($L_{dnr}$)

Military aircraft flying on Military Training Routes (MTRs) and in 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, overflights along MTRs are highly sporadic, ranging from 10 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 Sound Exposure Level (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, often seasonal, occurrences of aircraft overflights along MTRs and in Restricted Areas/Ranges, the number of daily operations is determined from the number of flying days in the calendar month with the highest number of operations in the affected airspace or MTR. This avoids dilution of the exposure from periods of low activity, much the way that the average busy day is used around military airbases. 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 $CNEL_{mr}$.

# A.3 Noise Effects

## A.3.1 Annoyance

The primary effect of aircraft noise on exposed communities is one of long-term annoyance. Noise annoyance is defined by the EPA as any negative subjective reaction on the part of an individual or group (U.S. Environmental Protection Agency 1974). As noted in the discussion of DNL above, community annoyance is best measured by that metric.

The results of attitudinal surveys, conducted to find percentages of people who express various degrees of annoyance when exposed to different levels of DNL, are very consistent. The most useful metric for assessing people's responses to noise impacts is the percentage of the exposed population expected to be "highly annoyed." A wide variety of responses have been used to determine intrusiveness of noise and disturbances of speech, sleep, television or radio listening, and outdoor living. The concept of "percent highly annoyed" has provided the most consistent response of a community to a particular noise environment. The response is remarkably complex, and when considered on an individual basis, widely varies for any given noise level (Federal Interagency Committee On Noise 1992).

A number of nonacoustic 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.

### A.3.2 Speech Interference

Speech interference associated with aircraft noise is a primary cause of annoyance to individuals on the ground. The disruption of routine activities such as radio or television listening, telephone use, or family conversation gives rise to frustration and irritation. The quality of speech communication is also important in classrooms, offices, and industrial settings and can cause fatigue and vocal strain in those who attempt to communicate over the noise. Speech is an acoustic signal characterized by rapid fluctuations in sound level and frequency pattern. It is essential for optimum speech intelligibility to recognize these continually shifting sound patterns. Not only does noise diminish the ability to perceive the auditory signal, but it also reduces a listener's ability to follow the pattern of signal fluctuation. In general, interference with speech communication occurs when intrusive noise exceeds about 60 dB (Federal Interagency Committee On Noise 1992).

Indoor speech interference can be expressed as a percentage of sentence intelligibility among two people speaking in relaxed conversation approximately 3 feet apart in a typical living room or bedroom (U.S. Environmental Protection Agency 1974). The percentage of sentence intelligibility is a non-linear function of the (steady) indoor background A-weighted sound level. Such a curve-fit yields 100 percent sentence intelligibility for background levels below 57 dB and yields less than 10 percent intelligibility for background levels above 73 dB. The function is especially sensitive to changes in sound level between 65 dB and 75 dB. As an example of the sensitivity, a 1 dB increase in background sound level from 70 dB to 71 dB yields a 14 percent decrease in sentence intelligibility. The sensitivity of speech interference to noise at 65 dB and above is consistent with the criterion of DNL 65 dB generally taken from the Schultz curve. This is consistent with the observation that speech interference is the primary cause of annoyance.

### A.3.3 Sleep Interference

Sleep interference is another source of annoyance and potential health concern associated with aircraft noise. Because of the intermittent nature and content of aircraft noise, it is more disturbing than continuous noise of equal energy. Given that quality sleep is requisite for good health, repeated occurrences of sleep interference could have an effect on overall health.

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

Sleep is not a continuous, uniform condition but a complex series of states through which the brain progresses in a cyclical pattern. Arousal from sleep is a function of a number of factors that include age, sex, sleep stage, noise level, frequency of noise occurrences, noise quality, and pre-sleep activity. Because individuals differ in their physiology, behavior, habitation, and ability to adapt to noise, few studies have attempted to establish noise criterion levels for sleep disturbance.

Lukas (1978) concluded the following with regard to human sleep response to noise:

- Children 5 to 8 years of age are generally unaffected by noise during sleep.
- Older people are more sensitive to sleep disturbance than younger people. Women are more sensitive to noise than men, in general.
- There is a wide variation in the sensitivity of individuals to noise even within the same age group.
- Sleep arousal is directly proportional to the sound intensity of aircraft flyover. While there have been several studies conducted to assess the effect of aircraft noise on sleep, none have produced quantitative dose-response relationships in terms of noise exposure level, DNL, and sleep disturbance. Noise-sleep disturbance relationships have been developed based on single-event noise exposure.

An analysis sponsored by the U.S. Air Force summarized 21 published studies concerning the effects of noise on sleep (Pearsons, et al. 1989). The analysis concluded that a lack of reliable studies in homes, combined with large differences among the results from the various laboratory studies, did not permit development of an acceptably accurate assessment procedure. The noise events used in the laboratory studies and in contrived in-home studies were presented at much higher rates of occurrence than would normally be experienced in the home. None of the laboratory studies were of sufficiently long duration to determine any effects of habituation, such as that which would occur under normal community conditions.

A study of the effects of nighttime noise exposure on the in-home sleep of residents near one military airbase, near one civil airport, and in several households with negligible nighttime aircraft noise exposure, revealed SEL as the best noise metric predicting noise-related awakenings. It also determined that out of 930 subject nights, the average spontaneous (not noise-related) awakenings per night was 2.07 compared to the average number of noise-related awakenings per night of 0.24 (Fidell, et al. 1994). Additionally, a 1995 analysis of sleep disturbance studies conducted both in the laboratory environment and in the field (in the sleeping quarters of homes) showed that when measuring awakening to noise, a 10 dB increase in SEL was associated with only an 8 percent increase in the probability of awakening in the laboratory studies, but only a 1 percent increase in the field (Pearsons, et al. 1995). Pearsons, et al. (1995), reported that even SEL values as high as 85 dB produced no awakenings or arousals in at least one study. This observation suggests a strong influence of habituation on susceptibility to noise-induced sleep disturbance. A 1984 study (Kryter 1984) indicates that an indoor SEL of 65 dB or lower should awaken less than 5 percent of exposed individuals.

Nevertheless, some guidance is available in judging sleep interference. The EPA identified an indoor DNL of 45 dB as necessary to protect against sleep interference (U.S. Environmental Protection Agency 1978). Assuming a very conservative structural noise insulation of 20 dB for typical dwelling units, this corresponds to an outdoor day-night average sound level of 65 dB to minimize sleep interference.

In 1997, the Federal Interagency Committee on Aviation Noise (FICAN) adopted an interim guideline for sleep awakening prediction. The new curve, based on studies in England (Ollerhead, et al. 1992) and at two U.S. airports (Los Angeles International and Denver International), concluded that the incidence of sleep awakening from aircraft noise was less than identified in a 1992 study (Federal Interagency Committee On Noise 1992). Using indoor single-event noise levels represented by SEL, potential sleep awakening can be predicted using the curve presented in Figure A-5. Typically, homes in the United States provide 15 dB of sound attenuation with windows open and 25 dB with windows closed and air conditioning operating. Hence, the outdoor SEL of 107 dB would be 92 dB indoors with windows open and 82 dB indoors with windows closed and air conditioning operating.

Using Figure A-5, the potential sleep awakening would be 15% with windows open and 10% with windows closed in the above example.

The new FICAN curve does not address habituation over time by sleeping subjects and is applicable only to adult populations. Nevertheless, this curve provides a reasonable guideline for assessing sleep awakening. It is conservative, representing the upper envelope of field study results.

The FICAN curve shown in Figure A-5 represents awakenings from single events. To date, no exact quantitative dose-response relationship exists for noise-related sleep interference from multiple events; yet, based on studies conducted to date and the USEPA guideline of a 45 DNL to protect sleep interference, useful ways to assess sleep interference have emerged. If homes are conservatively estimated to have a 20-dB noise insulation, an average of 65 DNL would produce an indoor level of 45 DNL and would form a reasonable guideline for evaluating sleep interference. This also corresponds well to the general guideline for assessing speech interference. Annoyance that may result from sleep disturbance is accounted for in the calculation of DNL, which includes a 10-dB penalty for each sortie

### A.3.4 Hearing Loss

Considerable data on hearing loss have been collected and analyzed. It has been well established that continuous exposure to high noise levels will damage human hearing (U.S. Environmental Protection Agency 1978). People are normally capable of hearing up to 120 dB over a wide frequency range. Hearing loss is generally interpreted as the shifting of a higher sound level of the ear's sensitivity or acuity to perceive sound. This change can either be temporary, called a temporary threshold shift (TTS), or permanent, called a permanent threshold shift (PTS) (Berger, et al. 1995).

The EPA has 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% of the population from greater than a 5 dB PTS (U.S. Environmental Protection Agency 1978). Similarly, the National Academy of Sciences Committee on Hearing, Bioacoustics, and Biomechanics (CHABA) identified 75 dB as the minimum level at which hearing loss may occur (Committee on Hearing, Bioacoustics, and Biomechanics 1977). However, it is important to note that continuous, long-term (40 years) exposure is assumed by both EPA and CHABA before hearing loss may occur.

Federal workplace standards for protection from hearing loss allow a time-average level of 90 dB over an 8-hour work period or 85 dB over a 16-hour period. 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 a time-average sound level of 70 dB over a 24-hour period.

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).

A laboratory study measured changes in human hearing from noise representative of low-flying aircraft on MTRs. (Nixon, et al. 1993). In this study, participants were first subjected to four overflight noise exposures at A-weighted levels of 115 dB to 130 dB. One-half of the subjects showed no change in hearing levels, one-fourth had a temporary 5-dB increase in sensitivity (the people could hear a 5-dB wider range of sound than before exposure), and one-fourth 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 resulted in the participants hearing a wider range of sound, but within 10 dB of their original range.

In another study of 115 test subjects between 18 and 50 years old, temporary threshold shifts were measured after laboratory exposure to military low-altitude flight (MLAF) noise (Ising, et al. 1999). According to the authors, the results indicate that repeated exposure to MLAF 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.

Because it is unlikely that airport neighbors will remain outside their homes 24 hours per day for extended periods of time, there is little possibility of hearing loss below a day-night average sound level of 75 dB, and this level is extremely conservative.

### A.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 (1974) 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

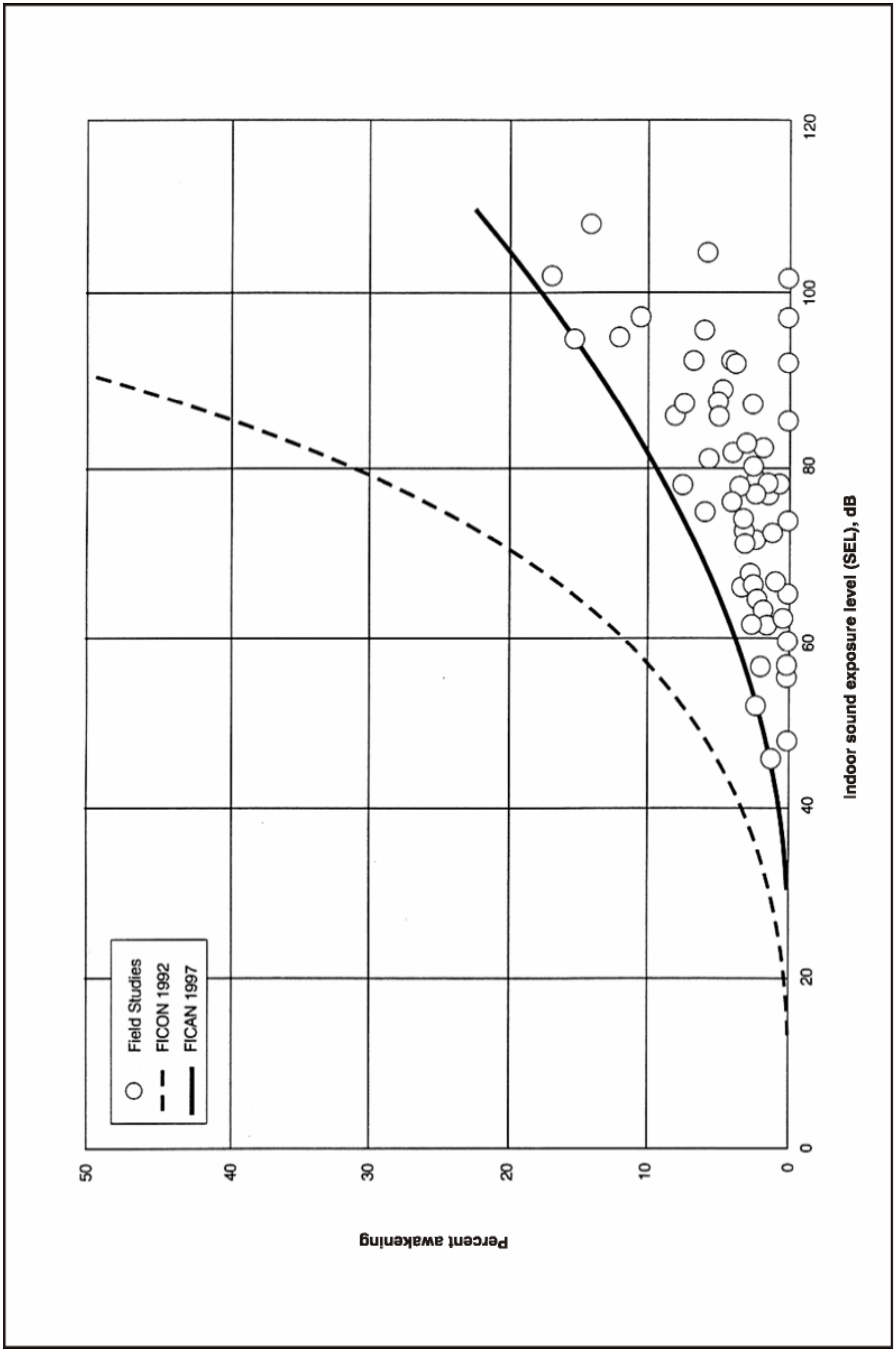



**Figure A-5. Recommended Sleep Disturbance Dose-Response Relationship**

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 (LA)() 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 LA)( 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 affects on pregnant women and the unborn fetus (Harris 1997).

### A.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.

### A.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.

### A.3.7.1 Effects on Learning and Cognitive Abilities

In the recent release (2002) of the "Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools," the American National Standards Institute refers to studies that suggest that loud and frequent background noise can affect the learning patterns of young children. 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. ANSI has approved a new standard for acoustical performance criteria in schools. The new criteria 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 (American National Standards Institute 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 (American National Standards Institute 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 (American National Standards Institute 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. 1995). 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, b). Similarly, a study conducted by Hygge (1994) found that students exposed to aircraft noise (76 dBA) scored 20% lower on recall ability tests than students exposed to ambient noise (42-44 dBA). Similar studies involving the testing of attention, memory, and reading comprehension of schoolchildren 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. 1995; 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 study conducted by Hygge, et al. (2002) 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.

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).

### A.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, relatively recent 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, Haines, et al. (2001b and 2001c) analyzed cortisol and urinary catecholamine levels in school children as measurements of stress response to aircraft noise. 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).

### A.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.

### A.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. 1990). 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).

## A.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).

### A.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. 1991).

#### A.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 1 to 5 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.

###### A.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.

#### A.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).

#### A.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% 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 1969, sonic booms were potentially linked to a mass hatch failure of Sooty Terns on the Dry Tortugas (Austin et al, 1969). 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 1991; 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.

### A.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.

#### A.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.

### A.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 DNL, and sites are conditionally acceptable with special approvals and noise attenuation in the 65 to 75 DNL noise zone and the greater than 75 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 LDN 65dB. 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/Tucson, AZ, Fidell found the homes near the airbase 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 base.

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.

### A.3.10 Noise Effects on Structures

Normally, the most sensitive components of a structure to airborne noise are the windows and, infrequently, the plastered walls and ceilings. An evaluation of the peak sound pressures impinging on the structure is normally used to determine the possibility of damage. In general, with peak sound levels above 130 dB, there is the possibility of the excitation of structural component resonances. While certain frequencies (such as 30 hertz for window breakage) may be of more concern than other frequencies, conservatively, only sounds lasting more than one second above a sound level of 130 dB are potentially damaging to structural components (Committee on Hearing, Bioacoustics, and Biomechanics 1977).

Noise-induced structural vibration may also cause annoyance to dwelling occupants because of induced secondary vibrations, or rattling of objects within the dwelling such as hanging pictures, dishes, plaques, and bric-a-brac. Window panes may also vibrate noticeably when exposed to high levels of airborne noise. In general, such noise-induced vibrations occur at peak sound levels of 110 dB or greater. Thus, assessments of noise exposure levels for compatible land use should also be protective of noise-induced secondary vibrations.

### A.3.11 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.

### A.3.12 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 supersonic 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

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**Table B-1 Land-Use Compatibility Recommendations**

| Land Use | | Suggested Land Use Compatibility | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Noise Zone 1 (DNL or CNEL) | | Noise Zone 2 (DNL or CNEL) | | Noise Zone 3 (DNL or CNEL) | | |
| SLUCM No. | Land Use Name | <55 | 55-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
| **10** | **Residential** | | | | | | | |
| 11 | Household units | Y | Y[1] | N[1] | N[1] | N | N | N |
| 11.11 | Single units: detached | Y | Y[1] | N[1] | N[1] | N | N | N |
| 11.12 | Single units: semidetached | Y | Y[1] | N[1] | N[1] | N | N | N |
| 11.13 | Single units: attached row | Y | Y[1] | N[1] | N[1] | N | N | N |
| 11.21 | Two units: side-by-side | Y | Y[1] | N[1] | N[1] | N | N | N |
| 11.22 | Two units: one above the other | Y | Y[1] | N[1] | N[1] | N | N | N |
| 11.31 | Apartments: walk up | Y | Y[1] | N[1] | N[1] | N | N | N |
| 11.32 | Apartments: elevator | Y | Y[1] | N[1] | N[1] | N | N | N |
| 12 | Group quarters | Y | Y[1] | N[1] | N[1] | N | N | N |
| 13 | Residential hotels | Y | Y[1] | N[1] | N[1] | N | N | N |
| 14 | Mobile home parks or courts | Y | Y[1] | N | N | N | N | N |
| 15 | Transient lodgings | Y | Y[1] | N[1] | N[1] | N[1] | N | N |
| 16 | Other residential | Y | Y[1] | N[1] | N[1] | N | N | N |
| **20** | **Manufacturing** | | | | | | | |
| 21 | Food and kindred products; manufacturing | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 22 | Textile mill products; manufacturing | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 23 | Apparel and other finished products; products made from fabrics, leather and similar materials; manufacturing | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 24 | Lumber and wood products (except furniture); manufacturing | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 25 | Furniture and fixtures; manufacturing | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 26 | Paper and allied products; manufacturing | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 27 | Printing, publishing, and allied industries | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 28 | Chemicals and allied products; manufacturing | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 29 | Petroleum refining and related industries | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| **30** | **Manufacturing (continued)** | | | | | | | |
| 31 | Rubber and misc. plastic products; manufacturing | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 32 | Stone, clay, and glass products; manufacturing | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |

**Table B-1 Land-Use Compatibility Recommendations**

| Land Use | | Suggested Land Use Compatibility | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Noise Zone 1 (DNL or CNEL) | | Noise Zone 2 (DNL or CNEL) | | Noise Zone 3 (DNL or CNEL) | | |
| SLUCM No. | Land Use Name | <55 | 55-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
| 33 | Primary metal products; manufacturing | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 34 | Fabricated metal products; manufacturing | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 35 | Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks | Y | Y | Y | 25 | 30 | N | N |
| 39 | Miscellaneous manufacturing | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| **40** | **Transportation, communication and utilities** | | | | | | | |
| 41 | Railroad, rapid rail transit, and street railway transportation | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 42 | Motor vehicle transportation | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 43 | Aircraft transportation | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 44 | Marine craft transportation | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 45 | Highway and street right-of-way | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 46 | Automobile parking | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 47 | Communication | Y | Y | Y | 25 [5] | 30 [5] | N | N |
| 48 | Utilities | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 49 | Other transportation, communication, and utilities | Y | Y | Y | 25 [5] | 30 [5] | N | N |
| **50** | **Trade** | | | | | | | |
| 51 | Wholesale trade | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 52 | Retail trade – building materials, hardware, and farm equipment | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 53 | Retail trade – shopping centers | Y | Y | Y | 25 | 30 | N | N |
| 54 | Retail trade – food | Y | Y | Y | 25 | 30 | N | N |
| 55 | Retail trade – automotive, marine craft, aircraft and accessories | Y | Y | Y | 25 | 30 | N | N |
| 56 | Retail trade – apparel and accessories | Y | Y | Y | 25 | 30 | N | N |
| 57 | Retail trade – furniture, home furnishings and equipment | Y | Y | Y | 25 | 30 | N | N |
| 58 | Retail trade – eating and drinking establishments | Y | Y | Y | 25 | 30 | N | N |
| 59 | Other retail trade | Y | Y | Y | 25 | 30 | N | N |
| **60** | **Services** | | | | | | | |
| 61 | Finance, insurance and real estate services | Y | Y | Y | 25 | 30 | N | N |
| 62 | Personal services | Y | Y | Y | 25 | 30 | N | N |

### Table B-1 Land-Use Compatibility Recommendations

| Land Use | | Suggested Land Use Compatibility | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Noise Zone 1 (DNL or CNEL) | | Noise Zone 2 (DNL or CNEL) | | Noise Zone 3 (DNL or CNEL) | | |
| SLUCM No. | Land Use Name | <55 | 55-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
| 62.4 | Cemeteries | Y | Y | Y | Y[2] | Y[3] | Y[4,11] | Y[6,11] |
| 63 | Business services | Y | Y | Y | 25 | 30 | N | N |
| 63.7 | Warehousing and storage | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 64 | Repair services | Y | Y | Y | Y[2] | Y[3] | Y[4] | N |
| 65 | Professional services | Y | Y | Y | 25 | 30 | N | N |
| 65.1 | Hospitals, other medical fac. | Y | Y[1] | 25 | 30 | N | N | N |
| 65.16 | Nursing homes | Y | Y | N[1] | N[1] | N | N | N |
| 66 | Contract construction services | Y | Y | Y | 25 | 30 | N | N |
| 67 | Governmental services | Y | Y[1] | Y[1] | 25 | 30 | N | N |
| 68 | Educational services | Y | Y[1] | 25 | 30 | N | N | N |
| 69 | Miscellaneous | Y | Y | Y | 25 | 30 | N | N |
| **70** | **Cultural, entertainment and recreational** | | | | | | | |
| 71 | Cultural activities (& churches) | Y | Y[1] | 25 | 30 | N | N | N |
| 71.2 | Nature exhibits | Y | Y[1] | Y[1] | N | N | N | N |
| 72 | Public assembly | Y | Y[1] | Y | N | N | N | N |
| 72.1 | Auditoriums, concert halls | Y | Y | 25 | 30 | N | N | N |
| 72.11 | Outdoor music shells, amphitheaters | Y | Y[1] | N | N | N | N | N |
| 72.2 | Outdoor sports arenas, spectator sports | Y | Y | Y[7] | Y[7] | N | N | N |
| 73 | Amusements | Y | Y | Y | Y | N | N | N |
| 74 | Recreational activities (including golf courses, riding stables, water rec.) | Y | Y[1] | Y[1] | 25 | 30 | N | N |
| 75 | Resorts and group camps | Y | Y[1] | Y[1] | Y[1] | N | N | N |
| 76 | Parks | Y | Y[1] | Y[1] | Y[1] | N | N | N |
| 79 | Other cultural, entertainment and recreation | Y | Y[1] | Y[1] | Y[1] | N | N | N |
| **80** | **Resource production and extraction** | | | | | | | |
| 81 | Agriculture (except livestock) | Y | Y | Y[8] | Y[9] | Y[10] | Y[10,11] | Y[10,11] |
| 81.5 | Livestock farming | Y | Y | Y[8] | Y[9] | N | N | N |
| 81.7 | Animal breeding | Y | Y | Y[8] | Y[9] | N | N | N |

## Table B-1 Land-Use Compatibility Recommendations

| Land Use | | Suggested Land Use Compatibility | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Noise Zone 1 (DNL or CNEL) | | Noise Zone 2 (DNL or CNEL) | | Noise Zone 3 (DNL or CNEL) | | |
| SLUCM No. | Land Use Name | <55 | 55-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
| 82 | Agricultural related activities | Y | Y | Y[8] | Y[9] | Y[10] | Y[10,11] | Y[10,11] |
| 83 | Forestry activities | Y | Y | Y[8] | Y[9] | Y[10] | Y[10,11] | Y[10,11] |
| 84 | Fishing activities | Y | Y | Y | Y | Y | Y | Y |
| 85 | Mining activities | Y | Y | Y | Y | Y | Y | Y |
| 89 | Other resource production or extraction | Y | Y | Y | Y | Y | Y | Y |

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

**Key to Table B-1:**

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.

**Notes for Table B-1:**

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 11010.36B 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 percent 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 1 May 99 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.

## Table B-1 Land-Use Compatibility Recommendations

| Land Use | | Suggested Land Use Compatibility | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Noise Zone 1 (DNL or CNEL) | | Noise Zone 2 (DNL or CNEL) | | Noise Zone 3 (DNL or CNEL) | | |
| SLUCM No. | Land Use Name | <55 | 55-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |

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. 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.

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### Table B-2 Air Installations Compatible Use Zones Suggested Land Use Compatibility in Accident Potential Zones[1]

| SLUCM No. | Land Use Name | CLEAR ZONE Recommendation | APZ-I Recommendation | APZ-II Recommendation | Density Recommendation |
|---|---|---|---|---|---|
| **10** | **Residential** | | | | |
| 11 | Household units | | | | |
| 11.11 | Single units: detached | N | N | Y[2] | Max density of 1-2 Du/Ac |
| 11.12 | Single units: semidetached | N | N | N | |
| 11.13 | Single units: attached row | N | N | N | |
| 11.21 | Two units: side-by-side | N | N | N | |
| 11.22 | Two units: one above the other | N | N | N | |
| 11.31 | Apartments: walk up | N | N | N | |
| 11.32 | Apartments: elevator | N | N | N | |
| 12 | Group quarters | N | N | N | |
| 13 | Residential hotels | N | N | N | |
| 14 | Mobile home parks or courts | N | N | N | |
| 15 | Transient lodgings | N | N | N | |
| 16 | Other residential | N | N | N | |
| **20** | **Manufacturing[3]** | | | | |
| 21 | Food and kindred products; manufacturing | N | N | Y | Max FAR 0.56 in APZ II |
| 22 | Textile mill products; manufacturing | N | N | Y | same as above |
| 23 | Apparel and other finished products; products made from fabrics, leather and similar materials; manufacturing | N | N | N | |
| 24 | Lumber and wood products (except furniture); manufacturing | N | Y | Y | Max FAR of 0.28 in APZ I & 0.56 in APZ II |
| 25 | Furniture and fixtures; manufacturing | N | Y | Y | same as above |
| 26 | Paper and allied products; manufacturing | N | Y | Y | same as above |
| 27 | Printing, publishing, and allied industries | N | Y | Y | same as above |
| 28 | Chemicals and allied products; manufacturing | N | N | N | |
| 29 | Petroleum refining and related industries | N | N | N | |
| **30** | **Manufacturing[3] (continued)** | | | | |
| 31 | Rubber and misc. plastic products; manufacturing | N | N | N | |
| 32 | Stone, clay, and glass products; | N | N | Y | Max FAR 0.56 in APZ II |

Table B-2 Air Installations Compatible Use Zones Suggested Land Use Compatibility in Accident Potential Zones[1]

| SLUCM No. | Land Use Name | CLEAR ZONE Recommendation | APZ-I Recommendation | APZ-II Recommendation | Density Recommendation |
|---|---|---|---|---|---|
| | manufacturing | | | | |
| 33 | Primary metal products; manufacturing | N | N | Y | same as above |
| 34 | Fabricated metal products; manufacturing | N | N | Y | same as above |
| 35 | Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks | N | N | N | |
| 39 | Miscellaneous manufacturing | N | Y | Y | Max FAR of 0.28 in APZ I & 0.56 in APZ II |
| **40** | **Transportation, communication and utilities** [4,5] | | | | |
| 41 | Railroad, rapid rail transit, and street railway transportation | N | Y[5] | Y | same as above |
| 42 | Motor vehicle transportation | N | Y[5] | Y | same as above |
| 43 | Aircraft transportation | N | Y[5] | Y | same as above |
| 44 | Marine craft transportation | N | Y[5] | Y | same as above |
| 45 | Highway and street right-of-way | N | Y[5] | Y | same as above |
| 46 | Auto parking | N | Y[5] | Y | same as above |
| 47 | Communication | N | Y[5] | Y | same as above |
| 48 | Utilities | N | Y[5] | Y | same as above |
| 485 | Solid Waste disposal (Landfills, incineration, etc.) | N | N | N | |
| 49 | Other transportation, comm., and utilities | N | Y[5] | Y | See Note 5 |
| **50** | **Trade** | | | | |
| 51 | Wholesale trade | N | Y | Y | Max FAR of 0.28 in APZ I & 0.56 in APZ II |
| 52 | Retail trade – building materials, hardware, and farm equipment | N | Y | Y | See Note 6 |
| 53 | Retail trade[7] – shopping centers, Home Improvement Store, Discount Club, Electronics Superstore | N | N | Y | Max FAR of 0.16 in APZ II |
| 54 | Retail trade – food | N | N | Y | Max FAR of 0.24 in APZ II |
| 55 | Retail trade – automotive, marine craft, aircraft and accessories | N | Y | Y | Max FAR of 0.14 in APZ I & 0.28 in APZ II |
| 56 | Retail trade – apparel and accessories | N | N | Y | Max FAR of 0.28 in APZ II |

**Table B-2 Air Installations Compatible Use Zones Suggested Land Use Compatibility in Accident Potential Zones[1]**

| SLUCM No. | Land Use Name | CLEAR ZONE Recommendation | APZ-I Recommendation | APZ-II Recommendation | Density Recommendation |
|---|---|---|---|---|---|
| 57 | Retail trade – furniture, home furnishings and equipment | N | N | Y | same as above |
| 58 | Retail trade – eating and drinking establishments | N | N | N | |
| 59 | Other retail trade | N | N | Y | Max FAR of 0.16 in APZ II |
| **60** | **Services[8]** | | | | |
| 61 | Finance, insurance and real estate services | N | N | Y | Max FAR of 0.22 for "General Office/ Office park" in APZ II |
| 62 | Personal services | N | N | Y | Office uses only. Max FAR of 0.22 in APZ II. |
| 62.4 | Cemeteries | N | Y[9] | Y[9] | |
| 63 | Business services (credit reporting; mail, stenographic reproduction; advertising) | N | N | Y | Max FAR of 0.22 in APZ II |
| 63.7 | Warehousing and storage services | N | Y | Y | Max FAR of 1.0 in APZ I; 2.0 in APZ II |
| 64 | Repair Services | N | Y | Y | Max FAR of 0.11 in APZ I; 0.22 in APZ II |
| 65 | Professional services | N | N | Y | Max FAR of 0.22 in APZ II |
| 65.1 | Hospitals, nursing homes | N | N | N | |
| 65.1 | Other medical facilities | N | N | N | |
| 66 | Contract construction services | N | Y | Y | Max FAR of 0.11 in APZ I; 0.22 in APZ II |
| 67 | Governmental services | N | N | Y | Max FAR of 0.24 in APZ II |
| 68 | Educational services | N | N | N | |
| 69 | Miscellaneous | N | N | Y | Max FAR of 0.22 in APZ II |
| **70** | **Cultural, entertainment and recreational** | | | | |
| 71 | Cultural activities | N | N | N | |
| 71.2 | Nature exhibits | N | Y[10] | Y[10] | |
| 72 | Public assembly | N | N | N | |
| 72.1 | Auditoriums, concert halls | N | N | N | |
| 72.11 | Outdoor music shells, amphitheaters | N | N | N | |
| 72.2 | Outdoor sports arenas, spectator sports | N | N | N | |

**Table B-2 Air Installations Compatible Use Zones Suggested Land Use Compatibility in Accident Potential Zones[1]**

| SLUCM No. | Land Use Name | CLEAR ZONE Recommendation | APZ-I Recommendation | APZ-II Recommendation | Density Recommendation |
|---|---|---|---|---|---|
| 73 | Amusements- fairgrounds, miniature golf, driving ranges; amusement parks, etc. | N | N | Y | |
| 74 | Recreational activities (including golf courses, riding stables, water recreation) | N | Y[10] | Y[10] | Max FAR of 0.11 in APZ I; 0.22 in APZ II |
| 75 | Resorts and group camps | N | N | N | |
| 76 | Parks | N | Y[10] | Y[10] | same as 74 |
| 79 | Other cultural, entertainment and recreation | N | Y[9] | Y[9] | same as 74 |
| **80** | **Resource production and extraction** | | | | |
| 81 | Agriculture (except livestock) | Y[4] | Y[11] | Y[11] | |
| 81.5, 81.7 | Livestock farming and breeding | N | Y[11,12] | Y[11,12] | |
| 82 | Agricultural related activities | N | Y[11] | Y[11] | Max FAR of 0.28 in APZ I; 0.56 in APZ II no activity which produces smoke, glare, or involves explosives |
| 83 | Forestry activities[13] | N | Y | Y | same as above |
| 84 | Fishing activities[14] | N[14] | Y | Y | same as above |
| 85 | Mining activities | N | Y | Y | same as above |
| 89 | Other resource production or extraction | N | Y | Y | same as above |
| **90** | **Other** | | | | |
| 91 | Undeveloped Land | Y | Y | Y | |
| 93 | Water Areas | N[15] | N[15] | N[15] | |

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

**Key to Table B-2**

SLUCM = Standard Land Use Coding Manual, U.S. Department of Transportation
Y (Yes) = Land use and related structures are normally compatible without restrictions.
N (No) = Land use and related structures are not normally compatible and should be prohibited.
$Y^x$ (Yes with restrictions) = The land use and related structures are generally compatible. However, see notes indicated by the superscript.
$N^x$ (No with exceptions) = The land use and related structures are generally incompatible. However, see notes indicated by the superscript.
FAR = Floor Area Ratio. A Floor area ratio is the ratio between the square feet of floor area of the building and the site area. It is customarily used to measure non-residential intensities.
Du/Ac = Dwelling Units per Acre. This metric is customarily used to measure residential densities.

## Table B-2 Air Installations Compatible Use Zones Suggested Land Use Compatibility in Accident Potential Zones[1]

| SLUCM No. | Land Use Name | CLEAR ZONE Recommendation | APZ-I Recommendation | APZ-II Recommendation | Density Recommendation |
|---|---|---|---|---|---|

**Notes for Table B-2**

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 FARs are provided as a guide to densities in some categories. In general, land-use restrictions which 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, including employees, 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 (MAX) assemblies of 50 people per acre in APZ II.
2. The suggested maximum density for detached single-family housing is one to two 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 percent 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 to pilots.
4. No structures (except airfield lighting), buildings or aboveground utility/communications lines should normally be located in the clear zone areas on or off the installation. The clear zone is subject to severe restrictions. See UFC 3-260-01, "Airfield and Heliport Planning and Design" dated 17 November 2008 for specific design details.
5. No passenger terminals and no major aboveground transmission lines in APZ I.
6. Within SLUCM Code 52, Max FARs for lumber yards (SLUCM Code 521) are 0.20 in APZ-1 and 0.40 in APZ-II. For hardware/paint and farm equipment stores, SLUCM Code 525, the Max FARs are 0.12 in APZ-1 and 0.24 in APZ-II.
7. A shopping center is an integrated group of commercial establishments that is planned, developed, owned, or managed as a unit. Shopping center types include strip, neighborhood, community, regional, and super regional facilities anchored by small businesses, supermarket or drug store, discount retailer, department store, or several department stores, respectively. Included in this category are such uses as big box discount and electronics superstores. The Max recommended FAR for SLUCM 53 should be applied to the gross leasable area of the shopping center rather then attempting to use other recommended FARs listed in Table 2 under "Retail" or "Trade."
8. Low intensity office uses only. Accessory use such as meeting places, auditoriums, etc., are not recommended.
9. No chapels are allowed within APZ I or APZ II.
10. Facilities must be low intensity and provide no tot lots, etc. Facilities such as clubhouses, meeting places, auditoriums, large classes, etc., are not recommended.
11. 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.
12. Includes feedlots and intensive animal husbandry.
13. 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.
14. Controlled hunting and fishing may be permitted for the purpose of wildlife management.
15. Naturally occurring water features (e.g., rivers, lakes, streams, wetlands) are compatible.

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