FINAL

Air Installations Compatible Use Zones Study for Naval Air Station Corpus Christi, Texas,

Including Naval Auxiliary Landing Fields Waldron and Cabaniss

August 2009

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Contract No. N 62470-06-D-7101

August 2009

Prepared by:

UNITED STATES DEPARTMENT OF THE NAVY
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Acronyms and Abbreviations

AAD	average annual day
AEW	airborne early warning
AICUZ	Air Installations Compatible Use Zones
APZ	accident potential zone
ARTCC	Air Route Traffic Control Center
ATAR	Air Traffic Activity Reports
ATC	Air Traffic Control
BASH	bird/animal aircraft strike hazard
CCAD	Corpus Christi Army Depot
CNATRA	Chief of Naval Air Training
CY	Calendar Year
dB	decibel(s)
dBA	A-weighted decibels
DNL	day-night average sound level
DoD	United States Department of Defense
EMI	electromagnetic interference
ETJ	extra-territorial jurisdiction
FAA	Federal Aviation Administration
FCLP	Field Carrier Landing Practice
FY	Fiscal Year
GCA	ground-controlled approach
HM-15	Helicopter Mine Countermeasures Squadron FIFTEEN
HUD	Housing and Urban Development
JPATS	Joint Primary Aircraft Training System
MSA	Metropolitan Statistical Area
MSL	mean sea level
NALF	Naval Auxiliary Landing Field
NASCC	Naval Air Station Corpus Christi
NASCORPCINST	Naval Air Station Corpus Christi Instruction

Acronyms and Abbreviations *(continued)*

Navy	United States Department of the Navy
NLR	noise level reduction
OPAREA	Operations Area
OPNAVINST	Office of the Chief of Naval Operations Instruction
RAP	regional airspace plan
SHP	shaft horsepower
SUA	Special Use Airspace
TDR	Transfer of Development Rights
TSDC and OSD	Texas State Data Center and Office of the State Demographer
TW-4	Training Air Wing FOUR
VFR	visual flight rules
VT-27	Training Squadron TWENTY-SEVEN
VT-28	Training Squadron TWENTY-EIGHT
VT-31	Training Squadron THIRTY-ONE
VT-35	Training Squadron THIRTY-FIVE
W-228	Warning Area 228

1 Introduction

All airports attract development. Housing is constructed for airport employees who want to live nearby, and businesses are established to cater to the airport. As development encroaches upon the airfield, more people are exposed to the noise and accident potential associated with aircraft operations.

DoD: United States Department of Defense

AICUZ: Air Installations Compatible Use Zones

The United States Department of Defense (DoD) initiated the Air Installations Compatible Use Zones (AICUZ) Program to help state and local governments promote compatible land use and development near military installations. The goal of this program is to protect military operational capabilities as well as the health, safety, and welfare of the public by achieving compatible land use patterns and activities in the vicinity of a military installation. The AICUZ Program recommends community land uses that are compatible with noise levels, accident potential, and flight clearance requirements associated with military airfield operations with the goal that the information will be incorporated into local community planning programs.

NASCC: Naval Air Station Corpus Christi

NALF: Naval Auxiliary Landing Field

The AICUZ Study for Naval Air Station Corpus Christi (NASCC), Naval Auxiliary Landing Field (NALF) Waldron, and NALF Cabaniss was originally prepared in 1978 and later updated in March 1986 as a component of the Installation's Master Plan.

This AICUZ Study has been prepared for NASCC, (also referred to herein as the Installation), NALF Waldron, and NALF Cabaniss. This AICUZ Study is part of the U.S. Department of the Navy's (Navy's) continuing participation in the local planning process. As local communities prepare land use plans and zoning ordinances, the Navy has the responsibility to provide input on its activities relating to the community. This Study is presented in the spirit of mutual cooperation and assistance by NASCC to aid in the local land use planning process. This Study updates information on base aircraft operations since the

APZ: accident potential zone

1986 AICUZ Study, and provides noise contours and accident potential zones (APZs) based on projected flight activities through 2009. This report has been prepared in consideration of expected changes in mission, aircraft, and operational levels that will occur within the next ten- to fifteen-year planning period. The 2009 AICUZ noise contours and APZs presented in this Study are based on 2015 projected flight operations to be conducted at NASCC, NALF Waldron, and NALF Cabaniss.

Section 1 of this AICUZ Study provides background on the AICUZ Program. Section 2 describes the Installation, the auxiliary airfields, its tenants, and operations. Section 3 discusses current airspace and aircraft operations at the Installation and auxiliary airfields. Section 4 presents information on aircraft noise zones – how noise zones are determined, what changes have occurred, and what measures have been implemented by the Navy in response to noise complaints. Section 5 discusses aircraft safety issues. Section 6 evaluates the compatibility of surrounding land uses with aircraft operations. Section 7 outlines tools for implementing the AICUZ Program and provides the Navy recommendations for promoting land use compatibility consistent with the goals of the AICUZ Program. Appendix A is a summary of the effects of noise on the environment. Appendix B is a matrix of compatible land uses recommendations for development within AICUZ noise zones and APZ adapted from the Navy's Air Installations Compatible Use Zones Program Instructions (Office of the Chief of Naval Operations Instruction [OPNAVINST] 11010.36C).

OPNAVINST: Office of the Chief of Naval Operations Instruction

1.1 AICUZ Program

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 development (encroachment) around military airfields. The goals of the AICUZ Program are:

- To protect the health, safety, and welfare of those living and working in proximity to military airfields; and
- To preserve the military flying mission.

To meet these goals, the Navy has identified the following components as requirements for a successful AICUZ Program:

- Develop and periodically update a study and map for each air installation to quantify and depict aircraft noise zones and APZs;
- Coordinate with federal, state, and local officials to encourage compatible land use development around each air installation;
- Inform the local communities of the importance of maintaining the Navy's ability to conduct aircraft operations; and
- Review operations and implement operational changes and noise abatement strategies to minimize noise impacts while ensuring mission requirements.

FAA: Federal Aviation Administration

EMI: electromagnetic interference

Under the AICUZ Program, the DoD identifies and delineates noise zones and APZs as planning tools for local planning agencies. The Federal Aviation Administration (FAA) and the DoD also encourage local communities to restrict development or land uses in the vicinity of the airfield that could interfere with aircraft operations. These interferences include lighting (direct or reflected) that would impair pilot vision; towers, tall structures, and vegetation that penetrate navigable airspace; uses that generate smoke, steam, or dust; uses that attract birds, especially waterfowl; and electromagnetic interference (EMI) related to aircraft communication, navigation, or other electrical systems.

1.2 Purpose, Scope, and Authority

The purpose of the AICUZ program is to achieve compatibility between air installations and neighboring communities.

The purpose of the AICUZ program is to achieve compatibility between air installations and neighboring communities. To satisfy the purpose of the AICUZ Program, the local command works with the host community to encourage compatible development of land adjacent to the Installation. As development encroaches upon the airfield, more people experience the noise and accident potential associated with aircraft operations.

The scope of the AICUZ Study includes a detailed analysis and quantification of:

- Aircraft noise and accident potential;
- Land use compatibility;
- Operational alternatives;
- Noise reduction strategies; and
- Potential solutions to existing and potentially incompatible land use problems.

The AICUZ Study analyzes community development trends, land use tools, and mission requirements 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 Station Command's cooperation with the local governments to protect and promote the public's health, safety, and welfare and, at the same time, protect the Installation's mission requirements. The authority for the establishment and implementation of the NASCC AICUZ Program is derived from:

- United States Department of Defense 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;
- Naval Facilities Engineering Command Publications (NAVFAC P-80.3), "Facilities Planning Factor Criteria for Navy and Marine Corps Shore Installations, Appendix E: Airfield Safety Clearances," dated January 19, 2002;
- Unified Facilities Criteria (UFC) 3-260-01, "Airfield and Heliport Planning and Design," dated May 19, 2006; and
- United States Department of Transportation, FAA Regulations, Code of Federal Regulations, Title 14, Part 77, "Objects Affecting Navigable Airspace."

NAVFAC: Naval Facilities Engineering Command

UFC: Unified Facilities Criteria

1.3 Responsibility for Compatible Land Use

Ensuring land use compatibility within the AICUZ is the responsibility of many, including the DoD, 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 Use and Development

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

1.4 Studies

Previous AICUZ efforts for NASCC, NALF Waldron, and NALF Cabaniss include the original 1978 AICUZ Study and the 1986 Update that was conducted for the Installation Master Plan. In addition to these AICUZ Studies, several noise studies have been conducted due to changes in aircraft, aircraft operations, and bed-down scenarios. The most recent Noise Study was finalized in August 2008 (Wyle Laboratories, Inc. 2008) and is the source of noise data contained in this AICUZ Study.

1.5 Changes that Require an AICUZ Update

AICUZ Studies are updated when required. Determining whether an AICUZ should be updated is based primarily on the following factors:

- Significant changes that have occurred in aircraft operations (i.e., the number of takeoffs and landings);
- Significant changes in the type of aircraft stationed and operating at an installation; or
- Significant changes that have occurred in flight paths or procedures.

This update to the NASCC AICUZ Study is required due to changes in aircraft, primarily the basing of the T-6 Texan II aircraft.

In accordance with OPNAVINST 11010.36C, this AICUZ has been prepared to reflect changes in airfield operations and aircraft since the last AICUZ Update in 1986 and to incorporate any reasonable projected mission changes. This update to the NASCC AICUZ Study is required due to changes in aircraft, primarily the basing of the T-6 Texan II aircraft.

2 NAS Corpus Christi

2.1 Location

NASCC is located along the southeast coast of Texas within the city limits of Corpus Christi in Nueces County. The City of Corpus Christi is a seaport on the Gulf of Mexico in the crescent-shaped area of South Texas known as the Coastal Bend. The city and its immediate surroundings are composed of generally flat terrain broken by several bays and the Nueces River. Corpus Christi is approximately 144 miles southeast of the City of San Antonio and 170 miles north of the United States/Mexico border.

The Installation is positioned on Encinal Peninsula with Corpus Christ Bay to the north, Laguna Madre to the east, and Oso Bay to the west. A mix of vacant land and residential and commercial property is south of the Installation.

NASCC is accessed at the North and South Gates of the property. State Highway 358 leads into the South Gate, which is the main entrance, and Ocean Drive leads into the North Gate.

NASCC has two auxiliary landing fields to support training operations:
1) **NALF Waldron,** located approximately 3.5 miles south of NASCC; and
2) **NALF Cabaniss,** located approximately 8 miles west of NASCC.

NASCC is a 2,340-acre military base with additional aviation and special use easements. NASCC has two auxiliary landing fields to support training operations: 1) NALF Waldron, located approximately 3.5 miles south of NASCC; and 2) NALF Cabaniss, located approximately 8 miles west of NASCC.

Both NASCC and NALF Waldron are located in the Flour Bluff area of Corpus Christi, and NALF Cabaniss is located within the Southside area along Oso Creek. Figure 2-1 provides a regional map of the South Texas coastline and identifies the locations of NASCC (Truax Field), NALF Waldron, and NALF Cabaniss.

2.2 Mission

NASCC's **mission** is *to maintain and operate facilities and to provide services and material to support operations of aviation activities and units of operating forces of the Navy, as well as other activities and units as designated by the Chief of Naval Operations.*

NASCC is an aviation training facility with a mission to maintain and operate facilities and to provide services and material to support operations of aviation activities and units of operating forces of the Navy, as well as other activities and units as designated by the Chief of Naval Operations.

2.3 History

CCAD: Corpus Christi Army Depot

TW-4: Training Air Wing FOUR

In the late 1930s, as World War II approached, the need arose for a training facility capable of training large numbers of U.S. military pilots. As a result of this demand, the Navy designated the city of Corpus Christi as the location for a large and new pilot training facility. Construction began June 30, 1940, and the air station was commissioned on March 12, 1941. The station was initially used to train pilots, navigators, aerologists, gunners, and radio operators. In 1961, the Army Aeronautical Depot Maintenance Center, today known as Corpus Christi Army Depot (CCAD), was established on base and is the largest tenant command at NASCC. In 1972, Naval Air Training Command Headquarters was relocated to NASCC from NAS Pensacola, Florida, and Training Air Wing FOUR (TW-4) was established. TW-4 squadrons conduct operations at Truax Field and NALFs Waldron and Cabaniss, training approximately 400 newly qualified aviators each year. On August 6, 1986, the airfield at NASCC was renamed Truax Field in honor of Navy Lieutenant Myron Milton Truax.

2.4 Operational Areas

NASCC operations are conducted at Truax Field, NALF Cabaniss, and NALF Waldron. A regional map of all airfields is provided as Figure 2-1.

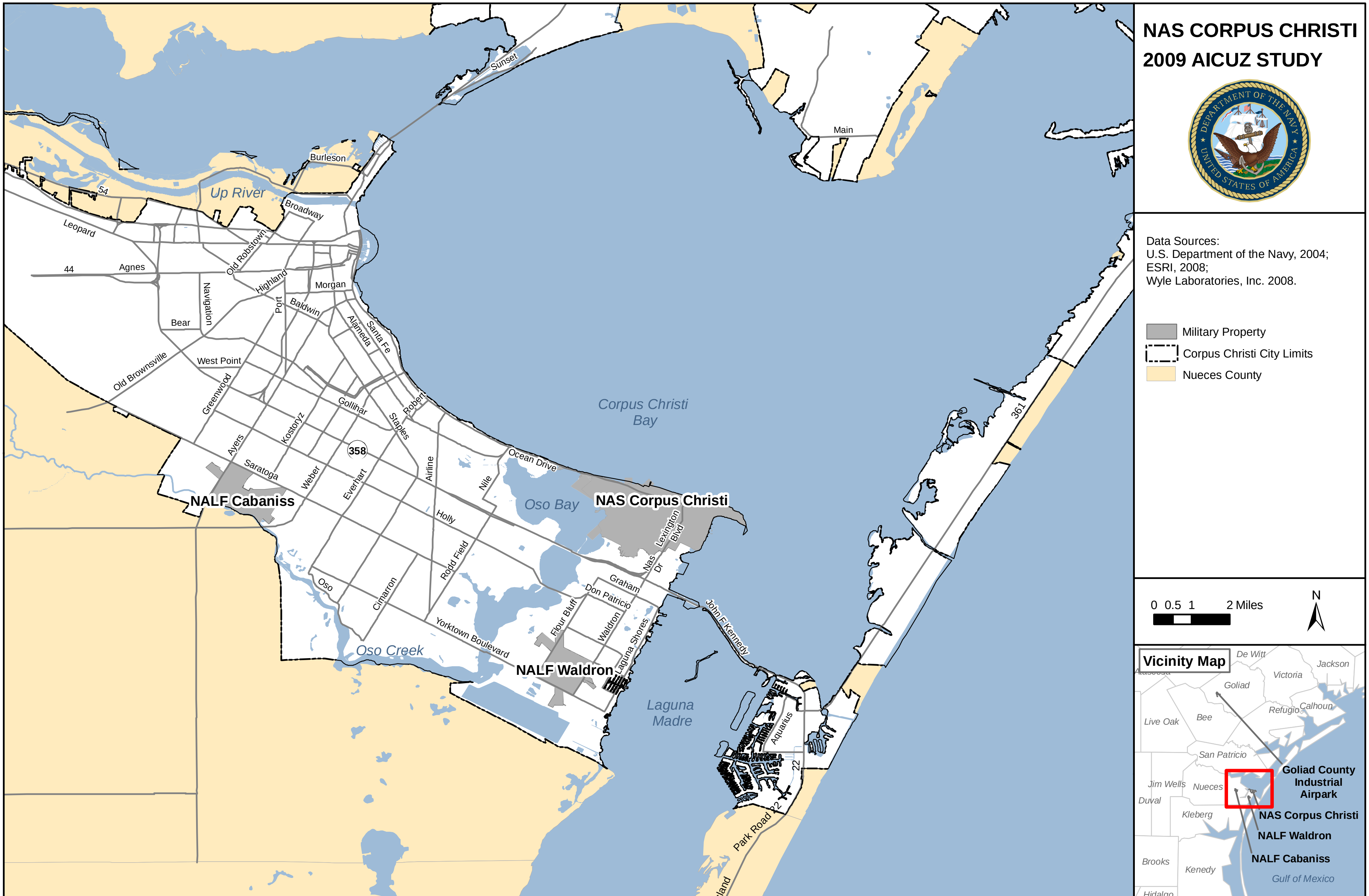

Figure 2-1: Regional Location Map
NAS Corpus Christi, Texas

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2.4.1 Truax Field

Truax Field is a Category B airfield sited on the main base of NASCC and is approximately 10 miles from the City of Corpus Christi's downtown area. The vicinity of the airfield is a moderately urbanized area, and the airfield is bordered by Corpus Christi Bay to the north, Laguna Madre Bay and Padre Island to the east, residential and commercial development to the south, and Oso Bay to the west. Truax Field is located at N 27º41.16', W 97 º17.68' at an average elevation of 19 feet above mean sea level (MSL). Figure 2-2 depicts the general location and runways of Truax Field.

Truax Field has six active helipads and four active runways for tenant training and missions.

Truax Field has six active helipads and four active runways for tenant training and missions. The dimensions of the runways are listed in Table 2-1. Runway 13R/31L is designated as the primary jet runway. This airfield is equipped with Navigational Aids, Instrument Landing Systems, and Precision Approach Radar (U.S. Department of the Navy 2007). Continuous, intensive student pilot training is conducted at Truax Field from Monday through Friday.

Table 2-1: Truax Field Runway Dimensions

Runway	Length (feet)	Width (feet)
13R/31L (Class B)	8,001	200
13L/31R (Class A)	4,998	200
17/35 (Class A)	5,004	200
04/22 (Class A)	5,000	200

Source: NASCC 2007.

2.4.2 NALF Waldron

NALF Waldron is an 851-acre training airfield for practice approaches and arrested landings for the T-34C aircraft in support of TW-4 pilot training operations.

NALF Waldron is an 851-acre training airfield for practice approaches and arrested landings for the T-34C aircraft in support of TW-4 pilot training operations. The airfield is situated approximately 3.5 miles south of NASCC in a moderately urbanized area, and it is accessible via South Padre Island Drive (State Highway 358) and Waldron Road. The property is fenced and secured at all times. NALF

Waldron is located at N 27º38’, W 97 º19’ at an average elevation of 25 feet MSL. Figure 2-3 provides the general location and runways of NALF Waldron.

VFR: visual flight rules

NALF Waldron has a control tower, fire department facility, and two runways. The runways’ dimensions are provided in Table 2-2. The airfield only offers visual flight rules (VFR) operations and essential safety and maintenance services (U.S. Department of the Navy 2007). The airfield does not have lighting and therefore does not allow for night operations. No aircraft are based at NALF Waldron.

Table 2-2: NALF Waldron Runway Dimensions

Runway	Length (feet)	Width (feet)
13 (Class A)	5,000 (takeoff) 4,700 (landing)	200
31 (Class A)	5,000 (takeoff) 4,250 (landing)	200
17 (Class A)	5,000 (takeoff) 4,580 (landing)	200
35 (Class A)	5,000 (takeoff) 4,815 (landing)	200

Source: NASCC 2007.
Note: All runways have a displaced landing threshold.

2.4.3 NALF Cabaniss

NALF Cabaniss is a 971-acre training airfield for practice approaches and arrested landings for the T-44A and the TC-12 aircraft in support of TW-4 pilot training operations.

NALF Cabaniss is a 971-acre training airfield for practice approaches and arrested landings for the T-44A and the TC-12 aircraft in support of TW-4 pilot training operations. The airfield is located approximately 8 miles west of NASCC (Figure 2-4) in a predominantly urbanized area, and it is accessible via South Padre Island Drive (State Highway 358), Ayers Street, Saratoga Boulevard, and Cabaniss Road. NALF Cabaniss is located at N 27º42’, W 97 º26’ at an average elevation of 30 feet MSL. Figure 2-4 provides the general location of the airfield and depicts the airfield runways.

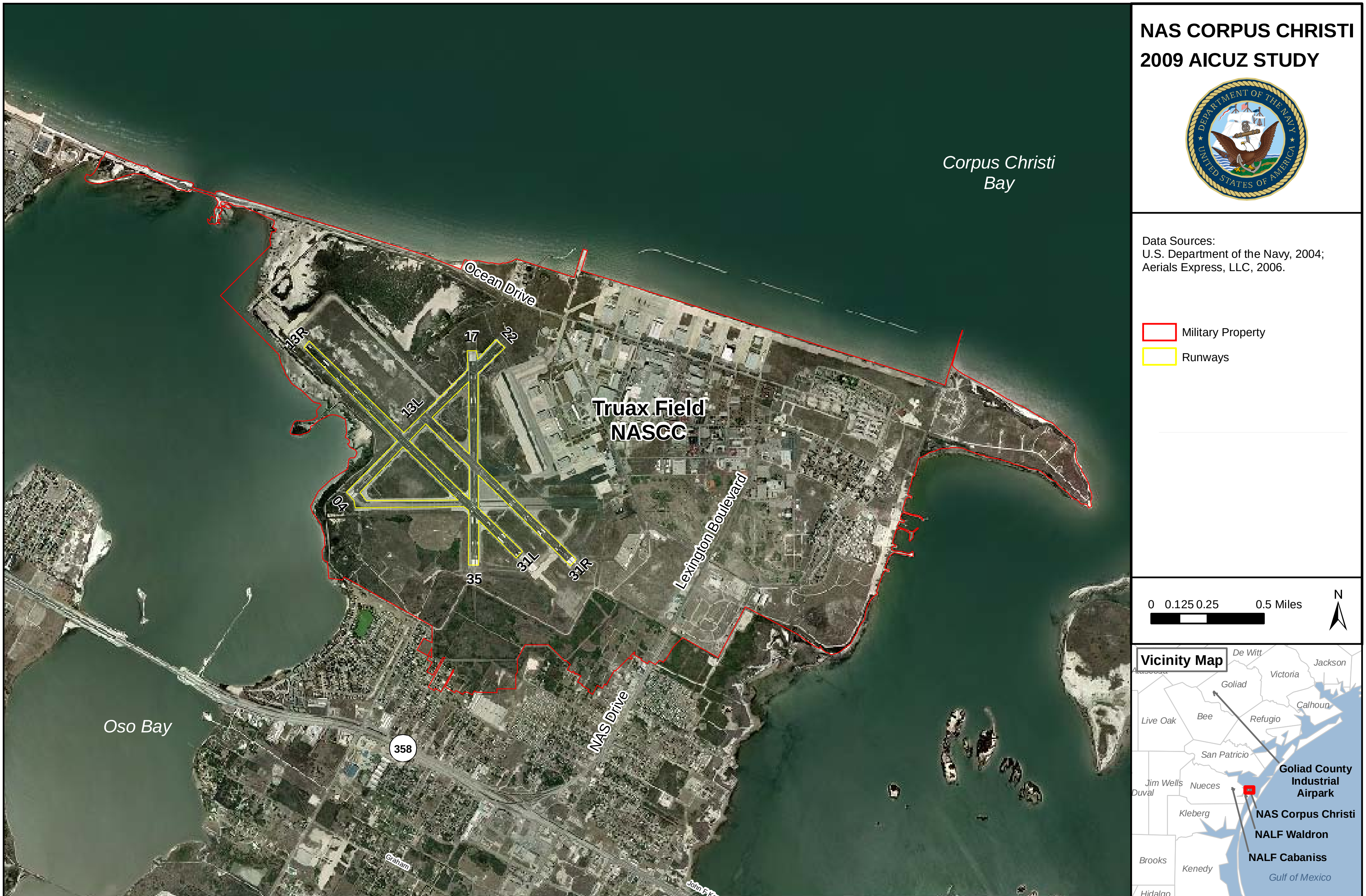

Figure 2-2: Truax Field Location and Vicinity
Corpus Christi, Texas

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NAS CORPUS CHRISTI
2009 AICUZ STUDY

Data Sources:
U.S. Department of the Navy, 2004;
Aerials Express, LLC, 2006;
ESRI, 2008.

Military Property
Runways

0 0.125 0.25 Miles
N

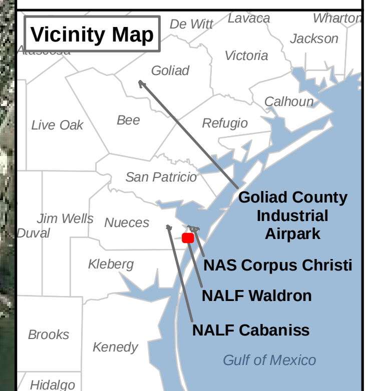

Figure 2-3: NALF Waldron Location and Vicinity
Corpus Christi, Texas

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Figure 2-4: NALF Cabaniss Location and Vicinity
Corpus Christi, Texas

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The airfield has a control tower and two active runways. The dimensions of the runways are listed in Table 2-3. The property is fenced and secured at all times, and both runways have field lighting. Two abandoned hangers remain on the property. NALF Cabaniss only offers VFR operations and essential safety and maintenance services (U.S. Department of the Navy 2007). No aircraft are based at NALF Cabaniss, but it currently supports touch-and-go training missions originating from NASCC.

Table 2-3: NALF Cabaniss Runway Dimensions

Runway	Length (feet)	Width (feet)
13/31 (Class A)	5,000	150
17 [(a)] /35 (Class A)	5,000 (landing) 4,500 (takeoff)	150

Source: NASCC 2007.
Note: (a) Runway 17 has a 500-foot displaced landing threshold.

2.5 Tenant Commands

NASCC hosts more than 50 tenant commands and activities. Of these, the following are major commands performing aviation activities at Truax Field, NALF Cabaniss, and NALF Waldron. The aircraft associated with these units and their operations are described in greater detail in Section 3.

Training Air Wing FOUR (TW-4). TW-4 is comprised of four individual units: Training Squadrons TWENTY-SEVEN (VT-27), TWENTY-EIGHT (VT-28), THIRTY-ONE (VT-31) and THIRTY-FIVE (VT-35). VT-27 and VT-28 are two of five primary training squadrons (the other three are located at Whiting Field in Milton, Florida). They fly the T-34C Turbo Mentor training aircraft. VT-31 and VT-35 provide advanced multi-engine training in the T-44A Pegasus or TC-12B Huron, respectively. VT-31 is also responsible for intermediate phase flight training for future E-2C Hawkeye and C-2A Greyhound pilots. VT-35 was established as a Joint Advanced Multi-engine Training Squadron in October 1999.

Corpus Christi Army Depot (CCAD). CCAD is the largest tenant organization on NASCC. It is the largest helicopter repair facility in the world, located on 158 acres with 2.2 million square feet of industrial space. CCAD provides helicopter repair and overhaul capability to all the U.S. military services as well as numerous foreign military organizations. With 3,800 personnel, it is the largest single industrial employer in south Texas. The depot is a full-service facility, with the ability to repair and test a variety of rotary-wing aircraft including but not limited to: the AH-1W Super Cobra, CH-47D Chinook, MH-60 Pavehawk, OH-58D Kiowa, AH-64A Apache, SH-60 Seahawk, UH-1N Huey, and the UH-60 Blackhawk.

U.S. Customs and Border Protection. The U.S. Customs Service operates the Surveillance Support Center at NASCC, a $30 million-a-year operation with 137 employees and $500 million in assets, including six radar planes. Its planes play a large role in the effort to eradicate drug production in Colombia. The U.S. Customs aviation fleet at NASCC is composed of P-3C Orion and P-3 airborne early warning (AEW) fixed-wing aircraft.

U.S. Coast Guard Sector CC. The Coast Guard fleet at Truax Field includes HH-65 Dolphin rotary-wing aircraft and HU-25C Falcon 20 fixed-wing aircraft. The primary mission of the Coast Guard Group/Air Station Corpus Christi is search and rescue.

2.6 Economic Contributions

In 2005, the DoD's total expenditures in Texas were $31.8 billion, creating a statewide total economic impact of $75 billion.

The military provides a significant economic contribution to the state of Texas and the Corpus Christi region. Benefits include employment opportunities, increases in local sales and business revenue, and property sales and tax revenue. In 2005, the DoD's total expenditures in Texas were $31.8 billion, creating a statewide total economic impact of $75 billion (Texas Military Preparedness Commission 2006).

In south Texas, Nueces County, San Patricio County, and Kleberg County are significantly impacted by two military installations: NASCC and NAS Kingsville. Collectively, these military facilities provide approximately 23,181 jobs, $971 million in salaries and wages, and $758 million in output sales. The number of personnel, value of annual payroll, local procurement, and contracts for NASCC are shown in Table 2-4.

Military facilities expenditures in south Texas, including spending by the facilities and by facility personnel and employees, generates approximately $59 million per year in revenues for regional cities, counties, school districts, and special taxing districts. Residential property tax on properties owned or occupied by military personnel or employers directly or indirectly supported by the military facilities accounts for $34 million in annual revenue in the region, and is the largest contributor of the total regional revenues.

Table 2-4: Personnel, Local Procurement, and Contracts at NASCC (Fiscal Year 2000)

Military Personnel		
	Number (jobs)	1,883
	Annual Payroll	$100,162,000
Civilian Personnel		
	Number (jobs)	4,239
	Annual payroll	$225,245,000
Total Personnel		
	Number (jobs)	6,122
	Annual payroll	$235,407,000
Other		
	Local procurement	$22,342,000
	Contracts	$54,351,000
	Total salaries, local procurement and contracts	$402,100,000

Source: Impact DataSource 2001.

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3 Aircraft Operations

The primary source of noise at naval air installations is from aircraft operations. Aircraft noise consists of two major sound sources: flight operations and ground engine maintenance "run-up" operations, which are associated with pre-flight and maintenance checks. NASCC possesses both flight operations and ground engine maintenance "run-up" operations in specific locations. The level of noise exposure is also related to several variables, including the aircraft type at an installation, engine power settings, altitudes that aircraft fly, direction of aircraft during run-ups, 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. This section discusses the types of aircraft stationed at NASCC and conducting operations at the auxiliary landing fields, the number of operations conducted by these aircraft, and the flight tracks used to conduct the operations.

3.1 Aircraft Types

NASCC conducts operations using a variety of fixed-wing and rotary-wing aircraft. These aircraft are further categorized by "based aircraft" and "transient aircraft." For this AICUZ Study, aircraft descriptions are provided for the home-based aircraft, as they account for the majority of the operations at the airfields.

3.1.1 Fixed-Wing Aircraft

TC-12 "Huron." The aircraft is powered by two Pratt & Whitney PT-6A-42 engines that produce 850 shaft horsepower (SHP) each. The TC-12 is 44 feet long with a height of 15 feet and a maximum gross take-off weight of 15,000 pounds. The range of the aircraft is approximately 1,974 nautical miles, with a maximum airspeed of 294 knots and a flight ceiling of 35,000 feet.

JPATS: Joint Primary Aircraft Training System

T-6 "Texan II." The T-6 Texan II turboprop trainer is one component of the Joint Primary Aircraft Training System (JPATS). This aircraft is replacing the Navy T-34C Turbomentor. It is powered by one Pratt & Whitney 1,100 horsepower engine. The aircraft's length is approximately 33.3 feet, with a height of 10.8 feet and a wingspan of 33.4 feet. Speeds of 270 knots can be reached, and the craft has a maximum range of 900 nautical miles.

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, length of 29 feet, and weight of 4,000 pounds. The T-34C can reach airspeeds of 280 knots, an altitude of 25,000 feet, and can fly up to 740 nautical miles during a single flight.

T-44A "Pegasus." The T-44A is a twin-engine, pressurized, Beechcraft King Air B90 aircraft. The aircraft is powered by two model PT6A-34B turboprop engines. The primary mission of the T-44A is to provide advanced maritime flight training for the Chief of Naval Air Training in Corpus Christi, Texas. The aircraft is approximately 35.5 feet long, over 14 feet in height, and has a wingspan of over 50 feet. The T-44A has a range of 1,625 nautical miles, a maximum airspeed of 250 knots, and a service ceiling of 31,000 feet.

P-3C "Orion" and P-3 AEW. The P-3C "Orion" and the P-3 AEW are land-based, four-engine, turboprop anti-submarine and maritime surveillance aircraft. The P-3 AEW is a P-3 airframe with a rotating, dome-mounted radar (mounted to the top of the plane's fuselage). These aircraft have primarily radar- and surveillance-related duties along the southern border of the U.S. The P-3 airframe is approximately 116 feet long and 33 feet high, with a wingspan of 99 feet. It has a range of 2,070 nautical miles, a maximum airspeed of 411 knots, and a service ceiling of 28,300 feet.

HU-25 "Falcon 20." The HU-25, also referred to as the "Guardian," is a medium-range, surveillance, fixed-wing aircraft used to perform search and rescue, enforcement of laws and treaties (including illegal drug interdiction), marine environmental protection, and military readiness. It is 56.25 feet in length, 17.6 feet in height, and has a crew of five. Its ceiling at Mach .855 is 42,000 feet; it flies at 350 knots at sea level and 380 knots at 20,000 feet.

3.1.2 Rotary-Wing Aircraft

AH-1W Super Cobra. The AH-1W is a tandem seat, twin-engine, single-rotor attack helicopter powered by two General Electric T700-GE-401 engines. The twin engines propel the AH-1W to a maximum cruising speed of 170 knots at a service ceiling of 12,200 feet and a mission radius of 317 nautical miles. The aircraft has a rotor diameter of 48 feet, a height of over 13 feet, and length of over 44 feet. When empty, the Super Cobra weighs 6,600 pounds.

MH-53E "Sea Dragon." The Sea Dragon is the largest helicopter in the U.S. military inventory. The Navy uses it to transport personnel and equipment, lift heavy loads, and conduct minesweeping missions. The helicopter is powered by three General Electric T64-GE-416 (A) turbo-shaft engines that each generate 4,380 SHP to propel the vehicle at speeds of 170 knots at a range up to 600 nautical miles and at altitudes of 18,500 feet. The helicopter carries a crew of three and has a rotor diameter of 79 feet, a length of 99 feet, and a height of 28 feet. When empty, the MH-53E weighs 33,000 pounds.

UH-1N "Iroquois (Huey)." The UH-1N is a medium-class, twin-piloted, twin-engine utility helicopter. The helicopter has two Pratt and Whitney T400-CP-400 engines that provide a maximum continuous power of 1,134 SHP that propel the aircraft to a maximum cruising speed of 121 knots. The UH-1N has a mission range of 172 nautical miles at a service ceiling of 14,200 feet. The aircraft has a rotor diameter of 48 feet, a length of 58 feet, and a height of 15 feet.

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 long, has a height of 18 feet, a rotor diameter of 54 feet, and weight that varies from 21,000 pounds to 23,000 pounds, depending on variation. Its operational ceiling is 19,000 feet, 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 Helicopters; and the HH-60H Jayhawk.

CH-47D "Chinook." The CH-47D Special Operations Aircraft is a long-distance, heavy-lift helicopter equipped with aerial refueling capability, a fast-rope rappelling system, and other upgrades or operations-specific equipment. U.S. Special Operations Command aircraft contribute to the Joint Vision 2010 concept of dominant maneuver by helping to create asymmetric advantages for combined application of land, air, and sea power against enemy defenses within the joint environment. They are eminently capable, as modernized, multi-mission platforms operating within tailor-to-task organizations, of supporting precise, agile, fast-moving joint operations.

HH-65 "Dolphin." The twin-engine Dolphin operates up to 150 miles offshore and flies at 120 knots for three hours. The HH-65A is unable to perform water landings.

3.2 Airspace

NASCC, NALF Cabaniss, and NALF Waldron airspace is controlled by the FAA Houston Air Route Traffic Control Center.

ARTCC: Air Route Traffic Control Center

ATC: air traffic control

NASCC, NALF Cabaniss, and NALF Waldron airspace is controlled by the FAA Houston Air Route Traffic Control Center (ARTCC). All instrument operations at NASCC and within the Corpus Christi Terminal Area are conducted under the authority of the Corpus Christi Approach Control located at the Corpus Christi International Airport. The Navy Corpus Tower provides air traffic control (ATC) services to all aircraft operating at NASCC, as well as services to aircraft and vehicles operating on the taxiways and runways at NASCC.

OPAREA: Operations Area

SUA: Special Use Airspace

RAP: Regional Airspace Plan

NASCC has offshore and limited onshore airspace to fulfill its training mission. Figure 3-1 depicts NASCC airspace. NASCC offshore Operations Area (OPAREA), which includes surface and subsurface waters and Special Use Airspace (SUA), are within the Gulf of Mexico Range Complex. NASCC SUA and airspace management capability is provided in the NASCC *Gulf Coast Regional Airspace Plan (RAP) Report* (NASCC 2008). NASCC SUA includes:

W-228 is designated for student pilot training, air combat training, A-A gunnery, spin training, helicopter mine warfare training, and tactical formation flights.

- **Warning Area 228 (W-288 A/B/C/D).** W-228 is a 12,574-square-mile airspace located approximately 55 nautical miles southeast of NASCC in the Gulf of Mexico. The airspace is divided into four sub-areas: W-288 A/B/C/D. TW-4 is the primary user of W-228A. W-228 is designated for student pilot training, air combat training, A-A gunnery, spin training, helicopter mine warfare training, and tactical formation flights. NASCC's pilot training program provides propeller flight training, weapons delivery training, and over-water operations training in W-228. W-228 is operated on an exclusive-use basis due to the high concentration of pilot training exercises. NASCC ATC is responsible for scheduling of W-228. Houston ARTCC is the controlling agency when military operations are occurring within the airspace.

A-632 is a designated area to alert transient pilots that high-density aircraft operations (mostly training operations) are occurring.

- **Alert Area 632 (A-632 A/B/C/D/E/F)** (airspace 10,000 feet to 17,999 feet MSL). A-632 is located 25 nautical miles southwest of NASCC. A-632 is a designated area to alert transient pilots that high-density aircraft operations (mostly training operations) are occurring. It is not an exclusive-use area and transit through the airspace by non-participants is not restricted. Within A-632, Corpus Christi Radar Approach Control provides traffic calls and VFR advisory services as needed to Navy aircraft below 10,000 feet MSL.

Within W-228 and A-632, the primary TW-4 flight training areas are called Mustang, Seagull, Delta, Juliett, and Foxtrot. Detailed information regarding utilization, entry procedures, exit procedures, and transition into these training areas is provided in the NASCC Air Operations Manual (NASCORPCINST 3710.13M).

Various encroachment factors including urban development, offshore energy terminals, and environmental issues, can restrict or limit operations within NASCC SUA. A pre-existing wildlife refuge within the underlying vicinity of A-632F has restricted training operations below 3,000 feet (NASCC 2008). Long-term airspace requirements may be impacted by the expected T-6 aircraft operations. Additional information regarding NASCC airspace is outlined in the RAP Report (NASCC 2008) and in the NASCC Air Operations Manual (NASCC 2007).

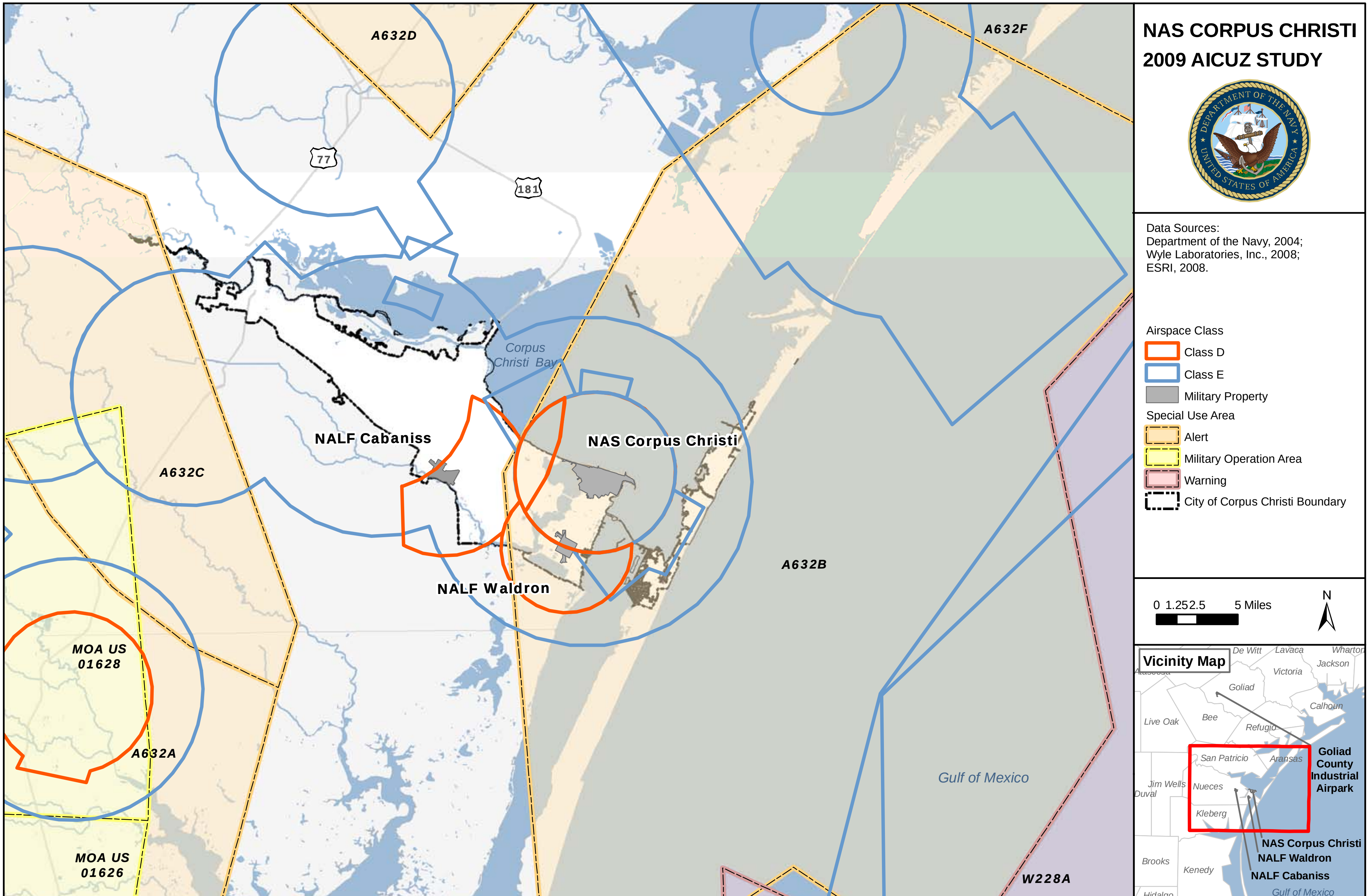

Figure 3-1: Regional Airspace
NAS Corpus Christi, Texas

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3.3 Aircraft Operations

The main noise sources at NASCC are aircraft operations, including flight arrivals, departures, pattern-work, and low-level activities. Engine maintenance operations or run-ups are also a contributor to noise levels at NASCC.

The main noise sources at NASCC are aircraft operations, including flight arrivals, departures, pattern-work, and low-level activities. Engine maintenance operations or run-ups are also a contributor to noise levels at NASCC.

The aircraft operations used to model the 2009 AICUZ noise contours and accidental potential areas are based on prospective conditions at Truax Field, NALF Waldron, and NALF Cabaniss for calendar year (CY) 2015 as a result of the expected TW-4 transition to the T-6 JPATS. The 2015 projected annual operations were assembled based on the following assumptions:

- Based T-34C aircraft are replaced by T-6 aircraft;
- Based UC-12 aircraft are excluded from the analysis since NASCC personnel expect all multi-engine training to take place in the T-44 (Wyle Laboratories, Inc. 2008);
- U.S. Coast Guard and HM-15 aircraft are deleted since NASCC personnel expect those squadrons to leave the station by 2009 (Wyle Laboratories, Inc. 2008);
- Transient T-37 aircraft are replaced by T-6 aircraft;
- Transient C-9 aircraft are replaced by C-40 aircraft; and
- F/A-18 flight operations are modeled as F/A-18C/D 25% and F/A-18E/F 75%.

3.3.1 Flight Operations

A **flight operation** refers to any takeoff or landing of one aircraft at NASCC or the auxiliary training airfields.

GCA: Ground-Controlled Approach

A *flight operation* refers to any takeoff or landing of one aircraft at NASCC or the auxiliary training airfields. The takeoff and landing may be part of a training maneuver (or pattern) associated with the air station runway or may be associated with a departure or arrival of an aircraft to or from defense-related SUA. Certain flight operations are conducted as patterns (e.g., Ground-Controlled Approach [GCA] Box and touch-and-go). A pattern consists of two flight operations.

Basic flight operations at NASCC and the associated landing fields are:

- **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 Arrival.** An expeditious arrival using VFR. An aircraft approaches the runway 500 feet above the altitude of the landing pattern. Approximately halfway down the runway, the aircraft performs a 180-degree turn to enter the landing pattern. Once established in the pattern, the aircraft lowers landing gear and flaps and performs a 180-degree descending turn to land on the runway.
- **GCA Box.** A radar or "talk down" approach directed from the ground by ATC personnel. ATC personnel provide pilots with verbal course and glideslope information, allowing them to make an instrument approach during inclement weather. The GCA Box is actually counted as two operations – the landing is counted as one operation, and the takeoff is counted as another.
- **Touch-and-Go Operation.** 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.
- **Field Carrier Landing Practice (FCLP).** An aircraft practices field carrier landings. FCLPs are required training for all pilots before landing on a carrier. The number of FCLPs performed is determined by the length of time that has elapsed since the pilot's last landing on a carrier. The FCLP is counted as two operations where the landing is counted as one operation and the takeoff is counted as another.

FCLP: Field Carrier Landing Practice

- **Low Approach.** An approach to a runway during which the pilot does not make contact with the runway.

3.3.1.1 Truax Field, NASCC Operations

ATAR: Air Traffic Activity Report

Annual flight operations totals are projected for NASCC as an element of the Noise Study. Table 3-1 provides historic data of annual flight operations conducted at Truax Field over the past 24 years based on Air Traffic Activity Reports (ATARs) from ATC personnel. In 2008, a total of 138,044 annual operations were reported at Truax Field.

YEAR	MILITARY		CIVIL		TOTAL
	Navy/Marine	Other Military	Air Carrier	General Aviation	
1985	177,279	9,697	0	450	187,426
1986	199,679	8,892	0	490	209,061
1987	220,428	10,092	0	3,022	233,542
1988	229,945	11,592	0	7,400	248,937
1989	216,506	10,770	0	4,928	232,204
1990	177,048	11,183	0	3,488	191,719
1991	189,320	11,357	0	4,122	204,799
1992	159,985	9,441	0	1,932	171,358
1993	152,811	10,646	0	2,857	166,314
1994	152,398	9,011	0	4,662	166,071
1995	149,497	14,549	0	3,264	167,310
1996	164,342	9,015	0	1,799	175,156
1997	174,422	8,068	0	1,811	184,301
1998	170,234	7,477	0	1,649	179,360
1999	118,536	3,938	0	1,156	123,630
2000	150,715	4,142	0	983	155,840
2001	170,030	3,636	0	1,200	174,866
2002	182,473	4,934	0	1,493	188,900
2003	175,063	3,813	0	1,581	180,457
2004	182,419	2,918	0	2,636	187,973
2005	185,661	1,804	0	4,073	191,538
2006	133,108	1,197	0	3,011	137,316
2007	120,918	1,289	0	2,874	125,081
2008	134,435	882	0	2,727	138,044

Table 3-1: Total Annual Operations at Truax Field

Source: Wyle Laboratories, Inc. 2008.
Notes:
Table based on annual Air Traffic Activity Reports.
Counts include transitions through Class D airspace.
Patterns are counted as two operations.

NOTE: When the Noise Study was completed, the 2007 and 2008 ATARs for Truax Field were not available. The 2007 annual operations totals for Truax Field provided in the Noise Study are based on estimated projections from NASCC ATC. (An estimated total of 182,044 annual flight operations at Truax Field for 2007 is reported in the Noise Study.) The Noise Study does not include data for 2008 total annual operations. The total annual operations reported in Table 3-1 reflect the actual total of flight operations as provided in the ATARs and may not coincide with the estimated totals in the Noise Study. The difference between the 2007 estimated annual operation totals compared to the 2007 ATAR annual operation totals was not significant enough to impact modeled noise contours.

Over the past 24 years, the peak year of operation was reached during 1988 with 248,937 aircraft operations. The least amount of activity over the past 24 years occurred in 1999 with only 123,630 aircraft operations. Aircraft activities at Truax Field averaged 180,050 aircraft operations between 1985 and 2008 and 155,990 aircraft operations over the last five years.

Operation types occurring at Truax Field include departures, straight-in arrivals, overhead-break arrivals, short-break arrivals, touch-and-go patterns, FCLP, and GCA operations.

Operation types occurring at Truax Field include departures, straight-in arrivals, overhead-break arrivals, short-break arrivals, touch-and-go patterns, FCLP, and GCA operations. Detailed information on flight operations tabulated by modeled aircraft and flight track for Truax Field is provided in the 2008 NASCC Aircraft Noise Study (Wyle Laboratories, Inc. 2008).

Modeled Flight Operations. A total of 208,004 annual flight operations are projected at Truax Field in 2015, which is a 51% increase from the total of flight operations in 2008. Projected conditions for Truax Field are based on the implementation of the JPATS and T-6 aircraft operations. T-34C operations at Truax Field will be replaced by T-6 aircraft operations. The T-6 JPATS primary syllabus has a greater number of flights per student than the historic T-34C syllabus. Approximately 114,752 T-6 operations are expected each year at Truax Field, including night operations (Wyle Laboratories, Inc. 2008). Table 3-2 presents Truax Field’s 2015 projected flight operations by operation type. The NASCC Aircraft Noise Study (Wyle Laboratories, Inc. 2008) provides more information on flight operations tabulated by modeled aircraft and flight track.

expected each year at Truax Field, including night operations.

Table 3-2: 2015 Modeled Flight Operations at Truax Field, NASCC				
Category	**Operation Type**	**Day 0700-2200**	**Night 2200-0700**	**Total**
Based Fixed-Wing	Departure	47,119	323	**47,442**
	Arrival	47,119	323	**47,442**
	Touch-and-Go[a]	63,782	900	**64682**
	GCA[a]	44,224	200	**44,424**
	Total	**202,244**	**1,746**	**203,990**
Based Rotary-Wing	Departure	306	0	**306**
	Arrival	306	0	**306**
	Touch-and-Go[a]	0	0	**0**
	GCA[a]	0	0	**0**
	Total	**612**	**0**	**612**
Transient Fixed-Wing	Departure	449	0	**449**
	Arrival	449	0	**449**
	Touch-and-Go[a]	2448		**2448**
	GCA[a]	0	0	**0**
	Total	**3346**	**0**	**3346**
Transient Rotary-Wing	Departure	28	0	**28**
	Arrival	28	0	**28**
	Touch-and-Go[a]	0	0	**0**
	GCA[a]	0	0	**0**
	Total	**56**	**0**	**56**
Grand Total	**Departure**	**47,902**	**323**	**48,225**
	Arrival	**47,902**	**323**	**48,225**
	Touch-and-Go[a]	**66,230**	**900**	**67,130**
	GCA[a]	**44,224**	**200**	**44,424**
	Total	**206,258**	**1,746**	**208,004**

Source: Wyle Laboratories, Inc. 2008.
Note: (a) Counted as two operations.
Key:
GCA = Ground Controlled Approach

3.3.1.2 NALF Waldron Operations

NALF Waldron supports the touch-and-go training practice for NASCC TW-4 training squadrons (VT-27 and VT-28) and is currently used primarily by T-34C aircraft. Operation types include departures, arrivals (90% are overhead break and 10% short-break arrivals), and touch-and-go patterns (Wyle Laboratories, Inc. 2008). NALF Waldron is a daytime-use only airfield and does not have any based flight units. In 2008, a total of 79,706 flight operations were reported at NALF Waldron.

Historic data of flight operations from 1995 through 2008 are provided in Table 3-3 based on annual ATARs obtained from ATC

Aircraft activities at NALF Waldron averaged approximately 98,839 aircraft operations between 2004 and 2008.

personnel. Since 1995, the peak year of operations was reached in 1997 with 130,305 aircraft operations. The least amount of activity occurred in 2008 with 79,706 aircraft operations. Aircraft activities at NALF Waldron averaged approximately 98,839 aircraft operations between 2004 and 2008.

Table 3-3: Total Annual Operations at NALF Waldron

YEAR	MILITARY		CIVIL		TOTAL
	Navy/ Marine	Other Military	Air Carrier	General Aviation	
1995	111,255	0	0	0	111,255
1996	122,538	0	0	0	122,538
1997	130,305	0	0	0	130,305
1998	119,186	0	0	0	119,186
1999	120,564	0	0	0	120,564
2000	126,394	0	0	0	126,394
2001	127,312	0	0	0	127,312
2002	94,186	0	0	0	94,186
2003	96,823	0	0	0	96,823
2004	88,330	0	0	0	88,330
2005	99,095	0	0	0	99,095
2006	114,777	0	0	0	114,777
2007	112,288	0	0	0	112,288
2008	79,706	0	0	0	79,706

Source: Wyle Laboratories, Inc. 2008.
Notes:
Table based on annual Air Traffic Activity Report.
Patterns are counted as two operations.

NOTE: At the time the Noise Study was completed, the 2007 and 2008 ATARs for NALF Waldron were not available. The 2007 annual operations totals for NALF Waldron provided in the Noise Study are based on estimated projections from NASCC ATC. (An estimated total of 85,548 annual flight operations at NALF Waldron is reported in the Noise Study for 2007.) The Noise Study does not include data for 2008 total annual operations. The total annual operations reported in Table 3-3 reflect the actual total of flight operations as provided in the ATARs and may not coincide with the estimated totals in the Noise Study. The difference between the 2007 estimated annual operation totals compared to the 2007 ATAR annual operation totals was not significant enough to impact modeled noise contours.

Modeled Flight Operations. In 2015, a total of 185,196 annual flight operations are projected at NALF Waldron (Wyle Laboratories, Inc. 2008), which is a 132% increase from 2008 total annual operations. Projected conditions for NALF Waldron are based on the expected TW-4 transition to the JPATS and the replacement of T-34C aircraft operations with T-6 aircraft operations. Under the projected conditions, an estimated 80% of T-6 OLF operations will be conducted at NALF Waldron and the remaining 20% of T-6 OLF operations will be conducted at Aransas County Airport. Table 3-4 presents the 2015 projected annual flight operations for NALF Waldron, including departures, arrivals, and touch-and-go patterns.

Table 3-4: T-6 2015 Modeled Flight Operations at NALF Waldron

Based/Transient	Operation Type	Day 0700-2200	Night 2200-0700	TOTAL
Transient	Departure	12,198	0	**12,198**
	Arrival	12,198	0	**12,198**
	Touch-and-Go[(a)]	160,800	0	**160,800**
	Total	**185,196**	**0**	**185,196**

Source: Wyle Laboratories, Inc. 2008.
Note:
(a) Counted as two operations.

3.3.1.3 NALF Cabaniss Operations

NALF Cabaniss supports touch-and-go training practice for NASCC TW-4 training squadrons (VT-31 and VT-35) and is primarily used by the T-44A and TC-12 aircraft. No based flight units are stationed at NALF Cabaniss. Flight operation types include departures, arrivals (90% are overhead break and 10% short-break arrivals), and touch-and-go patterns (Wyle Laboratories, Inc. 2008). In 2008, a total of 85,802 flight operations were reported at NALF Cabaniss.

Aircraft activities at NALF Cabaniss averaged approximately 102,577 aircraft operations between 2004 and 2008.

Historic data of flight operations from 1993 through 2008 are provided in Table 3-5 based on annual ATARs obtained from ATC personnel. Since 1993, the peak year of operation was reached during 2000 with 149,910 aircraft operations, and the least amount of activity occurred in 1994 with 69,463 aircraft operations. Aircraft activities at NALF Cabaniss averaged approximately 102,577 aircraft operations between 2004 and 2008.

Table 3-5: Total Annual Operations at NALF Cabaniss

YEAR	MILITARY		CIVIL		TOTAL
	Navy/ Marine	Other Military	Air Carrier	General Aviation	
1993	101,249	0	0	0	101,249
1994	69,463	0	0	0	69,463
1995	92,983	0	0	0	92,983
1996	111,351	0	0	0	111,351
1997	141,263	0	0	0	141,263
1998	126,484	0	0	0	126,484
1999	142,541	0	0	0	142,541
2000	149,910	0	0	0	149,910
2001	135,394	0	0	0	135,394
2002	126,833	0	0	0	126,833
2003	117,739	0	0	0	117,739
2004	104,931	0	0	0	104,931
2005	118,926	0	0	0	118,926
2006	102,531	0	0	0	102,531
2007	100,693	0	0	0	100,693
2008	85,802	0	0	0	85,802

Source: Wyle Laboratories, Inc. 2008.
Notes:
Table based on annual Air Traffic Activity Report.
Patterns are counted as two operations.

NOTE: At the time the Noise Study was completed, the 2007 and 2008 ATARs for NALF Cabaniss were not available. The 2007 annual operations totals for NALF Cabaniss provided in the Noise Study are based on estimated projections from NASCC ATC. (An estimated total of 109,050 annual flight operations at NALF Cabaniss is reported in the Noise Study for 2007.) The Noise Study does not include data for 2008 total annual operations. The total annual operations reported in Table 3-5 reflect the actual total of flight operations as provided in the ATARs and may not coincide with the estimated totals in the Noise Study. The difference between the 2007 estimated annual operation totals compared to the 2007 ATAR annual operation totals was not significant enough to impact modeled noise contours.

The implementation of the JPATS at NASCC is expected to replace T-34C aircraft operations with T-6 aircraft operations and cease all TC-12 aircraft operations at NALF Cabaniss.

Modeled Flight Operations. In 2015, both T-44A and T-6 aircraft operations are proposed at NALF Cabaniss for a projected total of 109,086 annual flight operations (Wyle Laboratories, Inc. 2008). T-6 aircraft operations account for approximately 600 of the total projected flight operations. The 2015 annual operations are based on the assumption that all TC-12 aircraft operations will be concluded at NALF Cabaniss and minimal T-6 aircraft operations will be conducted at the airfield with the implementation of the JPATS. According to CNATRA representatives, T-6 aircraft will conduct approximately 250 night operations at the airfield each year (Wyle Laboratories, Inc. 2008). The projected 2015 flight operations are an increase of 27% from 2008 annual operations. Table 3-6 presents the 2015 projected annual flight operations for NALF Cabaniss, including departures, arrivals, and touch-and-go patterns.

Table 3-6: 2015 Modeled Flight Operations at NALF Cabaniss

Aircraft Type	Operation Type	Day 0700-2200	Night 2200-0700	Total
T-44 (Transient)	Departure	3,375	0	**3,375**
	Arrival	3,375	0	**3,375**
	Touch-and-Go[a]	101,736	0	**101,736**
	Total	**108,486**	**0**	**108,486**
T-6 (Transient)	Departure	25	25	**50**
	Arrival	25	25	**50**
	Touch-and-Go[a]	300	200	**500**
	Total	**350**	**250**	**600**
	Grand Total	**108,836**	**250**	**109,086**

Source: Wyle Laboratories, Inc. 2008.
Note:
(a) Counted as two operations.

3.3.2 Pre-Flight and Maintenance Run-up Operations

Pre-flight and engine maintenance run-up operations are preformed at NASCC, Truax Field to test engines at various power settings and durations and to check for malfunctions. In-frame aircraft maintenance run-ups are performed outside on check pads. These run-ups operations can last anywhere from 15 seconds to 60 minutes and can contribute significantly to the total noise environment. Because ground engine maintenance run-ups are performed at high power settings, these run-ups operations are normally restricted between the hours of 2200 (10:00 p.m.) and 0700 (7:00 a.m.). No pre-flight or engine maintenance run-ups operations are preformed at NALF Waldron or NALF Cabaniss.

The T-34C, T-44A, TC-12, and MH-53 conduct the majority of pre-flight run-up operations. Only T-34C aircraft pilots reported pre-flight run-ups prior to brake release for a duration of three seconds. The T-6 is projected to conduct 32,326 preflight operations at Truax Field in 2015.

Figure 3-2 presents the run-up locations for NASCC. Since pre-flight and maintenance run-up operations are not conducted at NALF Cabaniss and NALF Waldron, these airfields do not have designated run-up locations.

Figure 3-2: Aircraft Run-up Locations
Truax Field, NASCC

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3.3.3 Runway and Flight Track Utilization

flight track: General pre-determined path an aircraft flies while conducting air operations near an airfield.

Runway and flight track information used to model the 2009 noise contours is based on the projected 2015 annual flight operations for each airfield. Aircraft approaching or departing from the air stations are assigned specific routes or flight tracks. Flight tracks in this report are idealized representations (single lines), but flights vary due to aircraft performance, configuration, pilot technique, air traffic conflicts, and weather conditions, such that the actual flight track is a band, often 0.5 to several miles wide. Runway information for each airfield is identified in Section 2.4, and flight track information for each airfield is provided in Tables 3-7 through 3-10.

Each flight track is identified and numbered according to runway utilization, flight operation, and course rule (or flight route). Flight operations are abbreviated as: Departure (D), Straight Arrival (A), Overhead Break Arrival (O), Touch-and-Go Pattern (T), Ground Pattern (G), and FCLP (F). Specific course rules are identified in Table 3-8. For example, flight track number 35D1 at NALF Waldron is interpreted as:

Utilized Runway: 35
Type of Flight Operation: Departure
Course Rule: Field Departure

3.3.3.1 Truax Field Runway and Flight Track Utilization

Flight operations at Truax Field are conducted on Runways 13L, 13R, 31R, 31L, 04, 22, 17, and 35. Parallel runways are distinguished by left (L) and right (R).Predominant runway usage for T-34C and T-6 operations at Truax Field occurs on Runway 13L (64 to 68%) and Runway 31R (13%), and the remaining 20% of runway use is divided among Runways 04/22 and 17/35. However, T-34C and T-6 overhead arrival from Point Lima use Runway 13R 80% of the time and Runway 31L 15% of the time. High noise level at the threshold of Runway 31L is due to the volume of departure operations occurring at the runway. Predominant runway usage for T-44 operations occur on Runway 13R (50%) and 13L (25%), and the remaining 25% utilization is divided among Runways 04, 31R, 31L, and 17/35. TC-12 operations are predominantly conducted on Runway 13R (75%) and 31L (25%). The arrival, departure, and pattern flight tracks for fixed-wing aircraft at Truax Field are identified in Table 3-7 and shown on Figures 3-3 through 3-5.

Table 3-7: Fixed Wing Aircraft Flight Tracks at Truax Field, NASCC

Operation Type	Runway	Flight Track ID	Flight Track Rule
Departure	13L	3LD1	Mustang/Seagull Departure
		3LD2	Sunrise/Nueces Transition Departure
		3LD3	Sunrise/Nueces Transition Departure
		3LD4	Portland Departure
		3LD5	Oso Bridge to Waldron Departure
		3LD6	IFR Departure
	13R	3RD1	Mustang/Seagull Departure
		3RD2	Sunrise/Nueces Transition Departure
		3RD3	Sunrise/Nueces Transition Departure
		3RD4	Portland Departure
		3RD5	Oso Bridge to Waldron Departure
		3RD6	IFR Departure
	31R	1RD1	Mustang/Seagull Departure
		1RD2	Sunrise/Nueces Transition Departure
		1RD3	Sunrise/Nueces Transition Departure
		1RD4	Portland Departure
		1RD5	Oso Bridge to Waldron Departure
		1RD6	IFR Departure
	31L	1LD1	Mustang/Seagull Departure
		1LD2	Sunrise/Nueces Transition Departure
		1LD3	Sunrise/Nueces Transition Departure
		1LD4	Portland Departure
		1LD5	Oso Bridge to Waldron Departure
		1LD6	IFR Departure
	04	04D1	Mustang/Seagull Departure
		04D2	Sunrise/Nueces Transition Departure
		04D3	Sunrise/Nueces Transition Departure
		04D4	Portland Departure
		04D5	Oso Bridge to Waldron Departure
		04D6	IFR Departure

Table 3-7: Fixed Wing Aircraft Flight Tracks at Truax Field, NASCC			
Operation Type	**Runway**	**Flight Track ID**	**Flight Track Rule**
Departure *(continued)*	22	22D1	Mustang/Seagull Departure
		22D2	Sunrise/Nueces Transition Departure
		22D3	Sunrise/Nueces Transition Departure
		22D4	Portland Departure
		22D5	Oso Bridge to Waldron Departure
		22D6	IFR Departure
	17	17D1	Mustang/Seagull Departure
		17D2	Sunrise/Nueces Transition Departure
		17D3	Sunrise/Nueces Transition Departure
		17D4	Portland Departure
		17D5	Oso Bridge to Waldron Departure
		17D6	IFR Departure
	35	35D1	Mustang/Seagull Departure
		35D2	Sunrise/Nueces Transition Departure
		35D3	Sunrise/Nueces Transition Departure
		35D4	Portland Departure
		35D5	Oso Bridge to Waldron Departure
		35D6	IFR Departure
Overhead Break Arrival	13L	3LOA	Overhead Break Arrival from Point Shamrock
		3LOB	Short Break Arrival from Point Shamrock
		3LOE	Overhead Break Arrival from Point Sunrise
		3LOF	Short Break Arrival from Point Sunrise
	13R	3ROA	Overhead Break Arrival from Point Shamrock
		3ROB	Short Break Arrival from Point Shamrock
		3ROE	Overhead Break Arrival from Point Sunrise
		3ROF	Short Break Arrival from Point Sunrise
	31R	1ROA	Overhead Break Arrival from Point Shamrock
		1ROB	Short Break Arrival from Point Shamrock
		1ROE	Overhead Break Arrival from Point Sunrise
		1ROF	Short Break Arrival from Point Sunrise
	31L	1LOA	Overhead Break Arrival from Point Shamrock
		1LOB	Short Break Arrival from Point Shamrock
		1LOC	Overhead Break Arrival from Point Lima
		1LOD	Short Break Arrival from Point Lima
		1LOE	Overhead Break Arrival from Point Sunrise
		1LOF	Short Break Arrival from Point Sunrise

Table 3-7: Fixed Wing Aircraft Flight Tracks at Truax Field, NASCC

Operation Type	Runway	Flight Track ID	Flight Track Rule
Overhead Break Arrival *(continued)*	04	04OA	Overhead Break Arrival from Point Shamrock
		04OB	Short Break Arrival from Point Shamrock
		04OC	Overhead Break Arrival from Point Lima
		04OD	Short Break Arrival from Point Lima
		04OE	Overhead Break Arrival from Point Sunrise
		04OF	Short Break Arrival from Point Sunrise
	22	22OA	Overhead Break Arrival from Point Shamrock
		22OB	Short Break Arrival from Point Shamrock
		22OE	Overhead Break Arrival from Point Sunrise
		22OF	Short Break Arrival from Point Sunrise
	17	17OA	Overhead Break Arrival from Point Shamrock
		17OB	Short Break Arrival from Point Shamrock
		17OE	Overhead Break Arrival from Point Sunrise
		17OF	Short Break Arrival from Point Sunrise
	35	35OA	Overhead Break Arrival from Point Shamrock
		35OB	Short Break Arrival from Point Shamrock
		35OC	Overhead Break Arrival from Point Lima
		35OD	Short Break Arrival from Point Lima
		35OE	Overhead Break Arrival from Point Sunrise
		35OF	Short Break Arrival from Point Sunrise
Straight Arrivals	13L	3LA1	IFR Arrival
	13R	3RA1	IFR Arrival
		3RA2	IFR Arrival
		3RA3	Arrival from Point Shamrock, U.S. Customs
		3RA4	Arrival from Point Nueces
		3RA5	IFR Arrival, US Customs
	31R	1RA1	IFR Arrival
	31L	1LA1	IFR Arrival
		1LA2	Arrival from Point Shamrock, U.S. Customs
		1LA3	Arrival from Point Nueces
		1LA5	IFR Arrival, U.S. Customs
	04	04A1	IFR Arrival
	22	22A1	IFR Arrival
	17	17A1	IFR Arrival
	35	35A1	IFR Arrival
Touch-and-Go Pattern	13L	3LTA	1 Aircraft Pattern
		3LTB	2 to 3 Aircraft Pattern
		3LTC	4 Aircraft Pattern
		3LTD	5 Aircraft Pattern

Table 3-7: Fixed Wing Aircraft Flight Tracks at Truax Field, NASCC

Operation Type	Runway	Flight Track ID	Flight Track Rule
Touch-and-Go Pattern *(continued)*	13R	3RTA	1 Aircraft Pattern
		3RTB	2 to 3 Aircraft Pattern
		3RTC	4 Aircraft Pattern
		3RTD	5 Aircraft Pattern
	31R	1RTA	1 Aircraft Pattern
		1RTB	2 to 3 Aircraft Pattern
		1RTC	4 Aircraft Pattern
		1RTD	5 Aircraft Pattern
	31L	1LTA	1 Aircraft Pattern
		1LTB	2 to 3 Aircraft Pattern
		1LTC	4 Aircraft Pattern
		1LTD	5 Aircraft Pattern
	04	04TA	1 Aircraft Pattern
		04TB	2 to 3 Aircraft Pattern
		04TC	4 Aircraft Pattern
		04TD	5 Aircraft Pattern
	17	17TA	1 Aircraft Pattern
		17TB	2 to 3 Aircraft Pattern
		17TC	4 Aircraft Pattern
		17TD	5 Aircraft Pattern
	35	35TA	1 Aircraft Pattern
		35TB	2 to 3 Aircraft Pattern
		35TC	4 Aircraft Pattern
		35TD	5 Aircraft Pattern
Ground Pattern	13L	3LG1	Ground Controlled Approach
	13R	3RG1	Ground Controlled Approach
	31R	1RG1	Ground Controlled Approach
	31L	1LG1	Ground Controlled Approach
	04	04G1	Ground Controlled Approach
	17	17G1	Ground Controlled Approach
	35	35G1	Ground Controlled Approach

Key: IFR = Instrument Flight Rules.

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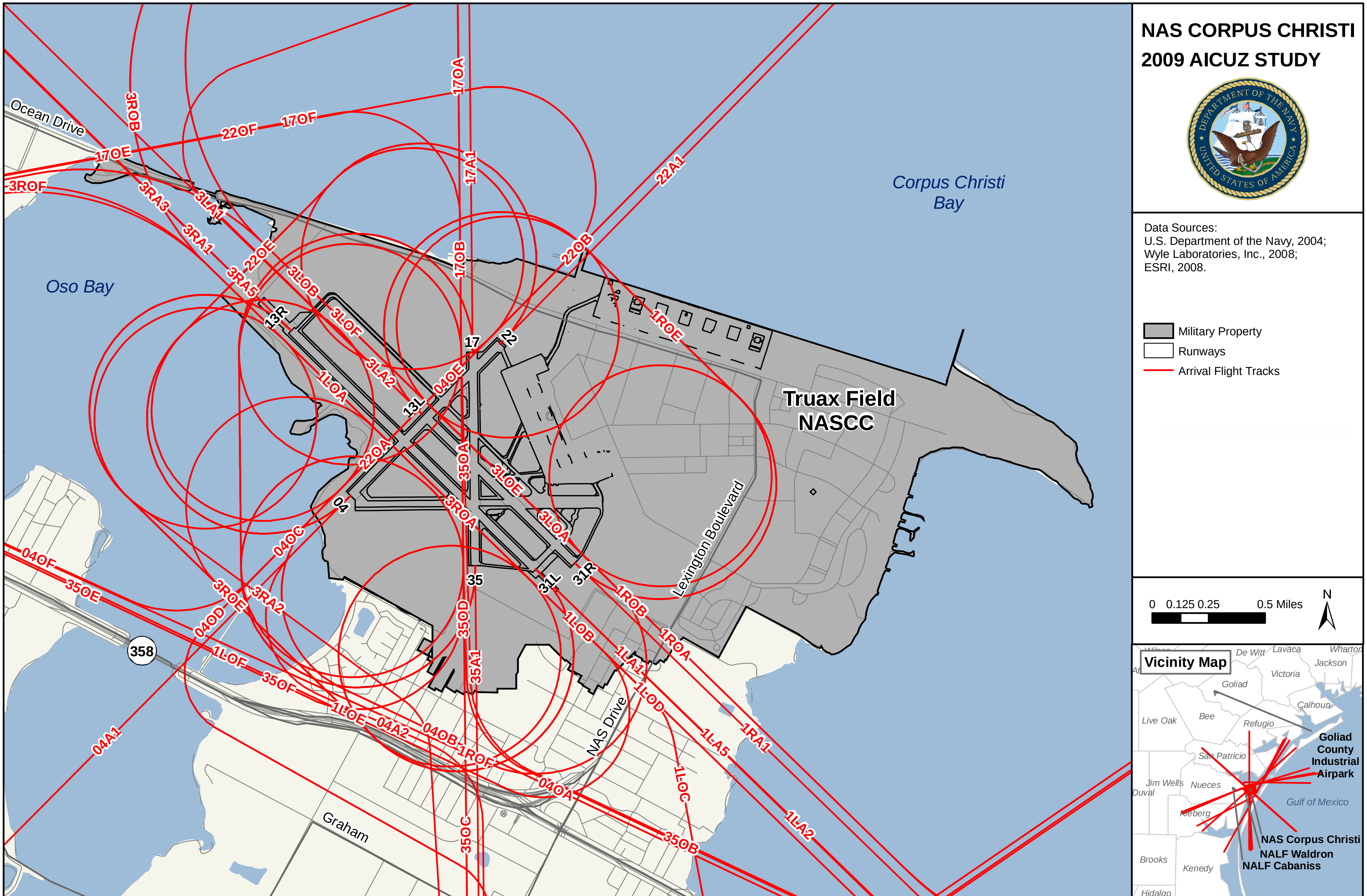

Figure 3-3: Arrival Flight Tracks (Fixed Wing)
Truax Field, NASCC

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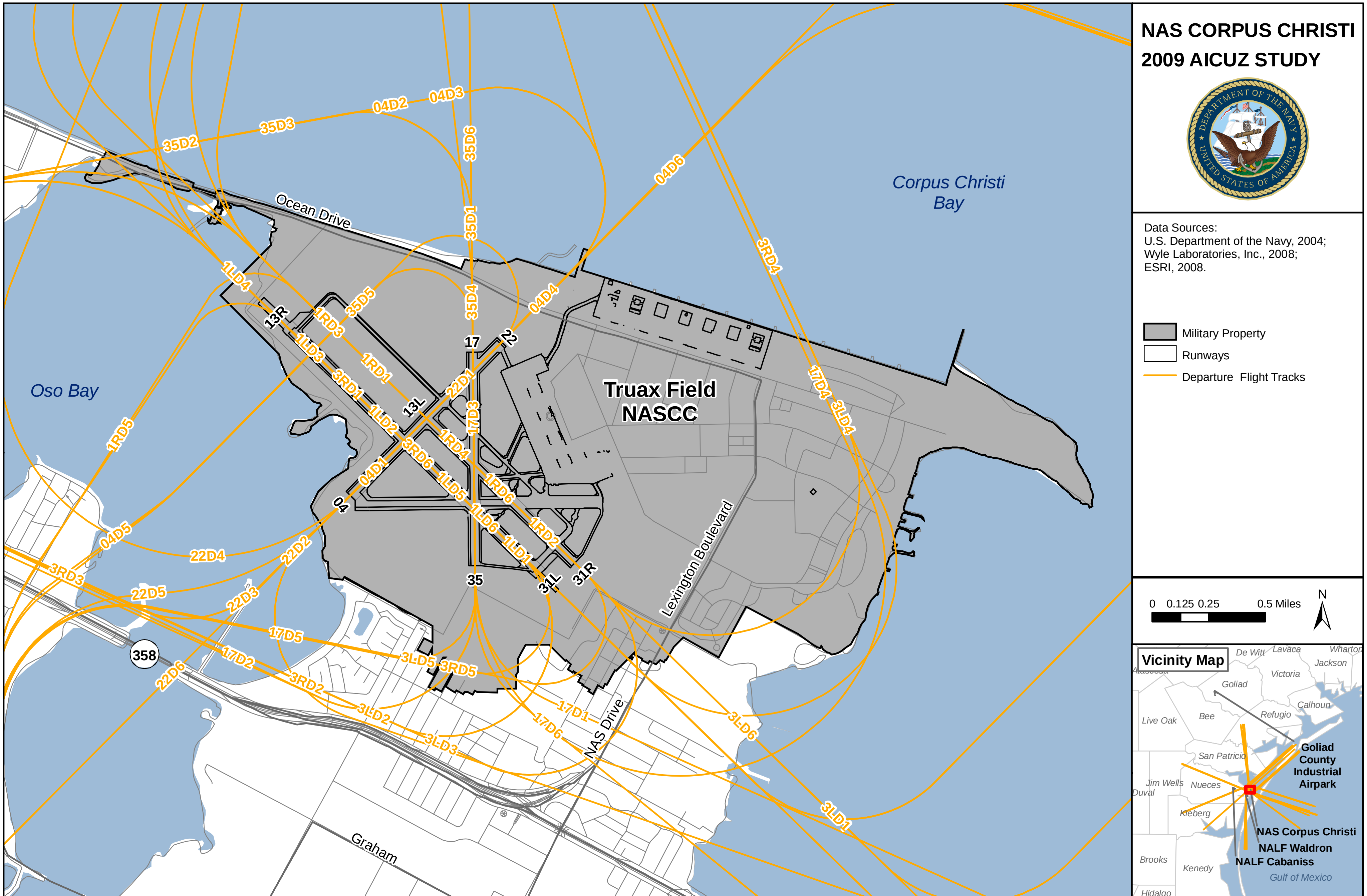

Figure 3-4: Departure Flight Tracks (Fixed Wing)
Truax Field, NASCC

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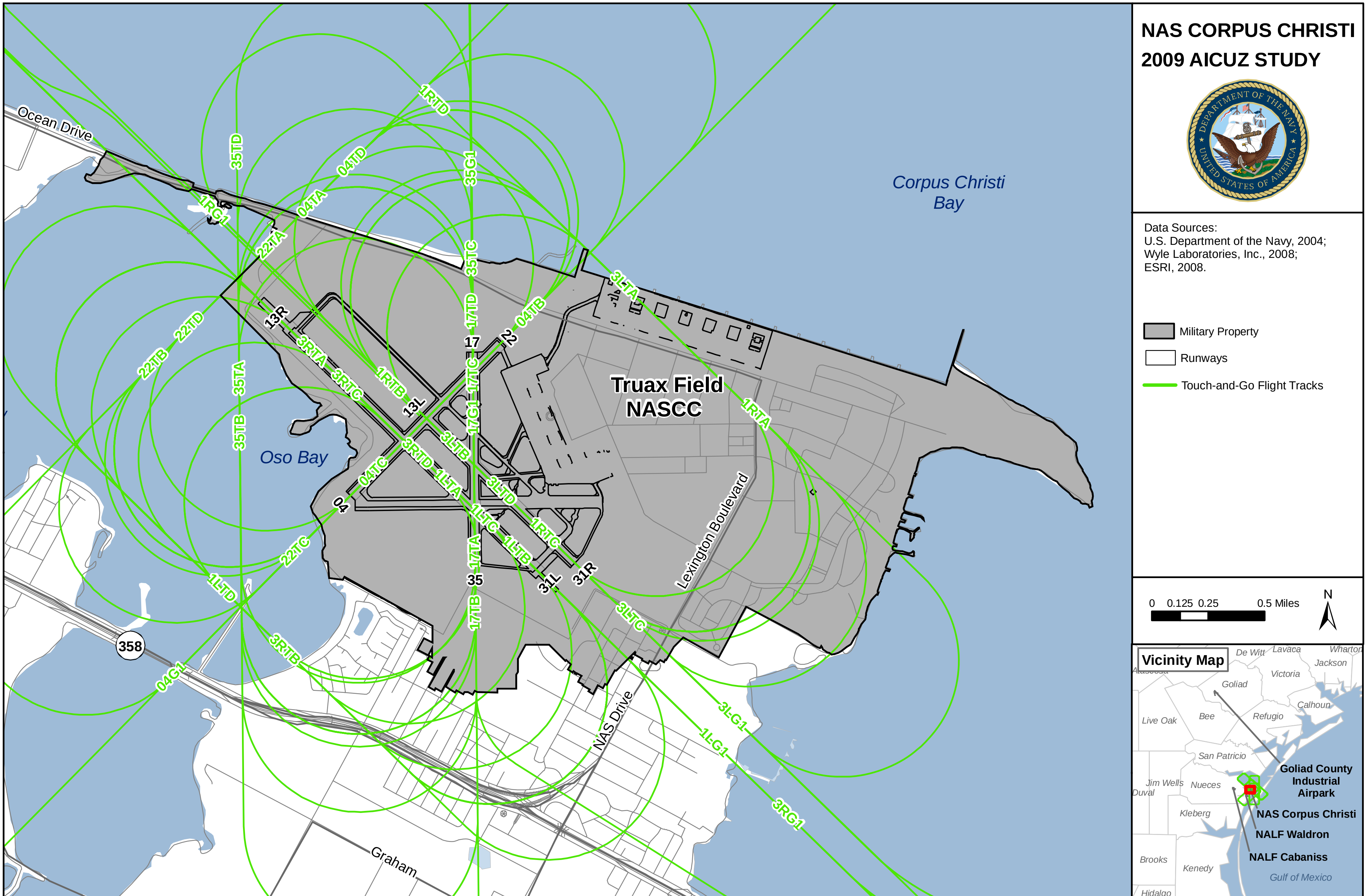

Figure 3-5: Pattern Flight Tracks (Fixed Wing)
Truax Field, NASCC

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Rotary-wing aircraft operations at NASCC use helicopter pads located along the shores of Corpus Christi Bay. The noise contours north of Truax Field are from these helicopter operations. The noise contours extending from the seawall to the north and east are due to MH-53 departure and arrival operations. The NASCC Aircraft Noise Study (Wyle Laboratories, Inc. 2008) provides detailed information on runway operations and utilization, flight track utilization, and average annual day operations for each aircraft at Truax Field. The arrival, departure, and pattern flight tracks for rotary-wing aircraft at Truax Field are identified in Table 3-8 and shown on Figures 3-6 through 3-8.

Table 3-8: Rotary Wing Aircraft Flight Tracks at Truax Field, NASCC

Operation Type	Pad ID	Flight Track ID	Flight Track Rule
Departure	HM-15	NAD1	HM15 Seawall Departure
		NAD2	HM15 Seawall Departure
		NAD3	HM15 Seawall Departure
		NAD4	HM15 Oso Bridge Departure
		NAD5	MOP Operations Departure
		NAD6	MOP Operations Departure
		NAD7	MOP Operations Departure
	CCAD	ADD1	CCAD Seawall Departure
		ADD2	CCAD Seawall Departure
	CG	CGD1	Coast Guard Seawall Departure
		CGD2	Coast Guard Seawall Departure
		CGD3	Coast Guard Seawall Departure
		CGD4	Coast Guard Seawall Departure
Arrival	HM-15	NAA1	HM15 Seawall Arrival
		NAA2	HM15 Seawall Arrival
		NAA3	HM15 Seawall Arrival
		NAA4	HM15 Oso Bridge Arrival
		NAA5	MOP Operations Arrival
		NAA6	MOP Operations Arrival
		NAA7	MOP Operations Arrival
	CCAD	ADA1	CCAD Seawall Arrival
		ADA2	CCAD Seawall Arrival

Table 3-8: Rotary Wing Aircraft Flight Tracks at Truax Field, NASCC

Operation Type	Pad ID	Flight Track ID	Flight Track Rule
Arrival *(continued)*	CG	CGA1	Coast Guard Seawall Arrival
		CGA2	Coast Guard Seawall Arrival
		CGA3	Coast Guard Seawall Arrival
		CGA4	Coast Guard Seawall Arrival
Field Carrier Landing Practice (FCLP) Pattern	HM-15	NAF1	HM15 FCLP
		NAF2	HM15 FCLP

Key:
CCAD = Corpus Christi Army Depot.
MOP = Magnetic Orange Pipe.

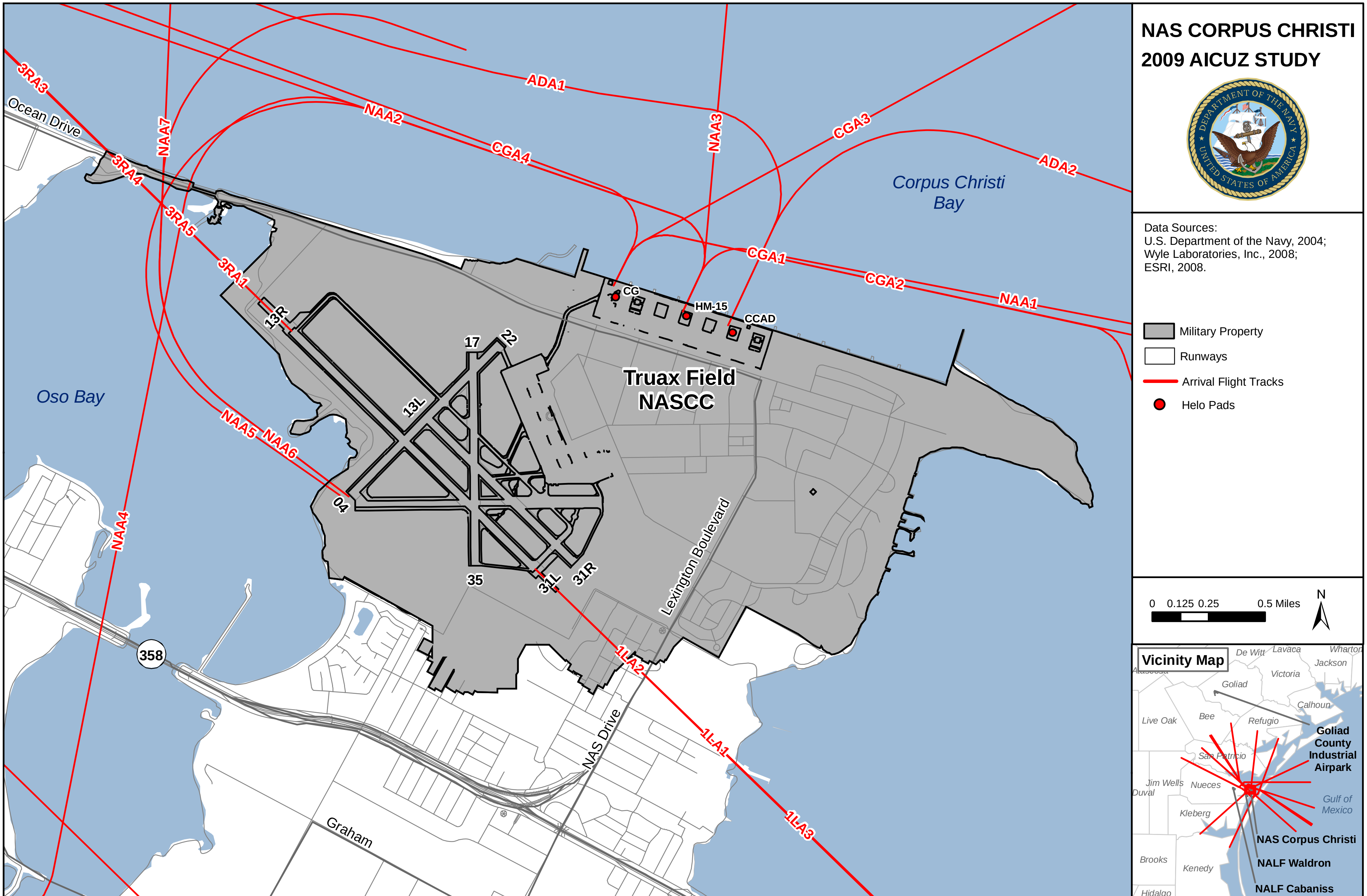

Figure 3-6: Arrival Flight Tracks (Rotary Wing)
Truax Field, NASCC

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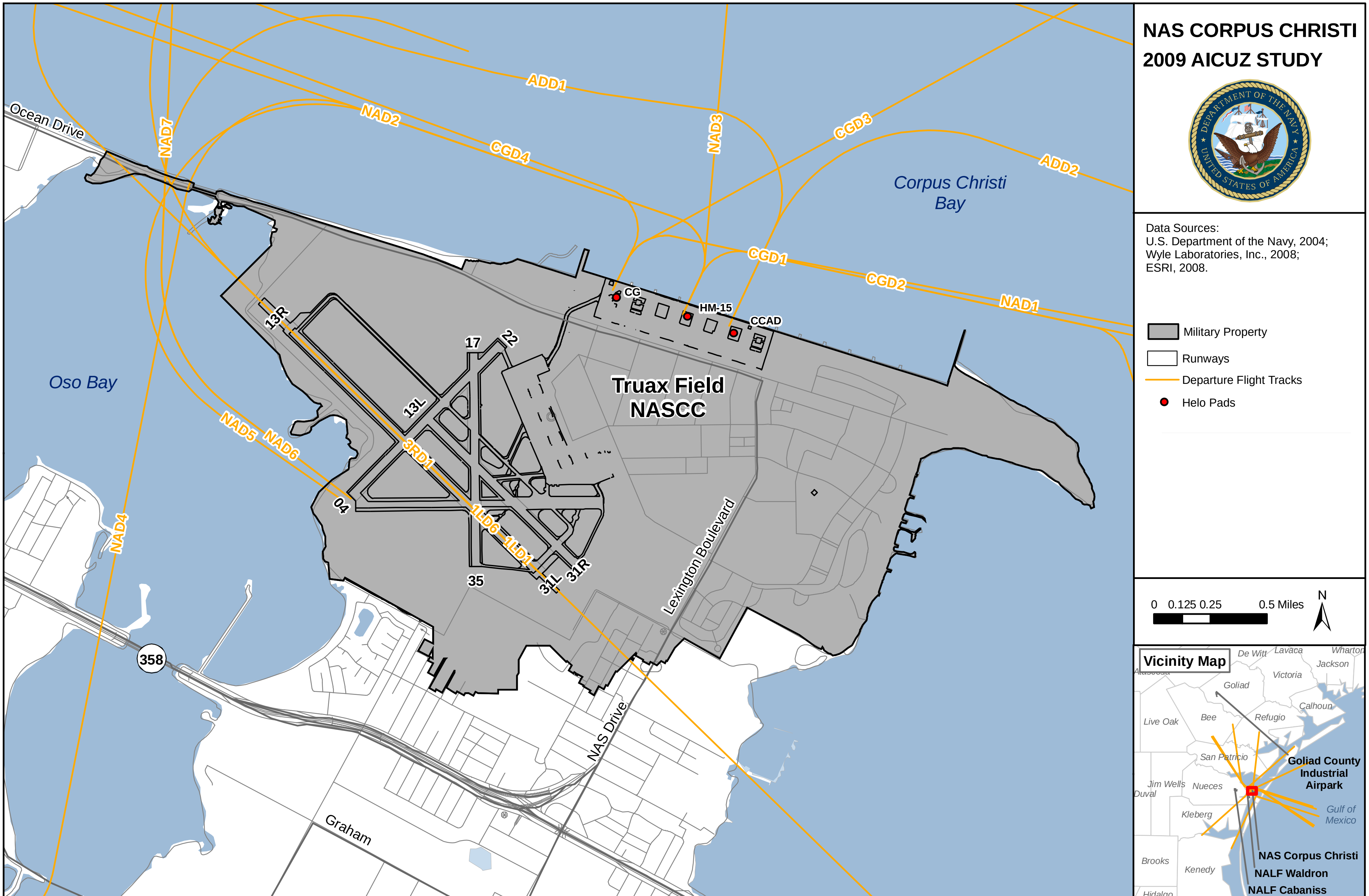

Figure 3-7: Departure Flight Tracks (Rotary Wing)
Truax Field, NASCC

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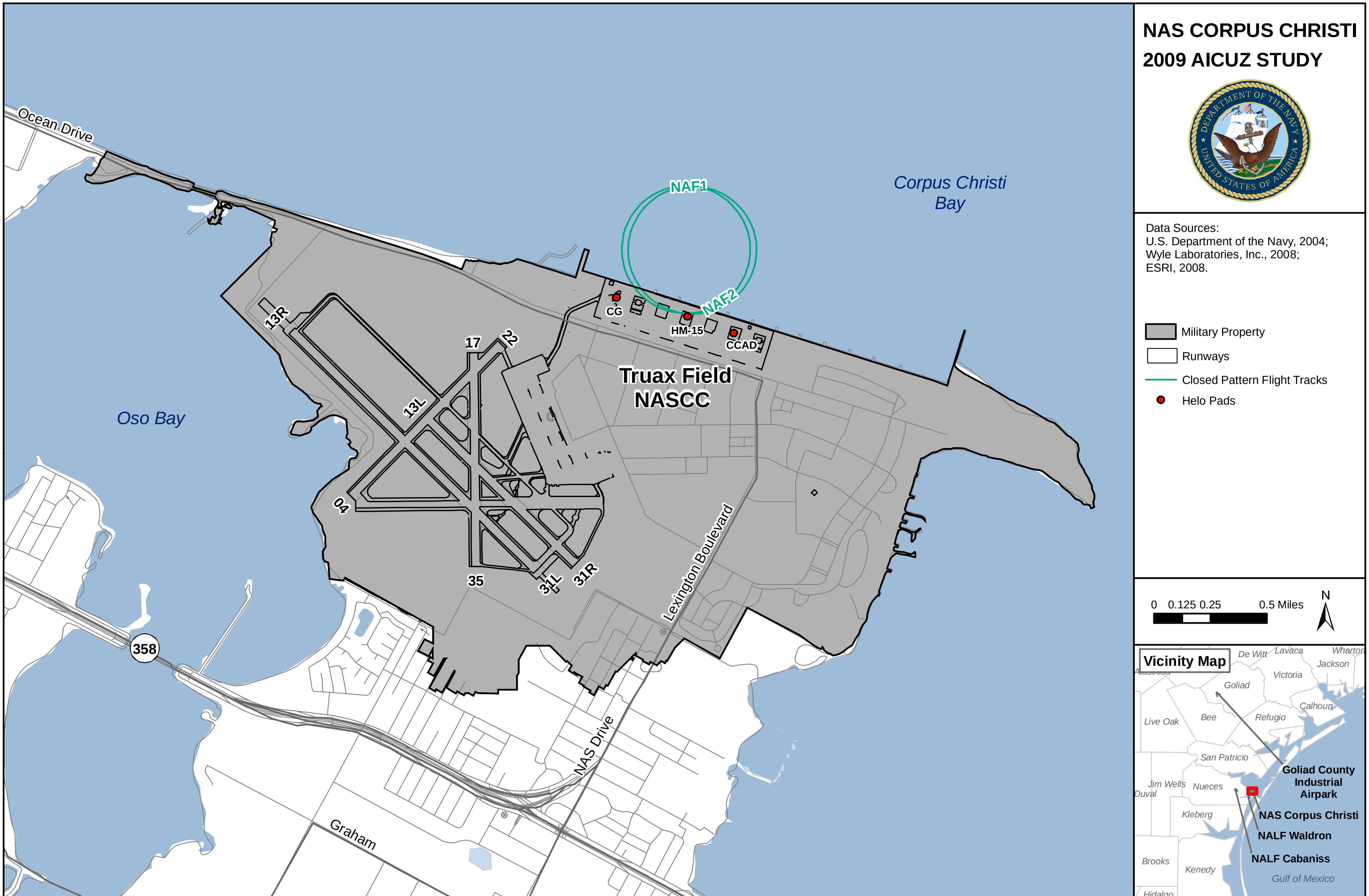

Figure 3-8: Pattern Flight Tracks (Rotary Wing)
Truax Field, NASCC

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3.3.3.2 NALF Waldron Runway and Flight Track Utilization

T-34C departure operations at NALF Waldron occur on Runway 13 (83%), Runway 31 (12%), Runway 17 (3%), and Runway 35 (2%). T-34C overhead arrivals at NALF Waldron predominantly use Runway 13 (71% to 80%), Runway 31 (11% to 15%), Runway 17 (11% to 2%), and Runway 35 (7% to 3%). Closed-pattern operations at NALF Waldron occur on Runway 13 (80%), Runway 31 (15%), Runway 17 (3%), and Runway 35 (2%). The T-6 aircraft is expected to use runways and flight tracks in the same manner as the T-34C aircraft. Predominant arrival, departure, and pattern flight tracks for runways at NALF Waldron are identified in Table 3-9 and shown on Figures 3-9 through 3-11. The NASCC Aircraft Noise Study (Wyle Laboratories, Inc. 2008) provides detailed information on runway operations and utilization, flight track utilization, and average annual day operations for each aircraft at NALF Waldron.

Table 3-9: Aircraft Flight Tracks at NALF Waldron

Operation Type	Runway	Flight Track ID	Flight Track Rule
Departure	13	13D1	Field Departure
		13D2	Tower-to-Tower
	17	17D1	Field Departure
		17D2	Tower-to-Tower
	31	31D1	Field Departure
		31D2	Tower-to-Tower
	35	35D1	Field Departure
		35D2	Tower-to-Tower
Overhead Break Arrival	13	13OA	Overhead Break
		13OB	Short Break
		13OC	Tower-to-Tower Overhead Break
		13OD	Tower-to-Tower Short Break
	17	17OA	Overhead Break
		17OB	Short Break
		17OC	Tower-to-Tower Overhead Break
		17OD	Tower-to-Tower Short Break

Table 3-9: Aircraft Flight Tracks at NALF Waldron

Operation Type	Runway	Flight Track ID	Flight Track Rule
Overhead Break Arrival *(continued)*	31	31OA	Overhead Break
		31OB	Short Break
		31OC	Tower-to-Tower Overhead Break
		31OD	Tower-to-Tower Short Break
	35	35OA	Overhead Break
		35OB	Short Break
		35OC	Tower-to-Tower Overhead Break
		35OD	Tower-to-Tower Short Break
Touch-and-Go Pattern	13	13TA	1 Aircraft Pattern
		13TB	2 to 3 Aircraft Patterns
		13TC	4 Aircraft Patterns
		13TD	5 Aircraft Patterns
	17	17TA	1 Aircraft Pattern
		17TB	2 to 3 Aircraft Patterns
		17TC	4 Aircraft Patterns
		17TD	5 Aircraft Patterns
	31	31TA	1 Aircraft Pattern
		31TB	2 to 3 Aircraft Patterns
		31TC	4 Aircraft Patterns
		31TD	5 Aircraft Patterns
	35	35TA	1 Aircraft Pattern
		35TB	2 to 3 Aircraft Patterns
		35TC	4 Aircraft Patterns
		35TD	5 Aircraft Patterns

Figure 3-9: Arrival Flight Tracks (Fixed Wing)
NALF Waldron

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Figure 3-10: Departure Flight Tracks (Fixed Wing)
NALF Waldron

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Figure 3-11: Pattern Flight Tracks (Fixed Wing)
NALF Waldron

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3.3.3.3 NALF Cabaniss Runway and Flight Track Utilization

T-44A operations at NALF Cabaniss occur on Runway 13 (70%), Runway 31 (15%), Runway 17 (10%), and Runway 35 (5%). The T-6 aircraft is expected to use runways and flight tracks in the same manner as the T-44A aircraft. At present, TC-12 aircraft operations are mostly conducted on Runway 13 (75%), but TC-12 operations are expected to end by 2015. Predominant arrival, departure, and pattern flight tracks for runways at NALF Cabaniss are identified in Table 3-10 and shown on Figures 3-12 through 3-14. The NASCC Aircraft Noise Study (Wyle Laboratories, Inc. 2008) provides detailed information on runway operations and utilization, flight track utilization, and average annual day operations for each aircraft at NALF Cabaniss.

Table 3-10: Aircraft Flight Tracks at NALF Cabaniss

Operation Type	Runway	Flight Track ID	Flight Track Rule
Departure	13	13D1	Field Departure
	17	17D1	Field Departure
	31	31D1	Field Departure
	35	35D1	Field Departure
Overhead Break Arrival	13	13OA	Overhead Break
		13OB	Short Break
		13OC	Overhead Break from Corpus International
		13OD	Short Break from Corpus International
	17	17OA	Overhead Break
		17OB	Short Break
		17OC	Overhead Break from Corpus International
		17OD	Short Break from Corpus International
	31	31OA	Overhead Break
		31OB	Short Break
		31OC	Overhead Break from Corpus International
		31OD	Short Break from Corpus International
	35	35OA	Overhead Break
		35OB	Short Break
		35OC	Overhead Break from Corpus International
		35OD	Short Break from Corpus International

Table 3-10: Aircraft Flight Tracks at NALF Cabaniss			
Operation Type	**Runway**	**Flight Track ID**	**Flight Track Rule**
Touch-and-Go Pattern	13	13TA	1 Aircraft Pattern
		13TB	2 to 3 Aircraft Patterns
		13TC	4 Aircraft Patterns
		13TD	5 Aircraft Patterns
	17	17TA	1 Aircraft Pattern
		17TB	2 to 3 Aircraft Patterns
		17TC	4 Aircraft Patterns
		17TD	5 Aircraft Patterns
	31	31TA	1 Aircraft Pattern
		31TB	2 to 3 Aircraft Patterns
		31TC	4 Aircraft Patterns
		31TD	5 Aircraft Patterns
	35	35TA	1 Aircraft Pattern
		35TB	2 to 3 Aircraft Patterns
		35TC	4 Aircraft Patterns
		35TD	5 Aircraft Patterns

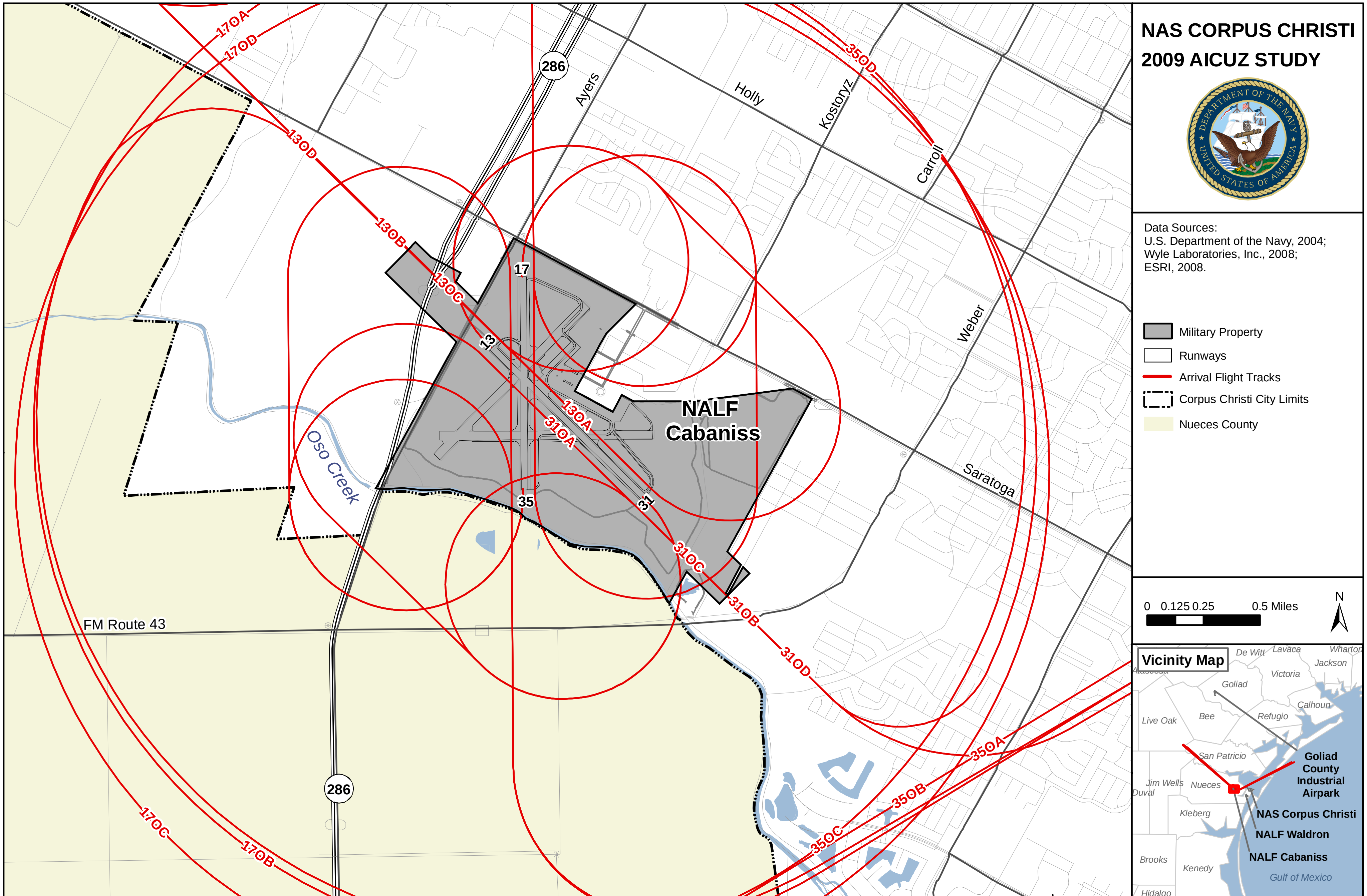

Figure 3-12: Arrival Flight Tracks (Fixed Wing)
NALF Cabaniss

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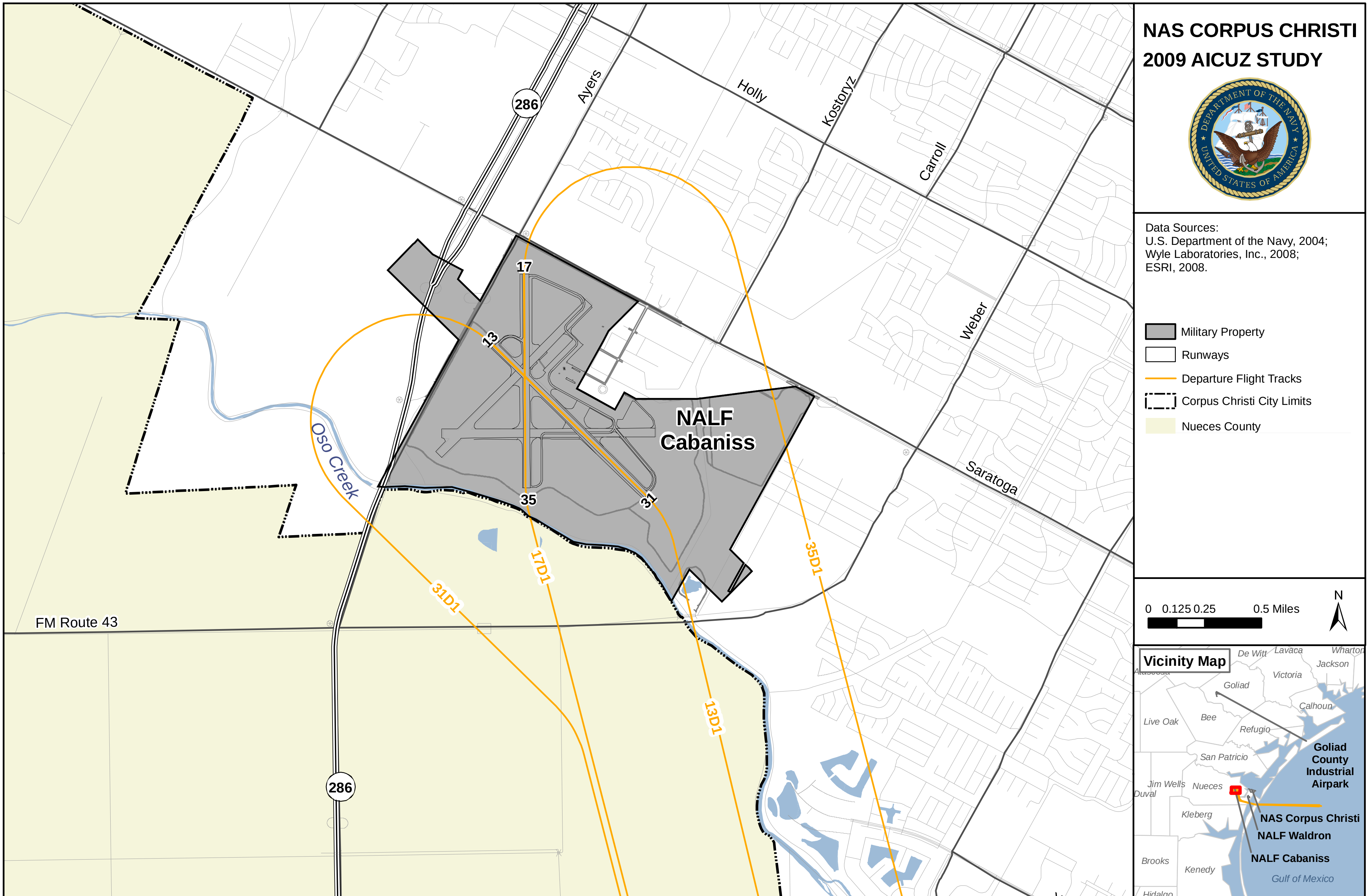

Figure 3-13: Departure Flight Tracks (Fixed Wing)
NALF Cabaniss

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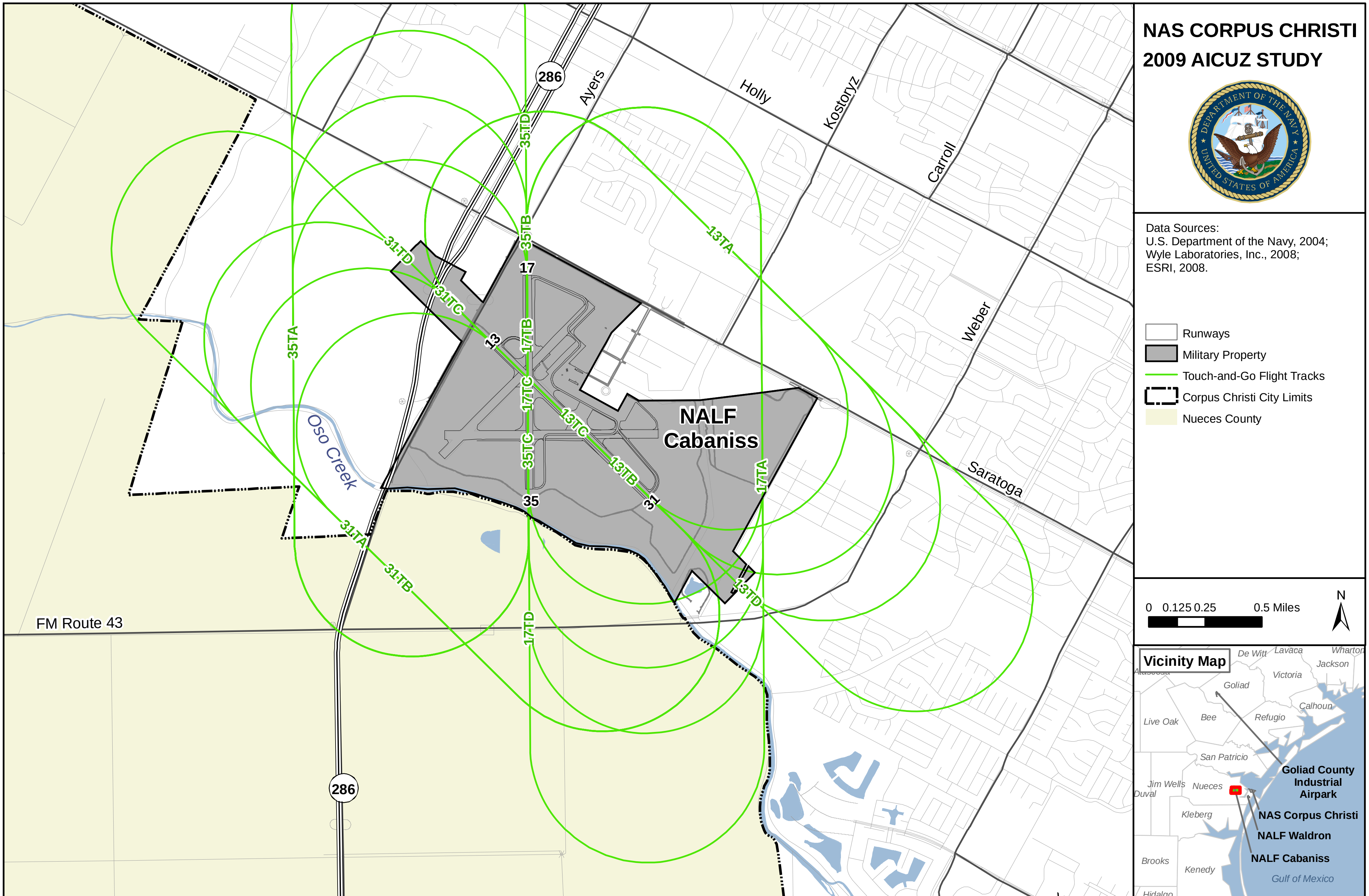

Figure 3-14: Pattern Flight Tracks (Fixed Wing)
NALF Cabaniss

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4 Aircraft Noise

Aircraft noise is of concern to many residents in the community surrounding NASCC and its associated operational areas. 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 significantly impacts areas surrounding an installation, NASCC has defined certain areas as high noise zones under their AICUZ Program. This section discusses noise associated with aircraft operations at NASCC, NALF Waldron, and NALF Cabaniss, including average noise levels, noise complaints, noise abatement/flight procedures, and noise contours.

4.1 What is Sound/Noise?

Sound: The result of a sound source inducing vibrations in the air.

Noise: Unwanted sound.

dBA: A-weighted decibels

The noise exposure from aircraft at NASCC and its associated operational areas is measured using the **day-night average sound level (DNL)**.

Sound is the result of a sound source inducing vibrations in the air. Noise can be defined as unwanted sound. Some of the potential sources of noise include roadway traffic, land use activities, railway activities, and aircraft operations. Whether sound becomes noise depends on the listener, but sound can become noise when it interferes with normal activities.

In this document, all sound or noise levels are measured in A-weighted decibels (dBA), which are units of sound pressure adjusted to the range of human hearing with intensity greater than the ambient or background sound pressure. Normal speech has a noise level of approximately 60 dBA. Generally, a sound level above 120 dBA will begin to provide discomfort to the human auditory system and the threshold of pain is a sound level between 130 dBA and 140 dBA (Berglund and Lindvall 1995).

The noise exposure from aircraft at NASCC and its associated operational areas, as with other installations, is measured using the day-night average sound level (DNL). The DNL metric, developed by the U.S. Environmental Protection Agency, 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 a similar metric). DNL averages aircraft sound levels at a location over a 24-hour period. DNL also adds an additional 10 decibels (dB) to events occurring between 10:00 p.m. to 7:00 a.m. This 10-dB “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 than during the day.

By combining factors most noticeable about noise annoyance (loudness, total noise energy [number and/or length of noise events], and time of day), 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 measure of that annoyance.

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 very 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 area between two noise contours is known as a noise zone. The noise exposure area is divided into noise zones as follows:

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

For land use planning purposes, noise zones are delineated by the severity of impact:

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

For land use planning purposes, the noise zones above are organized further into three zones delineated by the severity of impact:

- 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; and
- Noise 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 engine maintenance operations or 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 maintenance run-ups;
- Terrain;
- Surface type; and
- Environmental data (temperature and humidity).

4.3 Noise Complaints

NASCC has specific procedures defined in the Installation's Instructions (NASCORPCINST 3700.1D) for handling aircraft noise complaints. The procedures address how noise complaints shall be received, the responsible parties to be advised of the noise complaint, and what type of action is required to address the complaint. Individual response to noise levels varies and is influenced by many factors, including:

- Activity the individual is engaged in at the time of the noise;

- General sensitivity to noise;
- Time of day;
- Loudness of the event;
- Length of time an individual is exposed to a noise;
- Predictability of noise; and
- Average temperature.

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

NASCC actively pursues operational measures to reduce noise. The Navy conducts noise abatement procedures to its best ability, commensurate with safety and operational training requirements. Noise abatement procedures at NASCC and its associated operational areas are implemented under the NASCC air operations manual and are summarized in Table 4-2. The purpose of these procedures is to minimize noise in recognition of community response to aircraft noise at NASCC, NALF Cabaniss, and NALF Waldron. The NASCC Air Operations Officer is responsible for addressing aircraft noise complaints and for communication complaints to the Commanding Officer.

Table 4-2: Noise Abatement/Flight Procedures at NASCC, NALF Waldron, and NALF Cabaniss
NASCC, Texas
Noise Abatement ▪ Helicopter operations are conducted over water. ▪ Flight operations are concentrated to daylight hours. ▪ Flight squadrons will attempt to avoid flying directly over residences with a history of noise complaints.
NALF Waldron, Texas
Noise Abatement ▪ Do not fly over Flour Bluff High School.
NALF Cabaniss, Texas
Noise Abatement ▪ Runway 13 –Aircraft shall not fly at less than 800 feet MSL over the Saratoga Road, near the Weber Road Intersection. ▪ Schools – Flights over Sanders Elementary (1 ¾ nm East) and Los Encinos Elementary (1 ½ nm NNW) will be avoided.
Source: NASCC 2007. Key: MSL = mean sea level. nm = nautical miles.

4.5 Noise Contours

The AICUZ process calls for the modeling and analysis of existing conditions and any future operational changes that can be reasonably forecasted. Using available unclassified information, NASCC provided a forecast of air operation activity levels for the prospective condition. These operational projections were revalidated for this study.

The noise contours are developed using a computer-based model called **NOISEMAP**, where inputs such as aircraft activity and site-specific operational data at NASCC are used in calculating the noise contours.

The NASCC Aircraft Noise Study (Wyle Laboratories, Inc. 2008) includes existing (2007) and projected (2015) operational data. The initial step in the AICUZ process is the preparation of a noise study to define ground-level noise exposure contours. The noise contours are developed using a computer-based model called NOISEMAP, where inputs such as aircraft activity and site-specific operational data at NASCC are used in calculating the noise contours. This includes types and mix of aircraft, flight profiles (airspeed, altitude and power settings), and flight tracks, along with frequency and times of operations.

Projections of aircraft operations were based on information provided by personnel at NASCC, NALF Cabaniss, and NALF Waldron.

The mix of fixed-wing aircraft in the noise environment will evolve over the next few years as T-34C aircraft is retired and TW-4 transitions to the T-6 aircraft. As a result of the transition, annual flight operations will increase at Truax Field and NALF Waldron. Projected annual flight operations at NALF Cabaniss will slightly decrease, but the decrease in operations at NALF Cabaniss is also attributed to the ending of TC-12 flight operations. For the purposes of modeling, the T-6 aircraft was used to represent all transient fixed-wing aircraft to ensure the Navy noise impacts are not underrepresented.

Land use compatibility guidelines and long-term noise exposure assessments are based on yearly average noise levels. Therefore, the 2009 noise contours for NASCC were developed based on average annual day (AAD) operations. The AAD operations level is calculated by dividing the total annual airfield operations by 365 days, consistent with Navy guidelines OPNAVINST 11010.36C, dated October 2008. The 2008 NASCC Aircraft Noise Study provides a detailed discussion of noise modeling.

AAD: average annual day. The AAD operations level is calculated by dividing the total annual airfield operations by 365 days, consistent with Navy guidelines.

4.5.1 Truax Field, NASCC

The main noise sources at Truax Field are aircraft operations, including fixed-wing aircraft operations, rotary-wing aircraft operations, and engine maintenance operations or run-ups. This section describes the 2009 AICUZ noise contours, and compares the impacts of the 2009 AICUZ noise contours to the currently adopted 1986 AICUZ noise contours.

The main noise sources at Truax Field are aircraft operations, including fixed-wing aircraft operations, rotary-wing aircraft operations, and engine maintenance operations or run-ups.

4.5.1.1 2009 AICUZ Noise Contours

As shown on Figure 4-1, the DNL contour levels resulting in off-station noise impacts are the 60-dB and 65-dB contours. 2009 AICUZ noise contours extend off-station to the south of the base boundary and to the north of the Corpus Christi Bay shoreline. Touch-and-go operations shape the 2009 AICUZ noise contours immediately surrounding the airfield.

2009 AICUZ noise contours representing higher noise level concentrations are on Runways 13L and 31R, as well as the helicopter pads to the north shore of NASCC. The 60-dB noise contours extend two miles northwest of Runway 31L and two miles southeast of Runway 13R due to fixed-wing aircraft departures, primarily T-6 aircraft departures. The 2009 AICUZ noise contours extending north of Truax Field and over the shores of Corpus Christi Bay are due to helicopters operations. In particular, the 60-dB DNL noise contours extending from the seawall to the north and east are due to the MH-53 departures and arrivals. To the southeast of Laguna Madre, higher noise concentration is caused by hold-down procedures to avoid conflict between rotary-wing aircraft and outbound fixed-winged aircraft. The fixed-wing aircraft fly out at a lower altitude on the east side of Laguna Madre and then steadily increase altitude. The increased power settings and low altitude generate higher noise levels. Additional high noise concentration is caused by TW-4 maintenance operations to the east of Runway 22.

The Truax Field 2009 AICUZ noise contours (modeled 2015 air operations) are primarily contained within the Installation boundary or over open water; therefore, limiting the population and off-station land areas that are impacted. Population and area counts are performed to provide estimates of how many people and how much land area is encompassed by the noise contours. As provided in the 2008 Aircraft Noise Study, the population data are based on block-level Census 2000 data. Table 4-3 summarizes the people and acres exposed to noise in the 2009 AICUZ noise contours.

Table 4-3: Off-Base Population and Area Impact for 2009 AICUZ Noise Contours, Truax Field, NASCC

Noise Zone (DNL)	Population	Housing	Total Area (acres) [(a)]
60 to 65	1,094	416	284
65 to 70	290	223	155
70 to 75	0	0	9
75+	0	0	6

Source: Wyle Laboratories, Inc. 2008.
Note: (a) Total Area excludes areas within the Installation and over water.
Key:
AICUZ = Air Installations Compatible Use Zones.
DNL = Day-night average sound level.

4.5.1.2 Comparison of 1986 and 2009 AICUZ Noise Contours

Figure 4-2 compares the established 1986 NASCC AICUZ noise contours (NAS Corpus Christi 1986) with the 2009 AICUZ noise contours prepared for this AICUZ update. Although comparable areas are exposed to noise contours off-station, the 1986 AICUZ noise contours are typically higher DNL than the 2009 AICUZ noise contours. In comparison to the 1986 AICUZ noise contours, the 2009 AICUZ noise contours show areas of higher noise concentrations associated with the helicopter operations along the north shore of NASCC. Additionally, the 2009 AICUZ noise contours from Runways 17 and 22 have decreased in comparison to the 1986 AICUZ noise contours.

The difference in the geographic extent of the noise contours can be attributed to various factors, including change in aircraft, change in runway usage, and improved modeling.

The difference in the geographic extent of the noise contours can be attributed to a number of different factors, including change in aircraft, change in runway usage, and improved modeling. Aircraft utilization at Truax Field is not reported to have changed since 1986; therefore, the change in noise contours is likely due to a change in runway usage. Limited information is accessible to verify change since historic records of runway usage and operations are only available for approximately six years.

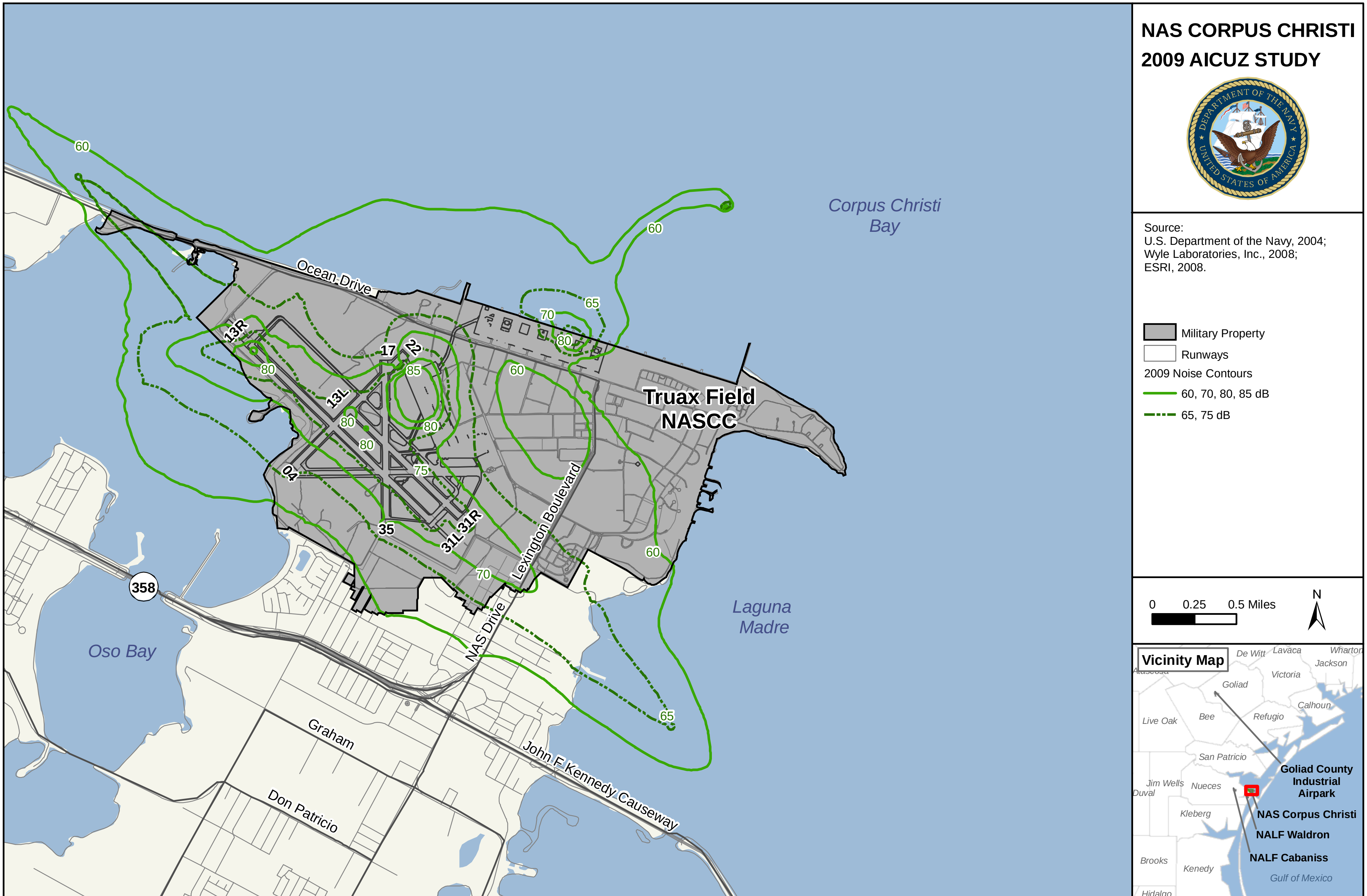

Figure 4-1: 2009 AICUZ Noise Contours
Truax Field, NASCC

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The 2009 AICUZ noise contours were modeled using a combination of modeling software such as NOISEMAP 7.2 and the Rotary Noise Model, which is designed specifically to model noise emissions from helicopter operations. In comparison to modeling software available in 1986, the NOISEMAP program has expanded to account for atmospheric sound propagation effects over varying terrain such as water.

Table 4-4 compares the area of high noise zones within the 1986 AICUZ noise contours with the 2009 AICUZ noise contours (also see Figure 4-2). The total area of the 2009 AICUZ noise contours is 4,116 acres less than the total area of the 1986 AICUZ noise contours; however, the geographic extent and distribution of the contours have changed. Significant differences in the area encumbered by high noise are identified within the 65- to 70-DNL range and the 70- to 75-DNL range.

Table 4-4: Areas within AICUZ Noise Zones (DNL) – 1986 and 2009, Truax Field, NASCC

Noise Zone (DNL)	TOTAL LAND AREA (acres)	
	1986 AICUZ Noise Zones	2009 AICUZ Noise Zones
60 to 65	NA	2,669
65 to 70	4,838	1,025
70 to 75	2,572	408
75+	1,194	386
TOTAL AREA	**8,604**	**4,488**

Source: Wyle Laboratories, Inc. 2008; NAS Corpus Christi 1986.
Key:
AICUZ = Air Installations Compatible Use Zones.
DNL = Day-night average sound level.

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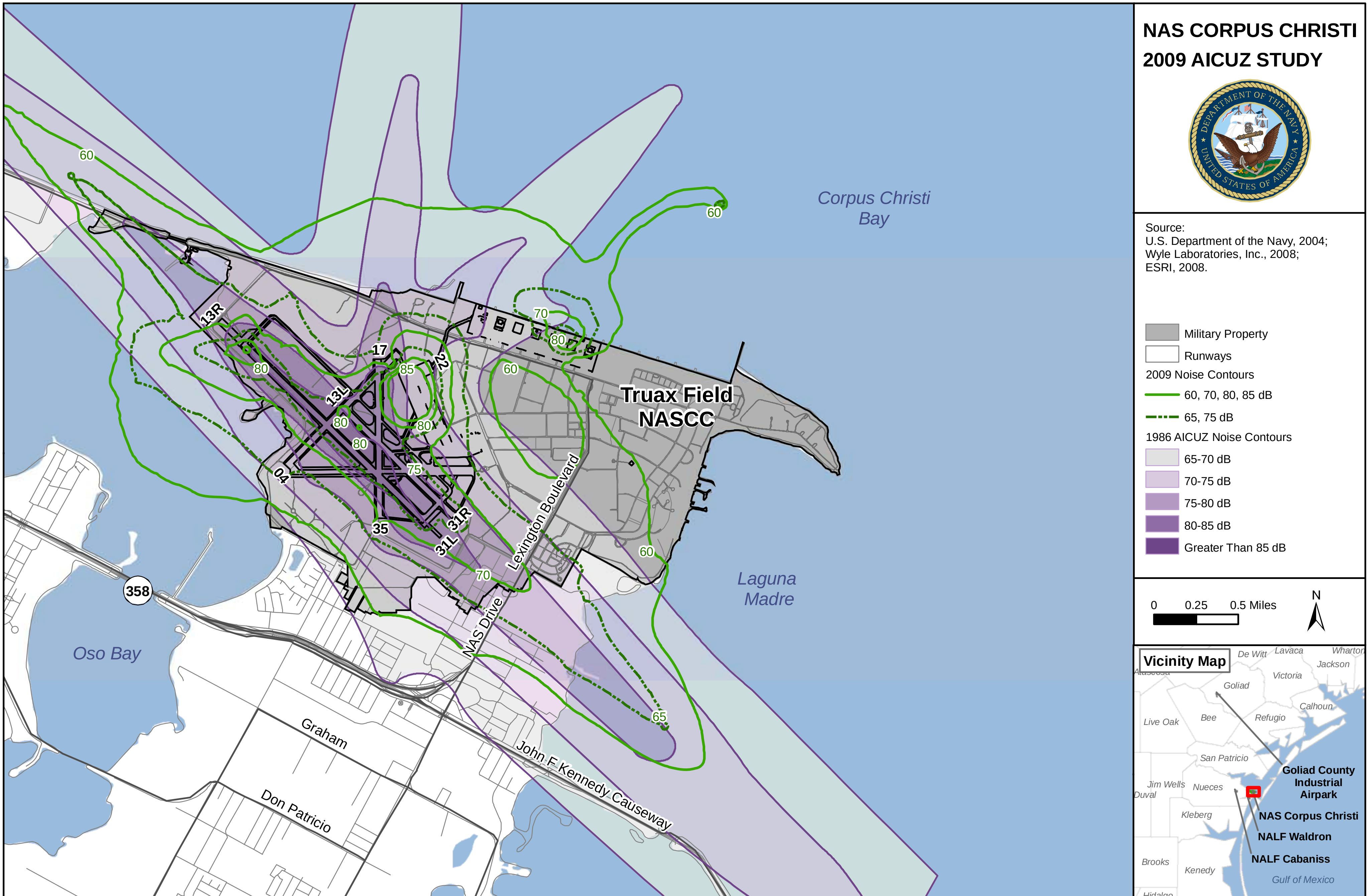

Figure 4-2: Comparison of 1986 and 2009 AICUZ Noise Contours
Truax Field, NASCC

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The main noise sources at NALF Waldron are fixed-winged aircraft operations. No engine maintenance operations or run-ups are conducted at NALF Waldron.

4.5.2 NALF Waldron

The main noise sources at NALF Waldron are fixed-winged aircraft operations. No engine maintenance operations or run-ups are conducted at NALF Waldron. This section describes the 2009 AICUZ noise contours and compares the impacts of the 2009 AICUZ noise contours to the currently adopted 1986 AICUZ noise contours.

4.5.2.1 2009 AICUZ Noise Contours

As shown on Figure 4-3, the DNL contour levels resulting in off-station noise impacts are the 60-dB, 65-dB, 70-dB, and 75-dB contours. The 2009 AICUZ noise contours extend off-station to the southeast and northwest of the base boundary as a result of touch-and-go operations on all runways. The 2009 AICUZ noise contours show that high noise levels are concentrated on Runway 13/31, which is the runway primarily used.

The NALF Waldron 2009 AICUZ noise contours (modeled for 2015) extend significantly to the southeast, impacting off-base land and the surrounding community. Population and area counts (based on block-level Census 2000 data) provide estimates on how many people and how much land area is encompassed by the noise contours. Table 4-5 summarizes the people and acres exposed to noise in the 2009 AICUZ noise contours.

Table 4-5: Off-Base Population and Area Impact for 2009 AICUZ Noise Contours, NALF Waldron

Noise Zone (DNL)	Population	Housing	Area (acres) [a]
60 to 65	1,569	594	908
65 to 70	1,534	590	448
70 to 75	308	107	91
75+	1	0	1

Source: Wyle Laboratories, Inc. 2008.
Note: (a) Total area excludes areas within the Installation and over water.
Key:
AICUZ = Air Installations Compatible Use Zones.
DNL = Day-night average sound level.

4.5.2.2 Comparison of 1986 and 2009 AICUZ Noise Contours

Operations at NALF Waldron have increased between the modeling of the 1986 and 2009 AICUZ noise contours. The primary utilization of the runways changed from Runway 17/35 (in 1986) to Runway 13/31 (in 2009), which resulted in substantial changes to the AICUZ noise contours. More land area is impacted by aircraft noise as a result of operations conducted on Runway 13/31 to the southeast of the airfield. Figure 4-4 compares NALF Waldron's 1986 AICUZ noise contours with the 2009 AICUZ noise contours prepared for this AICUZ update.

The projected noise levels for the 2009 AICUZ noise contours are greater than 1986 due to larger numbers of operations and noise levels of the T-6 aircraft.

New aircraft operations are another factor for the difference in the geographic extent of the AICUZ noise contours. The projected noise levels for the 2009 AICUZ noise contours are greater due to larger numbers of operations and noise levels of the T-6 aircraft. The Navy is completing an Environmental Assessment (*Assessment of Naval Air Station Corpus Christi, Texas, for Compatibility with the T-6 Joint Primary Aircraft Training System*, Final Draft dated July 2008) to evaluate action alternatives for the deployment of the T-6 JPATS program at NASCC.

Table 4-6 compares the area of high noise zones within the 1986 AICUZ noise contours with the 2009 AICUZ noise contours. The total area of the 2009 AICUZ noise contours is 2,256 acres greater than the total area of the 1986 AICUZ noise contours. A significant difference in the area encumbered by high noise is identified within the 60- to 75-DNL noise zones.

Table 4-6: Areas within AICUZ Noise Zones (DNL) – 1986 and 2009, NALF Waldron

Noise Zone (DNL)	TOTAL LAND AREA (acres)	
	1986 AICUZ Noise Zones	2009 AICUZ Noise Zones
60 to 65	-- [(a)]	1,466
65 to 70	125	679
70 to 75	22	191
75+	0	67
TOTAL AREA	**147**	**2,403**

Source: Wyle Laboratories, Inc. 2008; NAS Corpus Christi 1986.
Note: (a) 1986 noise modeling did not include the 60 to 65 DNL.
Key:
AICUZ = Air Installations Compatible Use Zones.
DNL = Day-night average sound level.

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Figure 4-3: 2009 AICUZ Noise Contours
NALF Waldron

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Figure 4-4: Comparison of 1986 and 2009 AICUZ Noise Contours
NALF Waldron

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4.5.3 NALF Cabaniss

The main noise sources at NALF Cabaniss are fixed-wing aircraft operations. No engine maintenance operations or run-ups are conducted at NALF Cabaniss. This section describes the 2009 AICUZ noise contours and compares the impacts of the 2009 AICUZ noise contours to the currently adopted 1986 AICUZ noise contours.

4.5.3.1 2009 AICUZ Noise Contours

The 2009 AICUZ noise contours at NALF Cabaniss do not extend beyond the airfield boundaries.

As shown on Figure 4-5, the 2009 AICUZ noise contours at NALF Cabaniss are only 60 DNL and do not extend beyond the boundaries of the airfield. Noise contours are a result of touch-and-go operations. Noise levels are concentrated on Runway 13/31, and areas outside the installation are exposed to very low levels of aircraft noise. There are no off-station impacts to housing or the local population as a result of noise surrounding NALF Cabaniss.

4.5.3.2 Comparison of 1986 and 2009 AICUZ Noise Contours

Operations at NALF Cabaniss have increased between the modeling of the 1986 and 2009 AICUZ noise contours. In comparison to the 1986 AICUZ noise contours, the 65-DNL noise contour no longer exists at NALF Cabaniss. Figure 4-6 compares NALF Cabaniss 1986 AICUZ noise contours with the 2009 AICUZ noise contours prepared for this AICUZ update.

Table 4-7 compares the area of high noise zones within the 1986 AICUZ noise contours with the 2009 AICUZ noise contours. The total area of the 2009 AICUZ noise contours is only 60 acres greater than the total area of the 1986 AICUZ noise contours. The area noted in Table 4-7 occurs on military property.

Table 4-7: Areas within AICUZ Noise Zones (DNL) – 1986 and 2009, NALF Cabaniss

Noise Zone (DNL)	TOTAL LAND AREA (acres)	
	1986 AICUZ Noise Zones	2009 AICUZ Noise Zones
60 to 65	-- [a]	62
65 to 70	11	9
70 to 75	0	0
75+	0	0
TOTAL AREA	**11**	**71**

Source: Wyle Laboratories, Inc. 2008; NAS Corpus Christi 1986.
Note: (a) 1986 noise modeling did not include the 60 to 65 DNL.
Key:
AICUZ = Air Installations Compatible Use Zones.
DNL = Day-night average sound level.

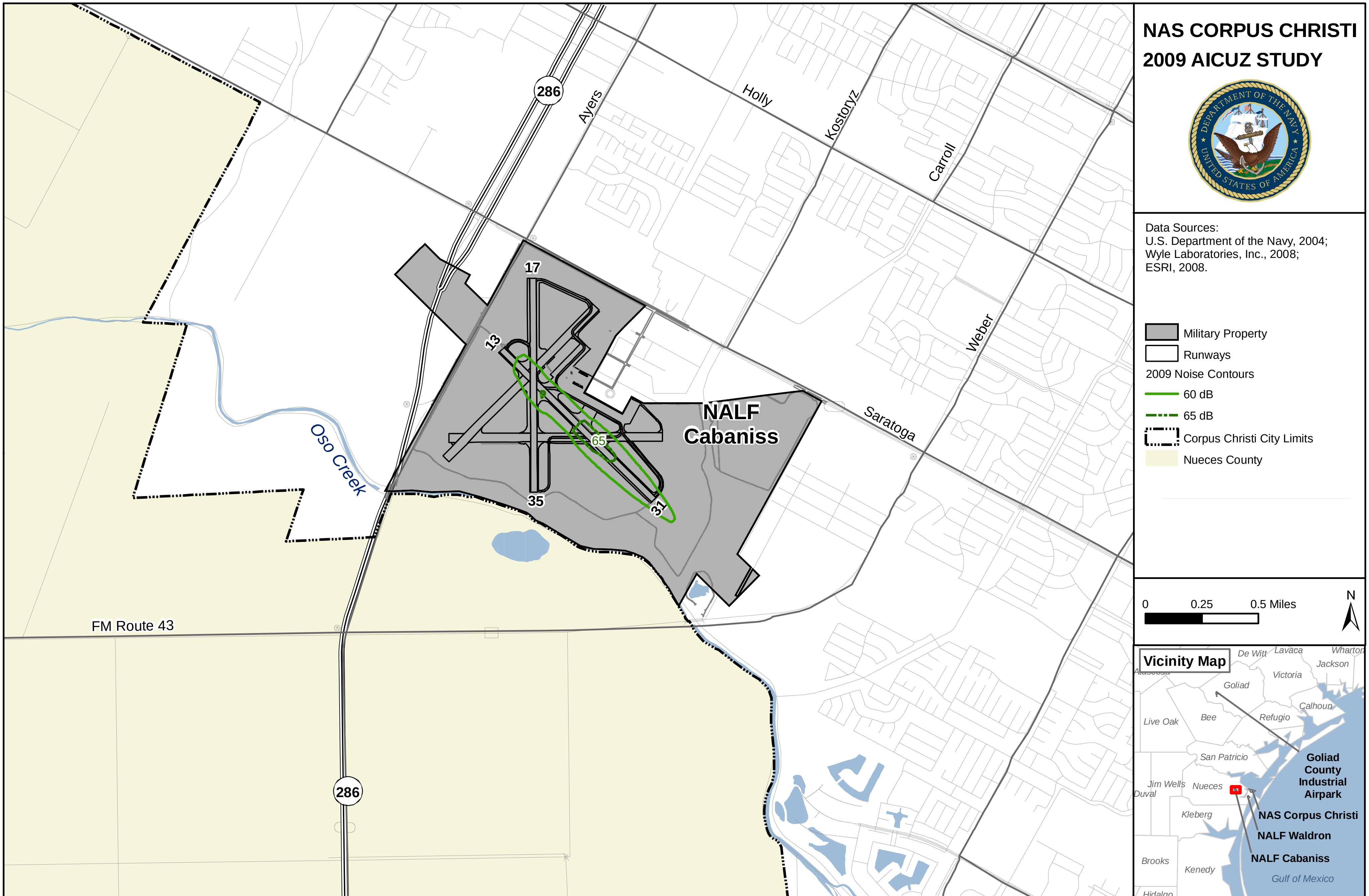

Figure 4-5: 2009 AICUZ Noise Contours
NALF Cabaniss

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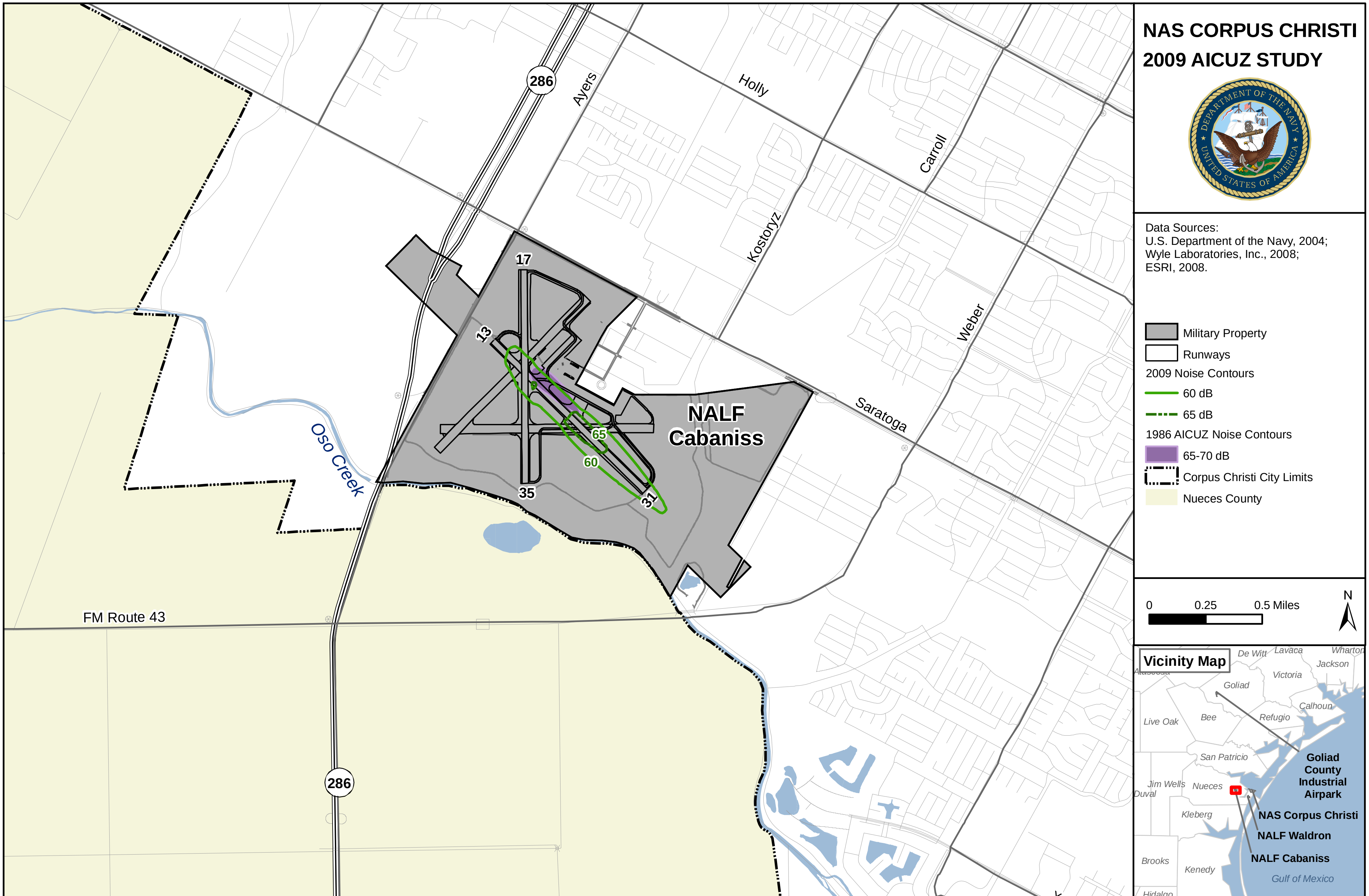

Figure 4-6: Comparison of 1986 and 2009 AICUZ Noise Contours
NALF Cabaniss

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5 Airfield Safety

The 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 and defines areas of accident potential to assist in land use planning. The Navy has identified 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 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
- EMI with aircraft communication, navigation, or other electrical systems.

5.1 Accident Potential Zones

5.1.1 Aircraft Mishaps

In the 1970s, recognizing the need to identify areas of accident potential, the military conducted a tri-service study of historic accident and operations data throughout the military. The study 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 DoD has identified APZs as areas where an aircraft accident is most likely to occur (if one was to occur); 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, a naval aircraft is destroyed or missing, or any fatality or permanent total disability results from the direct involvement of naval aircraft.

There have been four Class A mishaps at NASCC in the past fifteen years. On March 25, 1996, a T-44A trainer crashed in the Gulf of Mexico, and three Navy crew members died. On August 10, 2000, a MH-53E Sea Dragon helicopter crashed in the Gulf of Mexico, where four of the crew members were killed and two were injured but rescued. On January 27, 2006, a Navy T-34C training plane crashed in the backyard of a house near the airfield during a routine training flight, and both pilots died in the accident (Scott 2007). Most recently, on January 16, 2008, a MH-53 Sea Dragon crashed resulting in three casualties.

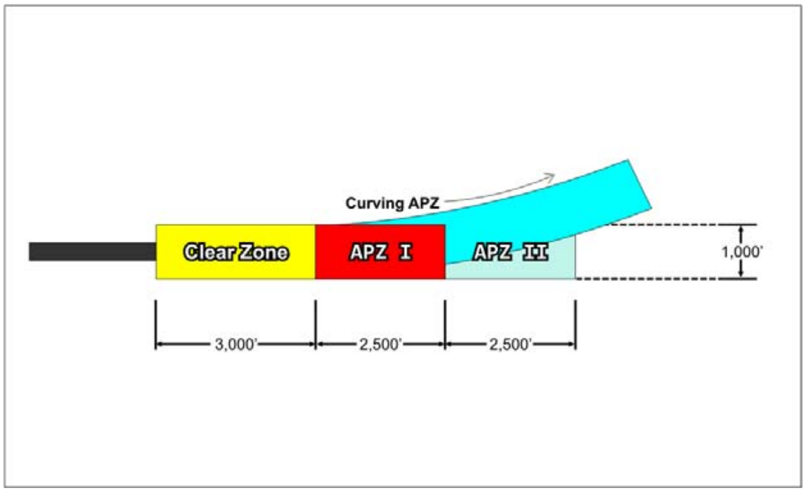
Other, minor incidents that occurred at or around the airfields are not considered Class A mishaps. These include an emergency landing by a T-34C aircraft in the mudflats area.

5.1.2 APZ Configurations and Areas

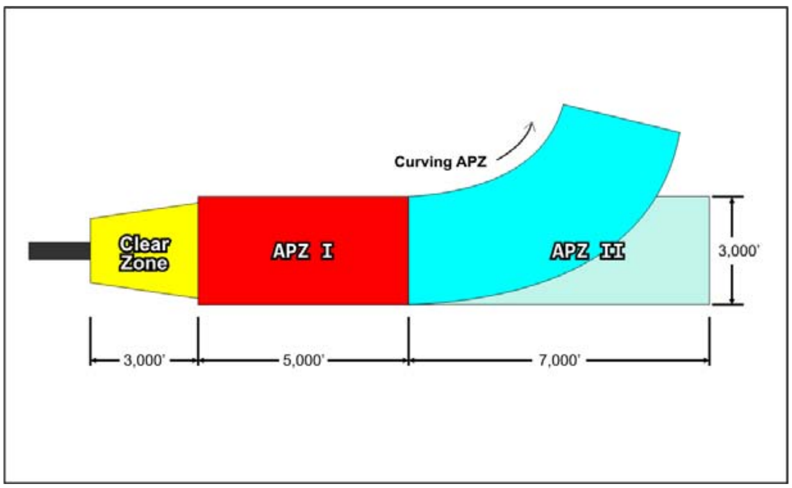
Clear Zones and APZs are areas in the vicinity of airfield runways where an aircraft mishap is most likely to occur. While the likelihood of a mishap is remote, the Navy recommends land uses within APZs be minimal or low density to ensure the maximum protection of public health and property. The DoD 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. Runway 13R/31L at Truax Field is a Class B runway, and all other runways at NASCC, NALF Cabaniss, and NALF Waldron are designated as Class A.

The components of a standard APZ for a Class A runway and Class B runway are identified on Figure 5-1 and are defined as (OPNAVINST 11010.36C):

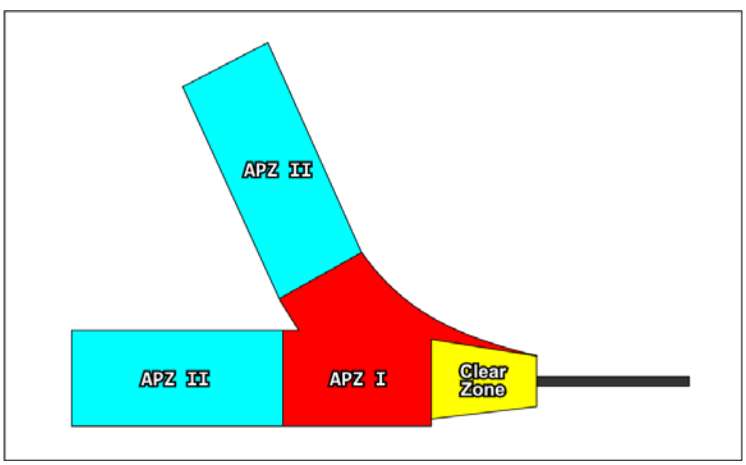
- **Clear Zone.** Extends 3,000 feet immediately beyond the runway and has the highest potential for accidents. The width dimensions of a Class A runway Clear Zone are uniform and measure 1,000 feet from the end of the runway and to its outer edges. A Class B runway measures 1,500 feet wide at the end of the runway and 2,284 feet wide at its outer edge. A Clear Zone is required for all active runways and should remain undeveloped.
- **APZ I.** A Class A runway APZ I extends 2,500 feet beyond the Clear Zone with a width of 1,000 feet. A Class B runway APZ I extends 5,000 feet beyond the Clear Zone with a width of 3,000 feet. An APZ I is typically rectangular; however, when circumstances warrant, the APZ may be curved to correspond with predominant flight tracks. An APZ I area is provided for flight tracks that experience 5,000 or more annual operations (departures or approaches).
- **APZ II.** A Class A runway APZ II extends 2,500 feet beyond the APZ I (or the Clear Zone if APZ I is not used) with a width of 1,000 feet. A Class B runway APZ II extends 7,000 feet beyond APZ I (or the Clear Zone if APZ I is not used) with a width of 3,000 feet. If APZ I is not warranted, the 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. When FCLP is an active aspect of aircraft operations at an installation, APZ II extends the entire FCLP track beyond APZ I.



a) Standard Accident Potential Zones for Class A Runway



b) Standard Accident Potential Zones for Class B Runway



c) Accident Potential Zones With More Than One Predominant Flight Track (for Class B Runway)

Figure 5-1: Accident Potential Zones

An accident is more likely to occur in APZ I than 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 (Figure 5-1c).

Within the Clear Zone, most land uses are incompatible with military aircraft operations. For this reason, the Navy's policy is to acquire sufficient real property interests in land within the Clear Zone to ensure that 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 initiative in combating the threat via their own authority, consideration will be given by the Navy to land acquisition, with priority to Clear Zones and secondary priority to APZs (U.S. Department of the Navy 2002).

In addition to the clear zone, there is a lateral clear zone (called the primary surface) that extends outward for 500 feet on each side and for the length of the runway. Table 5-1 identifies the 2009 AICUZ Clear Zone and APZ acreages at Truax Field, NALF Waldron and NALF Cabaniss (see also Figures 5-2 through 5-7).

Table 5-1: Land Area within the 2009 AICUZ APZs

Airfield	Clear Zone (acres)	APZ I (acres)	APZ II (acres)	Total Area (acres)
Truax Field	631	1,337	2,219	**4,187**
NALF Waldron	274	340	406	**1,020**
NALF Cabaniss	276	485	516	**1,277**

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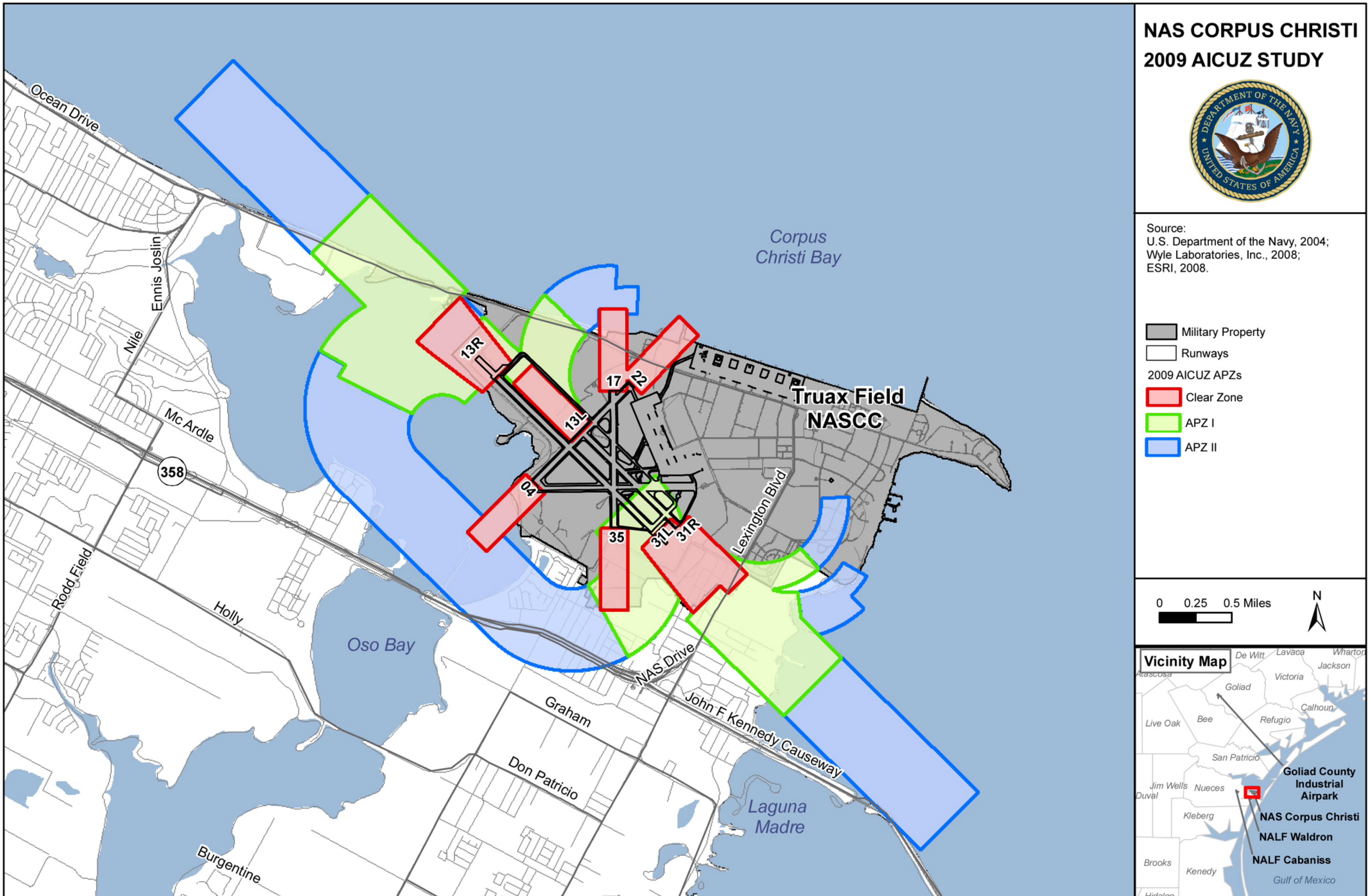

Figure 5-2: 2009 AICUZ APZs
Truax Field, NASCC

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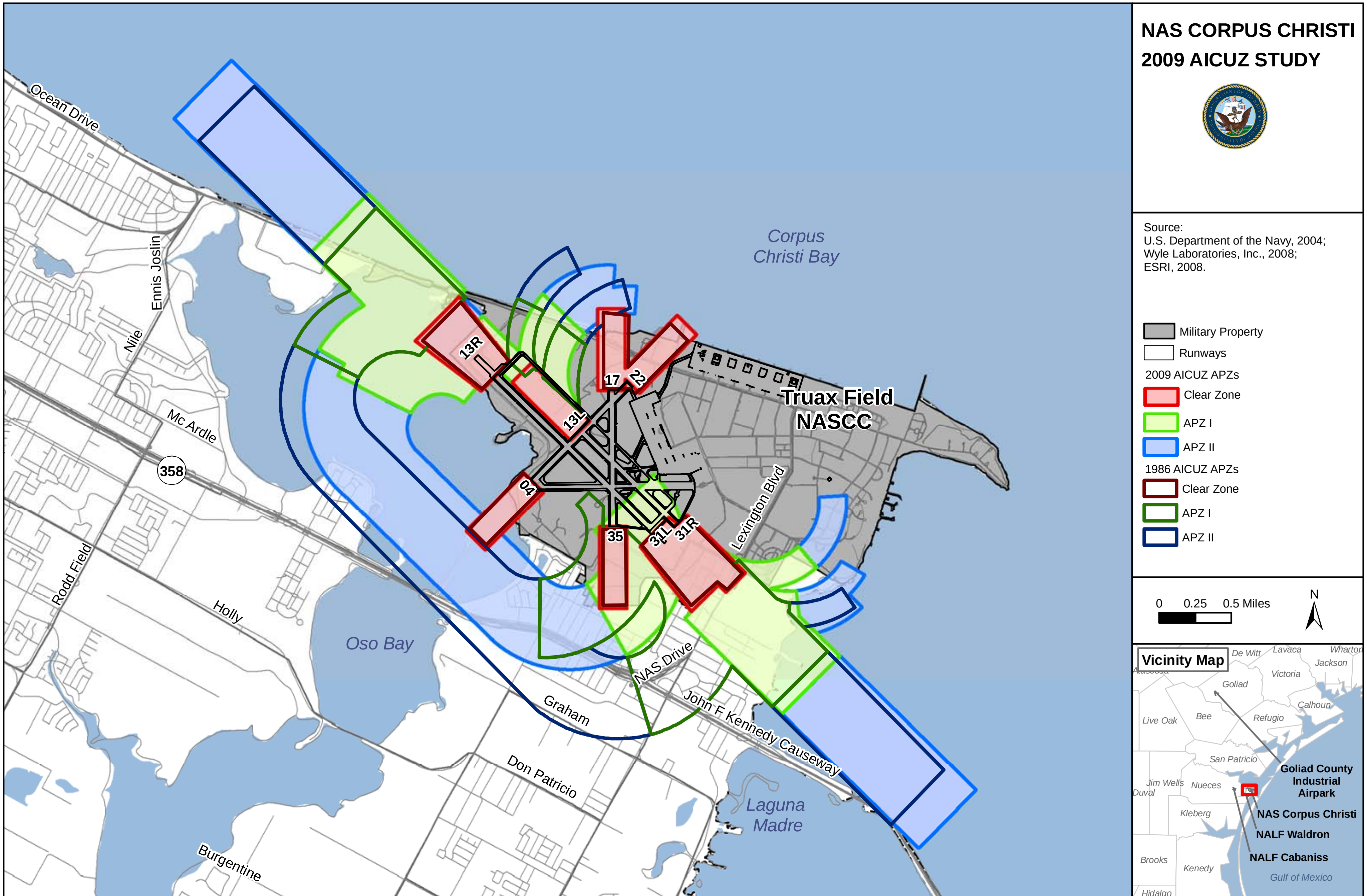

Figure 5-3: Comparison of 1986 and 2009 AICUZ APZs
Truax Field, NASCC

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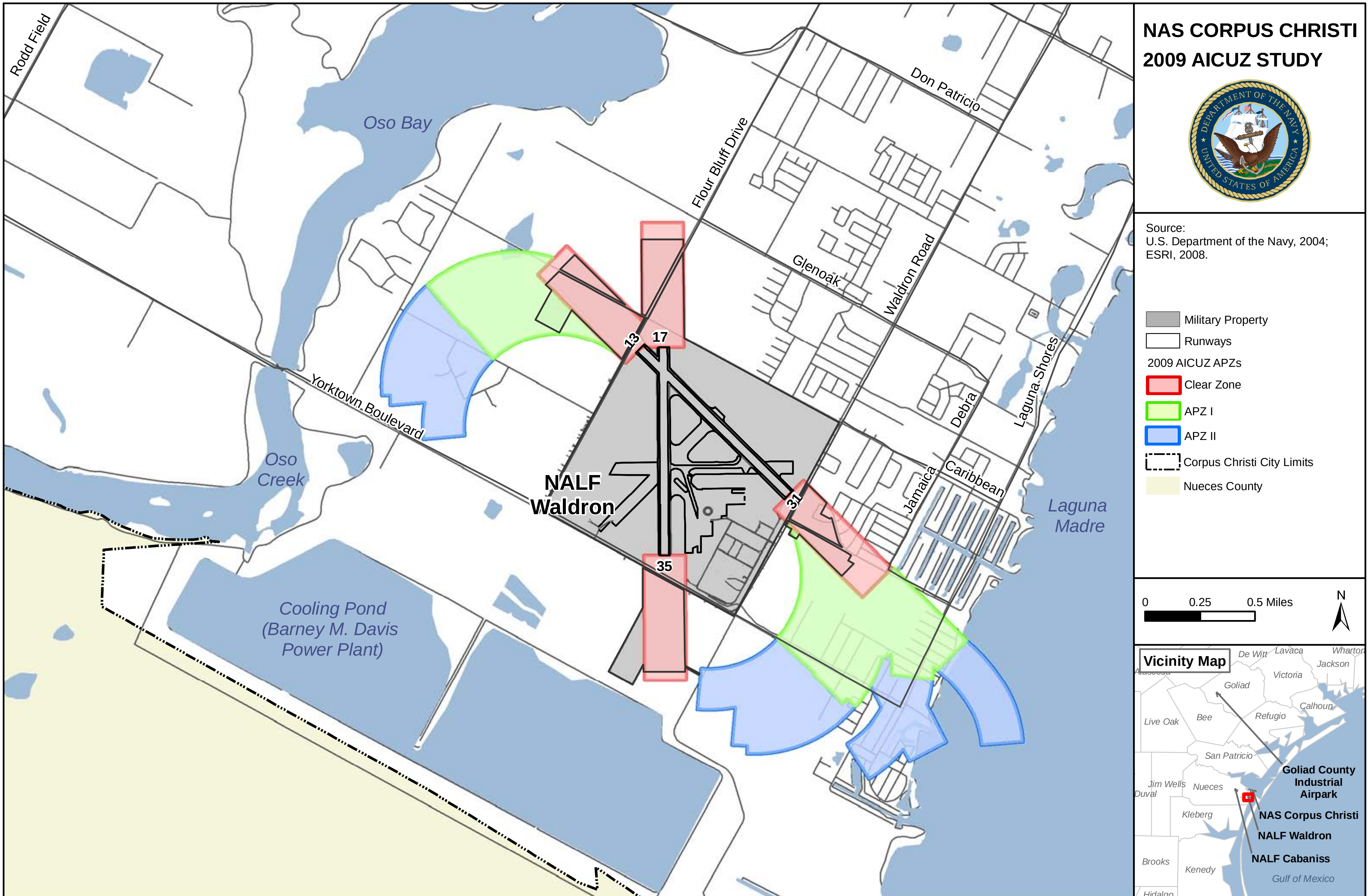

Figure 5-4: 2009 AICUZ APZs
NALF Waldron

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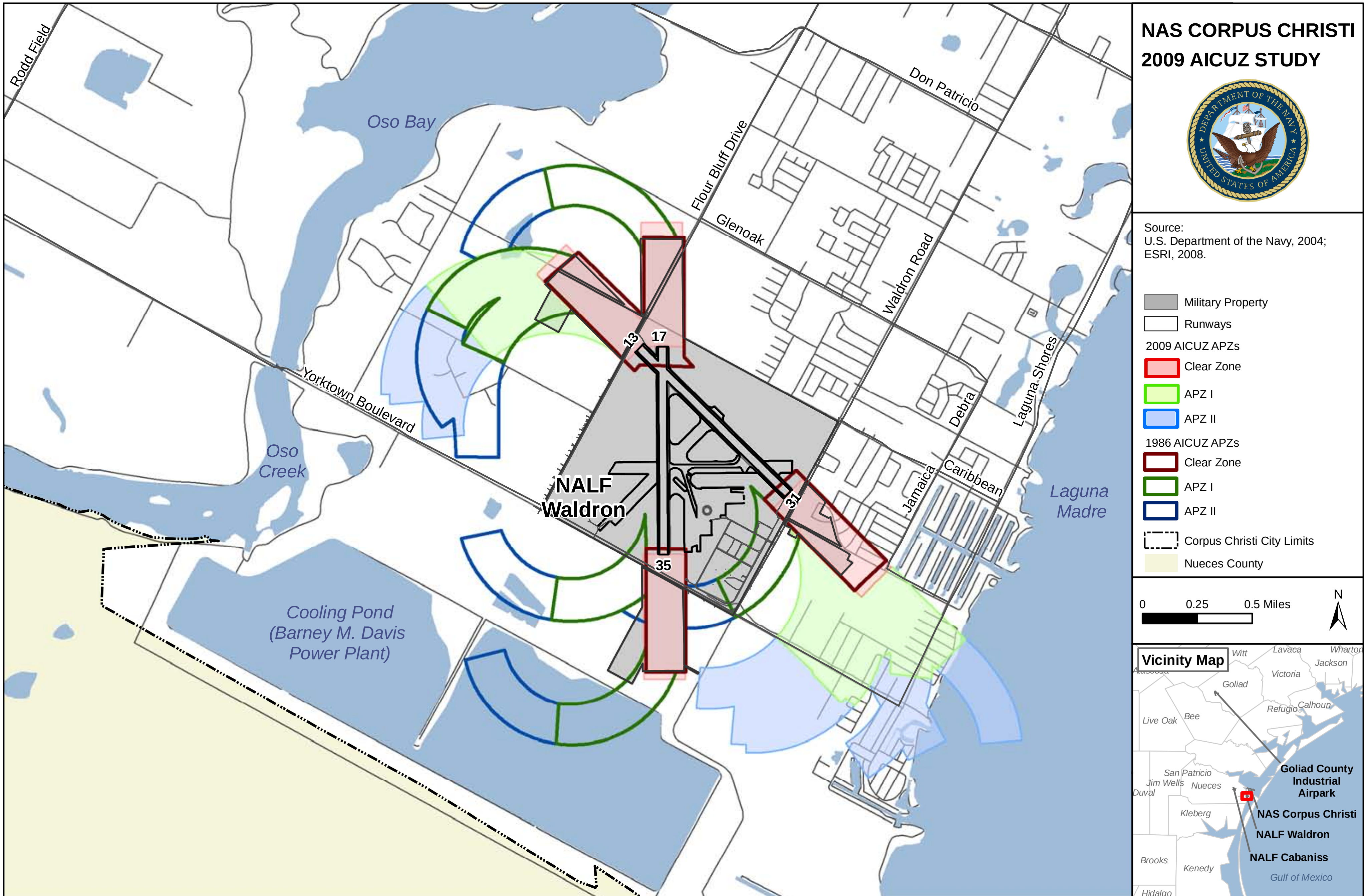

Figure 5-5: Comparison of 1986 and 2009 AICUZ APZs
NALF Waldron

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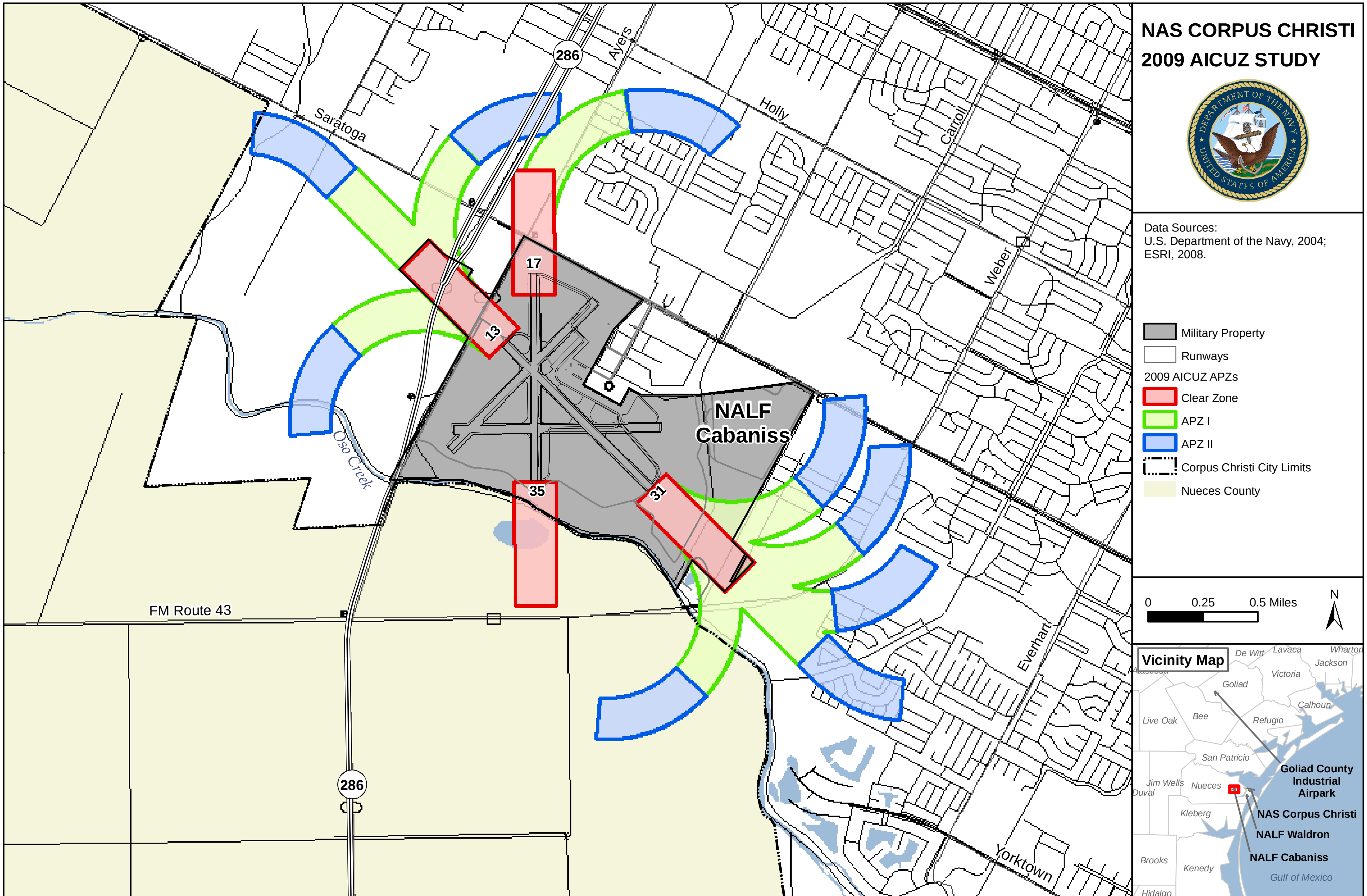

Figure 5-6: 2009 AICUZ APZs
NALF Cabaniss

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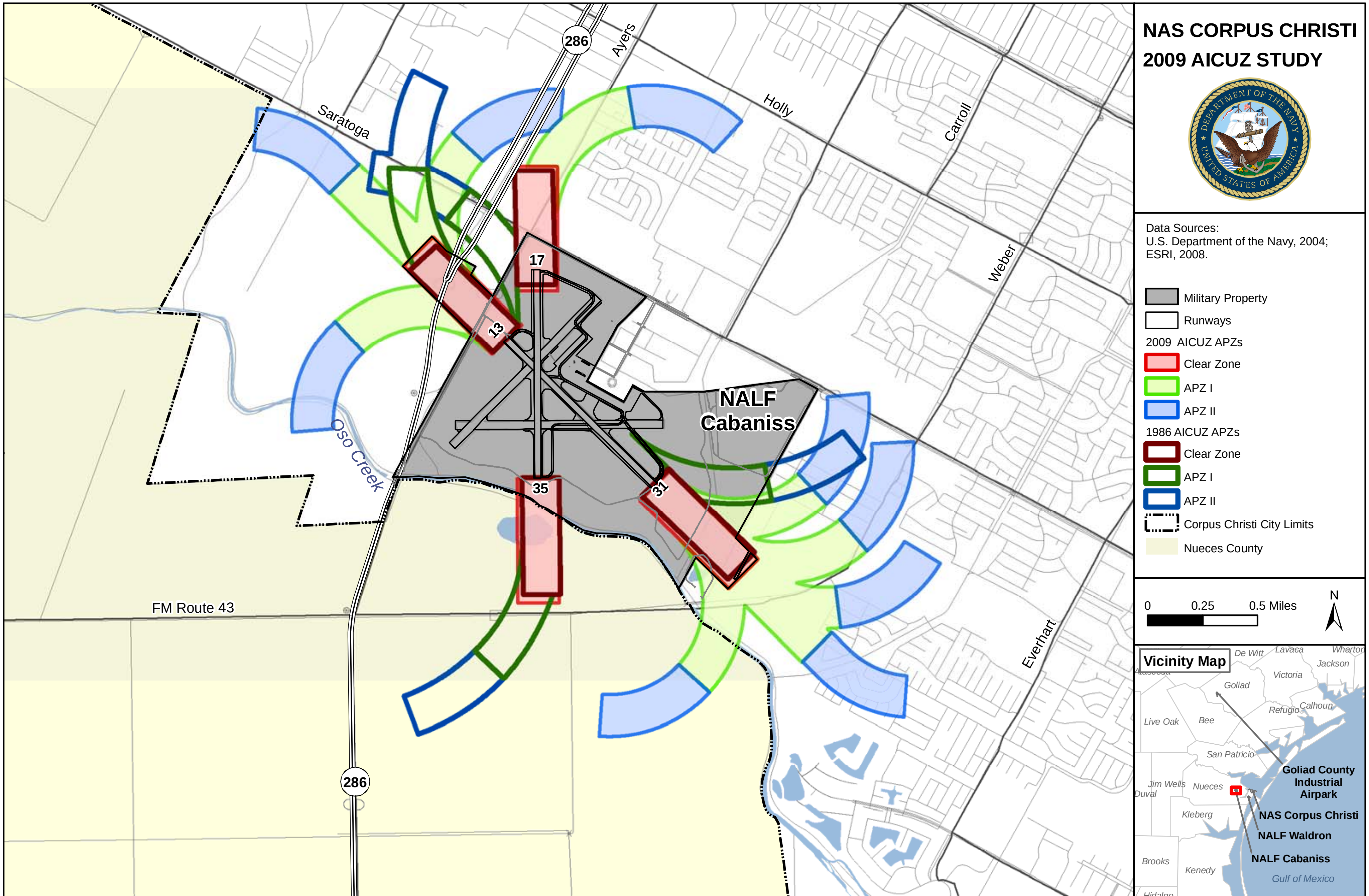

Figure 5-7: Comparison of 1986 and 2009 AICUZ APZs
NALF Cabaniss

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5.2 Flight Safety

5.2.1 Imaginary Surfaces

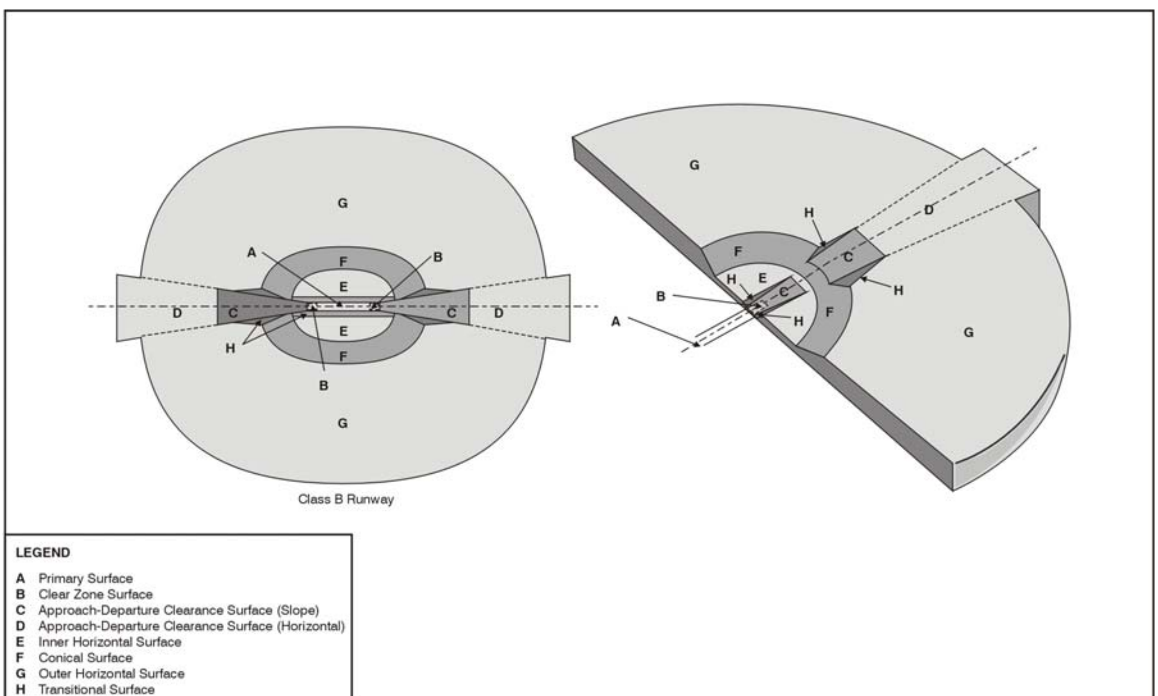
Imaginary planes and transition surfaces define the required airspace that must remain free of obstructions to ensure safe flight approaches, departures, and patterns. Obstructions may include natural terrain and manmade features, such as buildings, towers, poles, and other vertical obstructions to airspace navigation. Brief descriptions of the imaginary surfaces for Class A and B fixed-wing runways are provided in Table 5-2. These areas are labeled on Figure 5-8; Figures 5-9 through 5-11 show the composite imaginary and transitional surfaces at NASCC, NALF Waldron, and NALF Cabaniss, respectively.

Class A and Class B runways have different criteria for imaginary surfaces. Truax Field has both Class A and Class B runways. When the imaginary surfaces of Truax Field, NALF Waldron, or NALF Cabaniss overlap, the most height restrictive imaginary surface prevails.

Table 5-2: Imaginary Surfaces- Class A and Class 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.
Clear Zone	1,000 feet wide, extending 3,000 feet beyond the end of the runway.
Approach Surface	Longitudinally centered with the runway and extending beyond the primary surface.
Horizontal	Horizontal plane 150 feet above the established airport elevation. Constructed by swinging arcs around the end of the primary surface.
Conical Surface	20:1 slope surface extending beyond the horizontal surface.
Transitional Surface	An inclined plane that connects the primary surface and the approach-departure clearance surface to the inner horizontal surface, conical surface, and outer horizontal surface. These surfaces extend outward and upward at right angles to the runway centerline and the runway centerline, extended at a slope of 7:1 from the sides of the primary surface and from the sides of the approach surfaces.

Table 5-2: Imaginary Surfaces- Class A and Class B Fixed-Wing Runways	
Planes and Surfaces	**Geographical Dimensions**
Class B	
Primary surface	A 1,500-foot-wide plane centered over the runway and extending 200 feet beyond the end of the runway.
Clear Zone	A trapezoidal area 3,000 feet beyond the end of the runway, measuring 1,500 feet wide at the runway and 2,284 feet wide at its outer edge.
Approach-departure clearance surface (glide angle: 50:1)	An inclined plane extending at a 50:1 angle (i.e., 1 vertical foot for every 50 horizontal feet), from the end of the primary surface to an elevation of 500 feet above the airfield.
Approach-departure clearance surface (horizontal)	A horizontal surface extending from the 500-foot elevation of the glide angle for a distance of 50,000 feet from the point of origin.
Inner horizontal surface	An oval-shaped plane 150 feet above the runway, extending in a 7,500-foot radius from the centerline of the end of each runway.
Conical surface	A conical surface extending 7,000 feet from the periphery of the inner horizontal surface at a 20:1 slope (i.e., 1 vertical foot for every 20 horizontal feet) to an elevation of 500 feet above the airfield.
Outer horizontal surface	An oval-shaped plane 500 feet above the runway, extending 30,000 feet beyond the periphery of the conical surface.
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.
Source: U.S. Department of Transportation 2006; U.S. Department of Defense 1981.	



SOURCE: US Department of the Navy 1999.

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

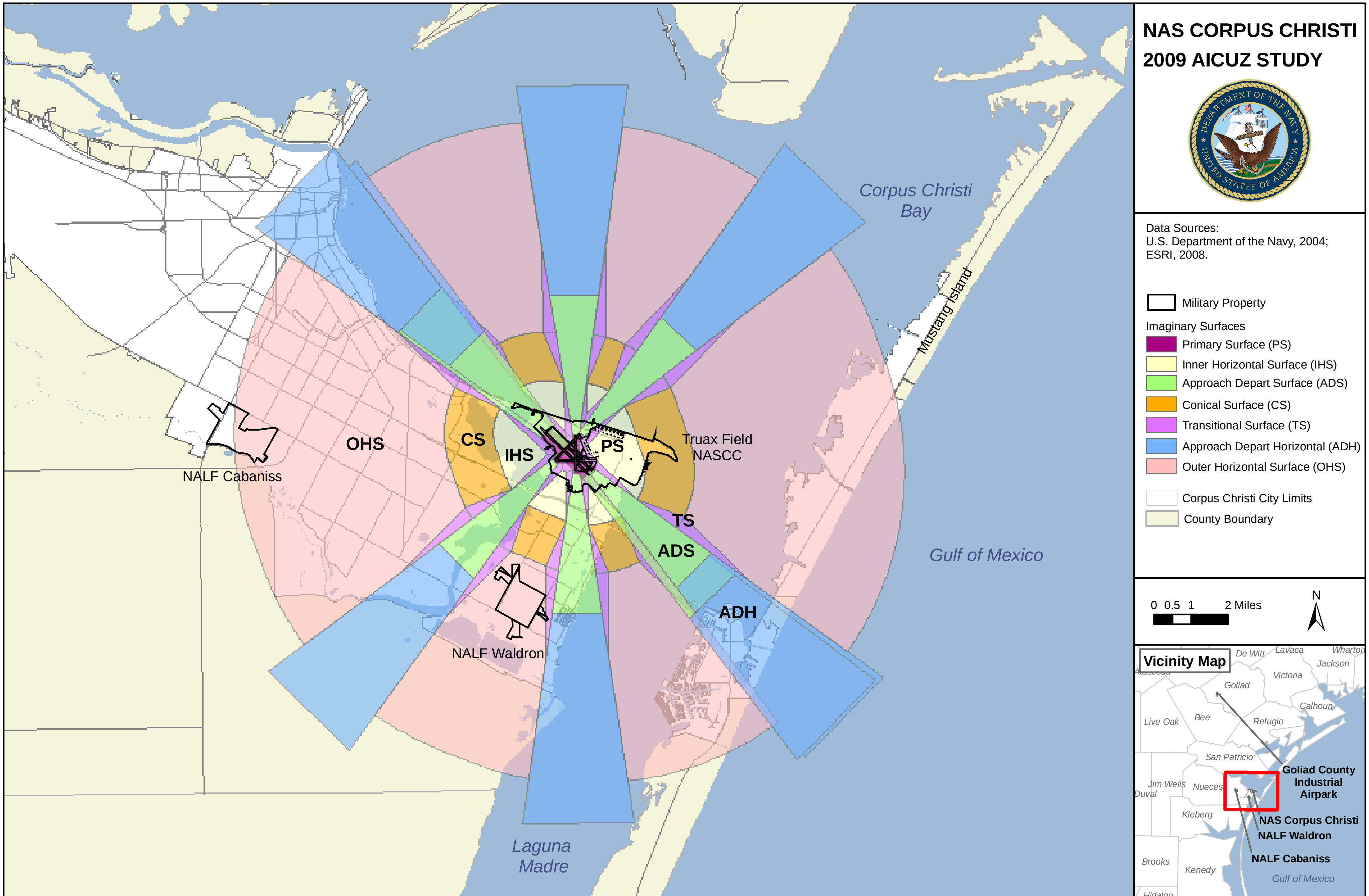


Figure 5-9: Imaginary Surfaces
Truax Field, NASCC

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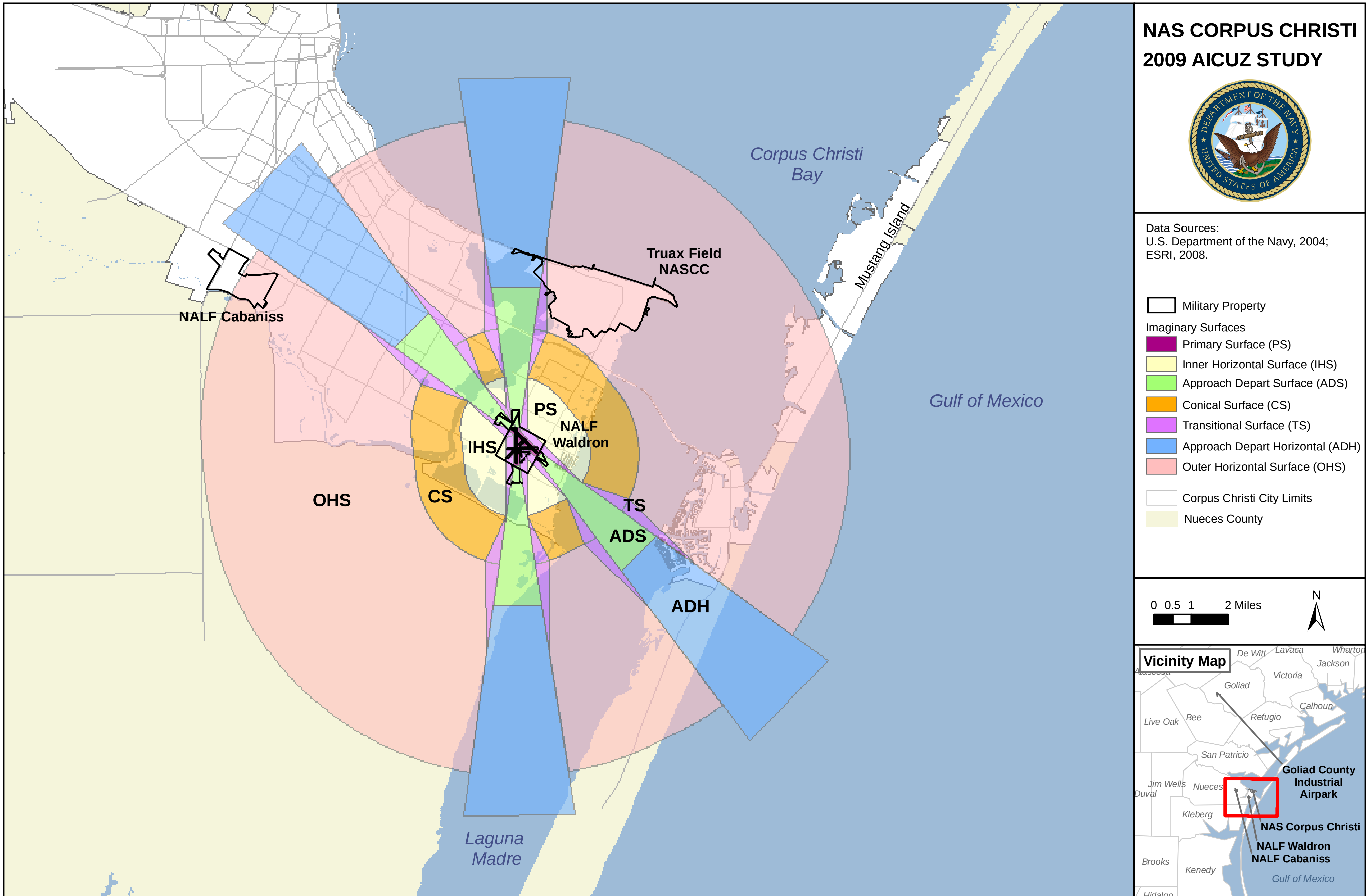

Figure 5-10: Imaginary Surfaces
NALF Waldron

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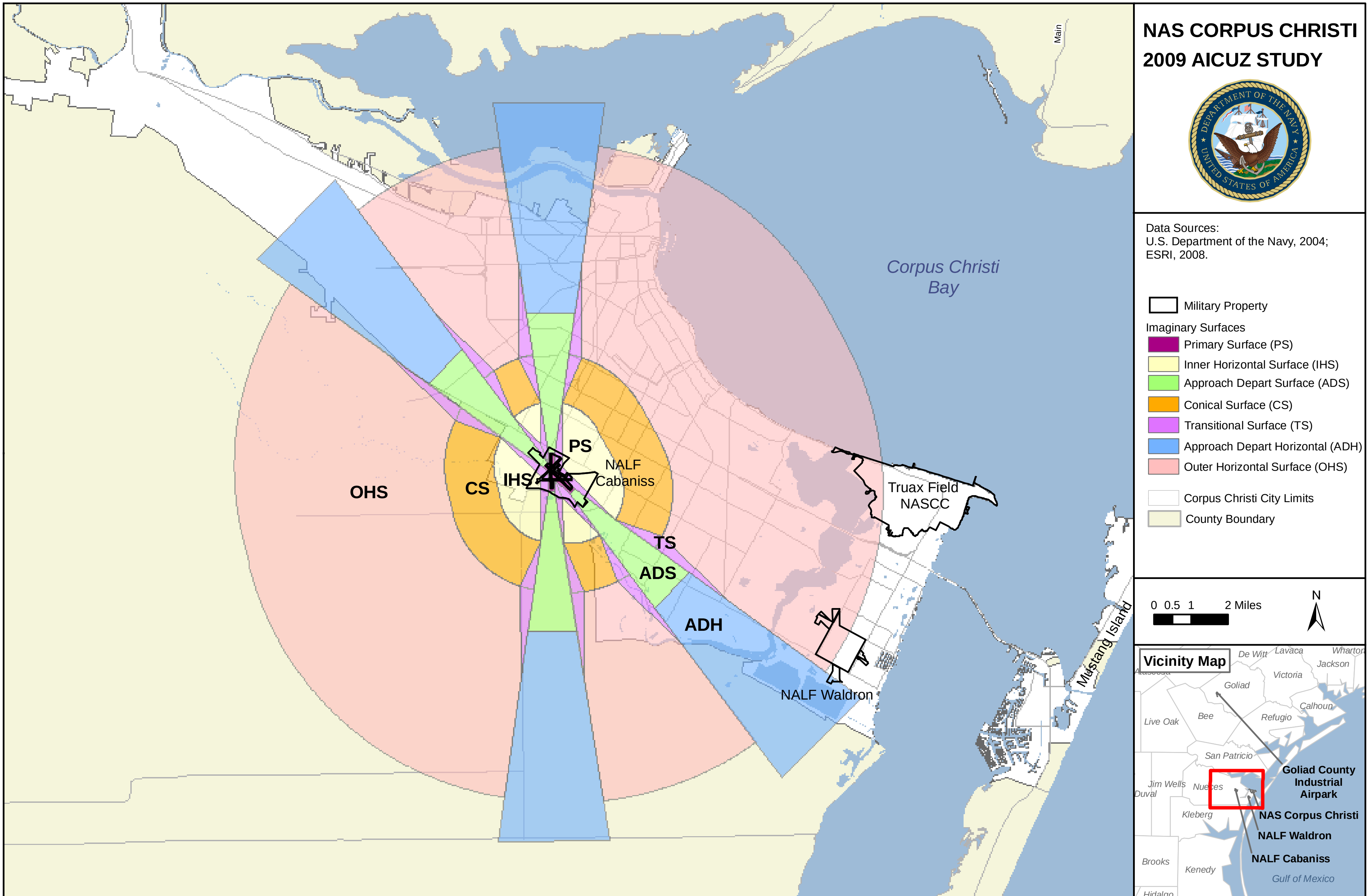

Figure 5-11: Imaginary Surfaces
NALF Cabaniss

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5.2.2 Bird/Animal Aircraft Strike Hazard

Wildlife represents a significant hazard to flight operations. Birds, in particular, are drawn to the open, grassy areas and warm pavement of the airfield. 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. Due to the speed of the aircraft, collisions with wildlife can happen with considerable force.

BASH: bird/animal aircraft strike hazard

To reduce bird/animal aircraft strike hazards (BASH), the FAA and the military recommend that any land uses that attract birds be located at least 10,000 feet from the airfield. These land uses include:

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

NASCC has a full-time BASH coordinator to develop management guidelines. The current BASH management strategies focus on modifying favorable bird habitat surrounding airfields and initiating ‘bird avoidance behavior’ from specified areas.

Design modifications also can be used to reduce the attractiveness of these types of land uses to birds and other wildlife. NASCC established a BASH program to study conditions that attract birds and determine actions to reduce bird densities at the airfields. NASCC has a full-time BASH coordinator to develop management guidelines. The current BASH management strategies focus on modifying favorable bird habitat surrounding airfields and initiating ‘bird avoidance behavior’ from specified areas. Flight operations are also scheduled to avoid known bird migration patterns.

5.2.3 Electromagnetic Interference

New generations of military aircraft are highly dependent on complex electronic systems for navigation and critical flight and

EMI is defined by the American National Standards Institute as any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics/electrical equipment.

mission-related functions. Consequently, care should be taken in siting any activities that create EMI. EMI is defined by the American National Standards Institute as any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics/electrical equipment. 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.

6 Land Use Compatibility Analysis

The **AICUZ footprint** of an airfield is a combination of noise impact zones and APZs. The AICUZ footprint defines the minimum recommended area in which land use controls are needed to protect the health, safety, and welfare of the neighboring community while sustaining the Navy's operational mission.

The **AICUZ Study** is an instrument for the Navy to approach government entities to adopt programs, policies, and regulations that support the Navy mission and encourage compatible development within the vicinity of military facilities.

The AICUZ Program promotes compatible land use development within the vicinity of the military airfields and encourages local governments to incorporate AICUZ recommendations as an element of land use planning. The program is intended to address potential conflict between military and community land uses by identifying high-level noise areas and accident potential areas surrounding a military airfield and recommending compatible land uses for these areas. The AICUZ footprint of an airfield is a combination of noise impact zones and APZs. The AICUZ footprint defines the minimum recommended area in which land use controls are needed to protect the health, safety, and welfare of the neighboring community while sustaining the Navy's operational mission. The NASCC AICUZ Study is a fundamental land use planning tool, and the information presented is intended for consideration by the Installation, the governing authorities of the City of Corpus Christi, and community interest groups.

Although land use activities outside the Installation can impact Navy operations, the use and development of the surrounding properties is under the jurisdiction of the local governments. The AICUZ Study is an instrument for the Navy to approach government entities to adopt programs, policies, and regulations that support the Navy mission and encourage compatible development within the vicinity of military facilities.

The land use compatibility analysis is based on the evaluation of existing land uses and proposed development plans of properties surrounding Truax Field, NALF Waldron, and NALF Cabaniss. Population projections, economic growth trends, land use regulations, and planning practices were also evaluated to determine how local and regional development patterns and growth management strategies could impact future operations at each airfield. Land use compatibility conditions and recommendations to address areas of incompatibility are included in the final assessment.

6.1 Regional Land Use and Development Control

6.1.1 Regional Land Use and Population Growth

The City of Corpus Christi is an urban community situated along the southern coastline of Texas at the mouth of the Nueces River. The city's total area is approximately 460 square miles (294,400 acres) comprised of 154 square miles of land area and 306 square miles of water. Primary land uses within the city are residential development, commercial business, public use facilities, and park land. According to the city's Future Land Use Plan, there are 78 square miles of undeveloped land within the city limits (City of Corpus Christi 2005).

The **City of Corpus Christi** is among the largest metropolitan areas in the Coastal Bend region of South Texas and ranks as the eighth most populous city in Texas.

The City of Corpus Christi is among the largest metropolitan areas in the Coastal Bend region of South Texas and ranks as the eighth most populous city in Texas with a density of 1,794.2 persons per square mile (U.S. Census Bureau 2000a). According to decennial demographic profiles, the City of Corpus Christi has a population of 277,454 persons, 98,791 households, and 70,437 families (U.S. Census Bureau 2000). Subsequent population estimates for 2007 indicate a 2.4% growth and a total population of 284,203 (Texas State Data Center and Office of the State Demographer [TSDC and OSD] 2007a). The greater Corpus Christi Metropolitan Statistical Area (MSA), which includes San Patricio, Aransas, and Nueces Counties, has a population count of 403,280 persons (U.S. Census Bureau 2000b).

Table 6-1 identifies the decennial population estimates and additional five-year projections for the City of Corpus Christi and the greater MSA from 1990 through 2025. The TSDC and the U.S. Census Bureau do not provide long-term population projections for cities/places.

Population projections through 2025 indicate continuous growth in the region.

Table 6-1: Population Estimates and Projections for the City of Corpus Christi and the Greater Corpus Christi Metropolitan Statistical Area (MSA)

Population Area	1990[(a)]	2000[(a)]	2005	2010	2015	2025
Corpus Christi, Texas	257,453	277,454	283,474	NA	NA	NA
Corpus Christi MSA, Texas	367,786	403,280	403,952	460,846	489,651	541,676

Source: U.S. Census Bureau 2000b; TSDC and OSD 2007a.
Note: (a) U. S. Census counts, not estimates

6.1.2 Regional Economy and Employment

The Corpus Christi metropolitan area's economic base is supported by a diversity of industries including energy-related development, oil and gas, agriculture, shipping and cargo, and military services. As a major resort area in Texas, tourism is important to Corpus Christi's economy. Among the largest employment base within the City of Corpus Christi is the refining and petrochemical industry. The City of Corpus Christi is one of the largest natural gas production areas and supports several refinery facilities, chemical plants, and onshore and offshore oil drilling operations.

The Port of Corpus Christi, located on the Gulf of Mexico and approximately 150 miles north of the United States/Mexico border, is the seventh largest port in the United States. This port supports coastal shipping and offshore oil and gas drilling. The Port of Corpus Christi is a significant employment source, offering approximately 40,000 job opportunities from cargo and shipping activities. Commodities distributed through the Port of Corpus Christi that generate the greatest revenue and have the greatest employment impact include petroleum, petroleum products, machinery, chemicals, ore, alumina, and bulk grain (Martin Associates 2004).

The Corpus Christi region is also home to a large military complex that includes NASCC and the CCAD, which is located on the

CCAD is the largest single employer in the Corpus Christi region.

Navy's property. CCAD is the largest single employer in the region (Impact DataSource 2001).

6.1.3 Planning and Zoning Authorities

ETJ: extra-territorial jurisdiction

The City Charter of Corpus Christi has mandated a Comprehensive Plan to guide and manage the development and redevelopment of lands within the city limits and within the city's 5-mile extra-territorial jurisdiction (ETJ). Properties surrounding NASCC, NALF Waldron, and NALF Cabaniss are under the City of Corpus Christi's jurisdiction and subject to the development policies, standards, and regulations that support the City's Comprehensive Plan. The Comprehensive Plan, which is adopted by the City Council, is comprised of several elements including Comprehensive Policy Statements, Area Development Plans, Specific Area Plans, a Future Land Use Master Plan, a Transportation Master Plan, an Annexation Plan, and various utility master plans.

The City's Planning Commission is an advisory board to the City Council and is responsible for reviewing land use activity and proposed development to ensure consistency with the Comprehensive Plan. Specifically, the Planning Commission advises the City Council regarding:

- The adoption, amendment, and implementation of the Comprehensive Plan and the Plan elements;
- Proposals to adopt or amend land development regulations;
- Five-year updates to the Comprehensive Plan;
- Requests for zoning amendments;
- Annual budget and capital improvement bond programs; and
- Platting and subdividing of property within the city limits and ETJ.

The Zoning Ordinance, Platting Ordinance, Building Code, and Capital Improvement Programs are the City's tools to implement the Comprehensive Plan objectives. To manage land utilization and direct future growth, the City of Corpus Christi has established zoning districts and regulations under the Corpus Christi Zoning Ordinance. All properties within the city are classified into zoning districts that permit or prohibit property use and development density. However, zoning districts do not always indicate the actual land use.

The City has not incorporated air installation zoning regulations into the local zoning ordinance to address compatible development in the vicinity of NASCC or the outlying fields. However, policy statements within the City's Comprehensive Plan reference the need for such regulations. The City's Comprehensive Policy Statements, adopted in 1987, specify that "Areas surrounding existing private, public, and military airports should be developed in a manner that is compatible with the operation of the airports" (City of Corpus Christi 1987). This policy has also been incorporated into the Future Land Use Plan that was adopted May 24, 2005. However, the Future Land Use Plan policies do not constitute zoning regulations or establish zoning districts.

Under the City's Platting Ordinance, the preliminary plat application for land subdivision requires developers to identify any AICUZ boundaries within the proposed subdivision property. Although air installation zoning regulations are not formally incorporated into a local ordinance, the City of Corpus Christi will notify NASCC regarding any proposed development or rezoning requests of properties around the installation and the auxiliary airfields.

6.1.4 Planned Land Use and Development

City of Corpus Christi policy promotes infill residential and commercial development to cost-effectively provide utility services and infrastructure to new businesses and homes. Truax Field, NALF Waldron, and NALF Cabaniss are located within the city limits, and the vacant properties within the vicinity of these airfields are subject to the City's contiguous development policy. The City's Future Land Use Plan may provide guidance to encourage cooperative development of vacant areas in the vicinity of the Installation, but the City's zoning regulations do not specifically restrict or limit development within the AICUZ noise

City of Corpus Christi policy promotes infill residential and commercial development to cost-effectively provide utility services and infrastructure to new businesses and homes.

contours and APZs. Additionally, properties within the City's ETJ are not subject to zoning regulations, and the City has limited jurisdiction to enforce land use restrictions.

6.2 Land Use Classifications and Compatibility Guidelines

The Navy's recommendations encourage noise-sensitive land uses (e.g., houses, churches, etc.) to be placed outside high-noise zones and discourages people-intensive uses (e.g., apartments, theaters, etc.) to be placed in APZs.

The Navy has developed guidelines for compatible development and land use within an airfield's AICUZ APZs and noise zones. The guidelines are provided in the Navy's Air Installations Compatible Use Zones Program Instructions OPNAVINST 11010.36C (U.S. Department of the Navy 2008). The guidelines are intended for land use planning and development within the AICUZ footprint of naval installations and auxiliary landing airfield. The Navy's recommendations encourage noise-sensitive land uses (e.g., houses, churches, etc.) to be placed outside high noise zones and discourages people-intensive uses (e.g., apartments, theaters, etc.) to be placed in APZs. The land use compatibility assessment conducted for NASCC, including Truax Field, NALF Cabaniss, and NALF Waldron, is based on the Navy's land use compatibility recommendations. Table 6-2 shows existing land use classifications and the associated land use compatibility with each land use designation for AICUZ noise zones and APZs.

Table 6-2: Land Use Classifications and Compatibility Guidelines

	Land Use Compatibility with AICUZ Noise Zone (DNL)						Land Use Compatibility with AICUZ APZs		
	Noise Zone 1		Noise Zone 2		Noise Zone 3		Clear Zone	APZ I	APZ II
	<55	55-64	65-69	70-74	75-79	>80			
Single family Residential	Compatible	Compatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible	Compatible (1)
Multi-family Residential, Hotels	Compatible	Compatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible
Public Assembly Areas and Auditoriums	Compatible	Compatible	Compatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible
Schools and Hospitals	Compatible	Compatible	Compatible (2)	Compatible (2)	Incompatible	Incompatible	Incompatible	Incompatible	Incompatible
Manufacturing/Industrial	Compatible	Compatible	Compatible	Compatible	Incompatible	Incompatible	Incompatible	Incompatible	Compatible
Outdoor parks and Recreation	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 A.

(1) = Maximum density of 1 to 2 dwellings per acre.
(2) = Land use and related structures generally compatible however, measures to achieve recommended noise level reduction should be incorporated into design and construction of the structures.
(3) = Maximum Floor Area Ratio that limits people density may apply.
(4) = Facilities must be low intensity.

Key:
(green) = Compatible
(red) = Incompatible

6.3 Land Use and Compatibility

The AICUZ land use compatibility analysis identifies existing and proposed land use incompatibilities within the 2009 AICUZ footprint of Truax Field, NALF Waldron, and NALF Cabaniss. Compatibility conditions were derived from the Navy's suggested land use compatibility guidelines in both AICUZ noise zones and APZs (Appendix A). Recommended strategies for the AICUZ implementation are based on the findings from the land use assessment.

Existing land use data were evaluated to ensure an actual account of land use activity regardless of conformity to zoning classification or designated planning or permitted use. For properties in the vicinity of Truax Field, NALF Waldron, and NALF Cabaniss, land use data were provided by the City of Corpus Christi's Development Services Department.

6.3.1 Existing Land Uses within AICUZ Footprints

6.3.1.1 Truax Field

Truax Field is sited on the main base of NASCC, which is located on the Encinal Peninsula and approximately 8 miles from the City of Corpus Christi downtown area. Bodies of water surround the airfield on the north, east, and west. To the south of Truax Field is a mix of urban development. Commercial business is heavily concentrated along State Highway 358 (also referred to as South Padre Island Drive) just south of the Installation and along NAS Drive/Lexington Boulevard leading into the South Gate entrance of the Installation. Mustang Island and Mustang Island State Park are further east from the Encinal Peninsula and across the Laguna Madre. Mustang Island is a luxury resort destination and tourist area with a variety of recreational amenities and marine activities.

Within the 2009 AICUZ noise zones surrounding Truax Field, approximately 386 acres are exposed to noise levels exceeding 75 DNL and 1,433 acres are exposed to noise levels ranging between 65 and 75 DNL. These high-level noise areas are almost entirely contained to military property and surrounding water bodies. Off-base land use within the 2009 AICUZ noise contours is primarily water and vacant land, minimizing the noise impact to the surrounding area. The total acreage of all existing land use within the 2009 AICUZ noise contours is summarized in Table 6-3 and illustrated on Figure 6-1.

Off-base land use within the Truax Field 2009 AICUZ noise contours is primarily water and vacant land, minimizing the noise impact to the surrounding area.

Table 6-3: Existing Land Use within Truax Field 2009 AICUZ Noise Zones

Land Use	NOISE ZONE (acres)				
	60 to 65 DNL	65 to 70 DNL	70 to 75 DNL	75+ DNL	TOTAL
Commercial/Office	6.68	5.48	0.00	0.00	**12.16**
Conservation/Preservation/Park	4.37	0.31	0.00	0.00	**4.68**
Light Industrial	1.22	0.40	0.00	0.00	**1.62**
Military	969.26	478.18	332.72	367.33	**2,147.49**
Public/Semi-Public	17.56	1.25	0.00	0.00	**18.81**
Residential- Low Density	20.97	2.04	0.00	0.00	**23.01**
Residential- Medium Density	2.54	0.31	0.00	0.00	**2.85**
Residential- Mobile Home	21.42	21.70	0.00	0.00	**43.12**
Right-of-Way/Drainage	26.02	8.92	0.00	0.00	**34.94**
Vacant	95.61	88.06	1.81	0.00	**185.48**
Water	1,503.35	418.31	73.80	18.23	**2,013.69**
Total	**2,669.00**	**1,024.96**	**408.33**	**385.56**	**4,487.85**

Key:
AICUZ = Air Installations Compatible Use Zones.
DNL = day-night average sound level.

The predominant land uses within the Truax Field 2009 AICUZ APZs are military properties, water, and vacant land. However, properties south of the airfield and within APZs I and II are comprised of mobile homes, low-density residential housing, and commercial development. East of the airfield and across Oso Bay are the Texas A&M University campus and student housing, which lie within the APZs I and II of Runway 13/31. Table 6-4 summarizes the total acreage of land uses within Truax Field APZs. Existing land use in the vicinity of Truax Field and the APZs are illustrated on Figure 6-2.

Table 6-4: Existing Land Use within Truax Field 2009 AICUZ APZs

Land Use	ACCIDENT POTENTIAL AREA (acres)			
	Clear Zone	APZ I	APZ II	TOTAL
Commercial/Office	0.90	17.18	58.22	**76.30**
Conservation/Preservation/Park	0.00	6.29	15.96	**22.25**
Light Industrial	0.00	0.58	0.57	**1.15**
Military	455.61	323.02	81.18	**859.81**
Public/Semi-Public	1.13	45.57	9.81	**56.51**
Residential- Low Density	0.23	23.73	79.76	**103.72**
Residential- Medium Density	0.08	4.39	48.95	**53.42**
Residential- Mobile Home	0.00	62.96	23.21	**86.17**
Right-of-Way/ Drainage Corridor	1.53	34.64	84.47	**120.64**
Vacant	1.30	181.49	63.66	**246.45**
Water	170.28	636.67	1,753.18	**2,560.13**
Total	**631.06**	**1,336.52**	**2,218.97**	**4,186.55**

Key:
AICUZ = Air Installations Compatible Use Zones.
APZ = Accident Potential Zone.

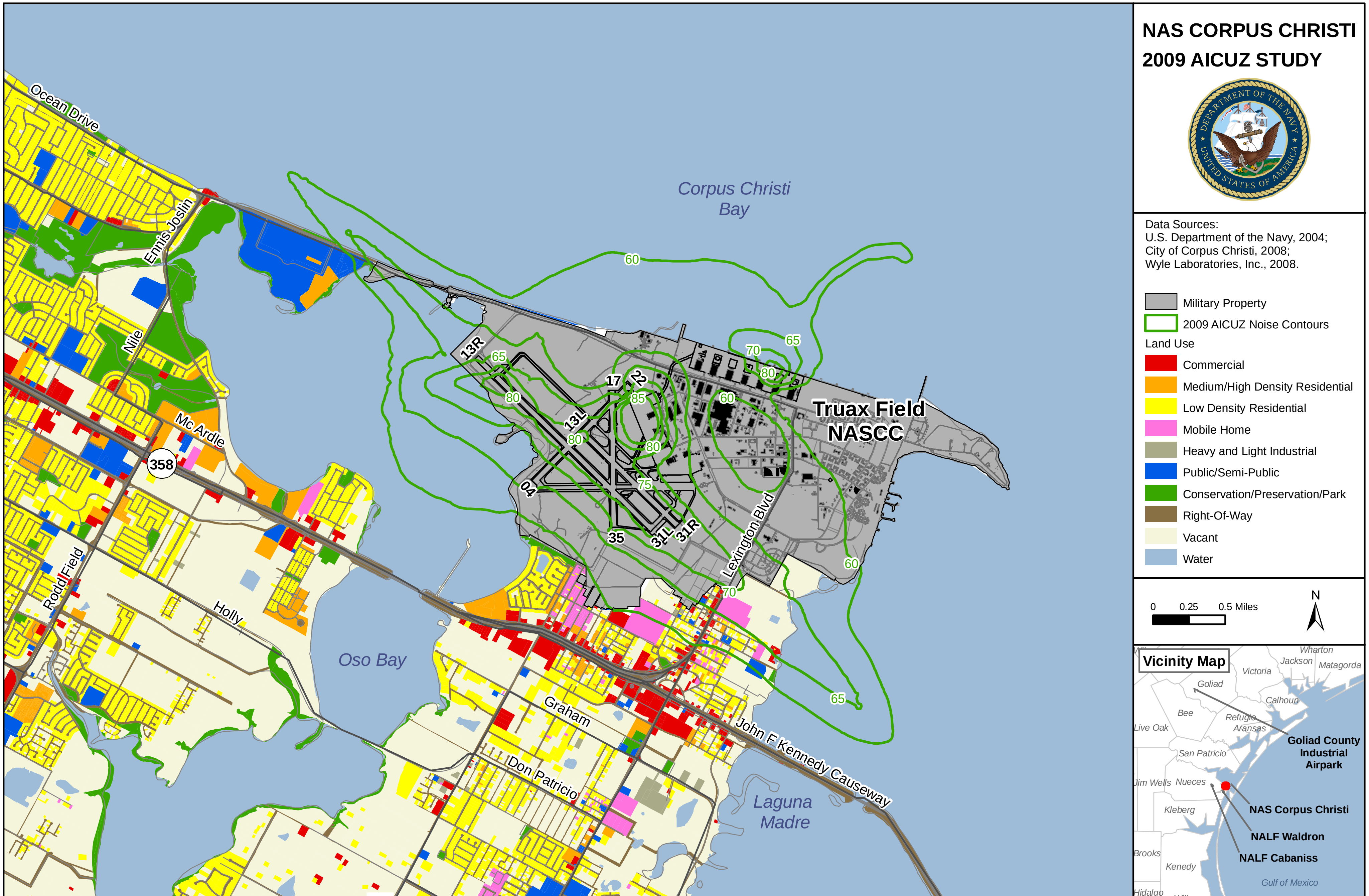

Figure 6-1: Existing Land Use and 2009 AICUZ Noise Contours
Truax Field, NASCC

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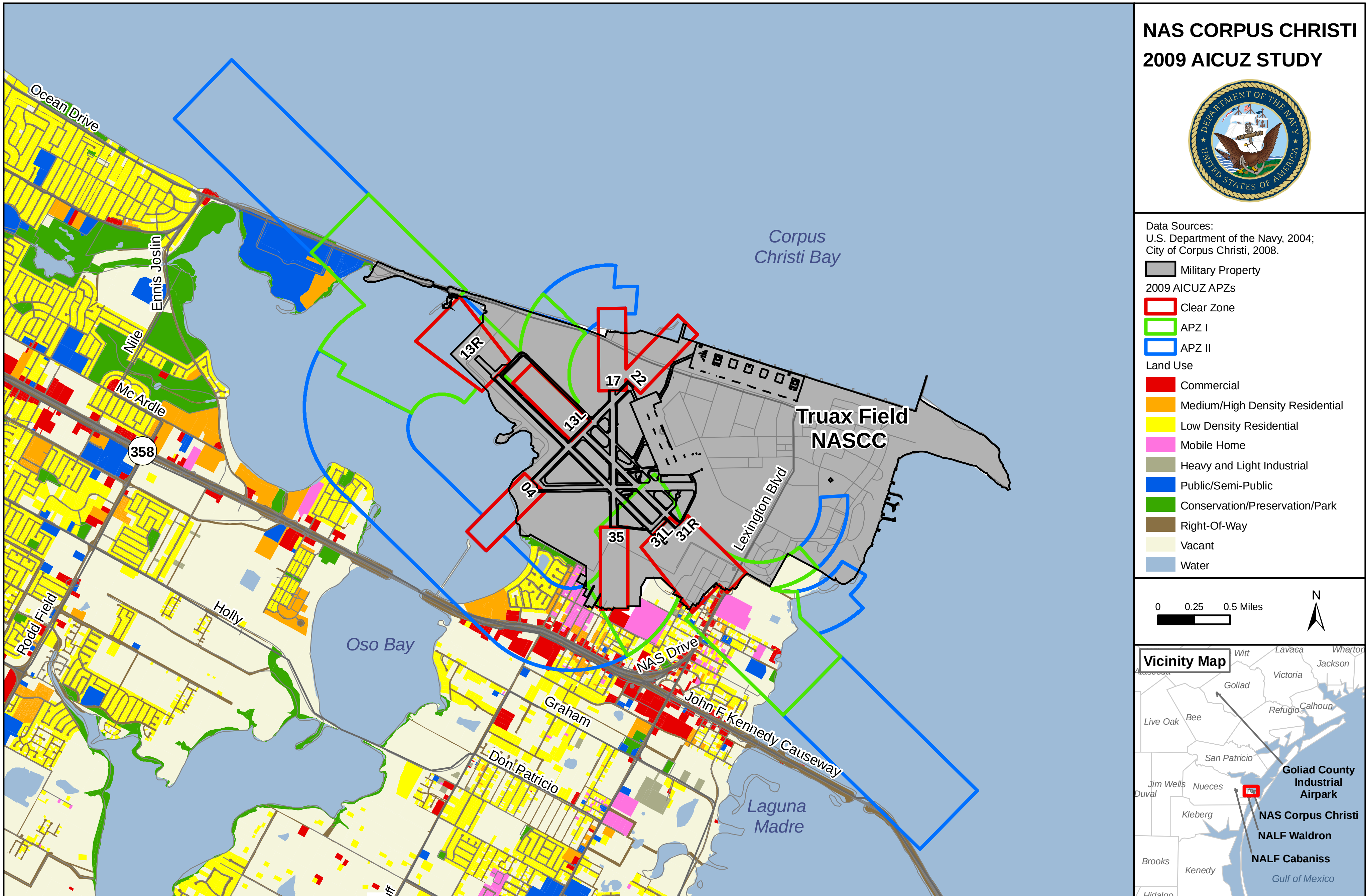

Figure 6-2: Existing Land Use and 2009 AICUZ APZs
Truax Field, NASCC

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6.3.1.2 NALF Waldron

NALF Waldron is located in a growing region in the southeast corner of the City of Corpus Christi, approximately 3.5 miles south of the main base. Existing community development is concentrated to the east of the airfield, while the areas north, south, and west are less populated. The areas northeast and southeast of NALF Waldron primarily consist of low-density residential development mixed with pockets of mobile homes, park land, medium-density residential development, public use facilities, and commercial development. Six schools and two churches are located in the far northeast vicinity of NALF Waldron. A mix of vacant lands, low-density residential housing, and commercial development is west of the airfield. Low-density residential property immediately borders the western boundary of the airfield. Although the area south of the airfield consists of large tracts of undeveloped land, small pockets of public/semi-public land use and mobile homes are immediately adjacent to the airfield's southern perimeter.

NALF Waldron's 2009 AICUZ noise contours extend over approximately 2,403 acres. While the highest level noise area (75+ DNL) is contained within the airfield boundaries, a considerable area of residential development (approximately 186 acres) is currently located within high-level noise zones (65 to 75 DNL). In addition to residential development, off-base land use within the noise contours is mostly water and vacant land. The total acreage of all existing land use within the 2009 AICUZ noise contours is summarized in Table 6-5 and illustrated on Figure 6-3.

Approximately 165 acres of low-density residential development is located within NALF Waldron's 2009 AICUZ APZs, of which 6 acres are directly within the Clear Zones.

Existing land use within the 2009 AICUZ APZs is primarily military property or vacant land. Approximately 165 acres of low-density residential development is located within the APZs, of which 6 acres are directly within the Clear Zones. One (1) acre of commercial development is also located directly in the Clear Zone of Runway 17/35. The total acreage of all existing land use within NALF Waldron's 2009 AICUZ APZs is summarized in Table 6-6 and illustrated on Figure 6-4.

Table 6-5: Existing Land Use within NALF Waldron 2009 AICUZ Noise Zones

Land Use	NOISE ZONE (acres)				
	60 to 65 DNL	65 to 70 DNL	70 to 75 DNL	75+ DNL	TOTAL
Commercial/Office	13.38	6.28	0.00	0.00	**19.66**
Conservation/ Preservation/Park	6.06	0.00	0.00	0.00	**6.06**
Light Industrial	0.00	0.87	0.00	0.00	**0.87**
Military	346.84	210.88	102.150	66.29	**726.16**
Public/Semi-Public	108.39	1.07	10.03	0.00	**119.49**
Residential- Low Density	159.10	162.95	14.51	0.00	**336.56**
Residential- Medium Density	6.06	0.90	0.00	0.00	**6.96**
Residential- Mobile Home	11.00	8.01	0.00	0.00	**19.01**
Right-of-Way/Drainage	50.90	57.63	8.76	0.89	**118.18**
Vacant	489.48	199.79	55.48	0.00	**744.75**
Water	275.27	30.22	0.00	0.00	**305.49**
Total	**1,466.48**	**678.60**	**190.93**	**67.18**	**2,403.19**

Key:
AICUZ = Air Installations Compatible Use Zones.
DNL = day-night average sound level.
NALF = Naval Auxiliary Landing Field.

Table 6-6: Existing Land Use within NALF Waldron 2009 AICUZ APZs

Land Use	ACCIDENT POTENTIAL AREA (acres)			
	Clear Zone	APZ I	APZ II	TOTAL
Commercial/Office	1.04	2.90	4.58	**8.52**
Conservation/ Preservation/Park	0.00	0.00	2.72	**2.72**
Light Industrial	0.00	0.00	0.87	**0.87**
Military	220.28	11.72	0.01	**232.01**
Public/Semi-Public	8.61	0.11	1.10	**9.82**
Residential- Low Density	6.09	74.78	84.43	**165.30**
Residential- Medium Density	0.00	0.00	0.59	**0.59**
Residential- Mobile Home	0.00	1.21	9.24	**10.45**
Right-of-Way/ Drainage	8.86	27.12	25.25	**61.23**
Vacant	28.33	220.56	213.41	**462.30**
Water	0.00	2.23	64.43	**66.66**
Total	**273.21**	**340.63**	**406.63**	**1,020.47**

Key:
AICUZ = Air Installations Compatible Use Zones.
APZ = Accident Potential Zone.
NALF = Naval Auxiliary Landing Field.

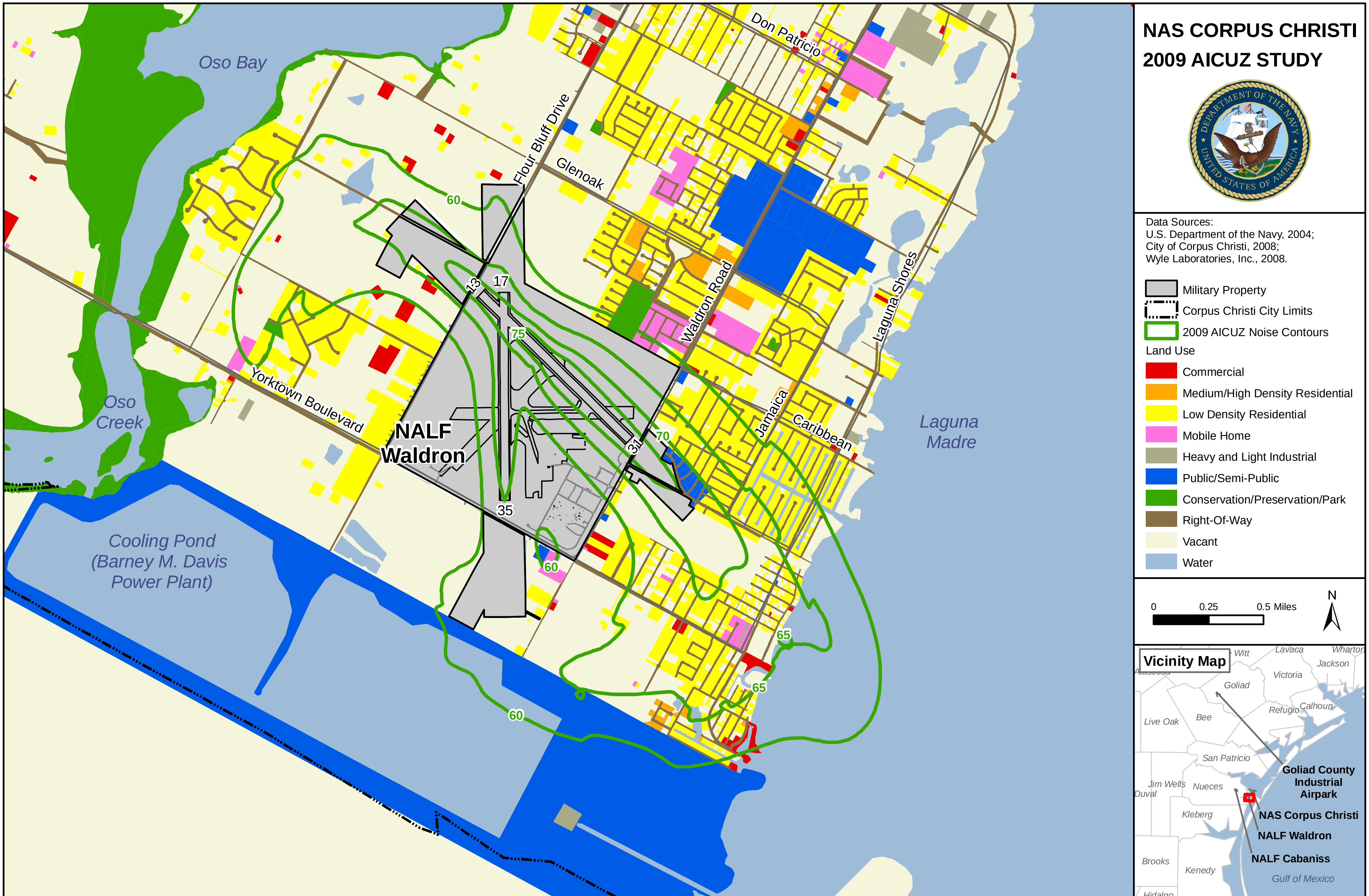

Figure 6-3: Existing Land Use and 2009 AICUZ Noise Contours
NALF Waldron

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Figure 6-4: Existing Land Use and 2009 AICUZ APZs
NALF Waldron

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6.3.1.3 NALF Cabaniss

NALF Cabaniss is located approximately 8 miles west of NASCC along Oso Creek and the southern city limits. The vicinity of NALF Cabaniss is characterized by a combination of industrial development and public use facilities to the west and community and commercial development to the east. The north entrance area approaching NALF Cabaniss includes the Cabaniss Industrial Park recreational complex and Corpus Christi Independent School District property. Land uses further north and east transition to development consisting of single-family housing, mobile home parks, and group quarters/apartments, commercial businesses, and neighborhood parks. Directly west of the airfield is State Highway 286 and a city-operated transfer station. The areas further west and south of the airfield are predominantly vacant lands and public-service industrial development. The City's ETJ is south of NALF Cabaniss, and this area is open and undeveloped land.

NALF Cabaniss 2009 AICUZ noise contours do not exceed the boundary of the airfield; therefore, military property is the only land use within the noise zones. Existing land uses surrounding NALF Cabaniss and the 2009 AICUZ noise contours are illustrated on Figure 6-5 (tabular information is not presented for land use within the noise zones).

The predominant land uses within the NALF Cabaniss 2009 AICUZ APZs are military property, vacant land, and public/semi-public

The total area of NALF Cabaniss 2009 AICUZ APZ is approximately 1,276 acres. The predominant land uses within the APZs are military property, vacant land, and public/semi-public properties (Figure 6-6). According to land use data provided by the City of Corpus Christi, the Clear Zones overlay 62.72 acres of undetermined public use property and 9.51 acres of right-of-way. Aerial photographs do not indicate that any structures are located on the identified public use property. The total acreage of all existing land use within the NALF Cabaniss 2009 AICUZ APZs is summarized in Table 6-7 and illustrated on Figure 6-6.

Table 6-7: Existing Land Use within NALF Cabaniss 2009 AICUZ s APZs				
Land Use	**Acres**			
	Clear Zone	**APZ I**	**APZ II**	**Total**
Commercial/Office	0.09	36.87	32.47	69.43
Conservation/Preservation/Park	0.00	18.85	1.83	20.68
Light Industrial	0.00	28.53	31.63	60.18
Military	175.89	22.74	0.00	198.63
Public/Semi-Public	62.72	46.94	78.36	188.02
Residential- Low Density	0.00	16.93	68.03	84.96
Residential- Medium Density	0.00	0.00	13.50	13.50
Residential- Mobile Home	0.00	8.84	15.89	24.73
Right-of-Way/ Drainage Corridor	9.51	42.24	72.04	123.79
Vacant	13.81	259.95	200.24	474.00
Water	13.46	3.41	1.69	18.56
Total	275.48	485.30	515.68	1,276.46

Key:
AICUZ = Air Installations Compatible Use Zones.
NALF = Naval Auxiliary Landing Field.

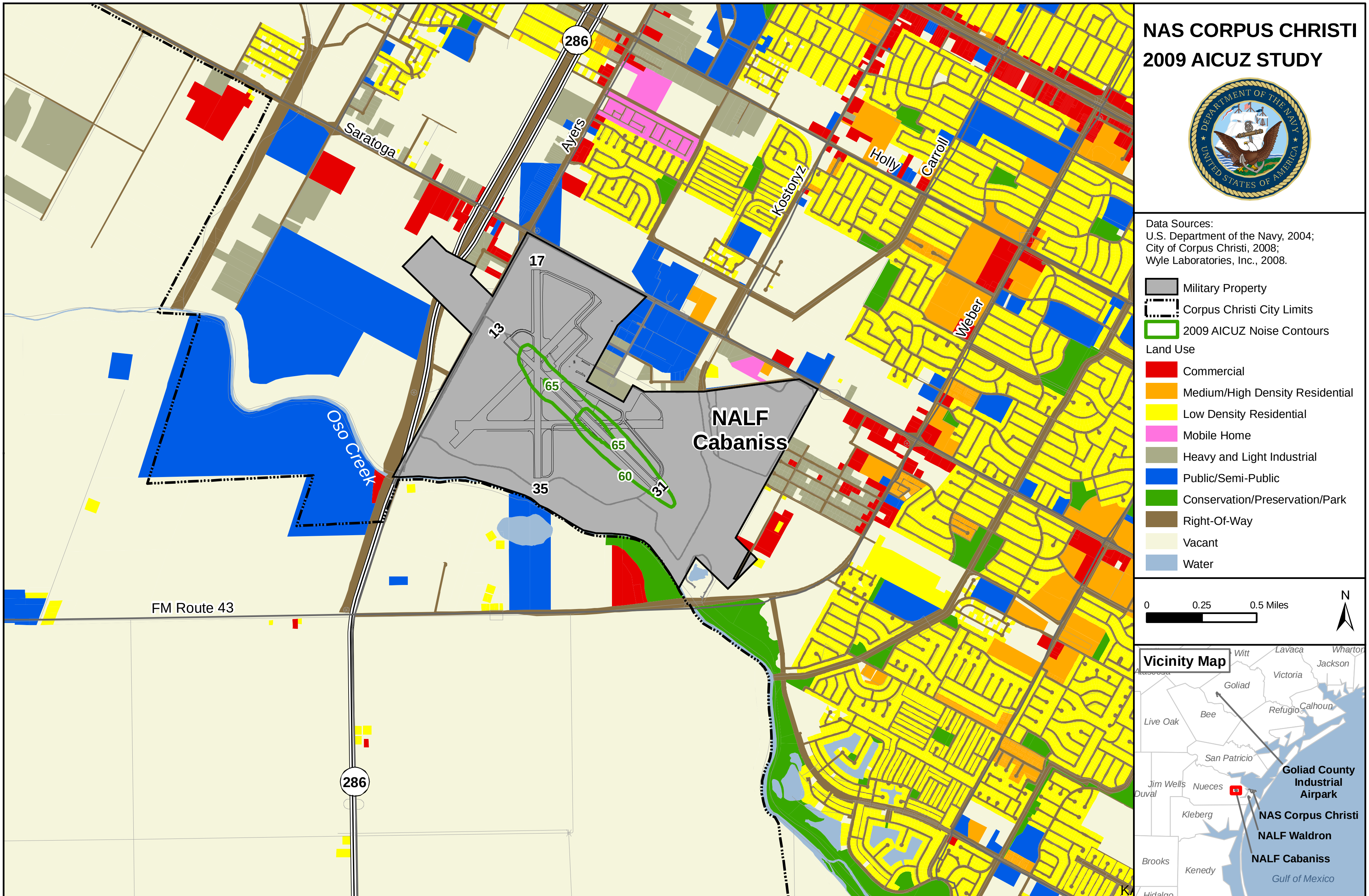

Figure 6-5: Existing Land Use and 2009 AICUZ Noise Contours
NALF Cabaniss

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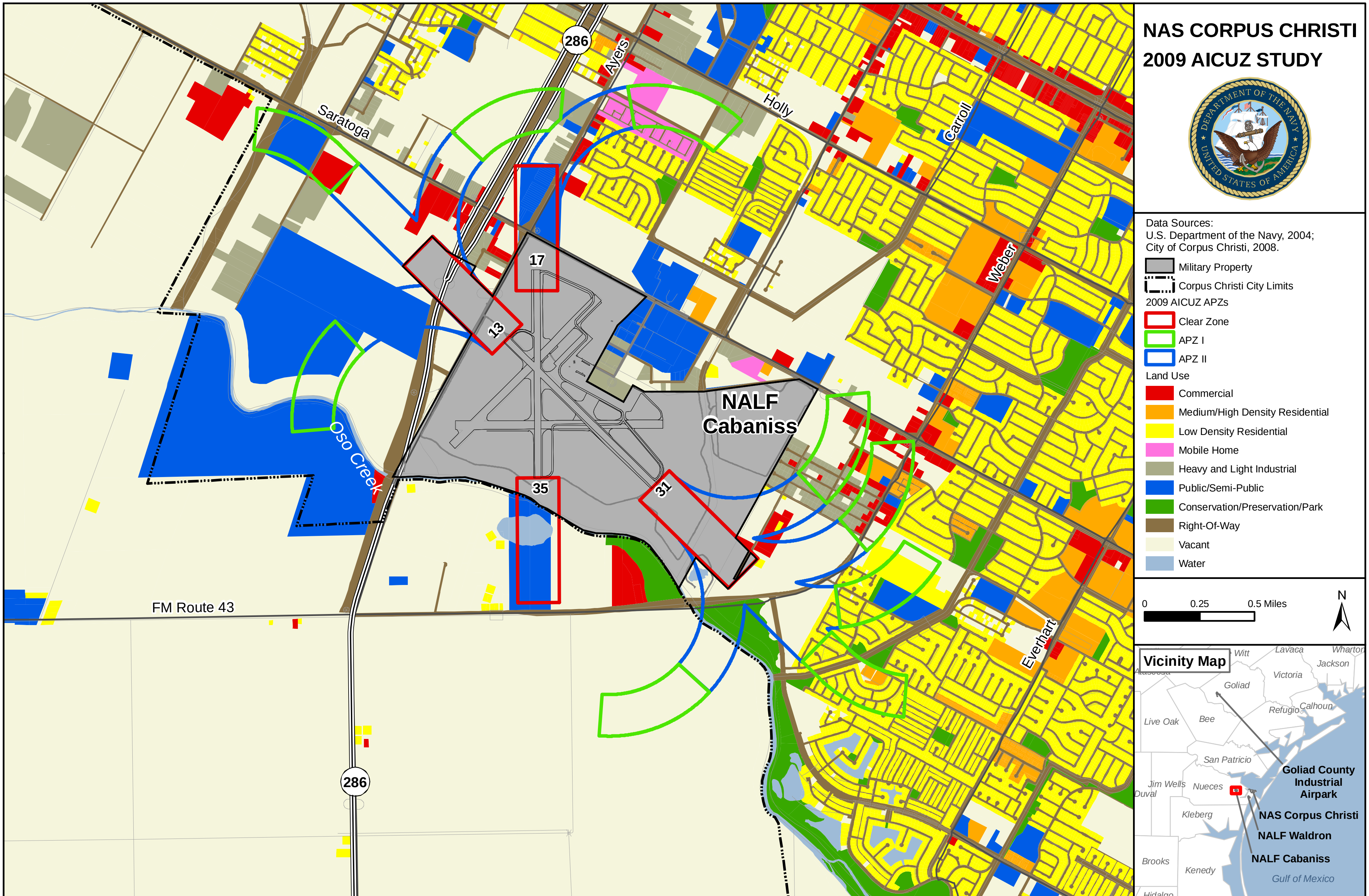

Figure 6-6: Existing Land Use and 2009 AICUZ APZs
NALF Cabaniss

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6.3.2 Existing Land Use Compatibility Conditions

Land use compatibility conditions determined in the analysis are derived from the Navy's recommended compatibility guidelines. Land uses and development patterns that do not impact Navy operations are deemed compatible and land uses that should be prohibited are deemed incompatible. In accordance with the Navy's guidelines, various land uses may be considered compatible with specific restrictions or incompatible with specific exceptions.

6.3.2.1 Truax Field, NASCC

Almost all existing land uses (99%) within the Truax Field 2009 AICUZ noise contours are compatible with Navy operations. A 22-acre block of mobile homes located southeast of the airfield is the only incompatible land use area within a high noise area (Figure 6-7). The total acreages of compatible and incompatible land uses within the Truax Field 2009 AICUZ noise contours are presented in Table 6-8, and the specific areas of compatible and incompatible land uses within each noise contour are depicted on Figure 6-7.

Table 6-8: Land Use Compatibilty within Truax Field 2009 AICUZ Noise Contours

Noise Zone (DNL)	Acres				
	Compatible	Compatible with Restrictions	Incompatible with Exceptions	Incompatible	Total
65 to 70	999.36	1.54	2.36	21.70	1,024.96
70 to 75	408.33	0.00	0.00	0.00	408.33
75 +	385.56	0.00	0.00	0.00	385.56
Total	**1793.25**	**1.54**	**2.36**	**21.70**	**1,818.85**

Key:
AICUZ = Air Installations Compatible Use Zones.
DNL = day-night average sound level.

Incompatible land uses, including residential and commercial development, have been identified within the Truax Field 2009 AICUZ APZs. The total acreage of compatible and incompatible land uses within each APZ are presented in Table 6-9 and depicted on Figure 6-8. (On Figure 6-8, residential development within the APZ II is labeled as 'compatible with restrictions', because residential lots with more than one or two dwellings per acre are considered incompatible). Specific areas of compatibility concern are also discussed in Section 6.4.2.1.

Table 6-9: Land Use Compatibilty within Truax Field 2009 AICUZ APZs

Accident Potential Area	Acres				
	Compatible	Compatible with Restrictions	Incompatible with Exceptions	Incompatible	Total
Clear Zone	627.19	0.00	0.00	3.87	**631.06**
APZ I	1,139.26	41.52	1.92	153.82	**1,336.52**
APZ II	1,982.49	164.31	0.00	72.17	**2,218.97**
Total	**3,748.94**	**205.83**	**1.92**	**229.86**	**4,186.55**

Key:
AICUZ = Air Installations Compatible Use Zones.

A summary of the overall compatibility of property land use in both the 2009 AICUZ noise zones and APZs of Truax Field is presented in Table 6-10. A composite of the Truax Field 2009 AICUZ footprint, including noise zones and APZs, overlaying existing land use is illustrated on Figure 6-9.

Table 6-10: Summary of Land Use Compatibility within Truax Field 2009 AICUZ Footprint

Compatibility	Noise Zones		Accident Potential Zones (APZs)	
	Acres	%	Acres	%
Compatible	1,793.25	98.59	3,748.94	89.55
Compatible with Restrictions	1.54	0.08	205.83	4.92
Incompatible with Exceptions	2.36	0.13	1.92	0.05
Not Compatible	21.70	1.19	229.86	5.49
Total	**1,818.85**	**100.00**	**4,186.55**	**100.00**

Key:
AICUZ = Air Installations Compatible Use Zones.

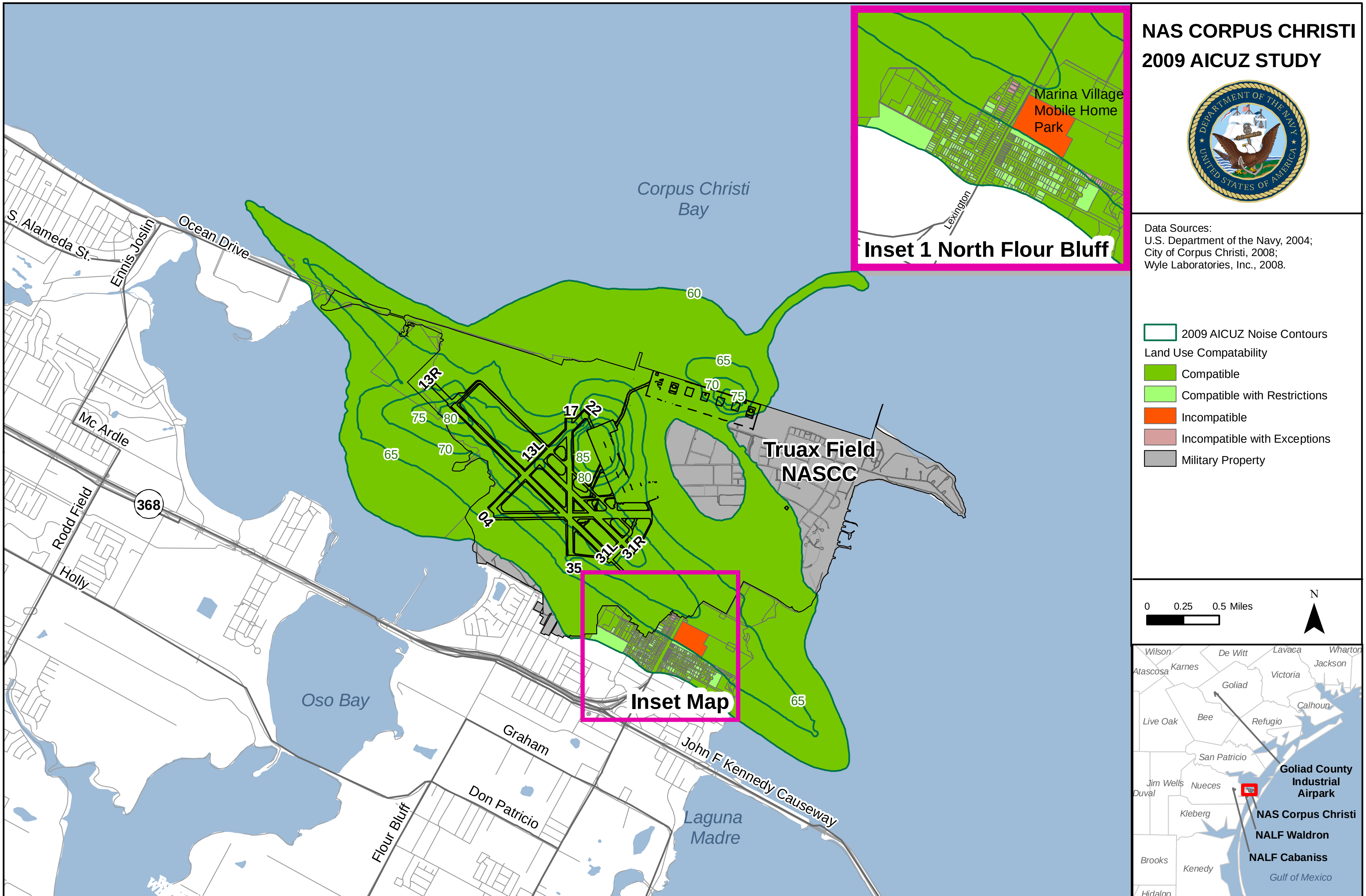

Figure 6-7: Land Use Compatibility and 2009 AICUZ Noise Contours
Truax Field, NASCC

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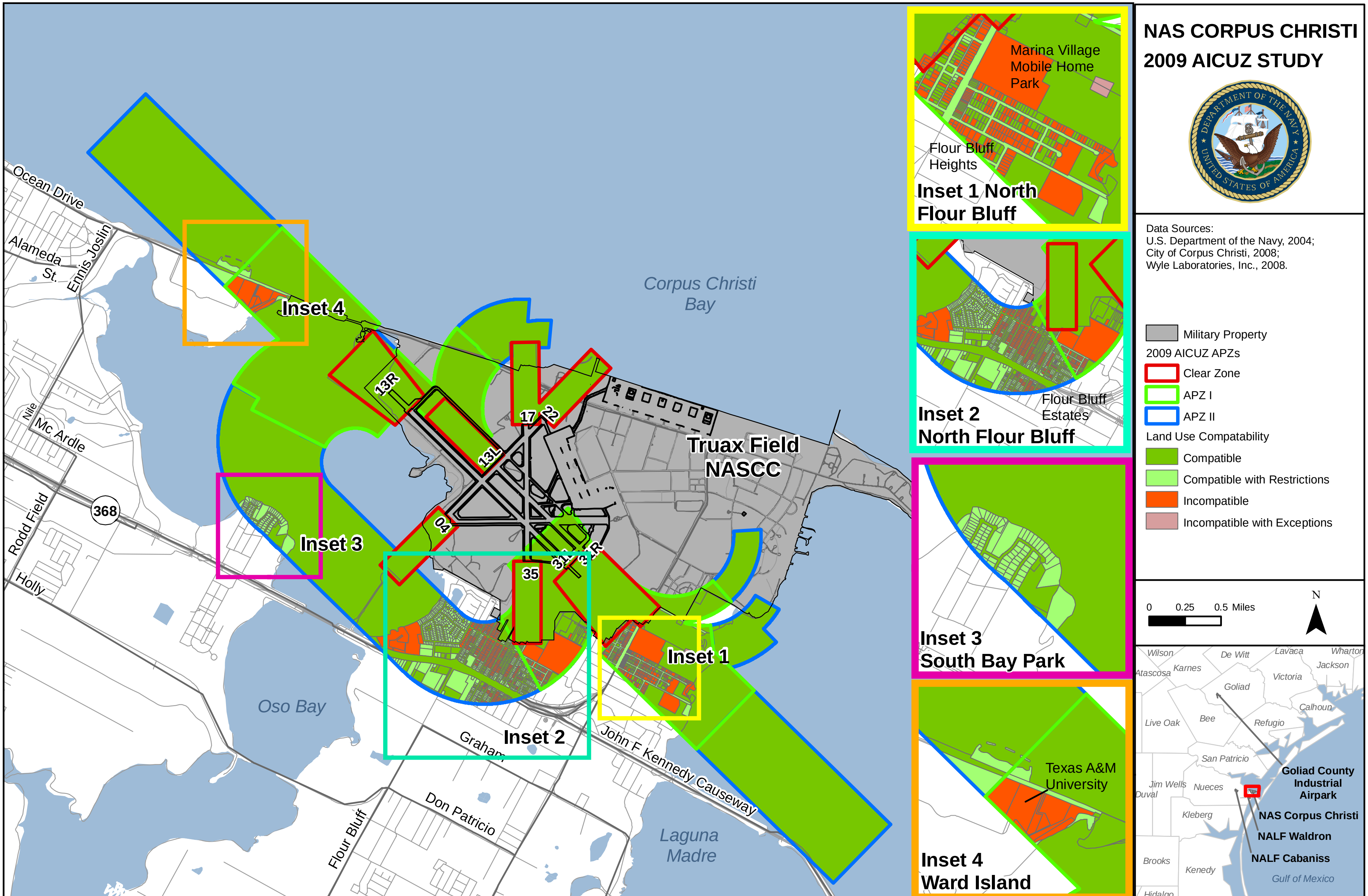

Figure 6-8: Land Use Compatibility and 2009 AICUZ APZs
Truax Field, NASCC

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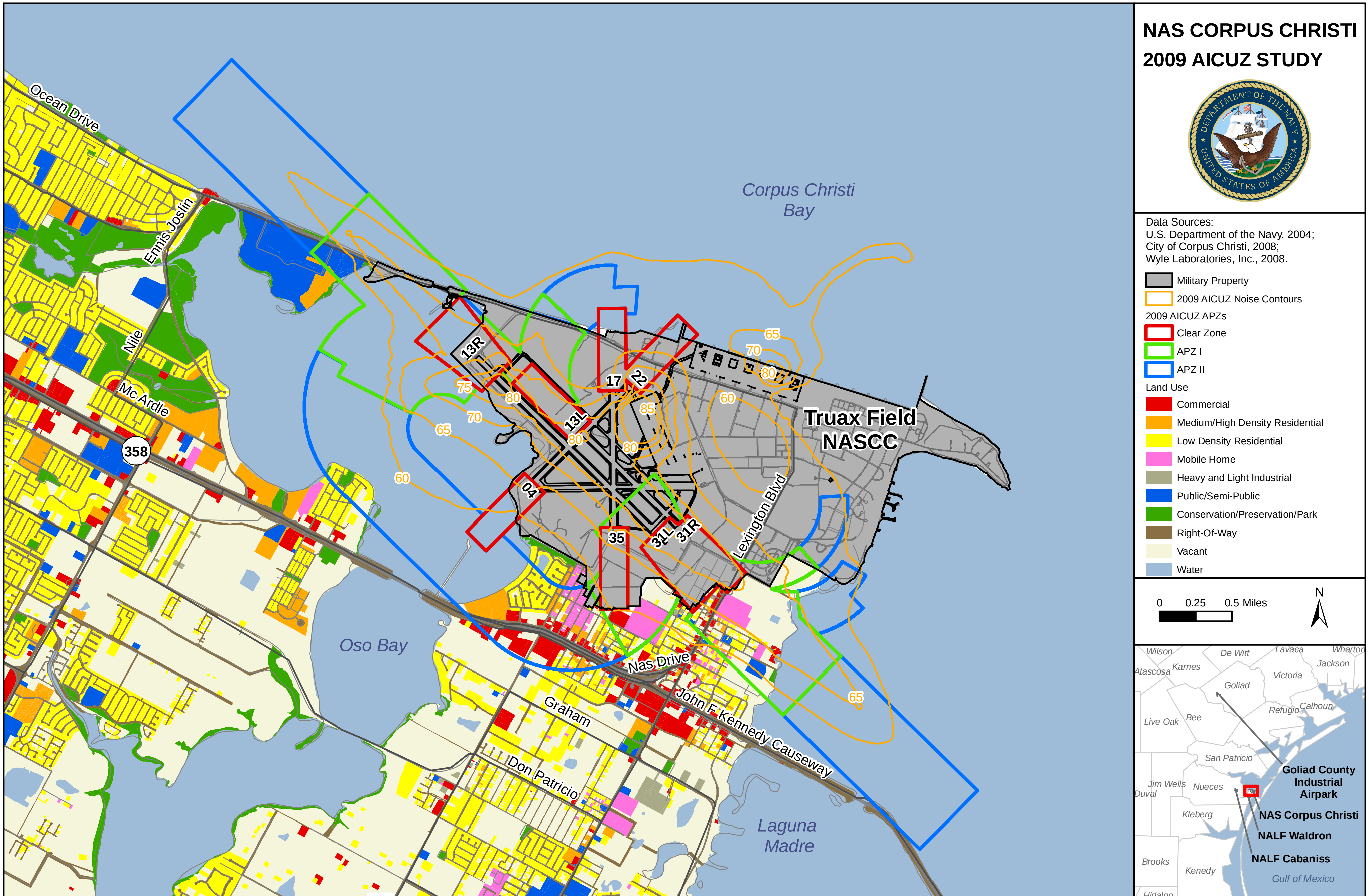

Figure 6-9: Composite Coverage of Surrounding Land Uses, 2009 AICUZ Noise Zones, and 2009 AICUZ APZs
Truax Field

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6.3.2.2 NALF Waldron

Developed areas in the vicinity of NALF Waldron are located southeast of the airfield where the 2009 AICUZ noise contours extend. While the majority of land uses within the noise contours are compatible, 8 acres of incompatible housing and businesses are located in high noise areas. Table 6-11 summarizes the total acreage of compatible and incompatible land uses within each 2009 AICUZ noise zone of NALF Waldron, and Figure 6-10 illustrates the specific areas of compatible and incompatible land uses within each noise zone.

Table 6-11: Land Use Compatibilty within NALF Waldron 2009 AICUZ Noise Zones

Noise Zone (DNL)	Acres				
	Compatible	Compatible with Restrictions	Incompatible with Exceptions	Incompatible	Total
65 to 70	505.68	1.06	163.85	8.01	678.60
70 to 75	157.63	18.79	14.51	0.00	190.93
75 +	66.29	0.89	0.00	0.00	67.18
Total	**729.60**	**20.74**	**178.36**	**8.01**	**936.71**

Key:
AICUZ = Air Installations Compatible Use Zones.
DNL = day-night sound level.
NALF = Naval Auxiliary Landing Field.

Land use compatibility conditions within the 2009 AICUZ APZs present a greater impact than conditions within the 2009 AICUZ noise contours. Approximately 114 acres of incompatible development, primarily housing, is situated within the APZs. Twenty-five (25) acres of incompatible land use, including residential development, public use facilities, commercial development, and right-of-way, are situated directly within Clear Zones. The total acreage of compatible and incompatible land uses within each APZ is summarized in Table 6-12, and Figure 6-11 shows specific areas of compatible and incompatible land uses within each APZ. (On Figure 6-11, residential development within the APZ II is labeled as 'compatible with restrictions', because residential lots with more than one or two dwellings per acre are considered incompatible).

Table 6-12: Land Use Compatibilty within NALF Waldron 2009 AICUZ APZs

Accident Potential Area	Acres				
	Compatible	Compatible with Restrictions	Incompatible with Exceptions	Incompatible	Total
Clear Zone	248.61	0.00	0.00	24.60	**273.21**
APZ I	232.67	27.12	1.84	79.00	**340.63**
APZ II	303.09	93.70	0.00	9.84	**406.63**
Total	**784.37**	**120.80**	**1.84**	**113.44**	**1,020.47**

Key:
AICUZ = Air Installations Compatible Use Zones.
NALF = Naval Auxiliary Landing Field.

A summary of the overall compatibility of property land use in both the 2009 AICUZ noise zones and APZs of NALF Waldron is presented in Table 6-13. A composite of the NALF Waldron 2009 AICUZ footprint, including noise zones and APZs overlaying existing land use is illustrated on Figure 6-12. Specific areas of compatibility concern at NALF Waldron are also discussed in Section 6.4.2.2.

Table 6-13: Summary of Land Use Compatibility within NALF Waldron 2009 AICUZ Footprint

Compatibility	Noise Zones		Accident Potential Zones (APZs)	
	Acres	%	Acres	%
Compatible	729.60	77.89	784.37	76.86
Compatible with Restrictions	20.74	2.21	120.80	11.84
Incompatible with Exceptions	178.36	19.04	1.84	0.18
Not compatible	8.01	0.86	113.44	11.12
Total	**936.71**	**100.00**	**1,020.47**	**100.00**

Key:
AICUZ = Air Installations Compatible Use Zones.
NALF = Naval Auxiliary Landing Field.

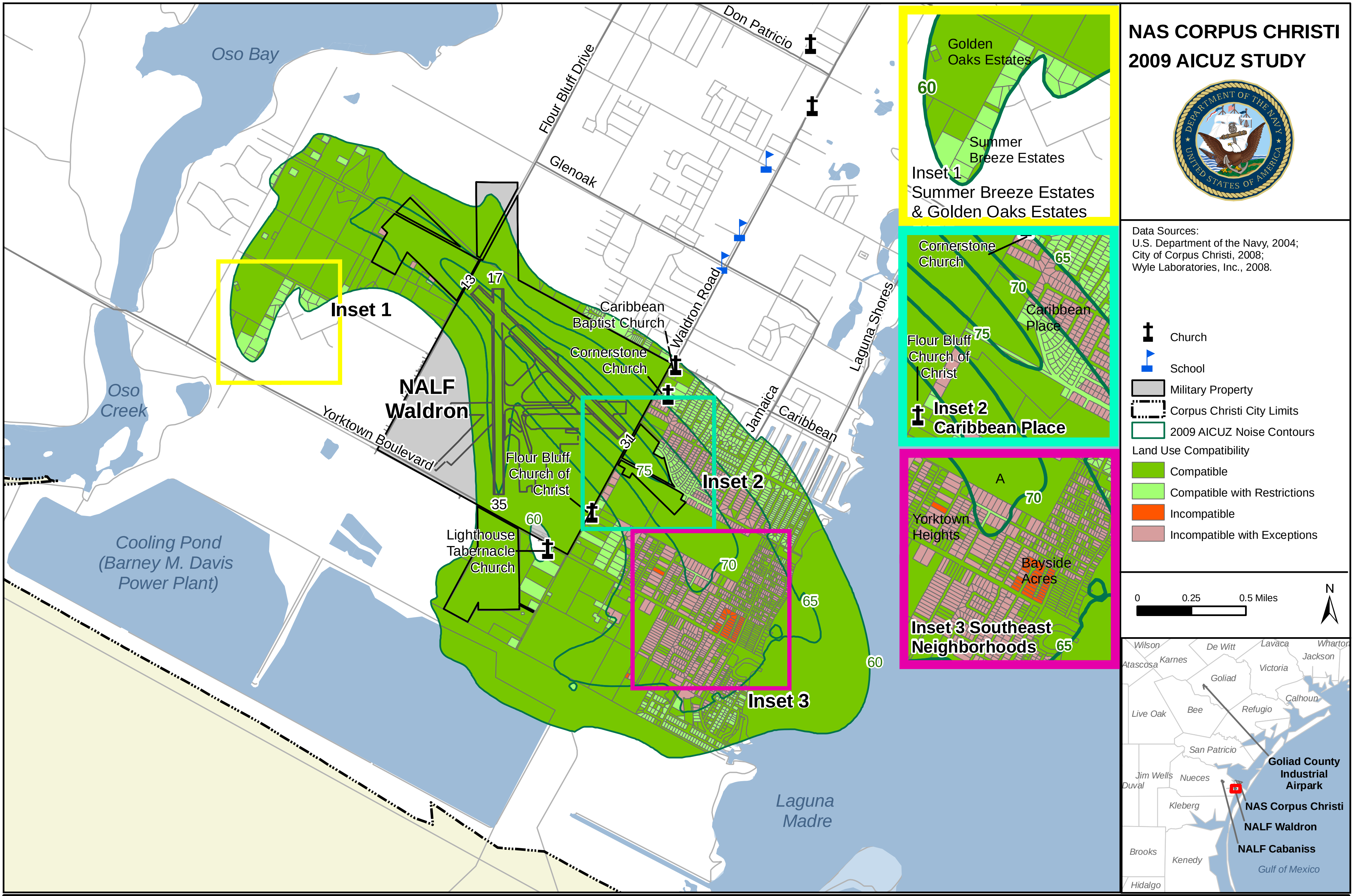

Figure 6-10: Land Use Compatibility and 2009 AICUZ Noise Contours
NALF Waldron

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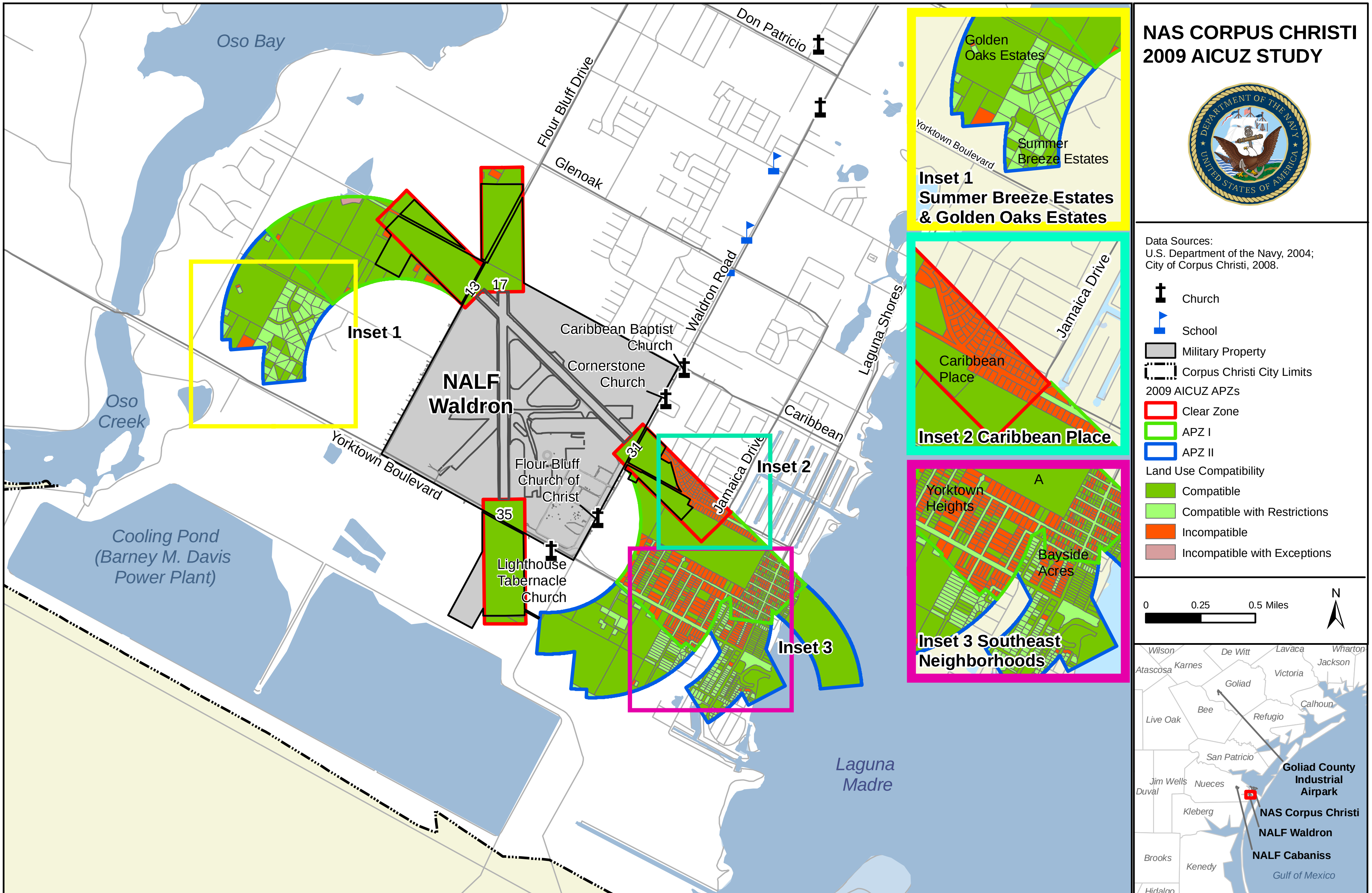

Figure 6-11: Land Use Compatibility and 2009 AICUZ APZs
NALF Waldron

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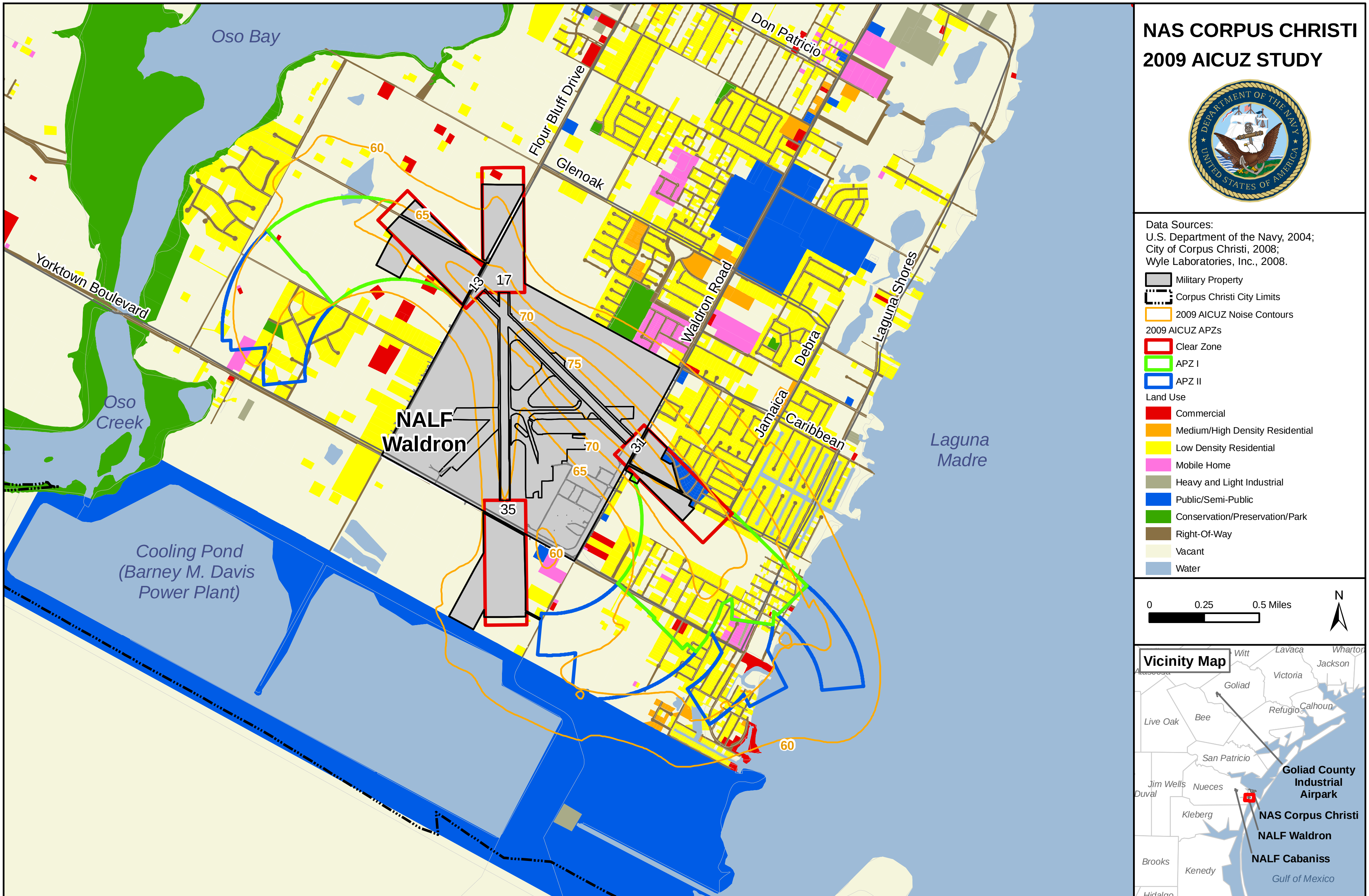

Figure 6-12: Composite Coverage of Surrounding Land Uses, 2009 AICUZ Noise Zones, and 2009 AICUZ APZs
NALF Waldron

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6.3.2.3 NALF Cabaniss

Noise-related impacts are not an immediate concern at NALF Cabaniss. The 2009 AICUZ noise contours are completely contained within the limits of the NALF Cabaniss property, and areas outside the Installation are exposed to very low levels of aircraft noise. As presented in Table 6-14 and illustrated on Figure 6-13, no incompatible land use is located within the 2009 AICUZ noise contours.

Table 6-14: Land Use Compatibilty within NALF Cabaniss 2009 AICUZ Noise Zones

Noise Zone (DNL)	Acres				
	Compatible	Compatible with Restrictions	Incompatible with Exceptions	Incompatible	Total
65 to 70	8.87	0.00	0.00	0.00	**8.87**
70 to 75	0.00	0.00	0.00	0.00	**0.00**
75 +	0.00	0.00	0.00	0.00	**0.00**
Total	**8.87**	**0.00**	**0.00**	**0.00**	**8.87**

Key:
AICUZ = Air Installations Compatible Use Zones.
DNL = day-night average sound level.
NALF = Naval Auxiliary Landing Field.

More than 15% of the total land area within the NALF Cabaniss 2009 AICUZ APZ is incompatible development. Approximately 72 acres of incompatible land use is located directly within the Clear Zones, and 139 acres of incompatible land use is located within the APZ I and II. A significant portion of incompatible land use identified within APZ I of Runway 31 is residential development. The total acreages of compatible and incompatible land uses within each APZ are presented in Table 6-15. The specific areas of compatible and incompatible land uses within each APZ are depicted on Figure 6-14. (On Figure 6-14, residential development within the APZ II is labeled as ‘compatible with restrictions’, because residential lots with more than one or two dwellings per acre are considered incompatible).

Table 6-15: Land Use Compatibilty within NALF Cabaniss 2009 AICUZ APZs

Accident Potential Area	Acres				
	Compatible	Compatible with Restrictions	Incompatible with Exceptions	Incompatible	Total
Clear Zone	190.30	0.00	13.45	71.73	**275.48**
APZ I	282.69	93.03	0.00	109.58	**485.30**
APZ II	272.28	212.32	1.69	29.39	**515.68**
Total	**745.27**	**305.35**	**15.14**	**210.70**	**1,276.46**

Key:
AICUZ = Air Installations Compatible Use Zones.
NALF = Naval Auxiliary Landing Field.

A summary of the overall compatibility of property land use in both the 2009 AICUZ noise zones and APZs of NALF Cabaniss is presented in Table 6-16. A composite of the NALF Cabaniss 2009 AICUZ footprint, including noise zones and APZs overlaying existing land use is illustrated on Figure 6-15. Specific areas of compatibility concern at NALF Cabaniss are also discussed in Section 6.4.2.3.

Table 6-16: Summary of Land Use Compatibility within NALF Cabaniss 2009 AICUZ Footprint

Compatibility	Noise Zones		Accident Potential Zones (APZs)	
	Acres	%	Acres	%
Compatible	8.87	100.00	745.27	58.39
Compatible with Restrictions	0.00	0.00	305.35	23.92
Incompatible with Exceptions	0.00	0.00	15.14	1.19
Not compatible	0.00	0.00	210.70	16.51
Total	**8.87**	**100.00**	**1,276.46**	**100.00**

Key:
AICUZ = Air Installations Compatible Use Zones.
NALF = Naval Auxiliary Landing Field.

Figure 6-13: Land Use Compatibility and 2009 AICIZ Noise Contours
NALF Cabaniss

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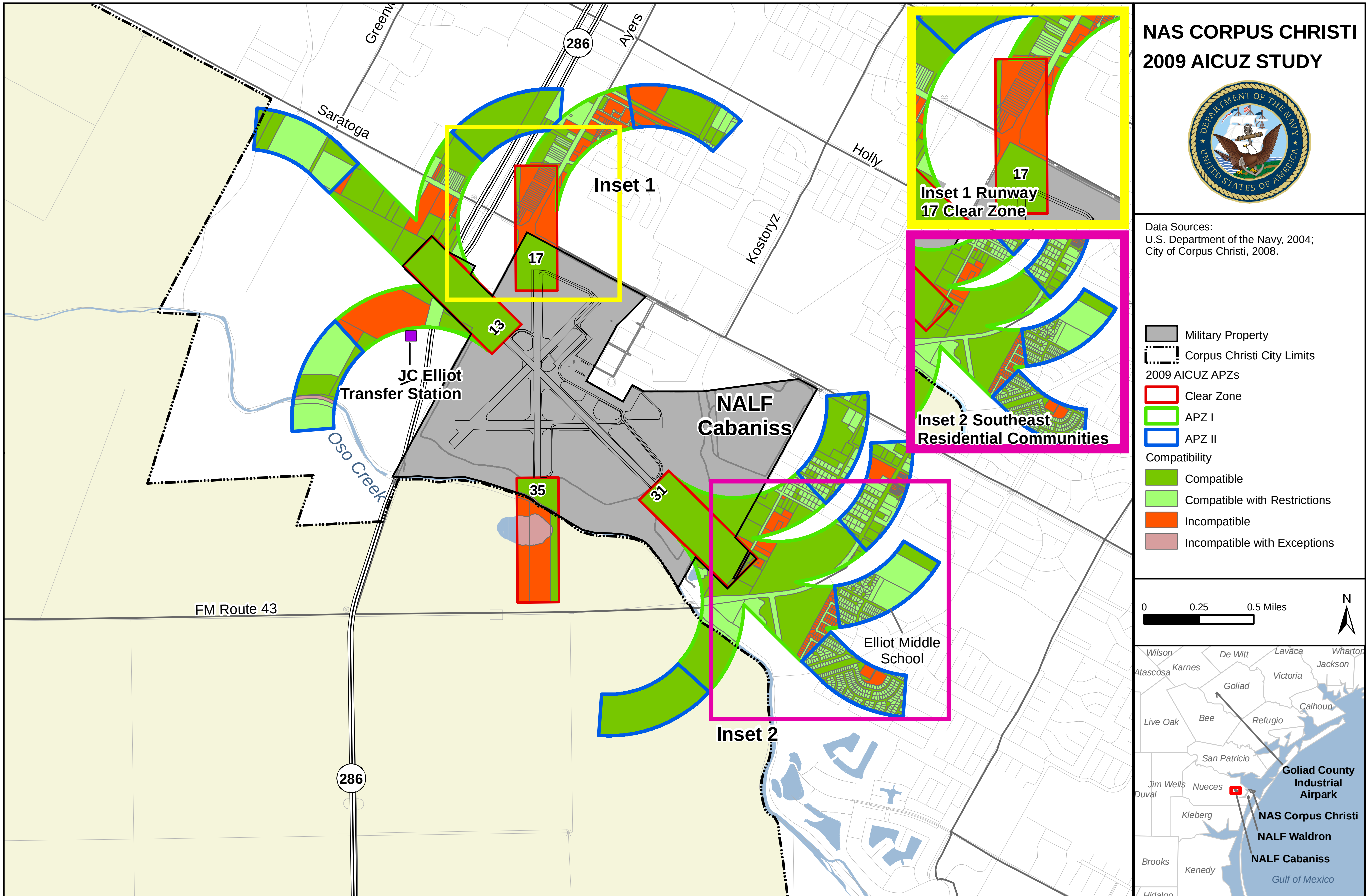

Figure 6-14: Land Use Compatibility and 2009 AICUZ APZs
NALF Cabaniss

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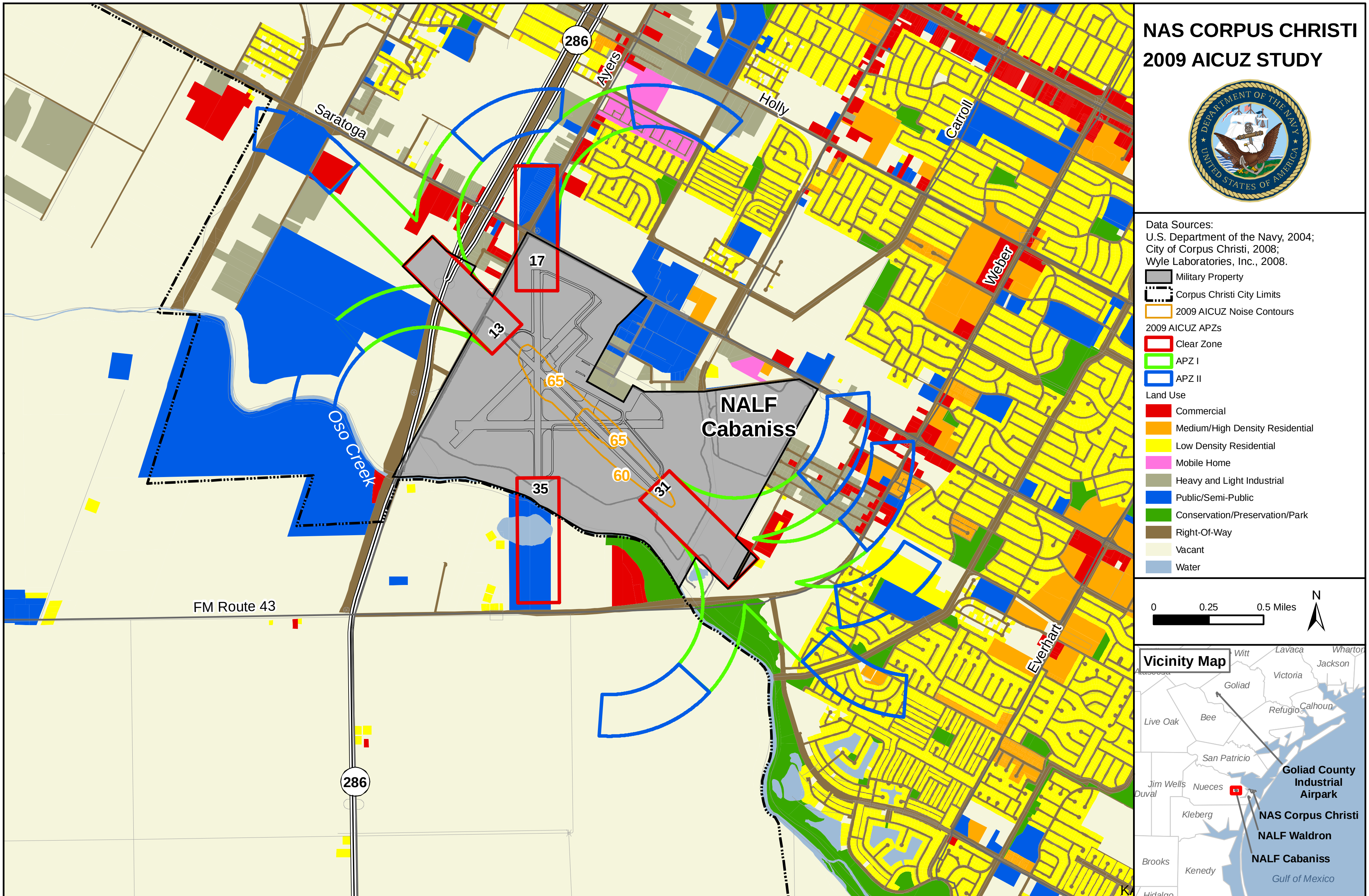

Figure 6-15: Composite Coverage of Surrounding Land Uses, 2009 AICUZ Noise Zones, and 2009 AICUZ APZs
NALF Cabaniss

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6.4 Land Use Compatibility Concerns

6.4.1 Installation Land Use Compatibility Concerns

The majority of development at NASCC occurs in the core areas of the airfield. The core areas are a mixture of land uses and are the most populated areas of the Installation. Development within the core areas is not encumbered by the 2009 AICUZ Clear Zones. Most of the on-station land use, with the exception of housing, community facilities, and recreational activities, is considered compatible or "compatible with restrictions" within the 2009 AICUZ 75- to 80-DNL noise contour.

Proposed military construction projects for NASCC revealed no proposed land use activities that are inconsistent with 2009 AICUZ APZs. No significant land use/noise incompatibilities are expected from military construction projects.

6.4.2 Community Land Use Compatibility Concerns

6.4.2.1 Truax Field

Within the vicinity of the Truax Field 2009 AICUZ footprint, the areas that pose the greatest land use compatibility concern are:

- North Flour Bluff (Figure 6-7 and insets 1 and 2 of Figure 6-8);
- South Bay Park (Figure 6-7 and inset 3 of Figure 6-8); and
- Ward Island (Figure 6-7 and inset 4 of Figure 6-8).

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

The land use compatibility analysis of these areas includes an assessment of developed properties, as well as identification of properties that are currently vacant or have development potential.

North Flour Bluff Area. The entire Flour Bluff area extends from Corpus Christi Bay to the southern city limits, bounded by Oso Bay on the west and Laguna Madre on the east. The main base of NASCC is in the northern half of Flour Bluff and, consequently, property in this area is susceptible to the impacts of the Truax Field 2009 AICUZ footprint (Figure 6-7 and Figure 6-8, insets 1 and 2).

Areas of land use compatibility concern are identified within the Truax Field 2009 AICUZ noise contours and the APZs of Runway 31L, 31R, and 35 that extend over the North Flour Bluff area. Incompatible land uses include residential communities and mobile homes. The Marina Village Mobile Home Park, located south of the Installation, is an incompatible land use in both the airfield APZ and noise zones. The mobile home park is situated within the 65- to 70-DNL noise exposure contour and within APZ I of Runway 31 (Figure 6-7, inset 1, and Figure 6-8, inset 1). Residential neighborhoods, Flour Bluff Estates and Flour Bluff Heights, and commercial businesses along Lexington Boulevard are also within the APZ I of Runway 31 and are considered incompatible or potentially restricted compatible land uses. Additional residential communities and mobile homes further south of the Installation are located within a low-impact noise area (60- to 65-DNL noise exposure contour). While housing is not considered incompatible within this AICUZ noise zone, the proximity to aircraft operations and generated noise exposure may lead to noise complaints from the public. Directly south of the Installation, APZs I and II of Runway 35/17 overlay a significant area of existing housing, mobile parks, public use facilities, park, and commercial business (Figure 6-8, inset 2). These land uses are deemed either incompatible or compatible with restriction within the AICUZ APZs.

Undeveloped properties in the North Flour Bluff area are also identified as a potential land use compatibility concern. Vacant properties may be currently zoned for a land use that is considered compatible within the AICUZ footprint; however, these properties may be rezoned as higher density land use to meet future development pressures. The City of Corpus Christi has not adopted zoning ordinances to specifically restrict development or limit density within the AICUZ APZs or noise zones. No development plans are currently proposed for the vacant properties.

South Bay Park. The South Bay Park peninsula, a residential community located southwest of the Installation and across Oso Bay, is located within the 2009 AICUZ APZ II of Runway 35/17 (Figure 6-8, inset 3). Although residential development is generally a compatible land use within an APZ II, single-family homes and dedicated park land may be subject to aircraft operation impacts. Surrounding properties on the peninsula that are susceptible to aircraft operation impacts include mobile homes, apartments, and commercial businesses. The 2009 AICUZ noise contours are not projected to reach this area and, therefore, noise is not an immediate compatibility concern.

The City's Southeast Area Development Plan, adopted on July 11, 1995, addresses the concern of land use compatibility with Navy operations in this area. As a short-term objective, the City proposes to create an APZ Overlay Zone to prohibit residential use and non-residential use that may congregate large groups of people in the APZ I or APZ II areas. Additionally, The City's short-term objectives propose to rezone vacant and unplatted properties that are not consistent with the AICUZ objectives. However, vacant properties within the AICUZ APZs are currently zoned for residential development.

Ward Island. Ward Island is located west of the Installation and across Oso Bay (Figure 6-8, inset 4). The Corpus Christi Texas A&M University campus, which is owned by the State of Texas, occupies the majority of Ward Island. Approximately 42 acres of the University property is within the 2009 AICUZ APZ I and II of Truax Field Runway 13, and educational service facilities are not compatible land uses within these designated areas. The City does not have zoning authority over state-owned property; therefore, zoning regulations do not apply to the university campus unless permitted by the State of Texas. In accordance with the City's Southeast Area Development Plan Policy Statement B.9, the City should communicate safety concerns and recommended land use guidelines if the University decides to expand the campus. Consequently, the Navy should remain in communication with the City regarding changes in operations or mission that could impact Ward Island.

6.4.2.2 NALF Waldron

Existing and proposed residential and commercial growth is impacting land use compatibility conditions in the areas to the southeast and west of NALF Waldron. Communities within the NALF Waldron 2009 AICUZ footprint that pose the greatest land use compatibility concern are:

- Summer Breeze Estates and Golden Oaks Estates (Figure 6-10, inset 1, and Figure 6-11, inset 1);
- Caribbean Place (Figure 6-10, inset 2, and Figure 6-11, inset 2); and
- Southeast neighborhoods such as Yorktown Heights, Laguna Vista, Bayside Acres, Holiday Harbor, and Blue Water (Figure 6-10, inset 3, and Figure 6-11, inset 3).

Vacant areas that present a potential compatibility concern are identified on Figures 6-10 and 6-11 and are labeled ‘A’.

Summer Breeze Estates and Golden Oaks Estates. Although the area west of NALF Waldron is sparsely developed, two residential communities – Summer Breeze Estates and Golden Oaks Estates – are located within the 2009 AICUZ noise exposure zones of 60 to 65 DNL and in 2009 AICUZ APZ II of Runway 13 (Figures 6-10 and 6-11, inset 1). While housing is compatible land use within the noise zone and APZ II, the proximity to aircraft operations and generated noise exposure may lead to noise complaints. The land surrounding these communities is undeveloped and is also identified as a potential land use compatibility concern. The undeveloped area north of Summer Breeze Estates and Golden Oaks Estates is within APZ I. This area is currently zoned for agricultural use, but growth demands could push properties to be rezoned and developed with a higher intensity and as an incompatible land use.

Caribbean Place. Caribbean Place is a low-density residential neighborhood located to the east of the airfield near the intersection of Jamaica Drive and Mediterranean Drive. This neighborhood is also located directly within the 2009 AICUZ Clear Zone of Runway 31 (Figure 6-11, inset 2). Although land use data provided by the City of Corpus Christi indicate that these properties are public/semi-public land (which is also an incompatible land use within airfield AICUZ Clear Zones), aerial photographs verify that these properties are residential land use. Aircraft operations in this area are an extreme safety concern and should be addressed in cooperation with the Navy and the City of Corpus Christi. The undeveloped area within the Clear Zone is currently zoned for agricultural land use. If the Navy does not own the land, these properties could be rezoned and developed similar to the communities neighboring Caribbean Place to accommodate future growth.

Caribbean Baptist Church (3125 Waldron Road), Flour Bluff Church of Christ (3745 Waldron Road), and the recently constructed Cornerstone Church (3409 Waldron Road) are located along the southeast perimeter of the airfield (Figure 6-10). Caribbean Baptist Church and Flour Bluff Church of Christ are within the 60- to 65-DNL 2009 AICUZ noise contour. Cornerstone Church is within the 65- to 70-DNL noise contour and immediately adjacent to the Clear Zone of Runway 31. The proximity of these churches to high noise levels will likely generate public noise complaints. Lighthouse Tabernacle Church (715 Yorktown Boulevard) is located just south of NALF Waldron across Yorktown Boulevard. This church is partially within the 60- to 65-DNL noise contour (Figure 6-10, inset 2) and may be subject to noticeable noise exposure from aircraft traffic.

Southeast Neighborhoods. A large residential community composed of several low-density neighborhoods, commercial businesses, and neighborhood facilities is located southeast of NALF Waldron. Existing development is impacted and proposed development also would be impacted by both the 2009 AICUZ noise contours and APZs.

The implementation of the JPATS syllabus is expected to increase annual aircraft operations at NALF Waldron and, consequently, 2009 AICUZ noise contours are projected to extend further than the 1986 AICUZ noise contours and beyond the airfield's boundary (refer to Figure 4-4). The 2009 AICUZ noise contours extend southeast of NALF Waldron over significant areas of low-density residential housing. Several houses are situated within the 65- to 70-DNL noise contours and considered an incompatible development (Figure 6-10, inset 3). A mobile home park at the intersection of Laguna Shores and Yorktown Boulevard is within the 65- to 70-DNL noise contour and is identified as an incompatible land use (Figure 6-10, inset 3). Increased operations over these residential areas will likely increase public noise complaints.

NALF Waldron 2009 AICUZ APZs also extend over a significant area of existing residential development in the southeast neighborhoods, as well as over undeveloped properties to the south (Figure 6-11, inset 3). These undeveloped areas are identified as a potential compatibility concern. The Bayside Acres and Yorktown Heights neighborhoods are located in APZ I of Runway 31, and housing within the area is considered incompatible. Additionally, the existing vacant lots are platted for more housing and will continue to increase incompatible conditions when developed. To the north of these neighborhoods is a larger tract of vacant land (Figure 6-11, inset 3, property A) zoned for single-family residential land use. While the City's Area Development Plan recognizes the impact of naval operations in the vicinity of the airfield and encourages sensible and appropriate development adjacent to naval facilities, the City has not adjusted zoning districts to coincide with the Area Development Plan recommendations. If developed, Property A would be incompatible with Navy operations.

6.4.2.3 NALF Cabaniss

NALF Cabaniss is located in a developing area of the City of Corpus Christi and is subject to demands from existing land uses, as well as proposed development. Residential community subdivisions and construction are proposed in the vicinity of NALF Cabaniss. If approved, more than 600 residential lots would be constructed within the vicinity of NALF Cabaniss (City of Corpus Christi 2006).

The areas of most significant land use compatibility concerns within the NALF Cabaniss 2009 AICUZ footprint include:

- Runway 17 Clear Zone and development directly north of the airfield (Figure 6-14, inset 1);
- J.C. Transfer Station Site (Figure 6-14, purple box); and
- Southeast residential communities (Figure 6-14, inset 2).

As mentioned in earlier sections, the NALF Cabaniss 2009 AICUZ noise contours (Figure 6-13) are contained to the airfield property and do not impact surrounding land uses.

Runway 17 Clear Zone. Directly north of NALF Cabaniss Runway 17, is a major thoroughfare intersection (Highway 286 and Saratoga Road) that is surrounded by commercial business and industrial facilities (Figure 6-14, inset 1). The area within the 2009 AICUZ Clear Zone of Runway 17 is currently undeveloped, but this property is zoned as a Business District and for limited industrial use. Any development within the Clear Zone would be incompatible and would compromise pilot safety and public welfare. Further north within Runway 17 APZ I and II are incompatible and potentially restricted compatible land uses, including industrial facilities, commercial business, and mobile homes. As the capacity of Highway 286 expands, commercial and industrial growth is expected to increase along the frontage roads and may impact future Navy aircraft operations.

J.C. Elliott Transfer Station Site. The City of Corpus Christi’s J.C. Elliott Transfer Station is located approximately 2,000 feet west of NALF Cabaniss near the City’s former landfill site (Figure 6-14, purple box). Birds and raptors in search of food or rodents flock to the transfer station and circle the airspace, significantly increasing the probability of BASH occurrences. BASH occurrences pose a significant encroachment issue for Navy operations, as they cause costly damage to aircraft and endanger pilot safety. Proximity to coastal shores, the migratory bird central flyway, and the landfill significantly increase the potential risk of BASH occurrences at NALF Cabaniss. Additionally, the Texas Gulf Coast is a primary wintering location for large flocks of waterfowl and a concentrated area for trans-Gulf migration, raptors, and shorebird migration. The increased bird population during the migration season creates a potential concern of bird-to-aircraft strike at all airfields.

Southeast Residential Communities. The 2009 AICUZ APZs of Runway 31 extend over commercial and residential areas southeast of NALF Cabaniss (Figure 6-14, inset 2). Increased exposure to aircraft operations will likely generate complaints from residents. The Elliot Grant Middle School is located within the APZ II of Runway 31 and is an existing incompatible land use.

The area further south of NALF Cabaniss is undeveloped and within the City's ETJ, which extends approximately 5 miles from the City limit boundary. Property within the ETJ is not subject to the City's zoning regulations, and the City has limited jurisdiction to enforce land use restrictions. Consequently, this undeveloped area is susceptible to development in a manner that is incompatible with training operations at NALF Cabaniss.

7 Land Use Tools and Recommendations

The **goal** of the AICUZ Program is *to protect the health, safety, and welfare of those living near military airfields while preserving the defense flying mission.*

The goal of the AICUZ Program – to protect the health, safety, and welfare of those living near military airfields while preserving the defense flying mission – can most effectively be accomplished by active participation of all interested parties, including Navy, 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 OPNAVINST 11010.36C (AICUZ Program), the Air Installation Commander at NASCC is committed to and shall:

- Implement an AICUZ Program for the Air Installation and associated outlying landing fields;
- Work with state and local planning officials to implement the objectives of the AICUZ plan;
- If appropriate, designate a community liaison officer to assist in the execution of the AICUZ plan 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 plan; 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.

Federal Level Tools for Implementing AICUZ

- Environmental Review
- Executive Order 12372, Intergovernmental Review of Federal Programs
- Housing and Urban Development (HUD) Circular 1390.2
- DoD Encroachment Protection Program

7.1 Tools for Implementing AICUZ

7.1.1 Federal Tools

Environmental Review. Environmental reviews are conducted to assess projects that may have some potential impact on land use and the public's interest. For example, the National Environmental Policy Act 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 or an environmental assessment, which is more limited in scope than an environmental impact statement. 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 that all Federal-Aid Development Projects must be coordinated with and reinforce state, regional, and local planning initiatives and mandates. Executive Order 12372 allows state governments to set up review periods and processes for federal projects.

Housing and Urban Development (HUD) Circular 1390.2, "Noise Abatement and Control, Department Policy and Implementation Responsibilities and Standards." Approvals of mortgage loans from the Federal Housing Administration are subject to requirements of this 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-DNL contour provided that methods of sound attenuation are implemented. 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 APZs unless the project is compatible with the AICUZ.

DoD Encroachment Protection Program. Title 10, 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 Protection 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. 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 protection 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 Local Government Tools

Local Government Comprehensive Plans and Zoning. Section 6.1.3 provided an overview of planning and zoning authority in the City of Corpus Christi, as well as each entity's plan to control future land use and development. The City of Corpus Christi has adopted a Comprehensive Plan that is comprised of several elements including the Comprehensive Policy Statements, Area Development Plans, Specific Area Plans, a Future Land Use Master Plan, a Transportation Master Plan, an Annexation Plan, and various utility master plans. While the Comprehensive Plan is guidance, it does not hold legal or binding implementation. Policy statements within the Comprehensive Plan provide guidance and encourage properties in the vicinity of military airports to be developed in a manner that is compatible with the operation of the airports.

Local Government Tools for Implementing AICUZ

- Local Government Comprehensive Plans and Zoning Planning
- Capital Improvements Programs
- Transfer of Development Rights
- Purchase of Development Rights
- Building Code
- Real Estate Disclosure
- Public Land Acquisition Programs
- Health Code Programs
- Special Planning Districts

To manage land utilization and direct future growth, the City of Corpus Christi has established zoning districts and regulations under the Corpus Christi Zoning Ordinance. All properties within the city are classified into zoning districts that permit or prohibit property use and development density. The City has not incorporated air installation zoning regulations into the local zoning ordinance to address compatible development in the vicinity of NASCC or the outlying fields. However, policy statements within the City's Comprehensive Plan reference the need for such regulations

Capital Improvements Programs. Capital improvement 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. The concept of Transfer of Development Rights involves purchasing property development rights and transferring those rights to another piece of property. Thus, development of the original property is prevented.

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 are implemented. Although this tool will not prevent incompatible development, building codes can ensure compatibility to the greatest extent possible.

Real Estate Disclosure. Real estate disclosures allow prospective buyers, lessees, or renters of property in the vicinity of military OPAREA 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 the 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.

Health Code Programs. These programs protect people from adverse elements that may endanger them, including poor sanitary facilities, diseases, and inadequate or unsafe water supplies. The programs also can be used to protect people from noise impacts.

Special Planning Districts. Local governments have the power to create special districts for a special purpose, such as land use control and protection of the environment and human health.

7.1.3 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. Citizens have the ability to avoid purchasing property within high noise zones and/or APZs.

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

7.2 Recommendations

7.2.1 NASCC Recommendations

Although land use and development in the vicinity of NASCC, NALF Waldron, and NALF Cabaniss are under the jurisdiction of the local government, the Navy has the ability and responsibility to conduct actions and implement programs in support of local efforts. To do so, NASCC should continue and/or consider the following measures.

Air Operations Procedures. Aircrew discipline in maintaining strict and well-defined pattern operations should be enforced along with field noise abatement procedures, as set forth in Section 4.4, Table 4-2. The Navy should continue to examine ways to improve noise abatement procedures.

Noise Complaint Hotline. A standard procedure is followed for noise complaints called into NASCC from operations at any of the airfields. This procedure is outlined in the NASCC Aircraft Noise Complaint Instructions (NASCORPCINST 3700.1D), dated March 20, 2002. Aircraft noise complaints received by telephone are directed to the Air Operations Duty Officer. The Air Operations Duty Officer or Flight Clearance Supervisor will complete a record of Aircraft Noise Complaint. A log of noise complaints is maintained and, when necessary, the Public Affairs Office performs any follow-up action required.

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 Program. The Community Outreach Program, which is an educational program of presentations to real estate offices, neighborhood civic leagues, and service clubs, should be updated and expanded. Develop a proactive working relationship with the City of Corpus Christi.

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

NASCC's mission. For this, the NASCC website could be expanded to include AICUZ-specific topics. 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 Program 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.

Engagement in the Local Planning Process. NASCC should attend public hearings and provide comments on actions that may affect AICUZ planning, including comprehensive plan and land development regulation updates and amendments.

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

- Requests for property rezoning or a variance to permit an incompatible use, such as a higher density or removal of height restrictions;
- 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 recordkeeping capabilities to enact restriction within the AICUZ footprint;
- Community facilities construction (e.g., schools, stadiums, churches);
- Updates and amendments to local zoning ordinances and comprehensive plans or other such ordinances that may affect the Installations; and
- Approvals for subdivisions, site plans, wetland permits, or other proposed approvals necessary for development.

Encroachment Partnering. Under the Navy's Encroachment Partnering Program, NASCC should identify private land conservation organizations and/or government agencies to share the cost of land acquisition in order to preserve valuable natural habitat and restrict incompatible land use. Through partnerships, the Navy can work with local municipalities and decision-makers to identify areas where land acquisition and preservation buffers, in the form of either outright fee simple purchase or conservation easements, would be mutually beneficial. Further information regarding Encroachment Partnering is provided in the Section 7.1.1 discussion on the DoD Encroachment Protection Program.

7.2.2 Local Government and Agency Recommendations

Communication. While it is NASCC'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 NASCC regarding land use decisions that potentially could affect the operational integrity of the Installation.

As a means of communicating with the public, local government/municipalities should post a map of the NASCC AICUZ footprint on their websites and provide a link to the NASCC website for information on aircraft operations and the AICUZ Program.

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 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 local governments work with NASCC 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 NASCC. As a beginning point, it is recommended local governments use the flight tracks presented in Section 3.3.3 to preserve the operational integrity of these flight tracks and protect the health and safety of the underlying population.

Land Use Plans and Regulations. Local governments with jurisdiction over the development of properties within the NASCC AICUZ footprint should recognize their responsibility in providing land use control measures to protect the public's health, safety, and general welfare. 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/or indirect impacts that such improvements may have on the ability to implement a successful AICUZ Program.

Building Codes. Local building code 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 NASCC and provide a link to the NASCC website for information on aircraft operations and the NASCC 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 City of Corpus Christi 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 NASCC AICUZ Program and learn about the program's goals and objectives; its value in protecting the health, safety, and welfare of the population; the limits of the program; and the positive community aspects of a successful AICUZ Program.

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Appendix A

Discussion of Noise and Its Effect on the Environment

From: *Aircraft Noise Study for NAS Corpus Christi, NALFs Waldron and Cabaniss and Goliad County Industrial Airpark, Texas*, Wyle Laboratories, Inc. February 2008

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APPENDIX A

Discussion of Noise and Its Effect on the Environment

APPENDIX A
Discussion of Noise and Its Effect on the Environment

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.

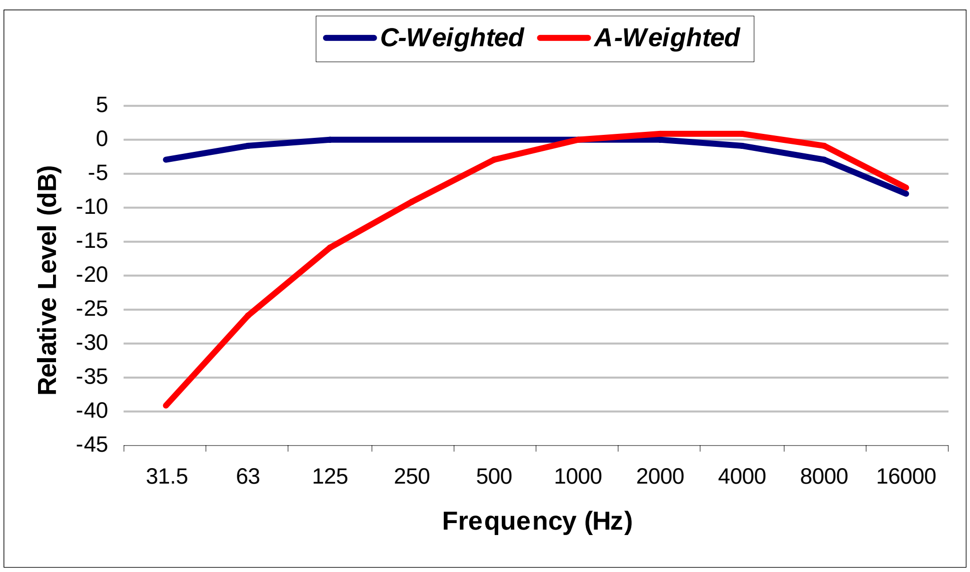
Second, the total sound level produced by two sounds of different levels is usually only slightly more than the higher of the two. For example:

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.

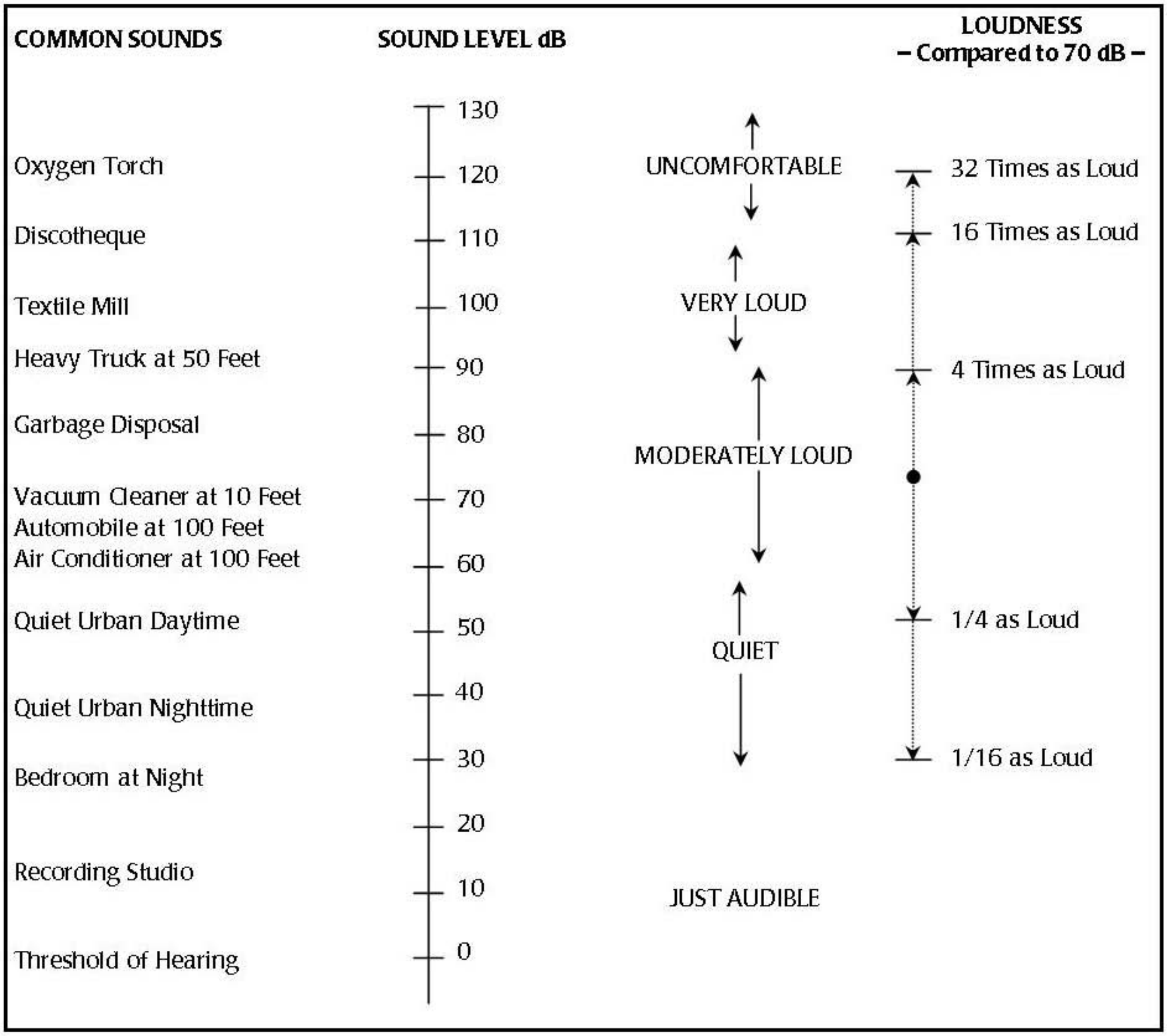
C-weighted Sound Level

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 L_{max} because an individual overflight takes seconds and the maximum sound level (L_{max}) 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., long-term annoyance), and particularly aircraft noise effects. In general, scientific studies and social surveys have found a high correlation between the percentages of groups of people highly annoyed and the level of average noise exposure measured in DNL (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.

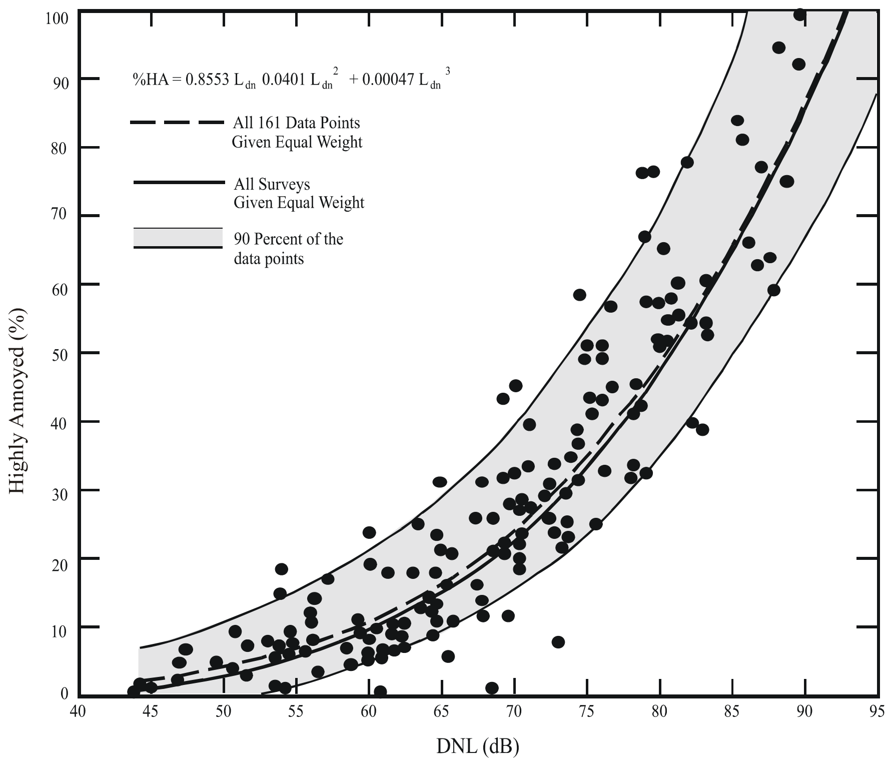


Figure A-3. Community Surveys of Noise Annoyance

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.

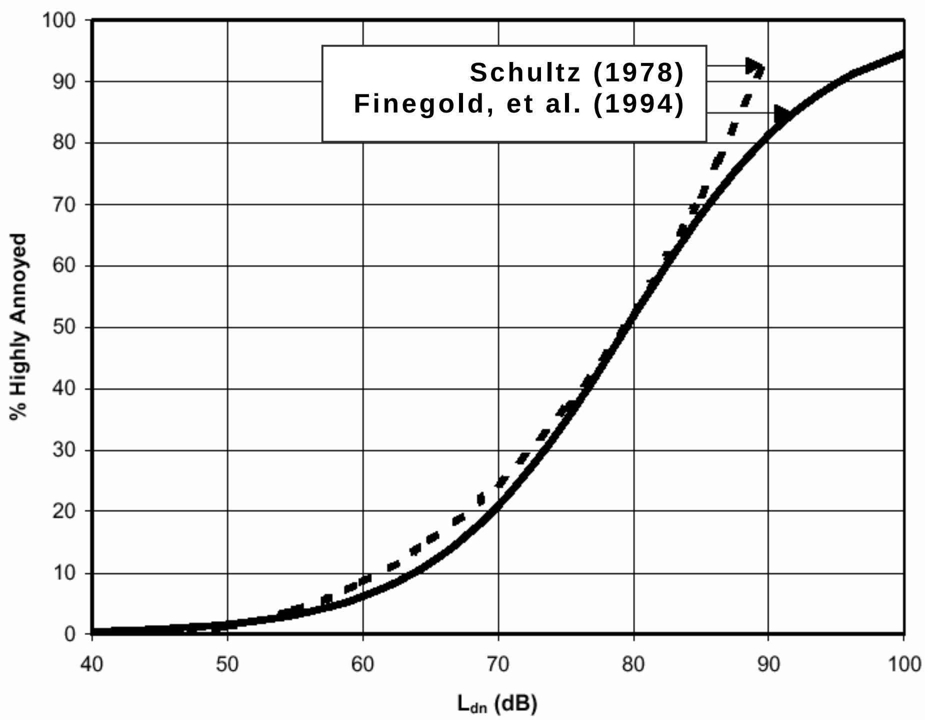


Figure A-4. Response of Communities to Noise; Comparison of Original (Schultz, 1978) and Current (Finegold, et al. 1994) Curve Fits

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

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 occurring after 10 pm or before 7 am.

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.

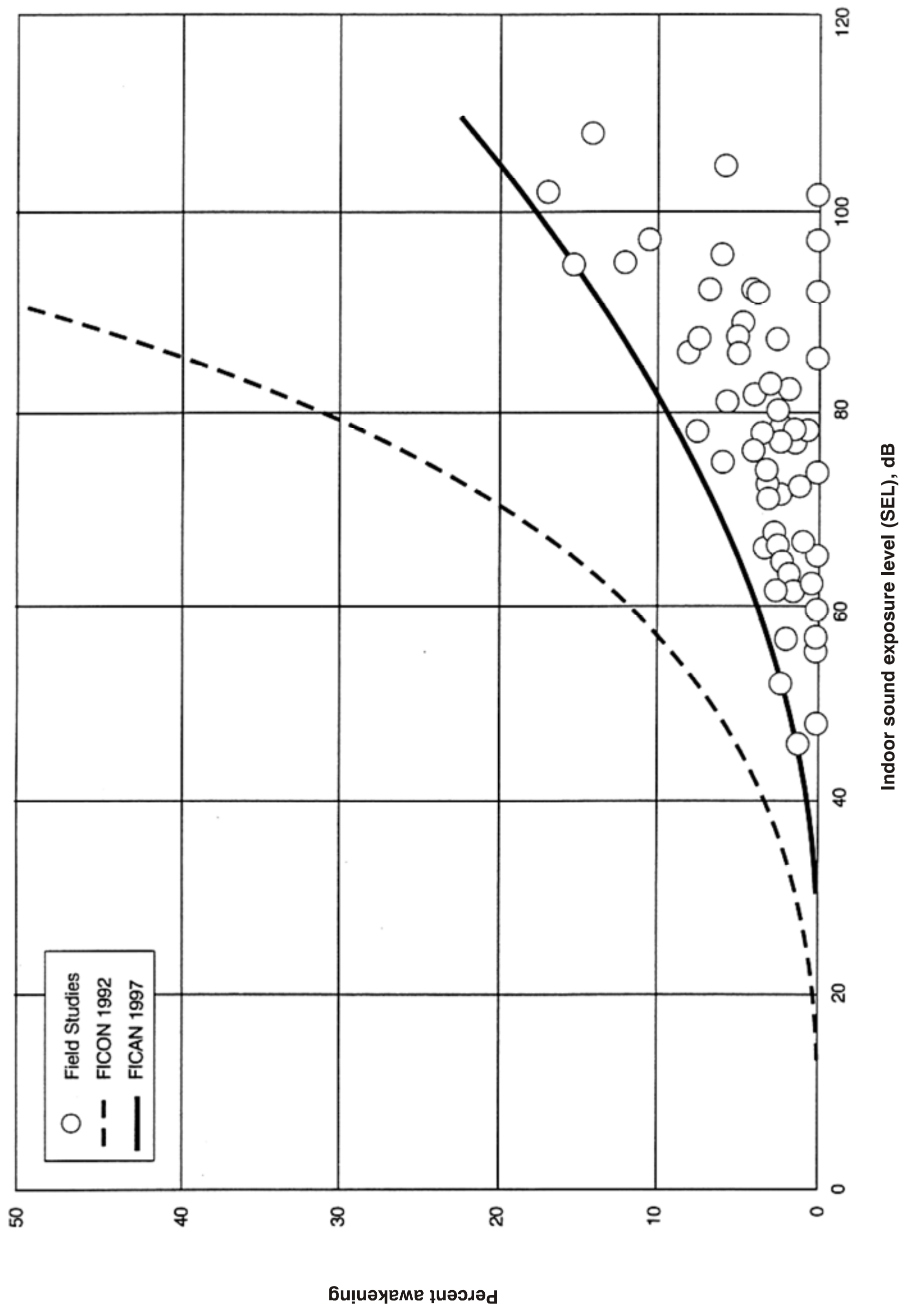


Figure A-5. Recommended Sleep Disturbance Dose-Response Relationship

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 likely that noise-related general ill-health effects are due to the psychological annoyance from the noise interfering with normal everyday behavior, than it is from the noise eliciting, because of its intensity, reflexive response in the autonomic or other physiological systems of the body." Psychological stresses may cause a physiological stress reaction that could result in impaired health.

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

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

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

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

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

Most studies of nonauditory health effects of long-term noise exposure have found that noise exposure levels established for hearing protection will also protect against any potential nonauditory health effects, at least in workplace conditions. One of the best scientific summaries of these findings is contained in the lead paper at the National Institutes of Health Conference on Noise and Hearing Loss, held on 22 to 24 January 1990 in Washington, D.C.:

> "The nonauditory effects of chronic noise exposure, when noise is suspected to act as one of the risk factors in the development of hypertension, cardiovascular disease, and other nervous disorders, have never been proven to occur as chronic manifestations at levels below these criteria (an average of 75 dBA for complete protection against hearing loss for an 8-hour day). At the recent (1988) International Congress on Noise as a Public Health Problem, most studies attempting to clarify such health effects did not find them at levels below the criteria protective of noise-induced hearing loss, and even above these criteria, results regarding such health effects were ambiguous. Consequently, one comes to the conclusion that establishing and enforcing exposure levels protecting against noise-induced hearing loss would not only solve the noise-induced hearing loss problem, but also any potential nonauditory health effects in the work place" (von Gierke 1990).

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

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

As a second example, two other UCLA researchers used this same population near LAX to show a higher rate of birth defects for 1970 to 1972 when compared with a control group residing away from the airport (Jones and Tauscher 1978). Based on this report, a separate group at the Center for Disease

Control performed a more thorough study of populations near Atlanta's Hartsfield International Airport (ATL) for 1970 to 1972 and found no relationship in their study of 17 identified categories of birth defects to aircraft noise levels above 65 dB (Edmonds, et al. 1979).

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

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

A3.8.2 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).

A3.8.2.1 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.

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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 commerical 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

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

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Table B-1
Land Use Compatibility Recommendations

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

Table B-1
Land Use Compatibility Recommendations

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

Table B-1
Land Use Compatibility Recommendations

Land Use		Accident Potential Areas[1]			Noise Levels			
SLUCM No.	Name	Clear Zone	APZ I	APZ II	65 to 70 DNL	70 to 75 DNL	75 to 80 DNL	80 to 85 DNL
62.4	Cemeteries	N	Y[15]	Y[15]	Y	Y[27]	Y[28]	Y[29,24]
63	Business services	N	N	Y[16]	Y	25	30	N
63.7	Warehousing and storage	N	Y[17]	Y[17]	Y	Y[27]	Y[28]	Y[29]
64	Repair services	N	Y[18]	Y[18]	Y	Y[27]	Y[28]	Y[29]
65	Professional services	N	N	Y[9]	Y	25	30	N
65.1	Hospitals, other medical facilities	N	N	N	25	30	N	N
65.16	Nursing homes	N	N	N	N[26]	N[26]	N	N
66	Contract construction services	N	Y[18]	Y[18]	Y	25	30	N
67	Governmental services	N	N	Y[10]	Y[26]	25	30	N
68	Educational services	N	N	N	25	30	N	N
69	Miscellaneous services	N	N	Y[9]	Y	25	30	N
70	Cultural, entertainment and recreational							
71	Cultural activities (including churches)	N	N	N	25	30	N	N
71.2	Nature exhibits	N	Y[19]	Y[19]	Y[26]	N	N	N
72	Public assembly	N	N	N	Y	N	N	N
72.1	Auditoriums, concert halls	N	N	N	25	30	N	N
72.11	Outdoor music shells, amphitheaters	N	N	N	N	N	N	N
72.2	Outdoor sports arenas, spectator sports	N	N	N	Y[31]	Y[31]	N	N
73	Amusements (including fairgrounds, miniature golf, driving ranges, amusement parks)	N	N	Y	Y	Y	N	N
74	Recreational activities (including golf courses, riding stables, water recreation)	N	Y[18,19]	Y[18,19]	Y[26]	25	30	N
75	Resorts and group camps	N	N	N	Y[26]	Y[26]	N	N
76	Parks	N	Y[18,19]	Y[18,19]	Y[26]	Y[26]	N	N
79	Other cultural, entertainment and recreation	N	Y[18,19]	Y[18,19]	Y[26]	Y[26]	N	N
80	Resource production and extraction							
81	Agriculture (except livestock)	Y[6]	Y[20]	Y[20]	Y[32]	Y[33]	Y[34]	Y[34,35]
81.5, 81.7	Livestock farming and animal breeding	N	Y[20,21]	Y[20,21]	Y[32]	Y[33]	N	N
82	Agricultural related activities	N	Y[20,22]	Y[20,22]	Y[32]	Y[33]	Y[34]	Y[34,35]
83	Forestry activities and related services [23]	N	Y[22]	Y[22]	Y[32]	Y[33]	Y[34]	Y[34,35]

Table B-1
Land Use Compatibility Recommendations

Land Use		Accident Potential Areas[1]			Noise Levels			
SLUCM No.	Name	Clear Zone	APZ I	APZ II	65 to 70 DNL	70 to 75 DNL	75 to 80 DNL	80 to 85 DNL
84	Fishing activities and related services [24]	N[24]	Y[22]	Y[22]	Y	Y	Y	Y
85	Mining activities and related services	N	Y[22]	Y[22]	Y	Y	Y	Y
89	Other resource production and extraction	N	Y[22]	Y[22]	Y	Y	Y	Y
90	Other							
91	Undeveloped land	Y	Y	Y	NA	NA	NA	NA
93	Water areas	N[25]	N[25]	N[25]	NA	NA	NA	NA

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

Notes:

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

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

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.

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

Addendum

FINAL

Goliad County Industrial Airpark—an Addendum to the

Air Installations Compatible Use Zones Study for Naval Air Station Corpus Christi, Texas,

Including Naval Auxiliary Landing Fields Waldron and Cabaniss

August 2009

Final Draft

Goliad County Industrial Airpark

An Addendum to:
Air Installations Compatible Use Zones Study for Naval Air Station Corpus Christi, Texas, Including Naval Auxiliary Landing Fields Waldron and Cabaniss

Contract No. N 62470-06-D-7101

August 2009

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UNITED STATES DEPARTMENT OF THE NAVY
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Jacksonville, Florida

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Acronyms and Abbreviations

AICUZ	Air Installations Compatible Use Zones
APZ	accident potential zone
DNL	day-night average sound level
DoD	United States Department of Defense
FCLP	Field Carrier Landing Practice
GCA	ground-controlled approach
JPATS	Joint Primary Aircraft Training System
MSA	Metropolitan Statistical Area
NASCC	Naval Air Station Corpus Christi
NASCC AICUZ Study	*Air Installations Compatible Use Zones Study for Naval Air Station Corpus Christi, Texas, Including Naval Auxiliary Landing Fields Waldron and Cabaniss*
Navy	United States Department of the Navy
TCEQ	Texas Commission on Environmental Quality
TSDC and OSD	Texas State Data Center and Office of the State Demographer
TW-4	Training Air Wing FOUR
VT-27	Training Squadron TWENTY-SEVEN
VT-28	Training Squadron TWENTY-EIGHT
VT-31	Training Squadron THIRTY-ONE

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1 Goliad County Industrial Airpark

1.1 Introduction

JPATS: Joint Primary Aircraft Training System

NASCC: Naval Air Station Corpus Christi

AICUZ: Air Installations Compatible Use Zones

The *Air Installations Compatible Use Zones Study for Naval Air Station Corpus Christi, Texas, Including Naval Auxiliary Landing Fields Waldron and Cabaniss* (referred to herein as the NASCC AICUZ Study) includes this addendum for Goliad County Industrial Airpark in the event the U.S. Department of the Navy (Navy) uses the airfield as an additional auxiliary landing field to accommodate the basing of the new T-6 Texan II aircraft and the implementation of the Joint Primary Aircraft Training System (JPATS) training program at Naval Air Station Corpus Christi (NASCC).

Goliad County Industrial Airpark is a former Navy outlying landing field (Goliad NOLF) for the former NAS Chase Field located in Beeville, Texas. The Navy closed Goliad NOLF in 1992. No previous Air Installations Compatible Use Zones (AICUZ) Study has been completed for Goliad County Industrial Airpark; however, an AICUZ Study was completed for the former Goliad NOLF in 1976. The 2008 Noise Study (Wyle Laboratories, Inc. 2008), which is the source of noise data contained in this AICUZ Study, includes an analysis of the Goliad County Industrial Airpark.

1.2 Location and Operational Area

Goliad County Industrial Airpark is located approximately 70 miles north of NASCC in Goliad County, Texas. The airpark is located in a rural and sparsely populated area and is accessible via State Highway 59, FM Route 883, FM Route 1351, East Air Base Road, and West Air Base Road. Figure 1-1 illustrates the airfield location.

TW-4: Training Air Wing FOUR

Goliad County Industrial Airpark, with an average elevation of 324 feet above mean sea level, has two active runways and associated taxiways. Runway dimensions are provided in Table 1-1. The 1,136-acre airpark property includes a control tower, an administration building, a maintenance building, and water and waste water treatment facilities (Goliad County 2008). Civilian operations are conducted at Goliad County Industrial Airpark, including private, single-engine and multi-engine aircraft operations. Additionally, the airfield currently supports touch-and-go training missions for Training Air Wing FOUR (TW-4) from NASCC, but no military aircraft are based at Goliad County Industrial Airpark.

Table 1-1: Goliad County Industrial Airpark Runway Dimensions

Runway	Length (feet)	Width (feet)
10/28 (Class B)	8,000	150
16/34 (Class B)	8,000	150

Source: AirNav LLC 2008 (Federal Aviation Administration information effective February 14, 2008).

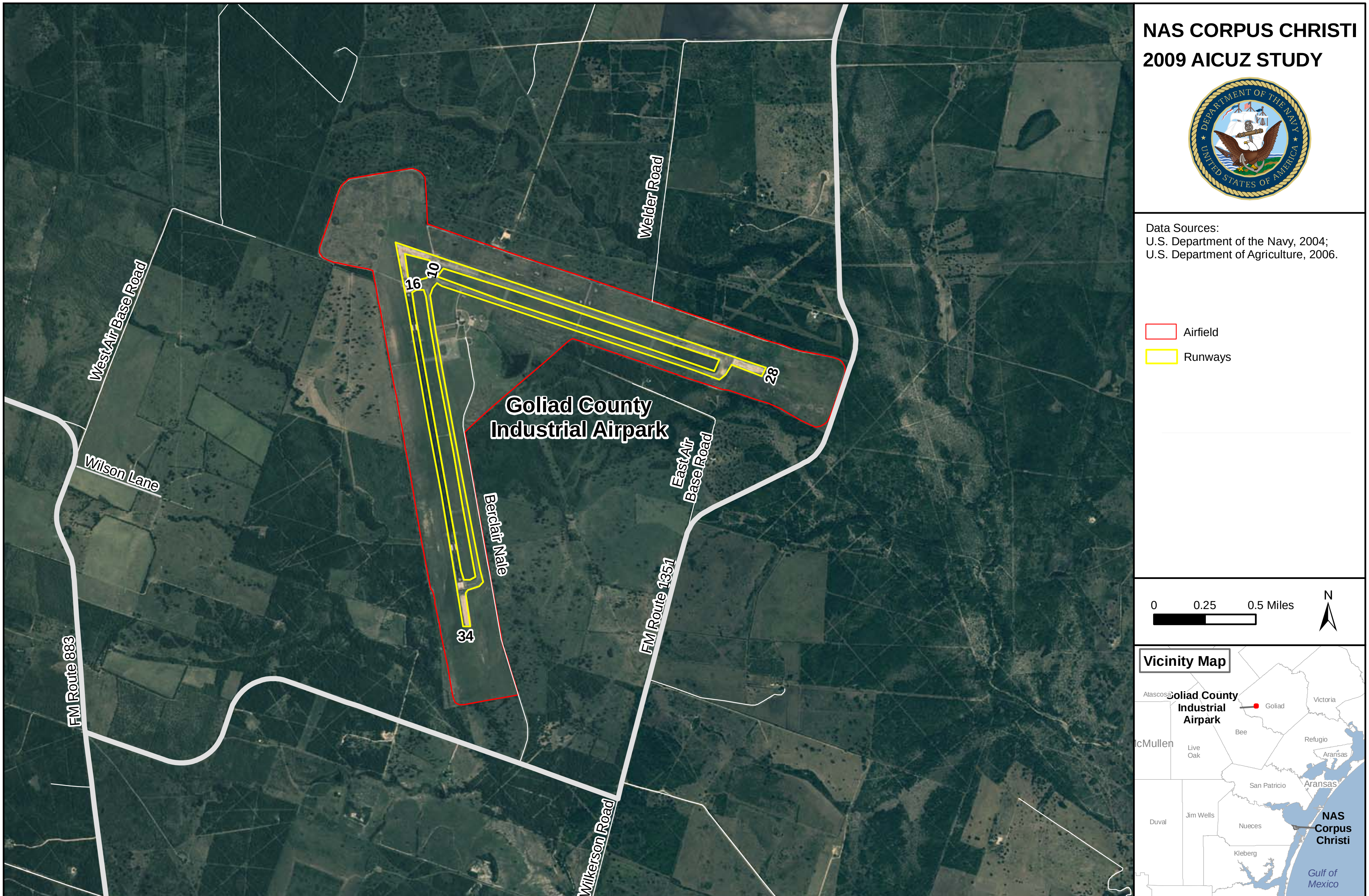

Figure 1-1: Goliad County Industrial Airpark Location Map

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2 Aircraft Operations

The aircraft operations used to model the 2009 AICUZ noise contours and accidental potential areas at Goliad County Industrial Airpark are based on prospective conditions for Calendar Year 2015 as a result of the expected TW-4 transition to the T-6 JPATS.

Goliad County Industrial Airpark is a public airfield that supports both civilian and military aircraft operations. This airfield is used by military aircraft (T-34 and T-44) and private, single-engine aircraft (C-172) and multi-engine aircraft (PA-32) visiting the area. No based military flight units are stationed at Goliad County Industrial Airpark. According to the Goliad County Industrial Airpark Manager, a total of 9,402 flight operations were conducted in 2007 at the airfield. The majority of 2007 operations were conducted by transient TW-4 Training Squadrons TWENTY-SEVEN (VT-27), TWENTY-EIGHT (VT-28), THIRTY-ONE (VT-31). Total annual flight operation types occurring at Goliad County Industrial Airpark, including departures, arrivals, and touch-and-go patterns, are presented in Table 2-1 (Wyle Laboratories, Inc. 2008).

A **flight operation** refers to any takeoff or landing of one aircraft at NASCC or the auxiliary training airfields.

Modeled Flight Operations. In 2015, a total of 238,228 flight operations are projected for Goliad County Industrial Airpark. Goliad County Industrial Airpark will serve all T-6 outlying landing field operations for the future TW-4 transition to the JPATS. Projected conditions for Goliad County Industrial Airpark are based on the assumption that T-34C aircraft operations will be replaced by T-6 aircraft operations. T-44 aircraft operations and general aviation operations are expected to continue at Goliad County Industrial Airpark. Table 2-2 presents the 2015 projected annual flight operations for Goliad County Industrial Airpark, including departures, arrivals, and touch-and-go patterns.

Table 2-1: 2007 Annual Flight Operations at Goliad County Industrial Airpark

	Operation Type	Day 0700-2200	Night 2200-0700	Total
Military	Departure	780	0	**780**
	Arrival	0	0	
	Overhead Break Arrival	780	0	**780**
	Touch-and-Go[a]			
	Total	**7,800**	**0**	**7,800**
Civil	Departure	21	0	**21**
	Arrival	21	0	**21**
	Overhead Break Arrival	0	0	**0**
	Touch-and-Go[a]			
	Total	42	0	**42**
	Grand Total	**9,402**	**0**	**9,402**

Source: Wyle Laboratories, Inc. 2008.
Note:
(a) Counted as two operations.

Table 2-2: 2015 Modeled Flight Operations at Goliad County Industrial Airpark

	Aircraft	Operation Type	Day 0700-2200	Night 2200-0700	Total
Military	T-6 (Transient)	Departure	15,248	0	**15,248**
		Arrival	0	0	**0**
		Overhead Break Arrival	15,248	0	**15,248**
		Touch-and-Go[a]	201,000		**201,000**
		Total	**231,496**	**0**	**231,496**
	T-44 (Transient)	Departure	546	0	**546**
		Arrival	0	0	**0**
		Overhead Break Arrival	546	0	**546**
		Touch-and-Go[a]	5,460		**5,460**
		Total	**6,552**		
Civil	General Aviation	Departure	90	0	**90**
		Arrival	90	0	**90**
		Overhead Break Arrival	0	0	**0**
		Touch-and-Go[a]	0		**0**
		Total	**180**	0	**180**
		Grand Total	**238,228**	**0**	**238,228**

Source: Wyle Laboratories, Inc. 2008.
Note:
(a) Counted as two operations.

2.1 Pre-Flight and Maintenance Run-up Operations

No pre-flight or engine maintenance run-ups operations are preformed at Goliad County Industrial Airpark. Since pre-flight and maintenance run-up operations are not conducted at Goliad County Industrial Airpark, this airfield does not have designated run-up locations.

2.2 Runway and Flight Track Utilization

flight track: General pre-determined path an aircraft flies while conducting air operations near an airfield.

Runway and flight track information used to model the 2009 noise contours is based on the projected 2015 annual flight operations at Goliad County Industrial Airpark. Aircraft approaching or departing from the airfield are assigned specific routes or flight tracks. Flight tracks in this report are idealized representations (single lines), but flights vary due to aircraft performance, configuration, pilot technique, air traffic conflicts, and weather conditions, such that the actual flight track is a band, often 0.5 to several miles wide. Runway and flight track utilization for Goliad County Industrial Airpark was provided by the airpark's Manager.

Each flight track is identified and numbered according to runway utilization, flight operation, and course rule (or flight route). Flight operations are abbreviated as: Departure (D), Straight Arrival (A), Overhead Break Arrival (O), and Touch-and-Go Pattern (T). Specific course rules are identified in Table 2-3. For example, flight track number 10D1 at Goliad County Industrial Airpark is interpreted as:

Utilized Runway: 10
Type of Flight Operation: Departure
Course Rule: Field Departure

Military fixed-wing operations at Goliad County Industrial Airpark predominantly occur on Runway 16 (78.4%), Runway 34

(19.6%), with the remaining 2% operations occurring on Runways 10 and 28. The T-6 aircraft is expected to use runways and flight tracks in the same manner as the T-34 and T-44 aircraft. Although T-34 operations will be replaced by the T-6 aircraft by 2015, the T-44 will continue flight operations. Predominant arrival, departure, and pattern flight tracks for runways at Goliad County Industrial Airpark are shown on Figures 2-1 through 2-3. The NASCC Aircraft Noise Study (Wyle Laboratories, Inc. 2008) provides detailed information on runway operations and utilization, flight track utilization, and average annual day operations for each aircraft at Goliad County Industrial Airpark. A summary of flight track information for Goliad County Industrial Airpark is provided in Table 2-3.

Table 2-3: Flight Tracks at Goliad County Industrial Airpark

Operation Type	Runway	Flight Track ID	Flight Track Rule
Departure	10	10D1	Field Departure
	28	28D1	Field Departure
	16	16D1	Field Departure
	34	34D1	Field Departure
Arrival	10	10A1	Straight-in Arrival
	28	28A1	Straight-in Arrival
	16	16A1	Straight-in Arrival
	34	34A1	Straight-in Arrival
Overhead Break Arrival	10	10O1	Overhead Break Arrival
		10O2	Short Break Arrival
	28	28O1	Overhead Break Arrival
		28O2	Short Break Arrival
	16	16O1	Overhead Break Arrival
		16O2	Short Break Arrival
	34	34O1	Overhead Break Arrival
		34O2	Short Break Arrival
Touch-and-Go Pattern	10	10T1	2 to 3 Aircraft Pattern
	28	28T1	2 to 3 Aircraft Pattern
	16	16T1	2 to 3 Aircraft Pattern
	34	34T1	2 to 3 Aircraft Pattern

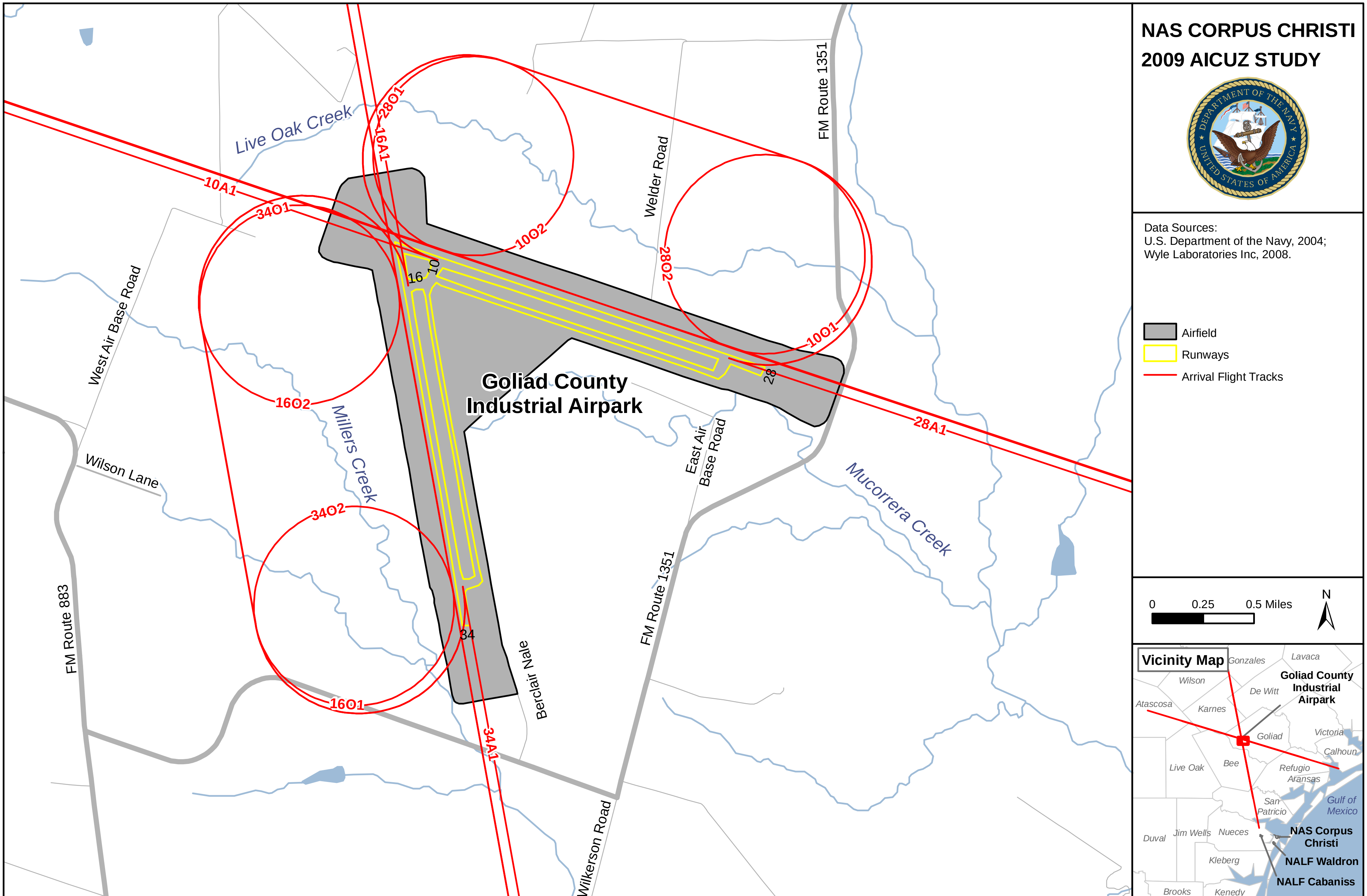

Figure 2-1: Arrival Flight Tracks (Fixed Wing)
Goliad County Industrial Airpark

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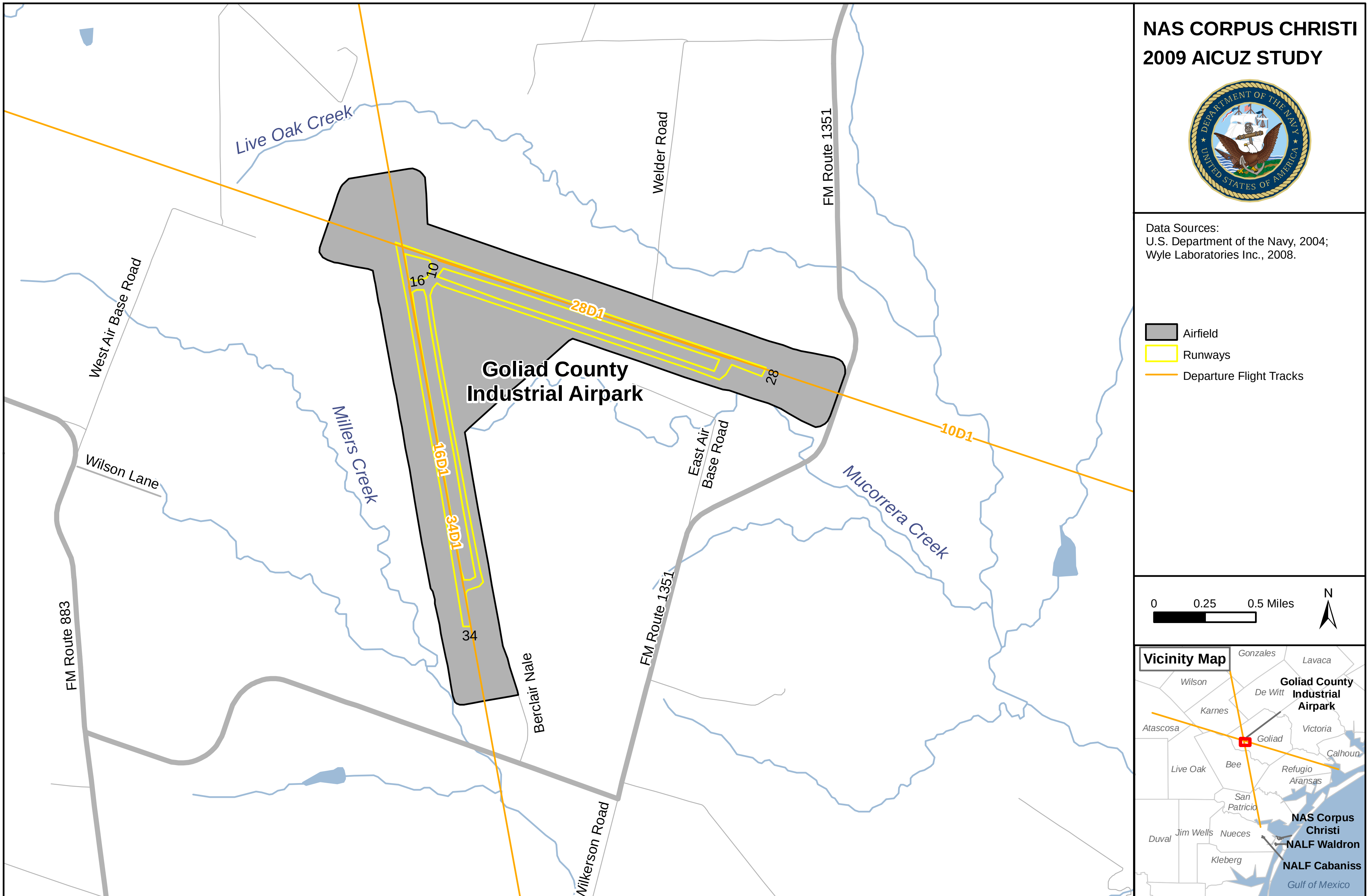

Figure 2-2: Departure Flight Tracks (Fixed Wing)
Goliad County Industrial Airpark

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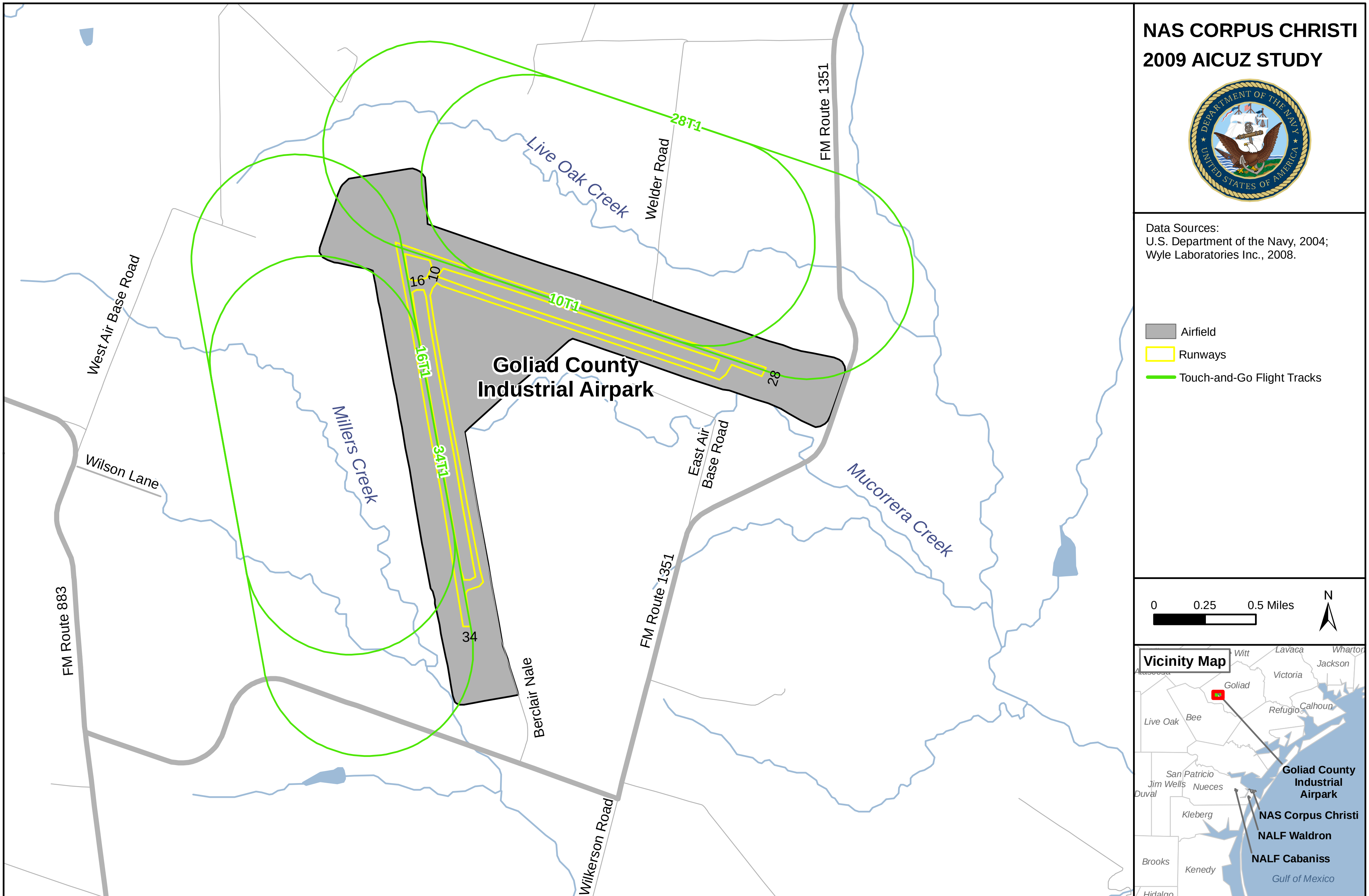

Figure 2-3: Pattern Flight Tracks (Fixed-wing)
Goliad County Industrial Airpark

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3 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 significantly impacts areas surrounding an airfield, high-noise zones are defined for Goliad County Industrial Airpark within this AICUZ Study Addendum. This section discusses noise associated with aircraft operations at Goliad County Industrial Airpark including average noise levels and noise contours.

3.1 Airfield Noise Sources

The main noise source at Goliad County Industrial Airpark is fixed-wing aircraft operations. No engine maintenance operations or run-ups are conducted at Goliad County Industrial Airpark. For the purposes of modeling, the T-6 aircraft was used to represent all transient fixed-wing aircraft to ensure the Navy noise impacts are not underrepresented.

3.2 2009 AICUZ Noise Contours

This section describes the modeled 2009 AICUZ noise contours. No previous noise contours were modeled at Goliad County Industrial Airpark. As shown on Figure 3-1, the Goliad County Industrial Airpark 2009 AICUZ noise contours extend 1.3 miles west of the end of Runway 34 and 1.1 miles west of Runway 16 as a result of touch-and-go operations. Table 3-1 summarizes the impact of aircraft operations and the people and acres exposed to noise in the 2009 AICUZ noise contours. There are minimal off-station impacts to housing and the local population as a result of noise surrounding Goliad County Industrial Airpark. Table 3-2 summarizes the total area within the 2009 AICUZ noise contours.

Table 3-1: Off-Base Population and Area Impact for 2009 AICUZ Noise Contours, Goliad County Industrial Airpark

Noise Zone (DNL)	Population	Housing	Area (acres) [a]
60 to 65	2	2	945
65 to 70	0	0	389
70 to 75	0	0	86
75+	0	0	0

Source: Wyle Laboratories, Inc. 2008.
Note: (a) Total Area excludes areas within the Installation.
Key:
AICUZ = Air Installations Compatible Use Zones.
DNL = Day-night average sound level.

Table 3-2: Areas within 2009 AICUZ Noise Zones (DNL) Goliad County Industrial Airpark

Noise Zone (DNL)	TOTAL LAND AREA (acres)
60 to 65	1,194
65 to 70	578
70 to 75	246
75+	89
TOTAL AREA	**2,107**

Source: Wyle Laboratories, Inc. 2008.
Key:
AICUZ = Air Installations Compatible Use Zones.
DNL = Day-night average sound level.

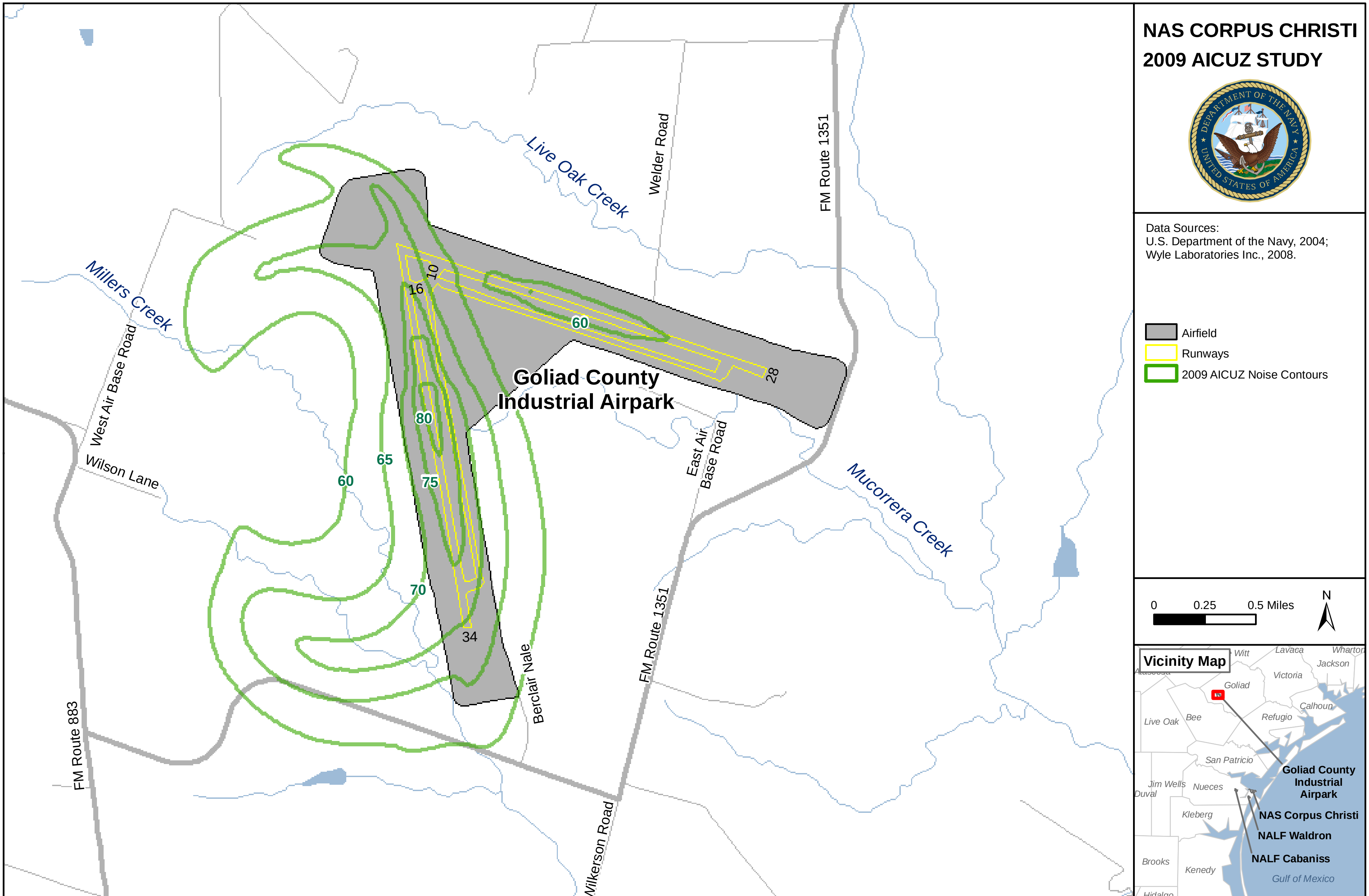

Figure 3-1: 2009 AICUZ Noise Contours
Goliad County Industrial Airpark

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4 Airfield Safety

The 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, areas of accident potential are identified and defined around the Goliad County Industrial Airpark runways to assist in land use planning.

4.1 Accident Potential Zone Configurations and Areas

APZ: accident potential zone

Clear Zones and Accident Potential Zones (APZs) are areas in the vicinity of airfield runways where an aircraft mishap is most likely to occur. The Navy recommends land uses within APZs be minimal or low density to ensure the maximum protection of public health and property. The U.S. Department of Defense (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.

The 2009 AICUZ APZs were modeled for Class B runways to account for future T-6 aircraft operations. General aviation is expected to increase at Goliad County Industrial Airpark by 2015, and projected flight operations include high performance aircraft such as the Boeing 727 and Lear 35 commercial jets (Wyle Laboratories, Inc. 2008). The components of a standard APZ for a Class B runway are identified and defined in Chapter 5 of the NASCC AICUZ Study. Further information on the configuration and definition of APZs is also provided in Chapter 5 of the NASCC AICUZ Study. Table 4-1 and Figure 4-1 identify the 2009 AICUZ Clear Zone and APZ acreages at Goliad County Industrial Airpark.

Table 4-1: Land Area within the 2009 AICUZ Accident Potential Zones (APZs) at Goliad County Industrial Airpark, Texas

Airfield	Clear Zone (acres)	APZ I (acres)	APZ II (acres)	Total Area (acres)
Goliad County Industrial Airpark	327	1,673	1,094	**3, 094**

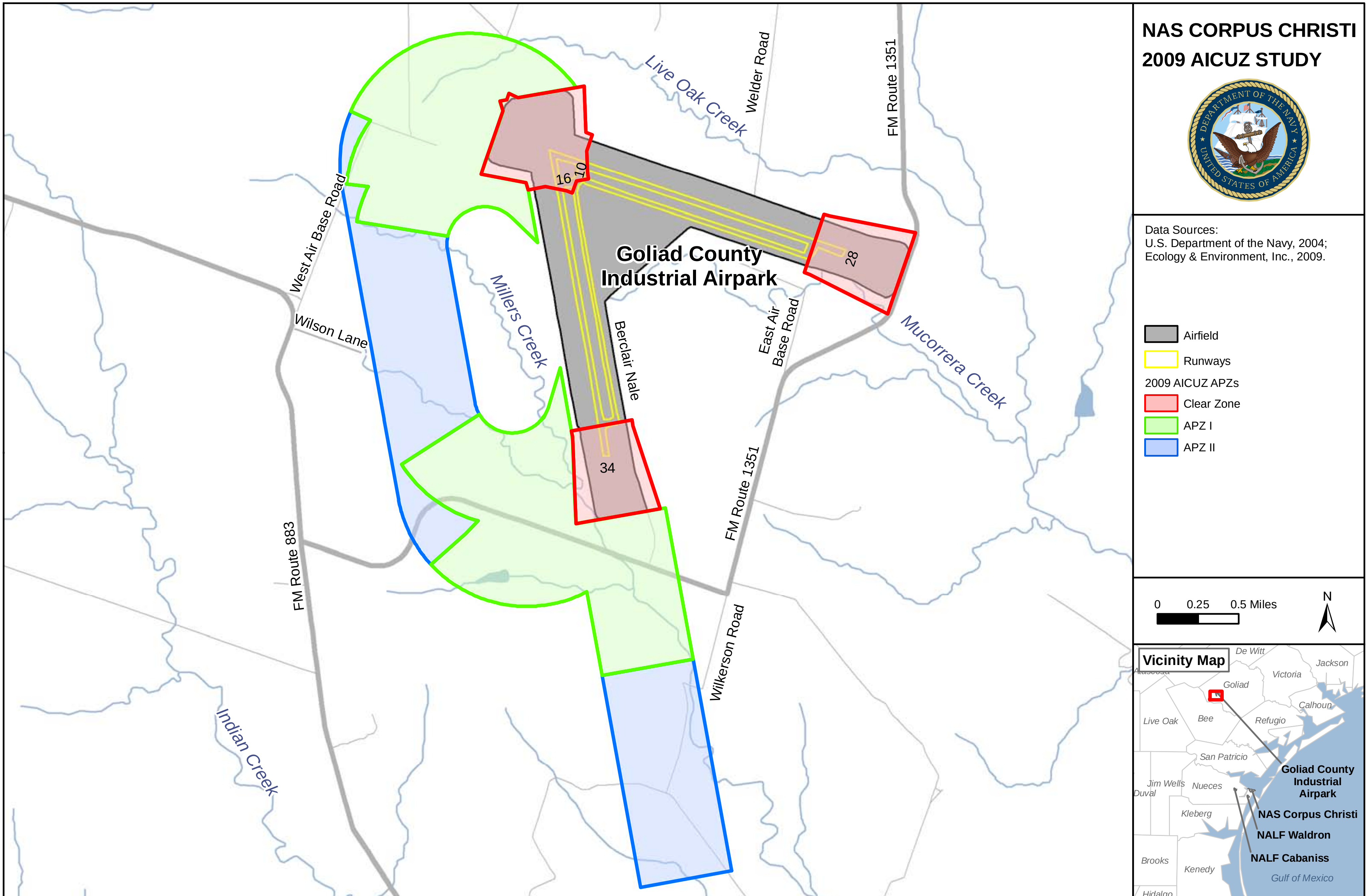

Figure 4-1: 2009 AICUZ APZs
Goliad County Industrial Airpark

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5 Land Use Compatibility Analysis

The land use compatibility analysis is based on the evaluation of existing land uses and proposed development plans of properties surrounding Goliad County Industrial Airpark. Population projections, economic growth trends, land use regulations, and planning practices were also evaluated to determine how local and regional development patterns and growth management strategies could impact future operations at Goliad County Industrial Airpark.

5.1 Land Use and Development Control

5.1.1 Land Use and Population Growth in Goliad County

Goliad County is 25 miles inland from the southeast Texas coastline and is situated between Bee County and Victoria County. The county's total area is 860 square miles (550,400 acres) comprised of 854 square miles of land area and 6 square miles of water. Goliad County is rural, and the land is used primarily for farming and cattle ranching. Uranium mines are located throughout the south Texas region, and mining is permitted in the north part of Goliad County. The county can lease land for uranium mining, and land above ground is used as pasture for livestock grazing and woodland.

Goliad County is sparsely populated with a density of 8.07 residents per square mile. The county population count is 6,928 persons, 2,644 households, and 1,975 families (U.S. Census Bureau 2000a). The county's population increased 4.5% since the 2000 Census for a total population of 7,238 persons, and projections indicate continuous growth through 2025 (Texas State Data Center and Office of the State Demographer [TSDC and OSD] 2007).

Goliad County is part of the greater Victoria Metropolitan Statistical Area (MSA), which also includes Calhoun County and Victoria County. The Victoria MSA has a population of 111,663 persons (U. S. Census Bureau 2000b) and is projected to grow more than 25% by 2025 to a population of more than 141,000 persons. Table 5-1 provides the decennial population estimates and additional five-year projections for Goliad County and the Victoria MSA from 1990 through 2025. In 2000, the Office of Management and Budget redefined MSA standards. The definition of the Victoria MSA was affected by the new standards, and as such, the Census count for the year of 1990 is inconsistent with the subsequent 2000 Census count and projections (Office of Management and Budget 2000).

Table 5-1: Population Estimates and Projections for Goliad County and Greater Victoria Metropolitan Statistical Area (MSA)

Population Area	1990	2000	2005	2010	2015	2025
Goliad County, Texas	5,980[(a)]	6,928[(a)]	7,170	7,416	7,610	7,904
Victoria MSA, Texas	N/A	111,663	117,982	124,293	130,690	141,536

Source: U.S. Census Bureau 2000a and 2000b; TSDC and OSD 2007.
Note: (a) Census counts, not estimates.

5.1.2 Goliad County Economy and Employment

The largest industries in Goliad County include educational, health and social services, agriculture, cattle, oil and gas production, construction, and tourism (U.S. Census Bureau 2000c; Texas Comptroller of Public Accounts 2001). As the third oldest municipality in Texas, Goliad County's numerous historic sites and heritage anchor a strong tourism industry. According to the Goliad Economic Development Office, increased business development is projected throughout the county's unincorporated area, but within proximity to cities or townships.

The nuclear power industry is seeking permits to mine uranium in Goliad County. In particular, Uranium Energy Corporation is promoting the initiation of the Goliad Uranium Project to mine uranium in the north-central area of Goliad County. The company recently filed a permit application with the Texas Commission on Environmental Quality (TCEQ) in December 2008. The project site consists of 13 mining leases over 1,421 net acres of contiguous properties (Uranium Energy Corporation 2009). The proposed site is located an estimated 25 miles northeast of Goliad Field. As of February 2009, the TCEQ issued a Permit by Rule (Uranium Energy Corporation 2009).The Goliad Economic Development Office does not expect that nuclear power development in the region will create a significantly stronger employment base in Goliad County (Lewis 2008). In the eastern area of the county (near Victoria, Texas), a power plant is scheduled to begin construction within the next year. Although the power plant is not adjacent to the airpark, it will generate employment and may increase housing demands throughout the county.

The largest employers in the county are Goliad Independent School District, Goliad County, and Central Power & Light (Office of the Comptroller of the Currency 2002). Nearby industrial plants such as DuPont, Formosa Plastics, and Alcoa Aluminum also provide employment for many Goliad County residents. Goliad County's unemployment rate is 3.8%, which is below the state of Texas average (U.S. Census Bureau 2000a).

5.1.3 Goliad County Planning and Zoning Authorities

Goliad County and the incorporated areas do not have a formal comprehensive planning process. The City Administrator, who reports to the City Council, governs land use and development in the city limits by means of codes and permitting. In Texas, county governments do not have zoning authority to control land use. Outside the city limits, the Goliad County Judge administers permits for development. Considering that municipalities within Goliad County have a relatively small land area, the majority of scheduled business development occurs in the unincorporated areas of the county (Lewis 2008).

5.1.4 Planned Land Use and Development

No large-scale commercial or residential development plans are proposed in the vicinity of Goliad County Industrial Airpark (Lewis 2008). The County does not currently have a strategic land use plan to dedicate future growth, but does not expect an increase in industrial or business development that would impact growth. Development plans are more likely to occur close to city limits and not in the rural areas of the county. Scattered single-family residences may be built in the rural area of the county and in the vicinity of the airpark.

5.2 Land Use and Compatibility

The AICUZ land use compatibility analysis identifies existing and proposed land use incompatibilities within the 2009 AICUZ footprint Goliad County Industrial Airpark. Compatibility conditions were derived from the Navy's suggested land use compatibility guidelines in both AICUZ noise zones and APZs (Appendix A of the NASCC AICUZ Study). Recommended strategies for the AICUZ implementation are based on the findings from the land use assessment.

Existing land use data was evaluated to ensure an actual account of land use activity regardless of conformity to zoning classification or designated planning or permitted use. Aerial photographs were evaluated in lieu of official land use data for the area surrounding Goliad County Industrial Airpark.

5.2.1 Existing Land Uses within Goliad County Industrial Airpark AICUZ Footprint

Goliad County Industrial Airpark is located 70 miles north of NASCC in a rural area. The airpark complex and its 500 acres of developable land has been designated by Goliad County as a 'Commercial Large Aviation Development' for general aviation, aviation maintenance, repair and paint businesses, aviation hangers, and aviation residential hanger developments (Goliad County 2008). Land use and development information for Goliad County is not readily available; therefore, the existing land use analysis is based on aerial photographs and U.S. Geological Survey land cover data. The area surrounding Goliad County Industrial Airpark is primarily cattle ranching and agricultural lands. Aerial photographs indicate very sparse residential use (an estimated one dwelling unit per 5 acres) within the airpark's vicinity. Approximately 15 houses are located within a 2.5- mile radius of Goliad County Industrial Airpark.

Table 5-2: Existing Land Use within Goliad County Industrial Airpark 2009 AICUZ Noise Zones

Land Use	NOISE ZONE (acres)				
	60 to 65 DNL	65 to 70 DNL	70 to 75 DNL	75+ DNL	TOTAL
Agricultural	944.93	388.39	86.43	89.11	**1,508.86**
Public/Semi-Public (airfield property)	249.24	189.97	159.76	0.00	**598.97**
Total	**1,194.17**	**578.36**	**246.19**	**89.11**	**2,107.83**

Key:
AICUZ = Air Installations Compatible Use Zones.
DNL = day-night average sound level.

Military and agricultural/ranching properties are the only land uses within Goliad County Industrial Airpark's 2009 AICUZ noise zones and APZs (Figures 5-1 and 5-2). Approximately three houses are located within the noise zones, and approximately four houses are located within the APZs. The total acreage of existing land uses within the noise zones and APZs are summarized in Tables 5-2 and 5-3, respectively, and are illustrated on Figures 5-1 and 5-2, respectively.

Table 5-3: Existing Land Use within Goliad County Industrial Airpark 2009 AICUZ Accident Potential Zones (APZs)

Land Use	Acres			
	Clear Zone	APZ I	APZ II	Total
Agricultural	125.88	1,649.21	1094.30	**2,869.39**
Public/Semi-Public (airfield property)	363.38	23.93	0.00	**387.31**
Total	**489.26**	**1,673.14**	**1,094.30**	**3,256.70**

Key:
AICUZ = Air Installations Compatible Use Zones.

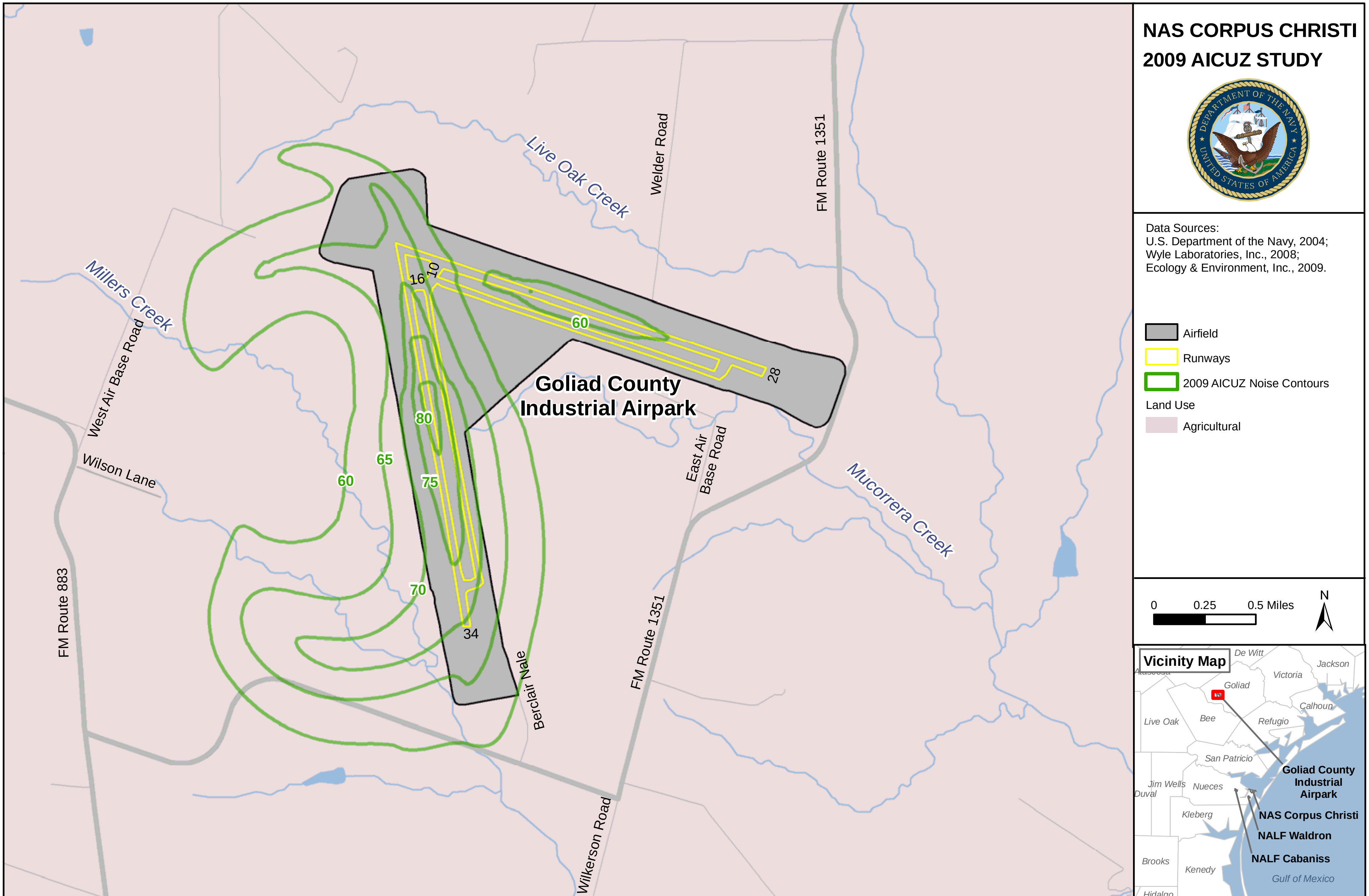

Figure 5-1: Existing Land Use and 2009 AICUZ Noise Contours
Goliad County Industrial Airpark

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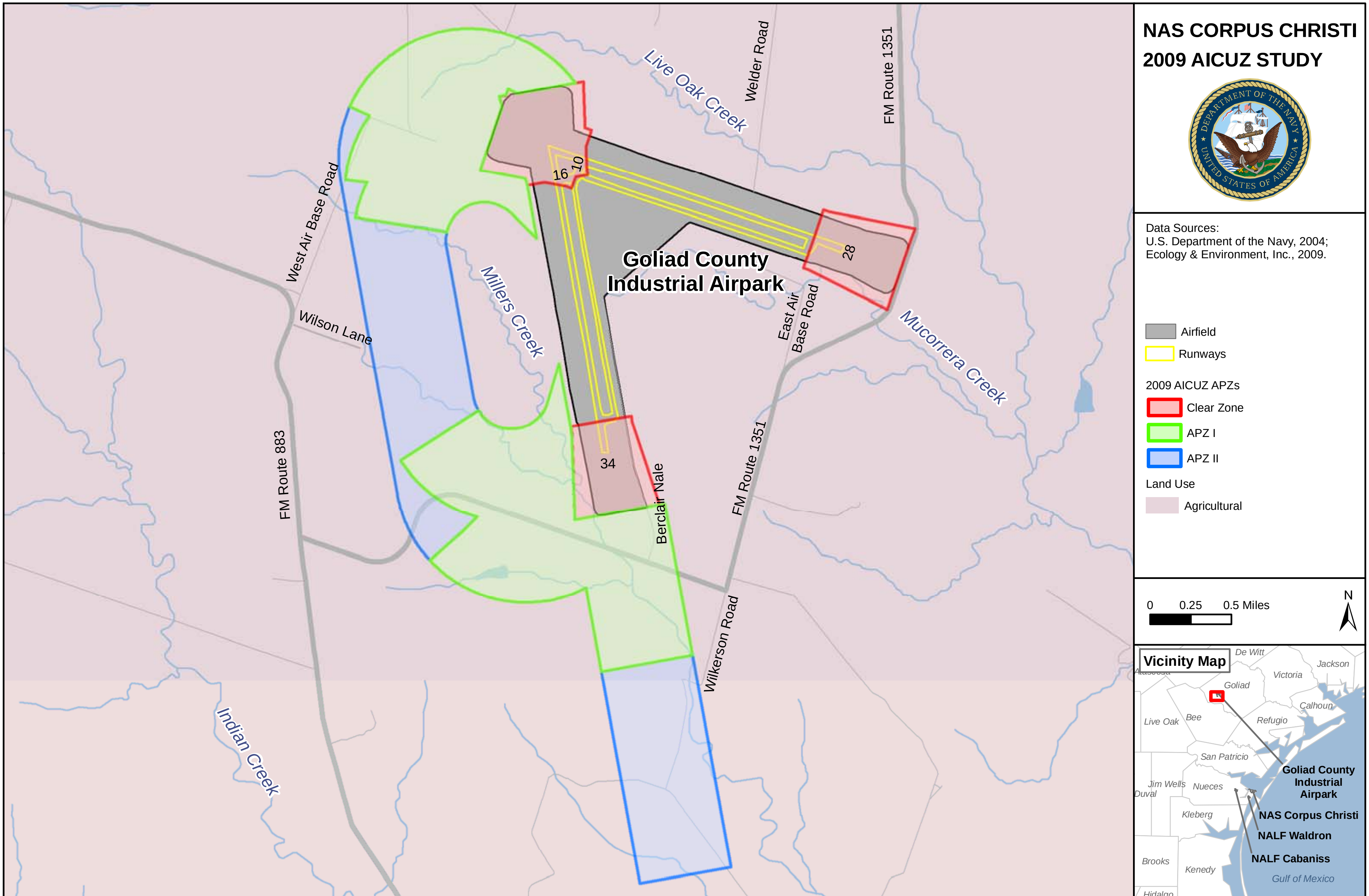

Figure 5-2: Existing Land Use and 2009 AICUZ APZs
Goliad County Industrial Airpark

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5.2.2 Existing Land Use Compatibility Conditions at Goliad County Industrial Airpark

Land use compatibility conditions determined in the analysis are derived from the Navy's recommended compatibility guidelines. Land uses and development patterns that do not impact Navy operations are deemed compatible and land uses that should be prohibited are deemed incompatible. In accordance with the Navy's guidelines, various land uses may be considered compatible with specific restrictions or incompatible with specific exceptions.

The vicinity of Goliad County Industrial Airpark is primarily agricultural land use and cattle ranching lands, and land use compatibility is not an immediate concern within 2009 AICUZ noise contours. Table 5-4 summarizes the total acreages of compatible and incompatible land uses within each noise zone of Goliad County Industrial Airpark. Figure 5-3 illustrates the specific areas of compatible and incompatible land uses within each noise zone.

Table 5-4: Land Use Compatibilty within Goliad County Industrial Airpark 2009 AICUZ Noise Zones

Noise Zone (DNL)	Acres				
	Compatible	Compatible with Restrictions	Incompatible with Exceptions	Incompatible	Total
65 to 70	189.97	388.39	0.00	0.00	**578.36**
70 to 75	159.76	86.43	0.00	0.00	**246.19**
75 +	89.11	0.00	0.00	0.00	**89.11**
Total	**438.84**	**474.82**	**0.00**	**0.00**	**913.66**

Key:
AICUZ = Air Installations Compatible Use Zones.
DNL = day-night average sound level.

An analysis of existing land use within the Goliad County Industrial Airpark 2009 AICUZ APZs identifies approximately 126 acres of agricultural and cattle ranching lands within the runway Clear Zones.

Agricultural is considered a compatible land use with restrictions, such as the absence of any structures within the airfield Clear Zones. Livestock farming and breeding is not a recommended compatible land use within the Clear Zones. While not indicated within the land use data, aerial photographs show approximately three houses/structures located within APZ I and one house/structure is located within APZ II. The total acreages of compatible and incompatible land uses within each APZ are presented in Table 5-5 and the specific areas of compatible and incompatible land uses within each APZ are depicted on Figure 5-4.

Table 5-5: Land Use Compatibilty within Goliad County Industrial Airpark 2009 AICUZ Accident Potential Zones (APZs)

Accident Potential Area	Acres				
	Compatible	Compatible with Restrictions	Incompatible with Exceptions	Incompatible	Total
Clear Zone	363.38	125.88	0.00	0.00	**489.26**
APZ I	23.93	1,649.21	0.00	0.00	**1,673.14**
APZ II	0.00	1,094.30	0.00	0.00	**1,094.30**
Total	**387.31**	**2,869.39**	**0.00**	**0.00**	**3,256.70**

Key:
AICUZ = Air Installations Compatible Use Zones.

A summary of the overall compatibility of property land use in both the 2009 AICUZ noise zones and APZs of Goliad County Industrial Airpark is presented in Table 5-6. Figure 5-5 is the 2009 Composite AICUZ Map showing noise zones and APZs at Goliad County Industrial Airpark overlaying existing land use surrounding the airfield.

Table 5-6: Summary of Land Use Compatibility within Goliad County Industrial Airpark 2009 AICUZ Footprint

Compatibility	Noise Zones		Accident Potential Zones (APZs)	
	Acres	%	Acres	%
Compatible	438.84	48.03	387.31	11.89
Compatible with Restrictions	474.82	51.97	2,869.39	88.11
Incompatible with Exceptions	0.00	0.00	0.00	0.00
Not Compatible	0.00	0.00	0.00	0.00
Total	**913.66**	**100.00**	**3,256.70**	**100.00**

Key:
AICUZ = Air Installations Compatible Use Zones.

5.2.3 Land Use Compatibility Concerns at Goliad County Industrial Airpark

Land use compatibility within the 2009 AICUZ footprint of Goliad County Industrial Airpark is not an immediate concern. The airpark is located in a rural area with minimal development or land use that would impact Navy operations. Likewise, Navy aircraft operations are unlikely to impact land use in the surrounding area. A select few residents have expressed concern regarding the expected increase in flight operations and aircraft noise due to the implementation of the JPATS. The County is conducting public hearings and officials are working with residents to address all concerns.

Goliad County does not have a strategic land use plan to guide future development. The Navy should initiate consistent communication with local government officials regarding changes in aircraft operations. The Navy should also actively participate in County Commission meetings and public hearings that address future development or planning directives.

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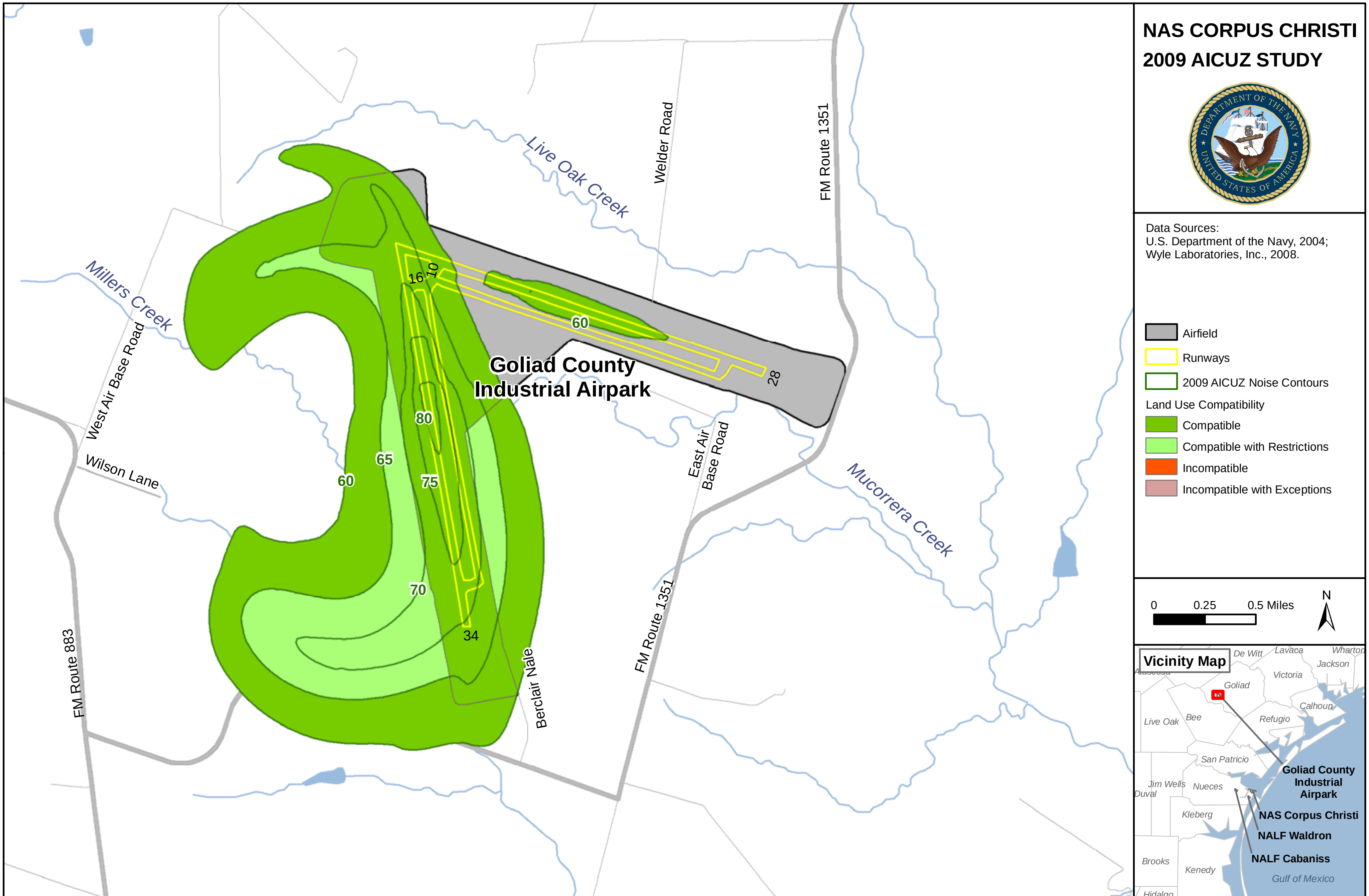

Figure 5-3: Land Use Compatibility and 2009 AICUZ Noise Contours
Goliad County Industrial Airpark

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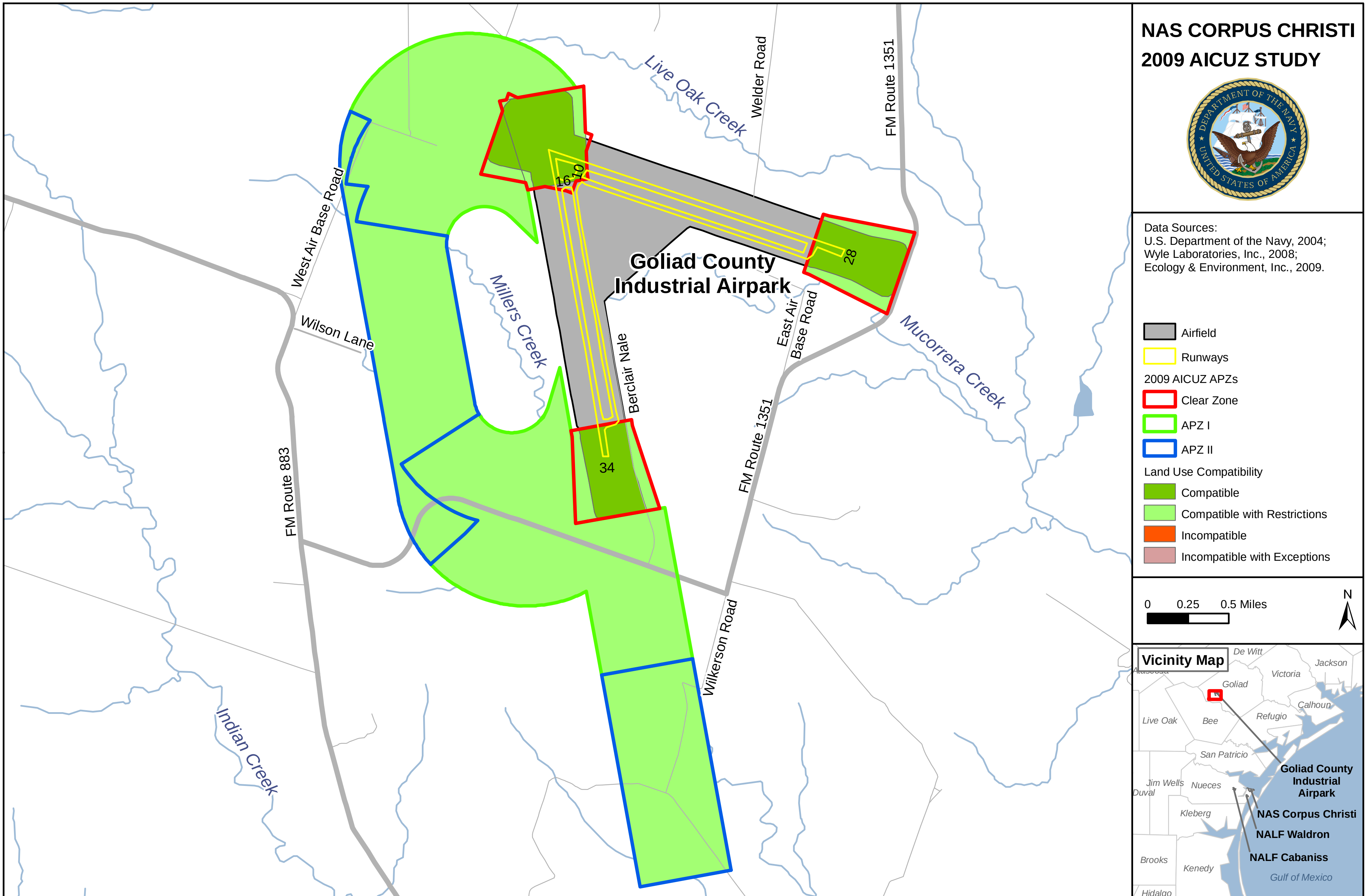

Figure 5-4: Land Use Compatibility and 2009 AICUZ APZs
Goliad County Industrial Airpark

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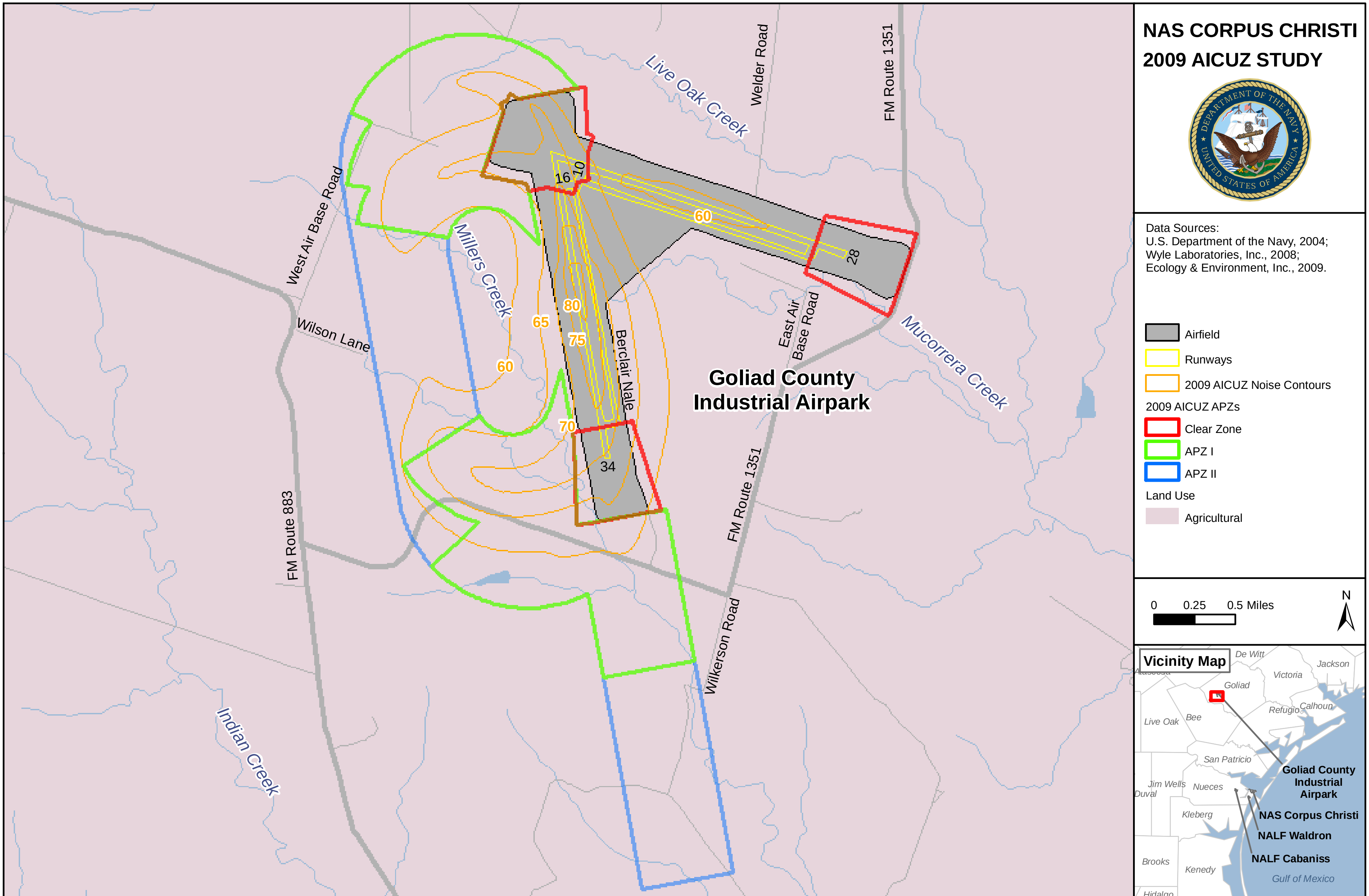

Figure 5-5: Composite Coverage of Surrounding Land Uses, 2009 AICUZ Noise Zones, and 2009 AICUZ APZs at Goliad County Industrial Airpark

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6 Land Use Tools and Recommendations

The **goal** of the AICUZ Program is *to protect the health, safety, and welfare of those living near military airfields while preserving the defense flying mission.*

The goal of the AICUZ Program – to protect the health, safety, and welfare of those living near military airfields while preserving the defense flying mission – can most effectively be accomplished by active participation of all interested parties, including Navy, local governments, private citizens, developers, real estate professionals, and others.

Land use planning tools and recommendations for implementing and achieving a successful AICUZ Program are provided in Chapter 7 of the NASCC AICUZ Study.

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